

**report** of the



सत्यमेव जयते

# RATES & COSTS COMMITTEE

PART I

NEW DELHI  
JANUARY, 1965

MINISTRY OF IRRIGATION AND POWER · CENTRAL WATER AND POWER COMMISSION

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**REPORT OF  
THE RATES AND COSTS COMMITTEE**

**GOVERNMENT OF INDIA**  
**MINISTRY OF IRRIGATION & POWER**

**REPORT OF**  
**THE RATES & COSTS COMMITTEE**

**Part I**

**January--1956**

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**GOVERNMENT OF INDIA**  
**MINISTRY OF IRRIGATION & POWER**  
**(RATES AND COSTS COMMITTEE)**

No. RCC/37/56

Curzon Road Barracks,  
*New Delhi, the 15th January, 1956.*

To

The Secretary to the Govt. of India,  
Ministry of Irrigation & Power,  
NEW DELHI.

Sir,

With reference to your letter No. DW-III-7(I), dated the 16th February, 1954, we submit herewith Part I of our Report.

Yours faithfully,

Sd/- (P. C. Agrawal)  
Chairman.

Sd/- (M. R. Varadarajan)  
Member.

Sd/- (S. Ramier)  
Member.

Sd/- (B. D. Nanda)  
Member Secretary.

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## INTRODUCTORY

### 1.1. THE ORIGIN

1.1.1. "The Government of India have been viewing with some concern the large increase in the estimated expenditure of some of the Major River Valley Projects under execution in the country. Special provision has been made for these projects in the Five-Year Plan and periodic increases in the estimated costs, apart from making it difficult to find ways and means of providing additional funds for the completion of such projects, are calculated seriously to affect the implementation of the plan. Under-estimating, due to the absence of adequate information on the rates to be adopted for different items of work seems to be one of the main causes of these mounting estimates. At present there are wide variations between the schedule of rates prevalent in different projects. Government of India, therefore, consider it necessary to evolve a comprehensive standard schedule of rates including detailed analysis of such rates, at least for the major items, which can be used as a basic schedule for all projects. These standard rates can be utilised for examination of future projects after making due allowance for local conditions. The Government of India have accordingly set up a committee of experts to examine the existing rates in the more important projects *viz.* Bhakra-Nangal, D.V.C., Hirakud, Tungabhadra, Lower Bhavani, Malam-puzha, Kakrapar, Bhadra, Mayurakshi and Chambal under execution in the country and submit a report to the Government."

[*Extracted from Ministry of Irrigation & Power's No. D. W. III-7 (I), dated 16-12-1954.*]

### 1.2. THE APPOINTMENT OF THE RATES & COSTS COMMITTEE AND ITS TERMS OF REFERENCE

1.2.1. Sarvashri P. C. Agrawal, ISE (Retd.), Ex-Chief Engineer, U.P. (Chairman), Raunaq Lal, Deputy Chief Accounts Officer, Bhakra-Nangal Project (Member) and G. G. Dhanak, now Superintending Engineer, Tapi Circle, P.W.D., Bombay (Member-Secretary) were appointed to the Committee on its formation, *vide* Ministry of Irrigation & Power letter No. DW-III-7(I) dated 16th Feb., 1954. The Committee was required to make recommendation on the following terms:—

- (i) A comprehensive standard schedule of rates for manual as well as machinery work, which can be used as a basic schedule

for all projects with such modifications as may be necessary for zonal consideration;

- (ii) Standard analysis of rates for the main items of River Valley Projects estimates which would enable rates being worked out for any project with the help of the basic schedule, after allowing for differences in cost of carriage and other local factors involved;
- (iii) The causes which have led to the difference in rates at present prevalent on the various major projects (dams and canal works); and
- (iv) To examine the present P.W.D. forms with a view to suggesting modifications which would serve the purpose of better cost accounting on all River Valley Projects.

1.2.2. These Terms of Reference were further amplified by the Government of India, with the concurrence of Comptroller and Auditor General in their letter No. DW-III-22 (108) dated 4th June, 1954 stating that the Committee will also visit a typical Railway Workshop (Central Railway Workshop, Parel), and after studying the system of maintenance and accounting of stores in force on the Projects, the Railway, and the Electricity Department of the Government of Madras and the procedure on stock control as laid down in B.S.S. 1100—Part 5 by British Standard Institution, and make recommendations on:—

- (i) Stock account rules to be adopted for both quantity and value of accounts of stores for River Valley Projects;
- (ii) Suitable forms for the maintenance of quantity and value accounts of stores;
- (iii) Procedure for the maintenance of accounts of special tools and plants and machinery and the forms pertaining thereto; and
- (iv) Rules for placing orders for stores, taking delivery from railway (or other carriages), carriage to godowns, safe custody (including construction of godowns, bins and yards), employment of guards, physical verification, issues, etc., with form such as challans, gate passes etc., for upkeep and custody of stores (including all tools and plants) to guard against thefts, shortages etc., and ensure fixing of responsibility thereof.

1.2.3. In so far as the Terms of Reference of the Committee relating to matters falling within Article 160 of the Constitution are concerned the Committee was deemed to function for and under the Comptroller and Auditor General of India, *vide* Government of India, Ministry of Irrigation & Power letter No. DW-III-22 (108) dated 4th June, 1954. Briefly these terms were :—

- (i) To make suggestions for the introduction of such subsidiary rules or accounts as would ensure a more effective control over the cost of certain items of works; and

- (ii) To suggest improvements, *inter alia*, in the system of store accounting as far as possible.

1.2.4. Government further directed that the Committee's recommendations in regard to these matters should be made in self-contained sections of the Report for transmission by the Government of India to the Comptroller and Auditor General of India for such action as he may consider necessary.

### 1.3. CHANGES IN THE PERSONNEL

1.3.1. Shri N. S. Sandhu, Executive Engineer, Stores Division, Bhakra Dam Project, was then appointed as an additional Member of the Committee in view of the extended scope of work outlined in para 1.2.2. The Committee was further strengthened by the inclusion of two more Members namely, Shri B. D. Nanda, Consulting Engineer and Ex. Member-Secretary, D.V.C. Enquiry Committee and Shri M. R. Varadarajan, General Manager, Hindustan Construction Co. Ltd., Bombay. They joined the Committee on 18-6-1954 and 18-7-1954 respectively.

1.3.2. Shri G. G. Dhanak was called back by the Bombay Government on the 1st November, 1954 and was relieved by Shri B. D. Nanda.

1.3.3. Shri N. S. Sandhu returned to the Bhakra-Nangal Project on the 31st December, 1954, while Shri Raunaq Lal proceeded on two months' leave for reasons of health from 10th January, 1955. He was replaced by Shri S. Ramier, Finance Officer, Ministry of Finance, Government of India.

### 1.4. CLARIFICATION OF THE TERMS OF REFERENCE

1.4.1. The Ministry of Irrigation & Power, in their letter No. DW-III-7 (I) dated 5th March, 1954, indicated the main items of work which were to be examined by the Committee for the preparation of standard analysis of rates. These are given below:—

- (a) Earthwork of all descriptions pertaining to:
1. Dams and Dykes,
  2. Excavation in foundation of dams and weirs and canal excavation, and
  3. Figures for Swell and shrinkage factors in earthwork;
- (b) Drilling and grouting;
- (c) Concrete in dams;
- (d) Shuttering for concrete in dams;

- (e) Reinforced concrete in ordinary and special structures:
1. Concrete,
  2. Reinforcement,
  3. Shuttering;
- (f) Brick Masonry;
- (g) Stone Masonry;
- (h) Steel Gates :
1. Crest Gates,
  2. Sluice Gates;
- (i) Plinth area rates for buildings :
1. Temporary,
  2. Permanent.

1.4.2. The Committee had an opportunity to meet Shri Gulzari Lal Nanda, Minister for Irrigation and Power on 25th May, 1954, when the Terms of Reference were discussed at length and further clarified.

1.4.3. The Committee obtained a confirmation from the Ministry that its Terms of Reference did not include an examination of items concerning Power Generation and Transmission.

### 1.5. COLLECTION OF DATA

1.5.1. The Committee visited the following places to collect data and acquire first-hand knowledge of the local conditions:—

#### A. River Valley Projects

- |                                 |                      |
|---------------------------------|----------------------|
| (1) The Bhakra-Nangal           | (East Punjab)        |
| (2) The Sarda Hydro-Electric    | (Uttar Pradesh)      |
| (3) The Sarda Sagar             | (Uttar Pradesh)      |
| (4) The Mayurakshi              | (West Bengal)        |
| (5) The D.V.C. Projects:        |                      |
| (i) The Tilaiya                 | (Bihar)              |
| (ii) The Maithon                | (Bihar)              |
| (iii) The Panchet Hill          | (West Bengal)        |
| (iv) The Konar                  | (Bihar)              |
| (v) The Durgapur                | (West Bengal)        |
| (vi) The Bokaro                 | (Bihar)              |
| (6) The Hirakud                 | (Orissa)             |
| (7) The Tungabhadra (Andhra)    | (Andhra)             |
| (8) The Tungabhadra (Hyderabad) | (Hyderabad)          |
| (9) The Lakhavali               | (Mysore)             |
| (10) Vaitarna                   | (Bombay Corporation) |
| (11) The Gandhi Sagar           | (Madhya Bharat)      |

- |                        |                 |
|------------------------|-----------------|
| (12) The Kotah Barrage | (Rajasthan)     |
| (13) The Mata Tila Dam | (Uttar Pradesh) |

**B. Workshops**

- |                                    |                 |
|------------------------------------|-----------------|
| (1) The Central Tractor Workshop   | (Delhi)         |
| (2) The Izzatnagar Workshop        | (Uttar Pradesh) |
| (3) The Government Workshop        | (Madras)        |
| (4) The Central Railway Workshop   | (Bombay)        |
| (5) The Central Workshop, Amritsar | (Punjab)        |

**C. Commercial Undertakings**

- |                                      |            |
|--------------------------------------|------------|
| (1) M/s Associated Imports & Exports | (Calcutta) |
| (2) M/s William Jack Ltd.            | (Calcutta) |
| (3) M/s Blackwood Hodge Ltd.         | (Calcutta) |
| (4) M/s Tractors (India) Ltd.        | (Calcutta) |
| (5) M/s Larson Toubro Ltd.           | (Bombay)   |
| (6) M/s Voltas Ltd.                  | (Delhi)    |
| (7) M/s Power Sams Ltd.              | (Bombay)   |
| (8) M/s Hollorith (India) Ltd.       | (Delhi)    |

1.5.2. The Committee also took into consideration the recommendations of the following Committees:—

1. Labour Conditions in Building & Construction Industries in India—Ministry of Labour.
2. Report of the Committee of Experts for Building Works—Ministry of Works, Production & Supply.
3. Report of the Environmental Hygiene Committee, October, 1949.
4. Report on the Central Public Works Department and the Central Water & Power Commission—Ministry of Works, Housing & Supply.
5. Report of the Construction Plant and Machinery Committee—Ministry of Irrigation & Power.
6. Report of the Damodar Valley Enquiry Committee—Ministry of Irrigation & Power.
7. Report on the Planning and Management of Building Contracts by Central Council of Works and Buildings, London.
8. Report of the Stores Purchase Committee.

1.5.3. Discussions were also held with several engineers, accounts officers and other well-informed persons in the Engineering Industry.

1.5.4. Questionnaires on matters relating to accounts and stores were issued to a large number of projects and State organisations and

the opinions received have been considered by us while making our recommendations.

1.5.5. Later, when the Committee during the course of its labours felt that the requisite engineering data was not forthcoming from the projects, it approached Ministry for assistance.

1.5.6. The Ministry of Irrigation & Power *vide* their No. DW-III-221(108)/5 dated 15th October, 1954, issued to the State Governments and the Project authorities a questionnaire on Rates & Costs along with a number of proformas, drafted by the Committee. The response from the projects, however, was not seen very encouraging. Replies from many of them were not forthcoming for considerable time and we felt that it would not be correct to draw conclusions from incomplete data as it might be the missing one which may be quite important in explaining the variations in prices.

The Committee, thereupon sought permission of the Government to submit an interim Report by the 30th June, 1955, without incorporating information in respect of Term (3). This was granted.

1.5.7. The report was circulated at the Engineer's Seminar at Srinagar (Kashmir). The Engineers and Officers present promised the Minister of Irrigation & Power to send in their comments thereon after a thorough study at home by 15th September, 1955.

1.5.8. Very few officers were however able to adhere to their resolve. Due consideration has been given to the comments received and the recommendations amended by us where necessary.

## 1.6. OUR APPROACH

1.6.1. The projects were furnished with proformas so as to seek information in respect of the direct and indirect expenditure and the break-up of the unit rates into their elements. Only in very few cases we have been able to get the complete information. It is true that the projects had their own difficulties in furnishing the data due largely to their accounts being not in shape to enable them to draw out the required information.

1.6.2. Realising that a single-ready-to-use schedule for the entire country was impracticable and the best that could be offered was the structure of each principal item, we decided to separate the highly variable elements like wages and prices from the constants like output of men and machines, proportions of materials etc., for purposes of the study.

1.6.3. We have on the basis of assumed wages, prices of materials, and equipment, etc., mentioned in Chapter 15, worked out analysis of rates for some of the principal items. Adjustments in these item rates



due to variations of time and place should be made in their analysis to derive new rates.

1.6.4. In determining the causes of variation in the prevailing rates over the projects, as required under Term 3, we were faced with innumerable difficulties as the Unit Rates on the projects differed widely in their composition and two projects offered the same conditions of work. Not only did they differ in details but their methods of control and execution, local materials, leads and lifts, etc., were very different. The only way out of this difficulty was to examine the various constituents of each item over the projects and bring out the variations as far as feasible.

## 1.7. THE LAYOUT OF THE REPORT

1.7.1. The Report has been divided into two parts to meet the special requirements of our Terms of Reference. Part I is meant for the Ministry of Irrigation & Power and Part II for the Comptroller and Auditor General of India. Chapters on Cost Control and Stores, which are of interest to both have been included in both the parts.

1.7.2. Part I comprises 16 Chapters as shown below:—

- |             |   |
|-------------|---|
| Chapter 1.  | Is the Introduction.  |
| Chapter 2.  | Deals with general matters relating to the study of rates and other elements of cost. |
| Chapter 3.  | Deals with the Economics of the Construction Equipment.                               |
| Chapter 4.  | Deals with Stores Management and Control.   |
| Chapter 5.  | Deals with the Control of Cost on Projects.   |
| Chapter 6.  | Deals with the outputs and rates of earth-moving machines.                            |
| Chapter 7.  | Deals with the analyses of Rates of Earthwork by Manual Labour.                       |
| Chapter 8.  | Deals with the Economics of Transport.  |
| Chapter 9.  | Deals with Quarrying and Drilling.  |
| Chapter 10. | Deals with Tunnelling.  |
| Chapter 11. | Deals with Brickwork and the Lining of Canals.  |
| Chapter 12. | Deals with Steel Gates.   |

- Chapter 13. Deals with Stone Masonry.
- Chapter 14. Deals with Cement Concrete and Formwork.
- Chapter 15. Contains the Analyses and Schedules of Rates.
- Chapter 16. Contains Observations.
- Appendices.

### 1.8. ADDITIONAL ASSIGNMENTS

1.8.1. At the instance of the Ministry of Irrigation & Power the Committee submitted a 'Paper relating to problems connected with its Terms of Reference' to the Engineers' Seminar at Roorkee, 1954. This paper was circulated to the participants but could not be discussed for lack of time. The Committee was, thereupon, asked to present an Interim Report in its place for discussion at the following Seminar which was done.

1.8.2. The Committee also functioned as Sub-Committee No. 2 of the Engineers' Seminar to examine the report of the Nangal Sub-Committee on Unit Rates for Concrete and Masonry Dams.

1.8.3. The Co-ordination Committee of Engineers was also requested to examine Shri Gupchup's paper on 'Gravity Dams' and make recommendations on the 'Relative Places of Concrete and Masonry' which was duly submitted.

1.8.4. Three meetings were held on the 2nd and 3rd September, 1954, and a number of eminent engineers participated therein. A report on the subject was submitted to the Co-ordination Committee for discussion at the Srinagar Seminar, 1955.

1.8.5. The Committee also participated in the Symposium on Concrete vs. Masonry for construction conducted in Delhi under the auspices of Central Board of Irrigation & Power on 10th November, 1955, and put up recommendations which were unanimously adopted.

The Ministry of Irrigation & Power also gave us a number of other small but important assignments, which are not included in this Report.

## CONSTRUCTION COST

### 2.1. PRELIMINARY INVESTIGATIONS

2.1.1. The expenditure on surveys and investigation of a project is booked under the Head 18 (A) in the first instance. After a project is sanctioned, this expenditure is debited to the item A-Preliminary of the same.

2.1.2. After a project is sanctioned, greater attention is paid to its execution and very often investigations and surveys do not receive the attention they deserve resulting in subsequent changes in design and methods of construction which prove expensive. It would lead to economy and efficiency if projects are taken in hand only after they have been thoroughly investigated.

### 2.2. PLANNING PROJECTS

2.2.1. Changes in design for want of proper advance planning have led to considerable excesses in expenditure on a number of projects. The delay and disorganisation caused thereby, not only add to the immediate cost of the work but they also undermine the general morale of the staff and have a far-reaching effect. It is, therefore, important to undertake planning in advance of construction. As detailed planning takes considerable time, due provision should be made in State and Central budgets for this work and steps should also be taken to encourage Indian experts on planning and design so that we may have to depend less and less in this respect on foreign assistance.

### 2.3. PROJECT ESTIMATES

2.3.1. On most projects there have been several revisions of estimates for one reason or the other. Only the latest estimates have been adopted by us for our study.

### 2.4. DIVISIONAL SCHEDULE OF RATES

2.4.1. The schedules of Rates are prepared in almost all Irrigation Divisions and are supported by the "ANALYSES OF RATES". These rates are used for purposes of estimating, negotiating job work, pricing extra items of contract and for cost control. They are based on current

wages and prices of materials and are revised periodically. Works are usually allotted to piece workers on the basis of these rates. They include direct charges and indirect expenses but are exclusive of departmental overheads.

2.4.2. Enquiries from Public Works Departments of the Centre and the States reveal that their schedules allow for on-costs and contractor's profit from 10 to 15% of the prime cost in the item rates which are applied to small works executed departmentally or by piece workers. For large works, it is usual to invite item rate tenders from contractors who include, in their offer, the cost of the ancillary services and on-costs including profits. Items rates, however, do not include *pro rata* share of departmental overheads expenses.

## 2.5. PRIMARY RATES

2.5.1. The divisional schedules of rates cannot be utilised as such for purposes of Cost Control in cases where works are executed departmentally. As the picture is not always clear at the time of framing an estimate whether a work is to be done by contract or the departmental agency, it would be advisable to frame the estimate in such a manner that the item rates do not include share of the indirect services and overheads as dealt with later.

## 2.6. DIVISION OF CONSTRUCTION COST

2.6.1. When the construction of a project is let out to one or more contractors the contract prices with the addition of departmental overheads would determine the cost of the project within close limits. When the project is being executed by force account, organized by the department itself the outlay on a project would fall in the following categories :

- (i) Direct labour and work charge establishment.
- (ii) Materials.
- (iii) Plant use.
- (iv) The Burden.

## 2.7. THE LABOUR COMPONENT

2.7.1. The labour component or the cost of the labour employed on the work relates only to that form of labour which does the physical work. Such work may be done by unskilled labourers, carpenters, masons, truck drivers, crane and shovel operators and others.

2.7.2. The variation in wages over the projects (Appendix 1) shows at a glance the extent of discrepancy in the wage schedules particularly between the south and the other parts of the country—the wages being on the low side in the former case. This also holds good in the case of the superior engineering personnel.

2.7.3. Labour can be paid either on the basis of output or time. The output or piece-rate method reduces the cost of supervision and simplifies both costing and control of expenditure and is therefore, recommended in preference to time-rate method. Group piece-rate, *i.e.* payment of rate to a group of workers on the basis of their combined output is particularly recommended.

2.7.4. To get the best out of labour, it is necessary that the minimum wage be tied to a minimum output and those who produce more should get more in the same proportion. As a further incentive names of efficient workers should find a place in departmental bulletins and even given token awards in recognition of their services.

## 2.8. WORKCHARGED ESTABLISHMENT

2.8.1. *Workcharged Establishment* :—Charges under this head comprise salaries of mistries, supervisors, foremen etc., who do not work with their own hands but exercise an immediate control over the quality and output of worker.

2.8.2. Provision under this head varies from 1 to 2%. That for some of the projects is given below :—

Bhakra	..	..	..	..	..	..	1 %
Kotah	..	..	..	..	..	..	2½%
Gandhi Sagar	..	..	..	..	..	..	1½%
Hirakud	..	..	..	..	..	..	2 %
Kakrapar	..	..	..	..	..	..	2 %

## 2.9. THE MATERIALS COST

2.9.1. Some of the important materials required for River Valley Projects are discussed below :—

2.9.2. *Cement* :—The issue rates of cement over the various projects are tabulated in the Table No. 2.9.2. given below:—

TABLE 2.9.2.

*Rates of Cement over the River Valley Projects*

Sl. No.	Name of project	Cement per ton		
		F.O.R.	In Store	Ex. Store
1	2	3	4	5
1	Bhakra	69/-	—	76/-
2	Nangal	82/15	85/3	86/7
3	Sarda Sagar	—	—	100/-
4	Matatila	—	—	100/-
5	Chambal (Raj) Kotah	—	—	105/-
6	Chambal (M.B.) Gandhi Sagar	73/3	94/8/6	99/-/4
7	Konar	—	80/-	84/6
8	Mayurakshi	83/12	—	95/-
9	Hirakud	65/4	80/12	85/-
10	Gangapur	94/10	105/-	108/5
11	Kakrapar	—	—	100/-
12	Vaitarna	87/8	—	100/-
13	Tungabhadra (Andhra)	99/8	103/12	105/-
14	Lower Bhawani	70/10	84/14	89/8
15	Malampuzha	61/4	71/11	72/13
16	Bhakra	90/-	—	100/-
17	Peechi	—	—	130/-
18	Perinchani	82/8	—	130/14

## 2.10. STEEL AND WOODWORK

2.10.1. The rates for steel (Table 2.10.3) are Rs. 360/- at Lower Bhawani to Rs. 560/- at Bhakra. This variation is due to purchases of steel having been made at different periods. Any project buying steel now will have to pay another Rs. 100/- or so over the highest price paid a year ago.

2.10.2. Price of timber varies over a long range (Table 2.10.3.) on the various projects depending on their nearness to the source of supply.

2.10.3. The issue rates of steel and timber over the various projects are given in Table 2.10.3.

TABLE 2.10.3.

*Issue Rates of Steel and Timber over the River Valley Projects*

Sl. No.	Name of Projects (Zone-wise)	Steel per ton	Timber (Teak) per FC	Remarks
1	2	3	4	5
1	Nangal	560/-	—	Rate at site.
2	Chambal (Rajasthan)	—	12/8	
3	Kotah			
4	Maithon			
5	Panchet Hill			
6	Tilaiya	500/-	15/8	Issue rates taken from the schedule of rates which is applicable to all the DVC Projects.
7	Durgapur			
8	Konar			
9	Hirakud	460/-	10/-	As per Schedule of rates.
10	Gangapur	—	10/-	—do—
11	Kakrapar	510/- to 483/-	7/- to 9/-	—do—
12	Vaitarna	332/- to 416/-	—	
13	Tungabhadra (Andhra)	420/-	20/-	—do—
14	Lower Bhawani	360/-	13/- to 17/-	—do—
15	Malampuzha	360/-	12/- to 24/-	—do—
	Peechi	520/-	19/3	—do—

## 2.11. P.O.L. GROUP, RUBBER GOODS, ETC.

2.11.1. The rates of these goods are Manufacturers' Association prices and the variations are small depending mainly on the distance of the project sites from rail-heads and ports of supply.

## 2.12. LOCALLY PRODUCED MATERIALS

2.12.1. The principal local construction materials in use on projects are building stone, coarse and fine aggregates and their prices vary depending on the method of their manufacture, their proximity to the project where they are to be used, the means of transport etc. The comparison of their prices is discussed elsewhere.

## 2.13. BASIC SCHEDULE RATES

2.13.1. Project Schedule of Rates which should be supported by the analyses of rates should also include the following basic data :—

1. Schedule of wages;
2. Schedule of prices of materials and equipment ; and
3. Schedule of transport rates.



2.13.2. It is necessary that a basic schedule of wages prevalent at the time of the submission of a project should invariably accompany the estimate to enable the project authorities to evaluate accurately the variations under this head at a future date.

2.13.3. Project estimates should always be supported by a schedule of basic prices of materials on which item rates have been framed as then alone can it be possible to examine the effects of variations in such prices on the total cost.

#### 2.14. COMPARISON OF ALL-IN RATES

2.14.1. For a comparative study the true rate of any item of work is the all-in rate which takes into account all the visible elements and also the invisible burden on that item. Such figures are not kept on any project.

2.14.2. Table 2.14.2. shows indirect expenses and overheads as percentages of the direct cost of the project exclusive of the cost of land and rehabilitation works. A break-up of the burdens between indirect and overheads is given below. Their averages come to 16% and 14% respectively.

TABLE 2.14.2.

*Burden as Percentage of Primary Cost for—*

*A—Dams*

Sl. No.	Name of Project	Primary cost of works in Lakhs exclusive of the cost of land and rehabilitation	Burden		Total % age
			Indirect % age	Over-head %age	
1	2	3	4	5	6
1	Gangapur	137	12	32	44
2	Matatilla	483	7	8	15
3	Gandhi Sagar	564	11	11	22
4	Mayurakshi	220	9	11	20
5	T.B.P. (Andhra)	478	20	15	35
6	T.B.P. (Hyd.)	501	24	11	35
7	Bhadra	534	18	17	35
8	Perinchani	36	22	22	44
9	Bhakra	4140	19	27	46
10	Maithon	732	24	18	42
11	Panchet Hill	757	25	15	40
12	Tilaiya	170	18	12	36
13	Konar*	850	5	9	14
14	Vaitarna	548	7	2	9
15	Lower Bhawani	398	13	6	19
16	Malampuzha	169	13	8	21
17	Hirakud	2771	19	11	30
Average			16	14	30

\*Contractors' burden is not included.

TABLE 2.14.2.—Contd.

*B—Weirs and Barrages*

1	2	3	4	5	6
1	Mayurakshi barrages	218	15	9	24
2	Kotah	261	8	9	17
3	Kakrapar	56	24	21	45
4	Nangal	331	8	9	17
5	Durgapur	344	30	15	45
		Average	17	13	30

*C—Canals*

1	Sarda Hydel	460	8	11	19
2	Chambal RT. & LT.	1632	5	10	15
3	Mayurakshi canals	578	8	11	19
4	Kakrapar	823	6	7	13
5	Tungabhadra (And.)	922	9	9	18
6	Tungabhadra (Hyd.)	1355	12	8	20
7	Bhadra	566	4	5	9
8	Bhakra	2926	3	10	13
9	Nangal	1018	7	12	19
10	Durgapur	829	10	12	22
11	Lower Bhawani	339	5	6	11
12	Malampuzha	151	5	8	13
13	Hirakud	654	9	11	20
		Average	7	8	15

## 2.15. ITEMS OF BURDEN

2.15.1. Apart from the direct cost, there are other elements excluding cost of the acquisition of land, which contribute to the total cost of a project. This burden may be classified as under :—

**A. Indirect Expenses (Ancillary and Incidental)**

1. Buildings, including internal services.
2. Service roads and other communications.
3. Water supply & sanitary installation.
4. Electric & power supply installation & telegraph, telephone lines and radio stations.

5. Workmen's compensation.
6. Work-site amenities.
7. Small tools and plant.
8. Laboratory testing.
9. Losses on stock and advances.
10. Maintenance of essential services.
11. Miscellaneous.

#### B. Overheads (Establishment and Audit)

(a) *Establishment charges, including those for the head-office and the field.*

1. Salaries (technical and non-technical) including leave and pensionary charges.
2. Stationery, printing, postage and telephone charges.
3. Staff cars and travelling allowances.
4. Entertainment and publicity.
5. Legal expenses (General).
6. Contingencies.

(b) *Consultants' fees.*

(c) *Audit charges.*

2.15.2. Land compensation including cost of settlement, if any, and abatement of land revenue which form a special subject, have been excluded from our studies. The above items of expense are now dealt with seriatim.

#### 2.16. PROVISION FOR BUILDINGS

2.16.1. The financial provision under the head 'Buildings' on the projects generally relates to accommodation for labour, staff, community services, workshops and administrative offices. Housing of labour at site, besides being the responsibility of the project authorities, leads to greater efficiency on the job, minimises absenteeism and introduces among the workers a higher sense of duty. We feel, therefore, that adequate accommodation and public utility services should be provided for all persons engaged on a project.

2.16.2. We observed on some projects that while the higher staff has been provided with accommodation and services on a lavish scale, even the bare necessities of life in this direction have been ignored in the case of labourers. We are, therefore, of the opinion that specific standards of accommodation be laid down for all classes of staff and workers, dependent on the country's economy.

2.16.3. The financial provision under the head 'K-Buildings' on the projects relates to offices, workshops, stores and accommodation for

labour and supervisory staff. The following Table gives analysis of the provision for different categories of personnel on the Hirakud Dam.

TABLE 2.16.3.

*Analysis of Capital Outlay on Buildings (Hirakud Project)*

Type of building	Capital outlay			Percentage		
	Permanent Buildings (Lakhs)	Temporary Buildings (Lakhs)	Total (Lakhs)	Individual group	Total cost	
Residential	Officers	24.6	0.2	24.8	15.7	10.6
	Staff	74.2	9.2	83.4	52.7	35.7
	Workmen	15.1	2.0	17.1	10.8	7.2
	Services	—	32.9	32.2	20.8	14.2
Total		113.9	44.3	158.2	100.0	67.7
Non-residential	Officers	7.6	1.2	8.8	11.7	3.8
	Stores	9.4	5.4	14.8	19.7	6.3
	W. Shops	0.6	0.4	0.9	1.3	0.4
	Community Works	23.9	0.6	24.5	32.7	10.6
	Services	—	26.1	26.1	34.7	11.2
Total		41.5	33.6	75.2	100.0	32.3
Grand Total				233.4		100.0

**2.17. THE FINANCIAL PROVISION**

2.17.1. Construction camp buildings are generally of two types, namely (a) temporary and (b) permanent. The former are required for the duration of the project only and their cost is an indirect expense on the project. The latter are constructed for use of the maintenance staff after the completion of the project.

2.17.2. The percentage provision of buildings in a project would depend on—

- (i) type of work ;
- (ii) duration of the project ;
- (iii) local availability of housing ;
- (iv) climatic conditions ;
- (v) specifications adopted for building construction ; and
- (vi) construction methods (manual or mechanised).

2.17.3. Buildings should be planned in a way that they could be dismantled and the materials re-used elsewhere. When it is not possible to do so they should be planned for duration of project only with no salvage value.

2.17.4. The following table 2.17.4. gives the percentages of the provision of buildings on the projects on direct cost of works excluding cost of land.

TABLE 2.17.4

*Dams*

Sl. No.	Name of project	Primary cost of Works (Lakhs)	Perma- nent Building (Lakhs)	Tempo- rary Building (Lakhs)	Total (Lakhs)	Per cent
1	2	3	4	5	6	7
1	Gangapur	187	—	—	12	6.5
2	Matatila	4883	5	8	12	2.4
3	Mayurakshi	220	5	6	11	5.2
4	Tungabhadra (And.)	478	3	41	44	9.2
5	Tungabhadra (Hyd.)	501	1	51	52	9.6
6	Perinchani	36	—	—	7	18.5
7	Bhakra-Nangal	4471	241	67	308	6.9
8	Maithon	732	—	—	83	11.4
9	Panchet Hill	757	—	—	86	11.3
10	Tilaiya	170	—	—	14	8.2
11	Lower Bhawani	398	—	—	25	6.3
12	Malampuzha	169	—	—	16	9.7
13	Hirakud	2771	—	—	198	7.1

*Weir and Barrages*

1	Mayurakshi	218	—	—	17.44	8.0
2	Kakrapar	56	4	4	8	14.1
3	Durgapur	344	9	412	50	14.6

*Canals*

1	Sarda Hydrel	450	10	6	16	3.5
2	Chambal Valley Projects	1632	22	25	47	2.9
3	Kakrapar	823	—	—	—	—
4	Mayurakshi	578	—	—	25	4.4
5	Tungabhadra (And.)	922	17	11	28	3.0
6	Tungabhadra (Hyd.)	1355	—	—	46	3.9
7	Bhakra-Nangal	3944	112	42	154	4.0
8	Bhadra	556	5	9	14	2.4
9	Durgapur	829	36	15	51	6.2
10	Lower Bhawani	399	—	—	6	1.8
11	Malampuzha	151	—	—	3	2.2
12	Hirakud	654	—	—	37	5.6

## 2.18. BUILDING COSTS

2.18.1. The plinth area rates for some of the residential buildings constructed on the projects have been tabulated in Appendix 2.

## 2.19. ROADS

2.19.1. Temporary roads have to be constructed in order to get access to various sites of work and constitute an important part of planning. Table 2.19.1. shows provision for roads, railways and trolley lines as a percentage of the total direct cost of the project.

TABLE 2.19.1.

*Expenses on Service, Roads, Railways and Trolley Lines*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small up to 5 crore rupees	Dams, large above 5 crore rupees	Weir & Barrages	Canals
1	2	3	4	5	6
1	Gangapur	2.1	—	—	—
2	Sarda Hydel	—	—	—	1.4
3	Matatila	0.8	—	—	—
4	Gandhi Sagar	—	4.2	—	—
5	Mayurakshi	2.3	—	2.62	2.12
6	Tungabhadra (And.)	2.6	—	—	1.3
7	Tungabhadra (Hyd.)	—	2.2	—	—
8	Bhadra	—	4.5	—	—
9	Perinchani	1.1	—	—	—
10	Kotah	—	—	1.5	0.1
11	Kakrapar	—	—	7.1	—
12	Bhakra-Nangal	—	6.9	—	0.1
13	Maithon	—	1.7	—	—
14	Panchet Hill	—	1.2	—	—
15	Durgapur	—	—	3.9	0.002
16	Lower Bhawani	6.0*	—	—	—
17	Malampuzha	—	—	—	—
18	Hirakud	—	6.1	—	0.2

\*Includes '0' Miscellaneous.

## 2.20. WATER SUPPLY AND SANITATION

2.20.1. Table 2.20.1. shows the expense on this head as percentage of direct cost of works on some of the projects.

TABLE 2.20.1.

*Expense on Water Supply Installation and Sanitation*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weirs & Barrages	Canals
1	2	3	4	5	6
1	Matatila	1.1	—	—	—
2	Gandhi Sagar	—	0.4	—	—
3	Mayurakshi	0.3	—	0.46	—
4	Tungabhadra (And.)	2.2	—	—	—
5	Tungabhadra (Hyd.)	—	4.4	—	—
6	Bhadra	—	1.1*	—	0.5
7	Kotah	—	—	**	0.6
8	Bhakra-Nangal	—	1.7	—	0.04
9	Maithon	—	1.6	—	—
10	Panchet Hill	—	4.3	—	—
11	Durgapur	—	—	0.03	—
12	Lower Bhawani	0.1	—	—	—
13	Hirakud	—	0.6	—	0.1

\*Chambal Valley Right & Left Canals.

\*\*Dam—Water Supply only.

## 2.21. POWER, TELEPHONE AND TELEGRAPH LINES

2.21.1. The cost of power other than that directly charged to works has to be included under indirect expense. Table 2.21.1. gives a consolidated statement of provision made under this head on some of the projects.



TABLE 2.21.1.

*Expenses on Power Supply and Telephone Lines*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weir & Barrages	Canals
1	2	3	4	5	6
1	Sarda Hydel	—	—	—	0.1
2	Gandhi Sagar	—	—	—	—
3	Mayurakshi	0.01	—	2.58	0.54
4	Tungabhadra (And.)	0.8	—	—	—
5	Tungabhadra (Hyd.)	—	1.4	—	0.8
6	Bhakra	—	0.6	—	—
7	Perinchani	0.3	—	—	—
8	Kotah	—	—	—	0.1*
9	Bhakra-Nangal	—	0.5	—	0.01
10	Maithon	—	5.4	—	—
11	Panchet Hill	—	2.3	—	—
12	Tilaiya	6.4	—	—	—
13	Durgapur	—	—	5.3	0.2
14	Hirakud	—	0.9	—	0.06

\*Chambal Valley Right and Left Canals.

## 2.22. WORKMEN'S COMPENSATION

2.22.1. Due provision also be made in all estimates for compensation to workers suffering injuries on works. We found that such provision was omitted from most of the projects.

## 2.23. WORKING-SITE AMENITIES

2.23.1. We also feel that adequate health and sanitary measures are essential on River Valley Projects. Rules on the subject in force in several States have been examined by us. They are generally on the pattern of those in the C.P.W.D. given in Appendix 3.

2.23.2. C.P.W.D. in their analyses of Scheduled Rates indicate a provision of 1.70% under this head. This is the Contractor's responsibility. Table 2.23.2. shows this provision on several River Valley Projects against the departmental obligation.

TABLE 2.23.2.

*Expense on Work-site Amenities*

Sl No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weir & Barrages	Canals
1	2	3	4	5	6
1	Gangapur	1.3	—	—	—
2	Sarda Hydel	—	—	—	0.03
3	Matatila	0.07	—	—	—
4	Gandhi Sagar	—	—	—*	0.1
5	Mayurakshi	—	—	0.05	0.04
6	Kotah	—	—	—	—
7	Tungabhadra (And.)	—	—	0.3	—
8	Tungabhadra (Hyd.)	—	2.8	—	1.4
9	Bhadra	—	1.6	—	1.5
10	Perinchani	0.06	—	—	—
11	Bhakra-Nangal	—	0.7	—	0.002
12	Kakrapar	—	—	0.3	—
13	Durgapur	—	—	0.4	0.006
14	Malampuzha	1.39	—	—	—

\*Chambal Valley Right and Left Canals.

## 2.24. SMALL TOOLS AND PLANT

2.24.1. Expense for small tools and plant is not charged directly to units of work but is added as a percentage charge to the cost of a project. This percentage would depend on the class and the value of the work. The general practice is to charge it at 1 per cent of the cost of the whole project including cost of land. We feel that this needs examination. Table 2.24.1. shows actual percentage expense under this head on direct cost of works of projects. The provision for small tools and plant should be based on direct cost of works.

TABLE 2.24.1.

*Expense on Ordinary Tools and Plant*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weir & Barrages	Canals
1	2	3	4	5	6
1	Gangapur	3.6	—	—	—
2	Sarda Hydel	—	—	—	0.9
3	Matatila	2.7	—	—	0.4
4	Gandhi Sagar	—	0.9	—	—
5	Mayurakshi	0.3	—	1.03	1.23
6	Tungabhadra (And.)	—	1.5	—	0.7
7	Tungabhadra (Hyd.)	—	—	—	6.1
8	Bhadra	—	0.9	—	—
9	Perinchani	2.1	—	—	—
10	Kakrapar	—	—	1.2	0.7
11	Bhakra-Nangal	—	2.0	—	1.0
12	Maithon	—	2.3	—	—
13	Panchet Hill	—	2.9	—	—
14	Tilaiya	2.1	—	—	—
15	Durgapur	—	—	3.3	3.1
16	Lower Bhawani	0.8	—	—	1.3
17	Malampuzha	2.3	—	—	2.5
18	Hirakud	—	1.3	—	1.1

## 2.25. LABORATORY AND TESTING CHARGES

2.25.1. There is a small expense on account of laboratory and testing equipment and organisation on the projects.

## 2.26. LOSSES ON STOCK AND ADVANCES

2.26.1. The value of stores held on 31-3-1954 at four large projects are given below and it can be expected that some losses would occur.

(Rs. in lakhs)

(1) Bhakra	508
(2) D.V.C. Projects	435
(3) Hirakud	436
(4) Tungabhadra	203

2.26.2. Table 2.26.2. shows provision under this head in the project estimates. It is likely, however, that the actual percentages should be different and higher in most cases.

TABLE 2.26.2.

*Losses on Stock and Advances*

(Estimated figures)

Sl. No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weir & Barrages	Canals
1	2	3	4	5	6
1	Sarda Hydrel	—	—	—	0.7
2	Kotah	—	—	1.5*	—
3	Gandhi Sagar	—	0.2	—	0.3
4	Kakrapar	—	—	0.2	—
5	Tungabhadra (And.)	0.5	—	—	0.1
6	Tungabhadra (Hyd.)	—	2.6	—	—
7	Bhakra	—	0.1	—	0.1
8	Maithon	—	1.3	—	—
9	Hirakud	—	0.4	—	0.3

\*Chambal Valley Right and Left Canals.

2.26.3. Losses may also be due to purchases of faulty goods, wastage in cutting up, bad workmanship, drying of volatile materials, leakage of liquids and gases etc.

## 2.27. MAINTENANCE

2.27.1. Table 2.27.1. shows figures for cost of maintenance of buildings and roads as percentage of the direct costs on various projects :—

TABLE 2.27.1.

*Expense on 'P-Maintenance'*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small	Dams, large	Weir & Barrages	Canals
1	2	3	4	5	6
1	Gangapur	1.9	—	—	—
2	Sarda Hydrel	—	—	—	0.6
3	Kotah	—	—	1.2*	0.3
4	Gandhi Sagar	—	2.0	—	—
5	Mayurakshi	0.1	—	—	—
6	Tungabhadra (Hyd.)	—	0.3	—	0.1
7	Bhakra-Nangal	—	2.0	—	0.9
8	Maithon	—	1.2	—	—
9	Panchet Hill	—	2.2	—	—
10	Tilaiya	1.2	—	—	—
11	Durgapur	—	—	2.0	0.6
12	Lower Bhawani	—	—	—	0.7
13	Malampuzha	0.1	—	—	—

\*Chambal Valley Right and Left canals.

## 2.28. MISCELLANEOUS

2.28.1. Table 2.28.1. gives an account of expense, which is not debitable to any of the above heads and is an indirect expense on some of the projects.

TABLE 2.28.1.

*Miscellaneous Expenses*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small up to 5 crore rupees	Dams, large above 5 crore rupees	Weir & Barrages	Canals
1	Sarda Hydrel	—	—	—	0.6
2	Kotah	—	—	0.8	—
3	Mayurakshi	—	—	0.08	—
4	Tungabhadra (And.)	0.4	—	—	1.2
5	Tungabhadra (Hyd.)	—	0.1	—	—
6	Bhadra	—	3.3	—	—
7	Perinchani	0.1	—	—	—
8	Bhakra-Nangal	—	0.003	—	—
9	Maithon	—	0.4	—	—
10	Durgapur	—	—	—	0.02
11	Lower Bhawani	—	—	—	1.1
12	Hirakud	—	—	—	0.04

## 2.29. ESTABLISHMENT OVERHEADS

2.29.1. Table 2.29.1. gives the establishment expense on various projects.

## 2.30. CONTINGENCIES

2.30.1. A provision for contingencies at 5 per cent is made when a project estimate is put up for the administrative sanction to cover the cost of unforeseen items, and incidental expenses of a miscellaneous character.

TABLE 2.29.1.

*Expense on Establishment and Overheads*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small up to 5 crore rupees	Dams, large above 5 crore rupees	Weir & Barrages	Canals
1	Gangapur	31.3	—	—	—
2	Matatila	6.2	—	—	—
3	Sarda Hydrel	—	—	—	9.5
4	Gandhisagar	—	3.4	—	—
5	Kotah	—	—	7.3*	9.1
6	Mayurakshi	8.8	—	7.8*	9.3
7	Kakrapar	—	—	21.6	11.7
8	Tungabhadra (And.)	13.3	—	—	7.9
9	Tungabhadra (Hyd.)	—	10.0	—	16.3
10	Bhadra	—	17.0	—	5.0
11	Perinchani	22.1	—	—	—
12	Bhakra-Nangal	—	23.2	—	11.1
13	Maithon	—	16.8	—	—
14	Panchet Hill	—	14.2	—	—
15	Tilaiya	14.4	—	—	—
16	Durgapur	—	—	14.8	11.3
17	Lower Bhawani	4.8	—	—	4.4
18	Malampuzha	6.7	—	—	7.5
19	Hirakud	—	9.7	—	10.5

\*Chambal Valley Right and Left canals.

The present provision of 5 per cent *ad valorem* irrespective of the magnitude of the work is very much on the high side in the case of large projects taken in hand after prolonged investigations and planning. We, therefore, recommend the following scales instead:—

1. For works costing upto 5 crores: 5%.
2. For works costing above Rs. 5 crores but less than Rs. 15 crores: 4 per cent with a minimum of Rs. 25 lakhs.
3. For works costing above Rs. 15 crores but less than Rs. 25 crores: 3 per cent with a minimum of Rs. 60 lakhs.

4. For works costing above Rs. 25 crores but less than Rs. 40 crores: 2 1/2 per cent with a minimum of Rs. 75 lakhs.
5. For works costing above Rs. 40 crores: Rs. 1 crore fixed.

NOTE—The cost of work should be exclusive of contingencies.

2.30.2. It is also a common practice to make a full provision of contingencies at 5 per cent in the case of revised estimates even though submitted in advanced stages of construction. When very little remains, unforeseen provision under this item should be suitably curtailed and many even be eliminated.

### 2.31. CONSULTANTS' FEES

2.31.1. Even on important projects no provision is made for payment of fees to consultants which sometimes becomes necessary during execution. No precise scale can be laid down for it but a fraction of a per cent of the cost of the project should meet the requirements generally. Table 2.31.1. shows expenditure under this on some of the projects.

TABLE 2.31.1.

*Expense on Consultant's Fees*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small up to 5 crore rupees	Dams, large above 5 crore rupees	Weir and Barrages	Canals
1	Matatila	0.1	—	—	—
2	Sarda Hydel	—	—	—	0.02
3	Gandhi Sagar	—	0.2	} *	—
4	Kotah	—	—		0.2
5	Bhakra-Nangal	—	1.7	—	—
6	Maithon	—	1.2	—	—
7	Panchet Hill	—	0.3	—	—
8	Hirakud	—	0.03	—	—

\*Chambal Valley Right and Left canals.



## 2.32. AUDIT CHARGES

2.32.1. Table 2.32.1. gives figures for percentage charges of audit and accounts to the direct charges on the various projects.

TABLE 2.32.1.

*Expense on Audit and Accounts*

Sl. No.	Name of Project	Percentage Expense			
		Dams, small up to 5 crore rupees	Dams, large above 5 crore rupees	Weir and Barrages	Canals
1	Gangapur	1.2	—	—	—
2	Sarda Hydel	—	—	—	—
3	Matatila	1.1	—	—	—
4	Gandhi Sagar	—	1.4	—	—
5	Kotah	—	—	1.2*	—
6	Mayurakshi	2.4	—	1.1	1.4
7	Kakrapar	—	—	—	—
8	Tungbhadra (And.)	1.8	—	—	—
9	Tungabhadra (Hyd.)	—	0.6	—	—
10	Bhakra-Nangal	—	0.7	—	—
11	Maithon	—	0.4	—	—
12	Panchet Hill	—	0.4	—	—
13	Tilaiya	3.8	—	—	—
14	Dargapur	—	—	—	—
15	Lower Bhawani	0.9	—	—	—
16	Malampuzha	1.1	—	—	—
17	Hirakud	—	1.3	—	—

\*Chambal Valley Right and Left canals.

## 2.33. THE OVERALL BURDEN

2.33.1. Whenever rates of items over different projects have to be compared, it would be necessary to add cumulative burden on primary rates. Burden will be a fixed percentage charge for most of the items of expense but may be variable percentage in some cases such as an indirect wage bill of establishment which will be inversely proportional to the variation of output on estimated production of men and machines.

2.33.2. In the case of construction works the burden on 'Prime Cost Base', which is likely to average out the peculiar variations in the nature of item of burden, should be used in preference to any other base such as cost of labour, materials, etc.

2.33.3. The overall burden is substantial and we feel that economy should be possible under this head, wherever possible.

## 2.34. RESPONSIBILITY FOR INDIRECT SERVICES

2.34.1. When a large project is carried out under a series of contracts, the responsibility for providing indirect services for the proper execution of works is shared among them and it can be understood that either services would not be adequately provided for or there may be waste due to multiplicity of provisions by several piece rate workers, although the latter has perhaps never occurred. It would, therefore, be only right that the provision of indirect works should separately made in each project. Only where the whole project is offered to a single agency for execution, this provision may form an invisible part of the contractor's bid items.

## 2.35. CONDITIONS OF PAYMENT ON WORKS

2.35.1. The provisions for interim payment on account of work or advances and those for the release of part of the retention and final payment deserve a very careful consideration, in framing the Conditions of Contracts. These arrangements intimately affect both the Government and the contractor. The Government must balance the advantages of paying promptly against fewer and larger payments needing contractors with larger financial resources which may affect the bids.

## 2.36. CONTRACTORS' OVERHEADS AND PROFITS

2.36.1. *Overheads*—An allowance of 10 per cent would be adequate for the contractor's actual expense on supervisory establishment, field office and share of head-office charges, travelling expenses, publicity, interest and insurance of damage to plant and injury to labour.

2.36.2. *Profits*—We believe that in normal circumstances an allowance of 10 per cent of the prime cost as contractor's profit is reasonable.

## 2.37. RATES OF EXPENDITURE ON PRELIMINARY SURVEY

2.37.1. The rates of expenditure on preliminary survey are highly variable, but those stipulated by the Survey of India and given below, may be treated as a guide (Table 2.37.1.).

TABLE 2.37.1

1.	Air mapping.	Re. -/10/8 per acre
2.	Detailed ground contour survey.	Rs. 1/10/0 Do.
3.	Land use survey and planning.	Re. /12/6 Do.
4.	Forest Survey.	Re. -/10/6 Do.
5.	Upland irrigation survey including drilling, test pits, canal layouts, dam design.	Rs. 1/8/- Do

## ECONOMICS OF CONSTRUCTION EQUIPMENT

### 3.1. CONSTRUCTION METHODS (MANUAL *versus* MECHANICAL)

3.1.1. Changes in living and social conditions at home and abroad have raised the labour wages and they are still rising. In view of the present tempo of works which has created a large demand for construction labour and also due to rise in their living standards, we feel that a reduction in labour rates is hardly possible.

3.1.2. While considering the economy of Manual *versus* Machines the following points should be taken into account:—

- (i) Expense on free transport for labour from their villages to project sites and sometimes railway or bus fares back on completion of the works;
- (ii) Adequate amenities in future; and
- (iii) General inaptitude of labour for hard work.

A comparison of rates of excavation both by manual and mechanical agencies has been dealt with elsewhere in the Report. It may be, however, stated here that for leads exceeding 300' and lifts exceeding 20' the execution of earthwork by manual labour is generally uneconomical.

3.1.3. Factors which militate against the use of machines in this country are:—

- (i) that they are almost invariably made in foreign countries and their use, therefore, tends to deplete reserves of foreign currency;
- (ii) that there is a tendency on the part of the agents not to have adequate stocks of spare parts in India; and
- (iii) that there is a lack of planning in obtaining spares from abroad, even when urgently needed, resulting in enormous losses of time and money on projects.

3.1.4. Machines become, more or less, indispensable for places, which are unhealthy, inaccessible, or where time is an important factor. They are expensive and the greatest care should be exercised in their acquisition. Some of the arguments against the use of machines would cease to apply when construction equipment industry is established in this country as recommended by us in para 3.2.4.

### 3.2. MANUFACTURE OF CONSTRUCTION EQUIPMENT

3.2.1. We do not share the Construction Plant and Machinery Committee's pessimism in regard to the feasibility of manufacturing construction equipment in India. They say that all the major construction projects in India have either been completed or are nearing completion and that the future projects will be either small or medium sized. This is not a correct appraisal of the present position. It may be true that some of the big dams would be completed in the next few years but they are not

going to be the last of their class. The country is so large and the possibilities of development so vast that many large works shall have to be built in future.

3.2.2. That we do not possess the "know-how" of the construction plant industry was until lately true of so many other industries which have since been successfully established. There are ways and means of getting all the "know-how" and we can adopt them in this case also. Construction machinery is fairly simple and if the country can manufacture locomotives, aeroplanes and machine tools, there is no reason why we cannot produce construction equipment.

3.2.3. The Plant and Machinery Committee has recommended that we should make a start with only one or two principal items of equipment on the major side and confine our attention mainly to minor pieces of equipment like 7/10 cft. capacity concrete mixers, tippers, rooters, sheepfoot rollers, etc. While we agree that we should standardise the sizes of equipment into as few items as possible, it would be a mistake to tackle only the minor items of work, as this will not solve the problem.

3.2.4. Our recommendation, therefore, is to concentrate on items of equipment in general demand, standardise their designs and sizes, and go in for their manufacture in right earnest, in co-operation between the public and private sectors.

### 3.3. STANDARDISATION OF EQUIPMENT AND SPARES

3.3.1. In the case of plant selection, full consideration should be given to the availability of spare parts and extent of the need for stocking them to ensure adequate supply of such parts on the job at all times. This brings up the question of the standardisation of equipment. A committee of the Government of India is already looking into this matter. We recommend that this Committee should also go into the standardisation of spares. We lay stress on this point because the prices of standard parts purchased from the manufacturers of parts would be very much lower than those charged by the suppliers of the equipment.

### 3.4. CAPITAL OUTLAY

3.4.1. The capital outlay on construction equipment on a project varies from 10 to 30 per cent of the total cost. This percentage is likely to go up in future with the increase in the mechanisation of construction methods. It is imperative that extreme care should be exercised in the selection of various units and as far as possible accurate provision for their depreciation, major repairs and overhauls and salvage value should be made.

TABLE 3.4.1

*Capital Outlay on Construction Equipment on Projects*

Sl. No.	Name of Projects	Primary cost of Works (lakhs) including 'Q' Spl. T. & P. provision	'Q' Spl. Tools & Plant		Remarks
			Provision (lakhs)	%	
1	2	3	4	5	6
1	Bhakra-Nangal	6009.03	1542.546	25.6	Exclusive of salvage value
2	Matatila	487.49	109.97	16.0	

TABLE 3.4.1.—contd.

1	2	3	4	5	6	
3	Gandhi Sagar	577.41	35.00	6.06	Exclusive of salvage value	
4	Maithon	746.21	226.00	30.29		
5	Panchet	806.68	195.20	24.20		
6	Tilaiya	184.76	52.60	28.47		
7	Mayurakshi	228.11	28.58	12.50		
8	Hirakud	3424.94	1139.06	33.25		
9	Gangapur	213.32	71.49	33.5		
10	Tungabhadra (And.)	505.69	76.00	15.05		
11	Tungabhadra (Hyd.)	519.05	90.00	17.40		
12	Bhadra	554.11	52.50	9.50		
13	Lower Bhawani	464.24	144.00	31.00		
14	Malampuzha	153.78	24.20	15.75		
<i>B. Weir and Barrages</i>						
1	Kotah	275.08	40.0	14.54		
2	Durgapur	373.10	81.74	21.91		
3	Kakrapar	60.63	—	—		
<i>C. Canals</i>						
1	Bhakra-Nangal	4563.40	442.87	9.70		
2	Sarda Hydel Scheme	460.09	82.47	19.00		
3	Chambal Rt. & Lt.	1692.15	142.54	8.42		
4	Tungabhadra (And.)	964.38	103.00	10.7		
5	Bhadra	565.78	20.97	3.70		
6	Lower Bhawani	346.10	25.00	7.23		
7	Malampuzha	139.27	9.50	6.80		

3.4.2. A reasonably accurate forecast of the number of years the equipment is likely to be employed on the project, the number of hours it could be worked per year and the estimated expense on its major repairs and overhaul for the period and its residual or salvage value, (if any), can be made at the outset. A schedule of basic use-rates can then be worked out by adding the estimated cost of running costs per hour viz: the cost of consumables, labour and field maintenance, to the rate of depreciation and major repairs and overhauls per hour. With use-rates' schedule and production tables, estimates of working cost with various plant combinations can be drawn up.

### 3.5. DETERMINATION OF LIFE OF EQUIPMENT

3.5.1. We concede that no authoritative life schedule of Construction machinery so far exists in this country and so in its absence our River Valley projects authorities have adopted hypothetical life figures which are quite often in excess of the standard lives recognised by standard institutions in U.S.A. and other foreign countries.

3.5.2. The economic lives of machines in years and hours adopted by the foreign authorities and that adopted on our projects have been tabulated in Tables 3.5.2. (i), (ii) 3.5.2. (iii) respectively.

TABLE

## Statement of Life of Rated Equipment in Years and Hour

Sl. No.	Equipment	A.G.C. Schedule		U.S.B.R. Bulletin	U.S.B.R. 'F' Bulletin		T.V.A. Schedule
		Years	Operating shift hours	Years	Operating shift hours	Years	Working hours
1	2	3	4	5	6	7	8
1	Air Compressors— Diesel	4.5	4,880— 6,000	4.5	4,800 6,000	—	10,000
2	Batching Plant	4.6	4,800— 7,200	4	4,800	—	50% of cost to project
3	Core-drilling machines	3	4,200	3	4,200	3	6,000
4	Concrete Buckets	5	6,000	5	6,000	5	5.6 to 8.3 yrs.
5	Cranes-Crawler:						
	(a) Upto 3 tons	4	6,400	—	—	5	10,000
	(b) 3 to 10 tons	5	8,000	5	8,000	5	12,000
	(c) Over 25 tons	7.75	10,850	8	11,200	9	20,000
6	Cranes (Truck- Mounted):						
	(a) Upto 6 tons	4	6,400	—	—	—	18,000
	(b) Upto 15 tons	5	8,000	4	7,200	—	20,000
	(c) Above 15 tons	6	8,400	4	7,200	—	—
7	Crushers—						
	(a) Jaw	6	7,200	6	7,200	10	—
	(b) Gyratory	10	12,000	—	—	10	40% of cost to project
	(c) Cone	10	12,000	—	—	10	—
8	Excavators— Crawlers:						
	(i) Diesel						
	(a) Upto $\frac{3}{4}$ Cyd.	4	7,200	4.5	9,000	—	10,000
	(b) Upto 1 Cyd.	4.56	7,200— 9,520	5.5	9,360	—	12,000
	(c) Upto 2 $\frac{1}{2}$ Cyd.	5.6— 6.25	8,960— 10,000	6.0	9,600	—	15,000
	(d) Above 2 $\frac{1}{2}$ Cyd.	7.1	10,650	6.0	9,600	—	15,000
	(ii) Electrically operated	5.10	7,000— 14,000	6.10	9,600— 16,000	5 to 10	20,000
9	Graders	5	8,000	5	8,000	4 to 8	12,000

3.5.2. (i)

*Adopted by Various Authorities for Depreciation*

D.C. & S.A. Bulletin		C.C.A. Bulletin		S.C.E.F. Bulletin	New Zealand		Estimating by S. Geddes	C.P. & M.C. Report
Years	Useful hours	Years	Operating hrs. maximum	Years	Years	Years	Working hours	Plant hours
9	10	11	12	13	14	15	16	17
—	—	6·25-7	12,500— 14,000—	—	—	5	8,000	8,000
—	—	5	7,500—	5	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	7	12,250	—	—	—	—	—
5	10,000	9	18,000	—	—	8	12,000	—
9	18,000	9	18,000	—	—	8	12,000	—
12	24,000	9	18,000	—	—	8	12,000	—
—	—	6·25	14,060	—	—	—	—	9,000
—	—	7	15,750	—	—	—	—	10,000
—	—	7	15,750	—	—	—	—	12,000
—	—	6·25-	10,940—	—	—	—	—	—
—	—	10	12,250 17,500	—	—	—	—	—
—	—	—	—	—	—	—	—	—
5	10,000	7	15,750	—	6·66 @15%	5	9,000	9,000
6	12,000	7	15,750	—	6·66	5	9,000	10,000
8	16,000	8·33	16,700	—	6·66	5	9,000	12,000
8	16,000	8·33	16,700	—	6·66	5	9,000	12,000
—	—	—	—	—	—	—	—	—
—	—	5	7,500	—	6·55 @15%	—	—	10,000

TABLE

1	2	3	4	5	6	7	8
10	Loaders	5	6,000	5	6,000	5-6	15,000
11	Locomotives— Diesel	6—8.3	9,600— 13,280	—	—	10	12,000
12	Mixers Concrete						
	(a) Less than 1 Cyd.	3	4,800	3	4,800	6	6,000
	(b) More than 1 „	4	6,400	4	4,800	8	6,000
13	Rollers—Road:						
	(a) Diesel	7	11,200	7	11,200	—	10,000
	(b) Gasoline	7	11,200	7	11,200	10	10,000
	(c) Steam	—	—	—	—	10	10,000
14	Scrapers—						
	(i) Motorised:						
	(a) Upto 10 Cyds.	4.5	6,400	—	—	—	15,000
			8,000				
	(b) Above 10 „	5	8,000	4	5,600	—	15,000
	(ii) Towed	3—4	4,200— 5,600	4.5	6,400 8,000	—	15,000
15	Tractors—						
	(i) Crawlers:						
	(a) Upto 89 B.H.P.	4—5	7,200	3—4	4,200		8,000
			8,000		5,600		
	(b) Above 89 „	5	8,000	4	5,600	—	8,000
	(ii) Wheeled:						
	(a) Upto 40 „	3.3—4	6,000— 7,200	3.3	6,000	—	—
			7,200				
	(b) Above 40 „	4—5	7,200	4	6,400		—
			8,000				
16	Trucks:						
	(a) Diesel	5	8,000	4	7,200	5—8	—
	(b) Gasoline	—	—	3—5	5,400— 8,000	5—8	—
17	Trucks—Dumpers:						
	(a) Rear Dump	5	8,000	4	8,000	—	8,000— 12,000
	(b) Bottom Dump	5	8,000	4	5,600	—	15,000
18	Well drilling machines 5"—6"	5	8,000	—	—	10	—

## Reference :—

1. A.G.C. Schedule :—Associated General Contractor of America Schedule of Equip-
2. U.S.B.R. Schedule :—United States Department of the Interior Bureau of Reclama-
3. U.S.B.R. 'F' Bulletin :—U.S. Bureau of Internal Revenue, Income-tax 'F' Bulletin.
4. T.V.A. Note :—"Procedure for Equipment Transfer Evaluation" by George K. Leonard
5. PC&SA Bulletin :—Power Crane and Shovel Association, USA Technical Bulletin.
6. Canadian Construction Association Bulletin.
7. S.C.E.F. Bulletin :—Socie of Civil Engineers of France Bulletin.
8. "Estimating" by S. Geddes—"Estimating for Building & Civil Engineering Works"
9. CP&MC Report :—Plant and Machinery Committee Report.



3.5.2. (i)—contd.

9	10	11	12	13	14	15	16	17
—	—	—	—	—	—	—	—	—
—	—	6.25—9	12,500— 18,000	—	—	10	15,000	—
—	—	3	6,000	—	—		12,600	—
—	—	5	10,000	—	—		12,600	—
—	—	8.33	12,500	—	5 20%	8	14,400	—
—	—	8.33	12,500	—	5 20%	—	—	—
—	—	12.5	18,750	—	5@20%	12	21,600	—
—	—	6.25	10,940	5	—	—	—	9,000
—	—	6.25	10,940	5	—	—	—	10,000
—	—	—	—	5	—	—	—	10,000
—	—	6.25	12,500	5	—	5	9,000	9,000
—	—	6.25	12,500	5	—	5	9,000	10,000
—	—	5	11,250	5	—	5	9,000	—
—	—	5—6	11,250— 12,500	5	—	5	9,000	10,000
—	—	.25						
—	—	5	11,250	—	—	5	11,000	—
—	—	5	11,250	—	—	5	11,000	—
—	—	6.25—	14,060—	4	—	4	8,000	10,000
—	—	.7	15,750					
—	—	6.25—	14,060—	4	—	4	8,000	10,000
—	—	.7	15,750					
—	—	7	12,250	—	—	—	—	—

ment Ownership expense.  
tion Schedule of Equipment Ownership Expense.

Chief Construction Engineer, Knawick U.S.A.  
No. 2, Operating Cost, Guide.

by Spence Geddes.

TABLE 3.5.2. (ii)

## Statement of Depreciation Rate per Month of Non-Rated Equipment

Sl. No.	Equipment	A.G.C. Schedule	T.V.A. Schedule	U.S.B.R. Bulletin	C.C.A. Bulletin
1	2	3	4	5	6
1	Air Compressors: Stationary	3.33%	1%	—	2—2.3%
2	Bins	3—4%	50% of cost to project	30 Mths.	2%
3	Boats	—	3%	—	—
4	Boilers	2.33%	1.5%	—	1.7% to 2%
5	Cableway	4—5.5%	50% of cost to project	—	—
6	Engines:				
	(i) Diesel—upto 100 HP	1.7%	—	59 Mths.	1.5%
	100 to 500 HP	1.4%	—	59 "	1.25%
	(ii) Gasoline				
	Upto 10 HP	3%	—	46 "	2.5%
	11 to 20 HP	2%	—	42 "	2%
	20 to 30 HP	2%	—	49 "	1.8%
	Above 30 HP	1.9%	—	59 "	1.7%
7	Electric Light Plant:				
	Diesel				
	Upto 10 kW	2.5%	—	56 "	1.7%
	Upto 25 kW	2.5%	—	56 "	2%
	Above 25 kW	2.5%	—	56 "	1.8%
	(ii) Gasoline				
	Upto 10 kW	2.5%	—	35 "	2%
	Upto 25 kW	2.5%	—	49 "	2%
	Above 25 kW	2.5%	—	56 "	1.8%
8	Hoists: Air	1.6%	3%	40 "	1.7%
	Chain	1.6%	50% of Cost to Project	80 "	2.5%
	Electric	1.6%	2%	56 "	1.5%
	Gasoline Upto 10 HP	2.5%	—	40 "	2.5%
	Above 10 HP	2%	—	48 "	2—1.5%
9	Pile Hammers				
	Single Acting	3%	1 1/2%	—	2.3%
	Double Acting	5.5—3%	1 1/2%	—	2.3%

TABLE 3.5.2. (ii)—contd.

Sl. No.	Equipment	A.G.C. Schedule	T.V.A. Schedule	U.S.B.R. Bulletin	C.C.A. Bulletin
1	2	3	4	5	6
10	Pneumatic Tools:				
	Drifters	4%	—	24 Mths.	6.7%
	Jackhammers	4.5%	3%	18 „	6.7%
	Pumps	5.5%	3%	—	6.6%
	Vibrators	4.7%	3%	21 „	5.5%
	Wagon drills	2%	3%	24 „	2%
11	Pumps :				
	Grout	—	2%	35 „	4%
	Pump etc.	4%	3%	24—30”	3%
	Centrifugal	3.3%	1½—3%	30 „	2—2.6%
12	Rollers :				
	Sheeps foot	3—4%	1½%	32 „	2.3%
13	Sand-Plant Outfit	3%	1½%	—	—
14	Welding Machines	2.5%	—	40 „	1.75—2%

*Reference :—*

1. A. G. C. Schedule : Associated General Contractors of America Schedule of Equipment, Ownership Expense.
2. T. V. A. Schedule : Procedure of Equipment Transfer Evaluation by George K. Leonend, Chief Const. Engineer, T. V. A.
3. U. S. B. R. Bulletin : United States Department of the Interior Bureau of Reclamation Schedule of Equipment Ownership Expense.
4. C. C. A. Bulletin : Canadian Construction Association Bulletin

TABLE  
Statement of Life Hours

Sl. No.	Equipments	Bhakra	Nangal
1	2	3	4
1	Air Compressors Diesel .. .. .	8,000	—
2	Batching & Mixing Plant .. .. .	—	—
3	Core-drilling Machines .. .. .	—	12,000
4	Cranes—Crawler :		
	a. Under 3 Tons .. .. .	—	—
	b. 3 to 10 Tons .. .. .	—	—
	c. Over 25 Tons .. .. .	15,000	—
5	Cranes—Truck-Mounted :		
	a. Under 6 Tons .. .. .	—	—
	b. Under 15 Tons .. .. .	—	—
	c. Above 15 Tons .. .. .	12,000	—
6	Crushers :		
	a. Jaw .. .. .	—	—
	b. Gyratory .. .. .	—	—
	c. Cone .. .. .	10,000	—
7	Excavators—Crawlers:		
	(i) Diesel—		
	Up to $\frac{3}{4}$ Cyd. .. .. .	17,000	20,000
	Up to $1\frac{1}{2}$ Cyd. .. .. .	17,000	15,000
	Up to $2\frac{1}{2}$ Cyd. .. .. .	22,000	30,000
	Up to $3\frac{1}{2}$ Cyd. .. .. .	22,000	30,000
	(ii) Electrical .. .. .	33,000	—
8	Graders .. .. .	12,000	8,000
9	Loaders .. .. .	—	—
10	Locomotives Diesel .. .. .	20,000	—
11	Mixers: Less than 1 Cyd. .. .. .	8,000	—
	More than 1 Cyd. .. .. .	8,000	—
12	Roolers Road :		
	a. Diesel .. .. .	—	—
	b. Gasoline .. .. .	—	—
	c. Steam .. .. .	—	—
13	Scrapers:		
	a. Motorised—		
	(i) Up to 10 Cyds. .. .. .	—	15,000
	(ii) Above 10 Cyds. .. .. .	—	15,000
	b. Towed .. .. .	—	—
14	Tractors :		
	(i) Crawlers—		
	a. Up to 89 BHP .. .. .	12,000	12,000
	b. Above 89 BHP .. .. .	12,000	12,000
	(ii) Wheeled		
	a. Up to 40 BHP .. .. .	—	—
	b. Above 40 BHP .. .. .	—	—
15	(i) Trucks :		
	(a) Diesel .. .. .	8,000	—
	(b) Petrol .. .. .	8,000	—
	(ii) Dumper Trucks :		
	(a) Rear Dump .. .. .	17,000—19,000	10,000—12,000
	(b) Bottom Dump .. .. .	—	—

3.5.2. (iii)

adopted by Projects

D.V.C.	Hirakud	Tungabhadra (Hyderabad)	Tungabhadra (Andhra)	Gangapur
5	6	7	8	9
Years				10,000
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
5	—	—	—	—
5	—	—	—	—
9—12	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
10	—	—	—	—
10	—	—	—	—
—	—	—	—	10,000
6	—	—	—	10,000
8	16,000	20,000	18,000—24,000	15,000
8	16,000	20,000	18,000—24,000	15,000
—	—	—	—	—
5	7,000	—	—	10,000
5	12,000	—	—	10,000
10	—	—	—	—
3—4	—	—	—	—
5	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
5	—	10,000	12,000	10,000
5	8,000	10,000	12,000— 24,000	10,000
—	—	—	—	—
4	7,000	20,000	10,000	10,000
5	7,000	20,000	10,000	10,000
5	7,000	—	—	—
5	7,000	—	—	—
5—8	—	—	—	—
5—8	—	—	—	—
4—5	10,000	10,000	10,000	10,000
5	10,000	—	10,000—12,000	10,000

## 3.6. DEPRECIATION

3.6.1. *Its relationship with life of equipment*—Depreciation usually refers to the process of charging into unit rates a fair amount of the “first cost” of construction plant to cover the wear and tear obsolescence and loss in value. It practically means that the difference between the first cost and re-sale or salvage value must be charged to the work.

3.6.2. Depreciation is directly connected with the life of machines and hence it is of utmost importance to determine the lives of equipment used in the calculation of depreciation.

3.6.3. The lives of equipment are mentioned in terms of (i) periods like weeks, months or years and (ii) hours as operating hours, shift hours, plant hours, etc. The depreciation is calculated by dividing the cost of the machine less the cost of tyres less the salvage value, if any, by the life period. Consequently, depreciation is expressed as (i) weekly rates, monthly rates or yearly rates or; (ii) as rate per hour; or (iii) depreciation percentages by quarters of the equipment’s expected life. In view of the great importance of determining the method of charging depreciation we elicited information on this subject from various foreign authorities, a summary of which is given below:—

TABLE 3.6.3.

*Methods of Charging Depreciation Adopted in Foreign Countries*

Sl. No.	Name of Authority	Method of charging depreciation
1	2	3
U.S.A.		
1	The Associated General Contractors of America, Washington.	The A.G.C. and the U.S.B.R. Schedule of ownership expense treat equipment depreciation by <i>straight line</i> method by which a uniform percentage of the capital investment is charged off on <i>monthly basis</i> . No salvage or scrap value is considered as this is usually negligible in contractor’s equipment. The
2	The U.S. Department of the Interior, Bureau of Reclamation.	

TABLE 3.6.3.—contd.

1	2	3
		<p>monthly charges multiplied by the average number of working months during which the machine is in use gives the annual depreciation. It varies extremely depending on the type of equipment, the climate, nature of work and other factors. The monthly expense rates are based on a single operating shift per day for 30 days a month. When equipment is operated 2 or 3 shifts per day an additional charge of 50% of the single shift rate for each additional 8 hour shift is made. Daily rate is derived by dividing monthly rate by 30. Largely, equipment depreciation is handled in such a manner that is most advantageous to the owners from a tax standpoint.</p>
<p>3 The U.S. Bureau of Internal Revenue, Income-tax, 'F' Bulletin.</p>	<p>The Schedule reveals the probable useful life <i>in years</i>. Annual depreciation rates are considered to be on <i>straight line</i> basis.</p>	
<p>4 Procedure for equipment transfer evaluation. Tennessee Valley Authority.</p>	<p>The life of 'Rated Equipment' for which records of hours of service and cost of operation will be maintained is given in terms of <i>operating hours</i>. Defined as not operating hours, that is gross hours minus all delays. The depreciation shall be computed by the use of <i>depreciation percentages by quarters</i> of the equipment's expected life.</p>	
		<p>The depreciations for non-rated equipment is figured on the <i>monthly depreciation</i> basis.</p>
		<p>The transfer values of plant assemblies such as conveyors, mixing plants, etc. which are generally installed for the life of the job, shall be 50% of the cost to the transferring job (excluding installation cost).</p>
<p>CANADA</p>		
<p>The Canadian Construction Association, Canada.</p>	<p><i>Straight line method of depreciation.</i> A uniform <i>percentage</i> is charged off <i>yearly</i>: the <i>monthly</i> percentage rate depending on the average use months per year. Monthly rental percentage is based on a minimum period of not less than one month operational time of not more than 250 hours a month, while the weekly rental percentage is based on operational time of not more than 60 hours in seven consecutive days while the daily rate has a basis of not more than 10 working hours in a 24 hour period. Overtime is charged by the hours at 50% of the straight line rate.</p>	

TABLE 3.6.3.—contd.

1	2	3
<b>UNITED KINGDOM</b>		
6	Federation of Civil Engineering Contractors, London.	The general practice in this country is to calculate. Depreciation on an estimated average life in years of the machine. This cost is then usually reduced to an hourly rate by reference to the average annual use, in hours, of the machine.
<b>AUSTRALIA</b>		
7	Institution of Engineers, Sydney, Australia.	It is the practice here to recover all fixed and maintenance costs by means of a hire-rate individually calculated for each type of machine and levied broadly on the <i>basis of the number of days</i> the plant is committed to a particular project. The hire-rates do not cover operator's wages, fuel costs etc.
8	State Rivers & Water Supply Commission, Melbourne.	The hire-rates are on the basis of time actually in the field less that for major repairs. Plant held idle on the job as standby, is charged 20% of the working rate. The working life is expressed in <i>hours</i> .
<b>FRANCE</b>		
9	Electricite de France, Paris, France.	Depreciation of power stations and electrical equipment is carried out by means of <i>equal annuities</i> the value of which is established by dividing the cost by the anticipated <i>life in years</i> .
<b>NEW ZEALAND</b>		
10	Department of Scientific & Industrial Research, Wellington.	<i>Annual method of depreciation adopted.</i> The depreciation rate for each item is a <i>fixed percentage</i> for each class of plant. The annual depreciation charge is calculated on the cost of the item at full depreciation rate, regardless of time worked, under repair or idle time. The annual depreciation in general, represents 2,000 working hours each year, based on a 40 hour week at 50 weeks.
<b>DENMARK</b>		
11	Christianis & Nielsen Civil Engineers & Contractors, Copenhagen, Denmark.	Depreciate <i>one per cent</i> of the original value of the plant per month at site, plus 0.1 per cent of the original value for each working day (8 hours).
<b>ISRAEL</b>		
12	Ministry of Agriculture, Water Authority, Deptt., of Water Supply, Sewage & Flood Control.	Depreciation based on 2,000 <i>working hours</i> per year. The normal depreciation period adopted as per A.G.C. Schedule of U.S.A.



The above table shows that the Straight Line method of calculating depreciation is the one generally preferred to other methods *viz.* (i) the Production Units method; (ii) the Declining Balance; and (iii) Sinking Fund method because of its simplicity in estimating.

3.6.3. Charging depreciation as a percentage on monthly or yearly basis is adopted by contractors and is most advantageous to them from the income-tax standpoint. The method of charging depreciation percentages by quarters of the life of equipment though feasible is cumbersome. Hence we recommend defining lives in terms of hours in case of 'rated equipment' for which records of service hours are maintained. In case of non-rated equipment *i.e.* those pieces of equipment for which no individual records of hours of service or cost of operation are maintained, the depreciation charges should be assigned on monthly basis.

### 3.7. DEFINITION OF HOURS

3.7.1. There exists considerable differences of opinion as to how the operating period in hours is to be defined for purposes of calculating depreciation. In this connection we come across the terms (i) the shift hours; (ii) clock hours; (iii) operating hours; (iv) plant hours; and (v) the meter hours. These are discussed below:

3.7.2. 'Shift Hour' includes the idle hours occurring in a shift and hence it is not correct to adopt it for working out depreciation. 'Clock Hours' are the working hours as noted by the time-piece and recorded in log books. These are the same as 'working hours' and differ from the 'operating hours' in that they include minor delays in working the machine on a job. 'Plant Hours' and 'Meter Hours' practically mean the same.

3.7.3. The C.P. & M.C. have in their report defined plant hours as under:—

'Plant Hour' means meter hours where meters are working, where such meters do not exist, commensurate effective hours, based on the working of similar other machines with meters should be used; where even this is not possible, the 'effective hour' can be based on the average fuel consumption and work done per hour, which gives the 'load factor'.

3.7.4. In view of the fact that on many items of plant and equipment 'meters' are not fixed and as the hour meter registration is not fool-proof and cannot be relied upon, the use of meter hour or plant hour cannot be accepted as a standard method for assessing lives of machines. Also to base life hours on fuel consumption and load factor is not only cumbersome but it lends itself to abuse in recording fuel consumption. Also, fuel consumption is a factor dependent on the mechanical condition of the plant and therefore unsuitable for adoption as a standard.

3.7.5. We, therefore, recommend the use of working hours of clock-hours for determining the life of rated equipment. Most projects prefer recording clock-hours in log books; and the use of working hours is not only simple but more reliable than any of the other methods. It will not be out of place to mention that almost all advanced countries advocate the

reckoning of depreciation by working hours basis as the soundest and the most practical method.

3.7.6. Our recommendations regarding the lives of rated equipment in working hours and those of the non-rated as monthly percentages are given below in Tables 3.7.6. (i) and 3.7.6. (ii).

TABLE 3.7.6. (i)

*Life Table of Rated Equipment Recommended by Rates & Costs Committee*

Sl. No.	Equipment	Life on working-hours
1	2	3
1	Air Compressors : Diesel Portable .. .. .	10,000
2	Batching Plant .. .. .	50% of cost to be charged to the project.
3	Core drilling machines .. .. .	6,000
4	Concrete buckets .. .. .	10,000
5	Cranes—Crawler :	
	(a) Upto 3 Tons .. .. .	10,000
	(b) 3 to 10 Tons .. .. .	12,000
	(c) Over 25 Tons .. .. .	20,000
6	Cranes—Truck mounted:	
	(a) Upto 6 Tons .. .. .	12,000
	(b) Upto 15 Tons .. .. .	15,000
	(c) Above 15 Tons .. .. .	15,000
7	Crushers:	
	(a) Jaw .. .. .	40% of cost to be charged to the project.
	(b) Gyratory .. .. .	do.
	(c) Cone .. .. .	do.
8	Excavators Crawlers—	
	(i) Diesel:	
	(a) Upto $\frac{3}{4}$ Cyd. .. .. .	10,000
	(b) Upto $1\frac{1}{2}$ Cyd. .. .. .	12,000
	(c) Upto $2\frac{1}{2}$ Cyd. .. .. .	15,000
	(d) Above $2\frac{1}{2}$ Cyd. .. .. .	15,000
	(ii) Electricity operated Excavators .. .. .	20,000
9	Graders .. .. .	12,000
10	Loaders .. .. .	15,000
11	Locomotives : Diesel .. .. .	12,000

TABLE 3·7·6. (i)—contd.

1	2	3
12	Mixers concrete :	
	(a) Less than 1 Cyd .. .. .	6,000
	(b) More than 1 Cyd .. .. .	6,000
13	Rollers—Road :	
	(a) Diesel .. .. .	12,000
	(b) Gasoline .. .. .	12,000
	(c) Steam .. .. .	20,000
14	Scrapers—	
	(i) Motorised : (rubber typed)	
	(a) Upto 10 Cyds .. .. .	12,000
	(b) Above 10 Cyds .. .. .	15,000
	(ii) Towed : .. .. .	15,000
15	Tractors—	
	(i) Crawlers :	
	(a) Upto 89 B.H.P. .. .. .	10,000
	(b) Above 89 B.H.P. .. .. .	12,000
	(ii) Wheeled :	
	(a) Upto 40 B.H.P. .. .. .	10,000
	(b) Above 40 B.H.P. .. .. .	10,000
16	Trucks :	
	(a) Diesel .. .. .	12,000
	(b) Gasoline .. .. .	12,000
17	Trucks—Dumpers :	
	(a) Rear dump .. .. .	12,000
	(b) Bottom dump .. .. .	15,000
18	Well drilling machines 5"—6"	12,000

TABLE 3.7.6. (ii)

*Life Table of Non-rated Equipment Recommended by R. & C.C.*

Sl. No.	Equipment	Depreciation % per month
1	2	3
1	Air Compressors—Stationary .. .. .	1
2	Bins .. .. .	2½
3	Boats .. .. .	3
4	Boilers .. .. .	1.5
5	Cableway .. .. .	50 of cost to project.
6	Engines—	
	(i) Diesel :	
	Upto 100 HP .. .. .	1.5
	100 to 500 HP .. .. .	1.5
	(ii) Gasoline :	
	Upto 10 HP .. .. .	2
	11 to 20 HP .. .. .	2
	20 to 30 HP .. .. .	2
	Above 30 HP .. .. .	2
7	Electric Light Plant—	
	(i) Diesel :	
	Upto 10 kW .. .. .	2
	Upto 25 kW .. .. .	2
	Above 25 kW—100 kW .. .. .	2
	(ii) Gasoline :	
	Upto 10 kW .. .. .	2
	Upto 25 kW .. .. .	2
	Above 25 kW .. .. .	2
8	Hoist—Air : .. .. .	2
	Chain .. .. .	2
	Electric .. .. .	2
	Gasoline : Upto 10 HP .. .. .	2.5
	Above 10 HP .. .. .	2
9	Pile Hammers—Single Acting .. .. .	1.5
	Double Acting .. .. .	1.5
10	Pneumatic—Tools :	
	Drifters .. .. .	3
	Jack Hammer .. .. .	3
	Pumps .. .. .	3
	Vibrators .. .. .	3
	Wagon Drills .. .. .	3
11	Pumps—Grout : .. .. .	2
	Pumps etc. .. .. .	3
	Centrifugal .. .. .	3
12	Rollers—Sheeps foot .. .. .	1.5
13	Sand blast outfit .. .. .	1.5
14	Welding Machine .. .. .	2

## 3.8. THE LIFE OF TYRES

3.8.1. Though the suppliers always include the price of tyres initially fitted on an equipment in their quotations for the equipment, tyres have to be treated quite separately for the inclusion of *pro rata* cost in the unit rate. On some equipment, the cost of tyres is a substantial part of the total price and their lives are not the same as those of the machines.

3.8.2. The recommendations of the C.P.&M.C. in respect of the average life of tyres of various types of equipment are reproduced below :

TABLE 3.8.2.

Equipment	Life Expectancy Hours	
	Average material	Abrasive material
Scrapers .. .. .	3,000	2,500
Dumpers—bottom .. .. .	3,500	3,000
Dumpers—end .. .. .	3,000	2,500
Tractors .. .. .	2,500	2,000
Rubber-belt for loaders .. .. .	3,000	2,500
Drawn scrapers .. .. .	4,000	3,500

## 3.9. DEPRECIATION FOR IDLE PERIOD

3.9.1. Equipment depreciates even while idle. We observe that no depreciation is allowed for the idle period in the working out unit costs on projects. We recommend that a quarter of the full rate of depreciation be charged to the project for idle hours. This will also lead to economy in the capital outlay on equipment on projects.

3.9.2. During monsoons when there is a shut-down on most of the works it can be expected that the equipment would be overhauled for use in the following season. This period which may last for 2 to 3 months, should not be considered as idle time for purpose of charging depreciation for idle hours. Any shut-down during the working season, howsoever long, should be treated as an idle period.

### 3.10. TWO-SHIFT WORKING

3.10.1. We recommend two-shift working on large projects and also periods in between these shifts by gangs attending to the machinery. Single shifts working of machines is uneconomical on large projects while *three-shift* working can only be justified where the time for the completion of the project is very limited.

### 3.11. METHOD OF DETERMINING THE PRICE OF OLD EQUIPMENT

3.11.1. The Co-ordination Board of Ministers have ruled that "the usual formula for determining the price of old equipment would be the book value, less depreciation. In the event of difference of opinion, the matter would be settled by a joint inspection of the two parties, and if necessary, ultimately by arbitration. This procedure, however, should not hold up the transfer of the machines". We agree with these observations and further recommend that before a machine is transferred from one project to another project, it should be completely overhauled and put in a perfect mechanical condition to the satisfaction of an independent authority. We are further of the opinion that each project should towards the end of its completion be required either to scrap the machine or put it in thorough working order at its own cost and get it evaluated by an independent body like C.W.&P.C. The equipment population in the country is so great and stores so large that C.W. & P.C. can afford to have a body of experts on its staff to act as a Central agency for the disposal of Stores and Equipment and their transfer from one project to another.

### 3.12. REPAIRS AND MAINTENANCE

3.12.1. Repairs and maintenance include the cost of labour and spare parts involved in overhauls at the end of the working season, as well as minor replacements or major repairs caused by accidents, etc., which may be required during the working period.

3.12.2. Expenditure on repairs cannot follow any uniform pattern as is the case with operation charges. Nor is there any apparent direct relationship between the depreciation charges and charges for repairs but some assumption about the likely cost of repairs on a machine is necessary and a method has to be devised for debiting it to the unit cost. The only datum available is the purchase price of the machine on which depreciation is based. Practices differ in the correlation of the estimated cost of repairs with the purchase price. Some fix it at some annual percentage of the purchase price and divide this by the number of hours assumed per year to arrive at an hourly cost; others express the total cost of repairs during the life of the machine as a percentage of the purchase price.

3.12.3. We give in Table 3.12.3. our recommendations for repairs and maintenance for the various classes of machines. It must, however, be noted that hourly costs of repairs and major overhauls depend largely

upon the severity of use or working conditions, and the care and attention given to the equipment. The rates given below would apply to average working conditions.

TABLE 3.12.3.

*Repairs and Maintenance as Percentage of Depreciation*

Class of Machinery	Percentage of Depreciation
1	2
Boilers, conveyors (portable), engines, motors (electric), pumps (high pressure, piston or pump), scrapers, shovels, tractors, bull-dozers, belt loaders, welders (acetylene).	100%
Automobiles, bins (aggregate), bituminous equipment (except kettles), compressors, conveyors (stationary), draglines, graders (motor), hoists (electric and steam), pavers, pile hammers, pit and quarry plans (small), pumps (centrifugal), pumps (concrete), trucks (dump), wagons (dump), welders (gas-driven).	80%
Bucket loaders, cables, cement guns, concrete plants, cranes, crushers, drills (pneumatic), hoists (gas), mixer concrete (medium), mixers (motor small), rollers (except sheepsfoot), trailers, trucks (except dump).	60%
Electric hand tools, mixers (concrete, small below 14·8), pipe, pneumatic tools, vibrators (concrete).	40% or less

3.12.4. Contrary to depreciation, expenditure on major repairs should follow an upward trend during the life of a machine, being low in the beginning when the machine is new and higher and higher in later years. It is, however, almost a universal practice to allow for repairs and overhauls in the unit rates on a straight line basis for the sake of simplicity in working. *Unlike depreciation no charge for repairs should be incorporated in unit costs for idle hours.*

3.12.5. The Government of India, in the Ministry of Finance, in their instructions to the Accountant General as contained in their letter No. F-8 (23-EC-II/51) dated 26-9-51 lay down that adjustments for transferring plant use-rate charges to works be made "annually or at more frequent intervals as may be considered expedient". We are of the opinion that such adjustments should be carried out monthly and incorporated in accounts. In the case of cost accounting shorter periods may be adopted, but there is no need to incorporate the figures earlier than one month in financial accounts.

## 3.13. REPAIRS AND RENEWALS OF TYRES

3.13.1. The repairs and maintenance charges of tyres and tubes are definitely smaller than those of the machines. The following figures of the percentage allowance for repairs of tyres have been adopted in our calculations and are recommended for use.

TABLE 3.13.1.

*Allowance for Repairs and Maintenance of Tyres*

Job Conditions	Bottom Dump	Rear Dump	Scrapers	Twin-power Scrapers	Loaders
1	2	3	4	5	6
Favourable .. .. .	40%	50%	45%	50%	40%
Average .. .. .	50%	60%	55%	65%	45%
Unfavourable .. .. .	60%	80%	65%	85%	50%
Extremely unfavourable .. .. .	70%	95%	75%	95%	55%

## 3.14. THE OPERATING COST

3.14.1. The operating cost includes expense on fuels, lubricants and labour per hour. The fuel and lubricant consumption is dependent on the B.H.P. of the equipment and its type. The labour charges are affected by local conditions, availability of skilled labour, etc. We have recommended in Chapter 2 the scale of wages for personnel required to man the construction equipment. The expenses incurred on the personnel engaged as "leave reserve" and for non-working season should also be included under the cost of labour. We have provided 25% of the total labour charge per hour under this head in our calculations of use-rates of equipment.

## 3.15. IMPORTANCE OF PREVENTIVE MAINTENANCE

3.15.1. While dealing with cost, we should not forget that the worst enemy of equipment is improper maintenance and it is imperative that full advantage be taken of the cost building features, which the modern expensive earthmoving equipment offers.



3.15.2. It is good commonsense to do little things in maintenance which can prevent serious failures later. Not only are the repair charges in a factory to be considered but much more important are the periods of shut-down of works resulting in total loss of production.

3.15.3. Most failures in a well designed and properly built machine are due to wear and tear, shocks, or overloads or a combination of the three. Failures due to wear and tear could be eliminated by proper lubrication, proper adjustment and the replacement of worn parts, before they cause failure of other parts in the assembly.

3.15.4. Failure due to shock could be eliminated by proper driving care and smooth driving operation, good haul roads and making sure that all parts on the vehicle are securely tightened and vibration eliminated. Failure due to overload could be eliminated by prohibiting all overloading.

Regular maintenance of check sheets and control reports along the lines of aircraft maintenance to do "little things" to prevent failures, would go a long way towards effecting saving in cost. Our recommendations on this subject are embodied in Appendix 4.

## STORES

### 4.1. GENERAL

4.1.1. A perfect store system should be capable of :—

- (i) Efficiency and economy in management.
- (ii) Prevention of waste and pilferage.
- (iii) The exact allocation of all stores bought.
- (iv) Stock records indicating qualities of goods delivered by outside suppliers not up to the standard mark.
- (v) Securing protection against running short of materials and stores, the stores ledger showing at a glance the exact stock held from day-to-day.
- (vi) Affording protection against over-stocking and thus running the risk of loss by falls in the market value, by deterioration of the goods, and by danger of obsolescence.
- (vii) Affording check against locking up of capital by carrying unnecessarily large stocks.
- (viii) Showing up cases of duplicate ordering and afford protection against it.
- (ix) Continuous test checks with a minimum stock-taking.

4.1.2. Stores Account system should in short be able:—

- (i) to produce figures wanted by the Costing Section promptly,
- (ii) to present a complete account of receipt and expenditure,
- (iii) to show bad and good buying,
- (iv) to indicate quantity and value of stores without stock-taking,
- (v) to indicate ordering level without inspection, and
- (vi) to indicate surplus, dead, and unserviceable stores.

4.1.3. The condition of stock accounts on most projects is far from satisfactory as they have failed to fulfil most of the essential requirements. Briefly put, the defects noticed can be grouped as follows :—

- (i) Purchase registers for Stores Ordered are not maintained to watch supplies and to avoid duplication of order.

- (ii) Registers for Railway Receipts are not maintained to watch incoming supplies.
- (iii) Articles are not priced promptly due to the absence of specified procedure for valuation prior to receipts of priced invoices and vouchers for miscellaneous charges.
- (iv) Payments of bills are unduly delayed on account of non-availability of measurement books containing the bills, due to a lengthy procedure of certification and payment.
- (v) Issues in the stores registers are wrongly entered due to absence of Code Numbers, resulting in confusion and extreme difficulty in reconciliation of differences.
- (vi) Half-yearly register of stock is not closed resulting in non-fixation of rates for the ensuing half year.
- (vii) Physical verification is not generally carried out.
- (viii) Large accumulation of surplus and dead stores exists at each project, resulting in unnecessary locking-up of capital and unnecessary waste.

4.1.4. The present state of affairs is due to :—

- (i) Absence of classification and condition for stores.
- (ii) The inadequacy of the existing rules on Management and Accounting.
- (iii) Lack of Trained Personnel for stores management and accounting.
- (iv) Cumbersome methods of pricing and verification of stores, closing of Stock Accounts half-yearly and enormous increase in the items of stores and their transactions due to the rapid advance towards mechanised methods of construction, now being adopted on works.
- (v) Unsuitability of some of the existing forms of stores accounting.
- (vi) Unsuitability and inadequacy of stores houses.
- (vii) Inadequacy of proper arrangements and methods for storing articles.

4.1.5. Our recommendations on the subject are contained in the succeeding paragraphs.

## 4.2. CLASSIFICATION AND CODIFICATION OF STORES

4.2.1. According to current practice, stores are classified as under and given no code numbers :—

Small Stores.  
 Building Materials.  
 Timber.  
 Metals.

Fuel.  
Painters Stores.  
House Fittings.  
Miscellaneous Stores.  
Manufacture.  
Land and Kilns  
Storage.

It is evident that the above classification had been evolved in the past to cover mainly the building materials and cannot serve the requirement of the large river valley projects.

4.2.2. There is at present no codification of stores on most of the river valley projects. For this purpose the decimal system is more suited than any other. In this system every item is given a code number, which makes for ease and accuracy in posting transactions. It also gives elasticity for expansion according to needs without disturbing the codification of items already in use and is capable of being adopted to the use of machines for stores accounting.

4.2.3. The following main classification and coding of stores is recommended :—

<i>Code Nos.</i>	<i>Main Classification</i>
11,000 to 11,999	Building Materials.
12,000 „ 12,999	Plant & Equipment.
13,000 „ 13,999	Auto Stores.
14,000 „ 14,999	Chemicals.
15,000 „ 15,999	Gums, Resins and Varnishes.
16,000 „ 16,999	Petroleum, Fuel Oils & Lubricants.
17,000 „ 17,999	Rubber Goods.
18,000 „ 18,999	Tar & Tar Products.
19,000 „ 19,999	Cement.
20,000 „ 20,999	Steel & Steel Products.
21,000 „ 21,999	Non-ferrous Metals.
22,000 „ 22,999	Electrical Stores.
23,000 „ 23,999	Sanitary Stores.
24,000 „ 24,999	Mechanical Stores.
25,000 „ 25,999	Scientific Stores.
26,000 „ 26,999	Hardware Tools.
27,000 „ 27,999	Photographic & Cine Stores.
28,000 „ 28,999	Railway Materials.
29,000 „ 29,999	Explosives.
30,000 „ 30,999	Clothing.
31,000 „ 31,999	Glass & Glass Products.
32,000 „ 32,999	Timber.
33,000 „ 33,999	Fire Arms & Ammunition.
.....	.....
.....	.....
and so on to	
99,000 to 99,999	Miscellaneous.

4.2.4. Each of the above group can be divided into 99 sub-groups and each sub-group can be sub-divided into 999 items allowing thereby ample scope for expansion.

### 4.3. LIMITS OF STOCK

4.3.1. According to the existing procedure, an upper limit is sanctioned for each division for holding store and the net outlay on stores at the end of the financial year should not exceed this limit. This limit may be revised as and when necessary. For each individual year, a net appropriation is made and it may be plus or minus accordingly as the estimated value of receipts of stores exceeds the value of issues and *vice versa*. But it is always implied that net outlay on stores will not exceed the limit mentioned above. This system may be all right for over-all financial control on stores but for efficient working of stores on large river valley projects, every item needs attention and proper planning so that stores may be in a position to supply all the items as required by construction engineers and at the same time there may not be unrequired accumulation of any item. Such accumulation does not only mean lock-up capital but results in continuous cost of storage and safe custody and risk of deterioration, obsolescence and loss.

4.3.2. It is, therefore, necessary that maximum, minimum and normal ordering limits of stock are determined for each article. Such limits will be a great help in efficient and economical working of stores. When the stock of an article is reduced to the minimum limit it should alert the stores keeper to take steps for its procurement and when the stock is at the upper limit purchases are stopped which will save locking up capital. Maximum and minimum limits should be fixed very judiciously with the objective that locked-up capital remains the minimum compatible with regular and timely availability of required stores so that progress of work remains unhampered. It is also considered desirable to fix a limit for normal ordering to be placed for supplies.

4.3.3. Minimum limit on the quantity of an item should be fixed at such a level that the existing stock may generally be sufficient to meet the requirement of works during the period which is necessary for its procurement after the date of purchase requisition. Maximum limit may be fixed by considerations of periodical requirements which will depend on the convenient intervals of replacements and requirements of works.

4.3.4. As a rule the maximum limit should not exceed the requirement of a year plus the minimum limit, unless some such conditions are foreseen that a certain article may become scarce in the near future or its price may go up. The limits for each individual item will depend upon the following factors :—

- (a) The time required to process an order.
- (b) The time required to procure the materials after an order is placed within or outside the country.
- (c) The rate of consumption of the article.

- (d) Availability of storage space.
- (e) Economical, commercial units of purchase.
- (f) The capacity of the store organisation to handle procurement orders, measurements of goods, binning and storing the articles and payment of bills thereof.
- (g) The provisions necessary to meet the contingencies of accidental needs of certain kinds of items.
- (h) The minimum amount of money that can reasonably be invested in stock.

4.3.5. If the procedure for procurement orders could be made short and quick, the minimum limits can be reduced thus effecting a saving on the overall investment. From this point of view it is better to have as many items under a Rate Contract as possible so that no time may be lost in inviting tenders etc. This is a pointer to the importance of minimum of centralisation and maximum of the delegation of authority to save time in routines of passing on the papers from one office to another.

4.3.6. The time required to procure materials is dependent upon the availability of the materials in the market and the speed of transportation. When articles are available in the local market, the minimum stock limit should normally not exceed the requirement of 6 to 8 weeks. For materials that have to be imported from abroad, the time required is usually large resulting in the necessity for higher minimum limit. The officer fixing the limits must, therefore, be conversant with the availability of the article.

4.3.7. The rate of consumption of an article will depend upon the time schedule of construction. It is necessary, therefore, that the officer fixing the limit should also have a detailed list of the phased requirements of materials for his works. The availability of storage space scarcely needs any comments except that this may have to be limited to keep down the investment on buildings, and reduce the hazards of fire, theft, etc.

4.3.8. Bulk purchases are always cheaper than piecemeal orders; but care should be taken to see that too much stores is not ordered, in an endeavour to purchase at bulk rates, which may not be required in the near future or may deteriorate with time or may otherwise become unusable.

4.3.9. Theoretically if an order could be placed every day for the requirements of a material in regular demand, the stock limit can be kept very low, say only to meet one day's needs. However, this will throw so much burden on the store organisation, that it will not be able to cope up with the work of ordering, receiving, paying and binning the goods. It is necessary, therefore, to bulk the requirements and indent them at one time. Such bulking of orders should, however, be limited to not more

than 3 months' requirements but deferred deliveries may be asked for when necessary.

4.3.10. Certain types of stores are required to be held against an unforeseen demand, which if not satisfied, might result in dislocation of entire work. The forward indents for contingent stock holding of spare parts is a typical example of this nature.

4.3.11. In the case of mechanical equipment, it is recommended that it should be standardized and the supply of spare parts by the dealer concerned during the life time of the machine should be made a condition of the purchase. Further prices of the parts should be controlled by the Government taking into account net price in manufacturing countries, transport and other incidental charges so that the dealers may not indulge in profiteering. This will greatly reduce the requirement of Government investment in spares which accounts for a great portion of stores on mechanised river valley projects.

4.3.12. The reserve limit of stores should be fixed on the basis of a detailed analysis on the above lines.

#### 4.4. PROCUREMENT OF STORES

4.4.1. Bulk purchasing of stores, in a manner suited to each individual case, can undoubtedly prove an economical proposition.

4.4.2. The various purchasing organisations in vogue on projects in India are the following:—

- (i) The project authorities themselves.
- (ii) The State Stores Purchase Departments.
- (iii) The Central Stores Purchase Department.
- (iv) The India Supply Missions in other countries.

4.4.3. Stores purchase is a highly technical job involving specialised knowledge of various branches of engineering and it is obvious that no other agency except (i) above can possibly afford to have all the experts on its staff without making the organisation unnecessarily expensive and even wasteful. It is also true that the disposal of business in an expeditious manner can alone be assured by agency No. (i). No other agency can be more conversant with the exigencies of the situation than the project authorities themselves.

4.4.4. We, therefore, recommend that a Stores Purchase Committee be constituted on each large project and vested with full powers to make purchases direct. In order that these purchases may be made in accordance with the principles accepted by the Ministry of Works, Housing and Supply of the Government of India or by the Stores Purchase Officer, a senior officer of these organisations should be associated with the Committee, as recommended by the Sub-Committee of the Central Board of

Irrigation and Power in their Report in Contract and Force Account System of Construction issued in 1952.

4.4.5. These Committees should ordinarily comprise :—

The project Manager	}	<i>Chairman</i>
The S.P. Officer, D.G.S.		<i>Members</i>
The Chief Mechanical Engineer		
The Financial Adviser		
The Chief Accounts Officer		
The Central Stores Officer		<i>Member-Secretary</i>

4.4.6. Budget for the annual stores requirements should be prepared with the same meticulous care as the Financial Budget, supported by Stores Purchases Programme presented before the Purchasing Committee and passed, before any orders are placed, except in emergencies for which special powers should be vested in the Project Manager.

4.4.7. The Chief Stores Officer should be placed directly under the Project Manager, so that the latter may remain in touch with the true position of stores at all times.

4.4.8. Requirements of stores, by consideration of time factor, can fall under three categories :—

- (a) Routine.
- (b) Urgent.
- (c) Immediate.

4.4.9. Under the last category, "Immediate", can fall only the emergency requisitions mentioned in para 4.4.6. All normal indents will comprise routine requirements for purpose of procurements. In case of supplementary indents most of the items may be available in stores and some others may be arranged by the routine procedure while some others may still require urgent attention. However, in the interest of the field engineers themselves, the magnitude of urgent and immediate requirements should be kept as low as possible. If their magnitude increases, such requirements cannot possibly obtain proper attention :—

(a) *Routine* — There should be pre-planning for the procurement of the routine requirements. If recourse has to be taken to direct purchase, procurement procedure should follow the normal channel and lend *itself* to free competition over as large a field in the market as possible.

(b) *Urgent* — Urgent demands are those against which supplies are required within a month. Procurement will have to be made from the ex-stock offers. The same may be available from some of the firms in Rate Contract with any Central or State agency, or else enquiry will have to be made from a group of selected suppliers whose names are maintained on



the approved list. Short notice quotations or telegraphic enquiries will have to be made to save time.

(c) *Immediate*—The enquiries for such demands may be made by telephone or telegrams from a few selected suppliers. It becomes sometimes necessary to place orders even without ascertaining the price of an article but this procedure is risky and should be resorted to only with firms of known repute and by officers of adequate status.

4.4.10. In view of the fact that sometimes short-cut procedures have to be resorted to for urgent and immediate demands, it is necessary to clearly define the powers of various officers in this respect depending upon the type of job, its magnitude and urgency.

4.4.11. There should be a close liaison between the Chief Stores Officer and the Field Engineer. As soon as a schedule of material required is worked out, the field engineer should examine the demand with reference to the materials already available in the Stores with a view to effecting necessary amendments. A requisition in form No. N-1 should then be carefully drawn up and sent in duplicate to the Procurement Section.

4.4.12. Purchase Requisitions received in form N-1 from the various Indenting Officers should be consolidated into one or more sets for issue of inquiries by the Procurement Section. As already pointed out purchases through the State and Central Government purchasing agencies have to follow the procedure laid down for them and procurement department should follow the same. For the rest an inquiry should be issued as may be necessary according to the nature of requirement if it is routine, urgent or immediate. Purchase enquiries should be sent out in the form No. N-2. For bulk purchases of routine category exceeding a certain value (to be decided by the State concerned), it is desirable to give an advertisement in newspapers. For purchases of smaller magnitude, the enquiries may be restricted to the list of selected suppliers.

4.4.13. Where detailed specifications or drawings cannot conveniently be furnished with the enquiry it is often more convenient to ask for samples along with the quotations. The selection of the firm on whom the order is to be placed will, in that case depend upon the quality of the goods and its relative price which may not necessarily be the lowest.

#### 4.4.14. Inquiries and Tenders

The following are amongst the different methods of obtaining quotations :—

1. Open tenders by advertisement in the press.
2. Limited tenders, *i.e.*, by issuing invitation to a limited number of firms.
3. Single tender, *i.e.*, by invitation to one firm only.

4.4.15. The primary duty of the Procurement Officer is to obtain the best value for the money spent consistent with timely procurement. The adoption of one or the other form of enquiry should be given very careful consideration as this is one of the effective methods of keeping down the rates.

#### **4.4.16. Open Tender System**

This system of invitation of tender by public advertisement should be used as a general rule for big purchases, the monetary limit for which should be fixed by the State concerned.

#### **4.4.17. Limited Tenders**

Enquiries under this procedure of purchase are issued to a limited number of firms on the approved list of suppliers for the class of required goods. This system is operated upon where the value of the goods required is below a certain limit, to be fixed by the State concerned or when the demand is urgent or immediate.

#### **4.4.18. Single Tender**

This system may be adopted when the article required is of a proprietary nature such as spare parts of machines. It should be ascertained if there is any rate-contract for the same, so that it may be utilised as far as possible.

#### **4.4.19. Receipt and Opening of Tenders**

Quotations should be invited in sealed covers with instructions to the suppliers to indicate on the cover, the nature of enquiry and the due date of opening the quotations. All these tenders should be collected by the Procurement Officer and kept under safe custody until the date and time fixed for their opening.

4.4.20. It is desirable to open tenders and quotations, as far as possible before the tenderers or their representatives, if any, by an officer authorised to do so, who should initial every page of the quotation or tender and conditions and number them serially.

4.4.21. Quotations received after the due date should not normally be admitted. The cases where there is evidence to show that the quotation was actually posted by the party prior to the date of opening but was not received in time owing to the delay in transit may be taken into consideration at the discretion of the officer calling for the quotations, but the tenders of quotations submitted after the scheduled date and hour of opening should be summarily rejected.

4.4.22. A comparative statement of quotations should then be made and scrutinised by some responsible official and initialled by him.

Orders of competent authority duly empowered to place the order should then be obtained. In dealing with the competitive quotations the same care should be exercised as is normally taken of the competitive tenders in the Public Works Department.

#### **4.4.23. The Purchase Order**

A suitable form of purchase order is given at form No. N-3. The number of copies of the purchase order required will depend upon the complexity of the organisation. In most of the cases six copies, distributed as under, will be found sufficient. These should be filled serially and suitable remarks made as materials are received.

1. To the firm.
2. To the officer receiving store.
3. To the officer holding the store.
4. To the ultimate user.
5. To the Accounts Branch.
6. Office copy of the Procurement Officer.

4.4.24. Any change in the rate or terms, etc. made subsequent to the placing of the orders must be intimated to all persons, to whom a copy of the purchase order was sent.

#### **4.4.25. Repeat Orders**

When materials are required during a contract period in excess of the quantities contracted for, and such excess is not sufficiently large to justify the invitation of fresh tenders, there may be no objection to quantities outstanding under the existing contract, if any, being increased suitably by a repeat order, provided that as a result of negotiation more favourable terms are received for the purchase than would have been possible by calling fresh tenders.

#### **4.4.26. The Register of Purchase Orders**

A register in form No. N-4 should be maintained by the Procurement Officer and the officer receiving the stores which should be kept posted up-to-date from the copies of purchase orders, etc. and periodically examined to watch prompt supplies, etc.

### **4.5. INSPECTION RECEIPT, AND PAYMENT OF STORES**

4.5.1. The Railway Receipts received from the suppliers for goods despatched by rail are required to be very carefully handled as they form an important link in the procedure for stores accounting. A record of Railway Receipts should be maintained in form No. N-5 by the official entrusted with the clearance from the Railway.

#### **4.5.2. Returned Stores**

Sometimes goods may be returned to stores from works, form No. N-17 should be used for this purpose and drawn up in triplicate. One copy should be retained by the person returning it and 2 copies should be given to the Stores Section to which goods are delivered. The person receiving the stores should sign both the copies in acknowledgement of the stores and return one copy to the person who sent the stores and keep the other to accompany the "Stores Received Book"

#### **4.5.3. Inspection and Measurements**

All consignments of materials received against a purchase order should be opened in the presence of an officer responsible for inspection and count. The inspection should be carried out in reference to the standard specifications or drawings, as indicated in the purchase order. In cases where orders are based on approved samples, the standard sample should be held under a seal by the Inspecting Officer and stores accepted only if they reach the standard of the approved sample.

4.5.4. All materials on receipt should be examined and counted, weighed or measured as necessary. Under the existing Financial Rules measurements have to be recorded in Measurement Books (Form CPWA-23) whether these relate to works or materials. This form of measurement books is not suitable for recording measurements of supplies of materials. Also it gives only a single record of the articles received. The procedure of having pass books and bills to various tables for payment causes delay in payments and arrears in the completion of the connected records. It is, therefore, proposed to replace this form with a form of "Stores Received Book" (form No. N-8) for recording receipts of stores. This form affords convenience for accelerated movements and timely completion of records. This form should in the first instance be prepared in triplicate by carbon process using indelible ink or copying pencil. One copy is retained by the officer receiving the store, the second is intended for the disbursing officers for making payments and posting ledger and the third for the preparation of an abstract in form No. N-11. The signature and designation of the officer taking measurement should invariably be endorsed thereon. The pages should be machine numbered. Complete instructions regarding its preparation are given in Chapter VI of Part II of this Report.

#### **4.5.5. Rejected Stores**

Unaccepted stores should be kept aside and the party concerned immediately notified of the rejection through a Rejection Memo in form No. N-6 with the request for immediate removal of the stores from the Government premises. In order to have a consolidated record of such rejections for future reference, it is recommended that a register in form No. N-7, known as Rejection Register, be maintained. This will also serve as a record of the unreliability of the firms in respect of supply of specific items.

#### **4.5.6. Materials Received Short**

The shortages found on opening the consignments should at once be notified to the supplier. In case of damaged packages booked at Railway

risk, a remark should be given in the Railway Delivery Book, short certificate obtained and claim lodged with the Railway immediately. Record of claims for such shortages should be kept in a manuscript register to watch the clearance. Payment to suppliers for shortages accepted by the Railway as their responsibility can be made debitable to Misc. P.W. Advances, pending clearance on recovery from the Railway.

#### **4.5.7. Payment of Railway Freight**

Various methods of payment of railway freights, by cheque, cash and credit notes are at present in vogue in the River Valley Projects. The delay generally attending the adjustment of credit notes, rules out the adoption of this method. Payment by cash would involve handling of large sums of money demanding adequate security arrangements and would not be suitable. On some projects payments by deferred freight system have been allowed by Railways, under which the Station Superintendent sends a consolidated bill once a week for the consignments cleared during the week and then payments made by cheque. This system does not seem to have any special advantage as the bills would require verification, etc. and may result in delays and accumulation. The Committee considers that such payments should be made by cheques and cash to cover the difference between the cheque and actual claims if demurrage, wharfage, etc. which cannot be known in advance, have to be paid. The system was referred to the Railway Board, who have stated in their letter No. 4486-TC dated the 19th May, 1955, that they have no objection to the facility of payment of freight by cheque being granted to such of the Civil Departments of the Central as well as State Government as may ask for it. A copy of correspondence is given in Appendix 6.

#### **4.5.8. Payment of Bills**

4.5.8.1. To avoid delays in payment of bills, it is recommended that the suppliers should be asked to send the bills in duplicate giving reference of Purchase Order and Railway Receipt, etc. These should be entered in the bill register form No. N-12 which is maintained to watch their settlement. During the course of our visits it was seen that many of the projects maintain such registers in some form or the other.

4.5.8.2. As the measurement of stores included in the bill should have already been recorded immediately on receipt, the relative "Stores Received Book" should be completed in respect of rates and amount. It will sometime happen that incidental charges like packing, forwarding, insurance, etc. cannot be included in the Stores Received Book until the receipt of bill. In such cases a supplementary Stores Received Book should be prepared including these charges so that the total of the two Stores Received Books will tie up the accounts between the value of the stores received and the expenditure through cash book on the stock sub-head concerned.

4.5.8.3. The receiving officer will connect the bill with the relative Stores Received Book giving its reference thereon. He will check it with entries made therein and the purchase order and record the

certificate of verification required as per instructions for completing Stores Received Books given in Appendix 4.

#### 4.6. ACCOUNTING OF RECEIPTS AND ISSUES

##### 4.6.1. Direct Purchase *Versus* Purchases through Stock

C.P.W.A. Code Para 99(a) requires that the cost of stores should be debited to the final head of account concerned or to the particular work for which they are required if either of these can be determined at once otherwise it should be kept in suspense account pending clearance as materials are issued by debit to the specific heads of accounts of work. This system can prove satisfactory only when stores are small and arrangements can be made to keep materials charged to work and those charged to stock separately from each other. It does not suit the large River Valley Project organisations where all stores are held by a Central Stores Organisation for ultimate users. It is not possible for such organisation to keep the materials charged to works separately from those charged to stock. The Committee invited views of the various project authorities and is of the opinion that in cases where control stores are maintained all materials should be passed through one channel *viz.* Stock Account. This has the advantages of better control of receipts and issues and knowing the total consumption of an article at a glance from the ledger. It may mean a slight increase in clerical work in stock accounting but the fact remains that it would afford a better control particularly when detailed and clear M.A.S. accounts could not be maintained for certain types of works *e.g.*, operation and repairs of machines, in accordance with the Code Rules.

4.6.2. At present the Suspense Head "Purchase" is sub-divided into two parts, *viz.*, (1) Purchases for stock and (2) Purchases for works. The Committee has recommended in para 4.6.1. that all purchases of stores should pass through stock account. The procedure for such purchases in para 344 of the CPWA Code is that "when materials are received from a supplier or from other department their value should be credited to purchases on closing the accounts of the month if they have been received for stock and payment has not been made for them during the month so as to secure agreement between the quantity and value account". In this system Purchase Account cannot be prepared until the close of the month specially where stock account is prepared in an office different from the one that is making payment. To avoid this difficulty it is recommended that all purchases even for stock should pass through "Purchase Account" in the first instance and clearance effected as and when bills are paid. This may involve some additional work in the maintenance of "Purchase Register" but this would afford the much needed advantage of having control over the transactions and by this method the Purchase Account and its clearance can be maintained and watched from day to day.

##### 4.6.3. Purchase Register (Suspense)

On almost all the River Valley Projects large balances were found outstanding clearance under Suspense Head "Purchase" mostly due to the

difficulty of identifying items with the bills. To overcome this difficulty it is suggested that references to Store Received Book number and date, Railway Receipt number and date, Purchase Order number and date and the names of some prominent items be given in the column of particulars of item of P.W.A. form No. 67 (Register of Supense) which would facilitate linking of the items and their ultimate final clearance.

#### 4.6.4. Abstract of Receipts

4.6.4.1. At present the abstract of store receipts is prepared for the entire sub-division abstracted monthly in a single Abstract of Stock Receipts which are required to be posted in the Sub-divisional Office from the Register of Stock Receipts and issues form No. 8, entries being made in respect of quantity. All transactions of the month need not be entered severally in the abstract but it would be sufficient to show as a single transaction for the total receipt from each source. These transactions are so written as to group the articles by the prescribed Heads of Stock. After all the transactions of the month have been posted, the total receipt of each article is computed and entered in the column headed "Quantities". No entries are to be made in the Sub-divisional Office, in any of the money columns as these are to be filled up in the Division's Office. The values of the stores received are abstracted in the Divisional Office separately by each of the sub-head of stores and are further classified under 'Cash Payment or Purchases'.

4.6.4.2. The existing form No. 9 was suitable for small stores holding a few items only, but they are inadequate for recording large numbers of transactions common to the large River Valley Projects. Moreover the sizes of the columns for transaction are also inadequate to enter the quantities and the value figures. In addition, this form is required to be prepared within a few days intervening the date of closing of the monthly account and the date of its submission. The transactions are so large that it is very difficult to prepare it in duplicate which has to be done by hand, the layout being not convenient for typing.

4.6.4.3. The Committee is of the opinion that when once the receipt of stock has been recorded in the Stores Received Book form, which is already classified by the sub-heads of stock, the duplication of working in preparation of this form is unnecessary. It is adequate to prepare an abstract of the Stores Received Books sub-divided by stock sub-heads to serve the purpose of the existing form No. 9. In view of the fact that we have recommended passing of such transactions through purchases, no further sorting by 'Purchases or Cash Payments' is necessary. The form No. N-11 of Abstract of Receipt recommended by us is given in Appendix 4. This form can be filled up daily from the copy of Stores Received Book which would accompany the abstract.

4.6.4.4. We invited opinion of the various River Valley Projects authorities and Accounts Officers on the suitability of this system. The recommendations of the officers are divided on this subject but the Accountant General, Madras, Andhra and the Tungabhadra Board and

Electricity Department of Madras are already using this system and have stated that they have found it very convenient and simple in operation. We have also recommended the use of ledger system regarding the quantity and value account of receipts and issues. One copy of the Store Received Book will be utilised for posting of the ledger.

#### 4.6.5. Monthly Reconciliation

4.6.5.1. Monthly reconciliation should be effected as under:

1. Total value of the abstract of receipts should tally with total in the Purchase Register for stock.
2. The total of the stock sub-heads in the abstract should tally with the total of the monthly receipts of the ledgers under each of the stock sub-heads.

4.6.5.2. *Measurements of Gases.* Very often payments are made for leaky gas containers resulting in considerable loss to the projects. The cubical contents of the containers should be marked on them and the pressure measured by a gauge on their receipt. With these two figures and atmospheric temperature, bills for stores could be checked.

#### 4.6.6. Intimation of Receipt of Indentors

The intimation of materials having been received should be at once sent to the indentor by the Stores Receiving Officer. He should also watch receipts against the orders placed.

#### 4.7.1. PRICING OF STORES

4.7.1.1. According to para 118 of the CPWA Code an issue rate is assigned to an article of stores as soon as it is brought on stock on the principle that there should ultimately be no profit or loss on stock account, and should consequently provide beyond the original price paid for carriage and other incidental charges, if any, *actually* incurred on the acquisition. This is worked out to the nearest anna and normally remains constant throughout the half year. Appreciable variations are, however, watched and issue rates may and in important cases, shall at once be revised. When closing the half-yearly Register of Stock, all issue rates have to be reviewed and revised if necessary to bring them within the market rates.

4.7.1.2. This principle of fixing issue rates has not proved practicable in the case of large stores handled on River Valley Projects due to the tremendous amount of work involved in breaking up the incidental charges for each item and the time required for enquiry about the market rate for each item etc. This work was found in arrears on almost all the River Valley Projects. The following procedure is recommended for adoption in order to meet the requirements.



4.7.1.3. *Standard Prices.*—The growth in the number and complexity of stores and the need of planning and controlling stores has led to the establishment of standard prices in several commercial organisations. The existing code rule of market price to be fixed periodically involves so much clerical labour that the work remains almost invariably in arrears and it fails to provide the control data for management. We, therefore, recommend the adoption of the first purchase price as the standard price of the store for the duration of the project, except for violent fluctuations in the prices of important stores when corrigendum can be issued. Any profit or loss on stores due to difference in rates can be charged direct to work periodically so as to make costing of items realistic. Whenever violent fluctuations are noticed, the issue rates of the articles should be worked out as best as possible at actuals plus approximation of items of expenditure not known at the time of receipt and this issue rate will remain constant till such an occasion crops up again.

#### 4.7.2. Delivery of Materials to Central Store

The materials along with the original Stores Received Book are passed on to the Store Holder the officer receiving the stores. The Store Holder checks up the materials and allots Bin Cards number to each item in the column provided for the purpose in the Stores Received Book and then makes entries in his Bin Card and signs the Stores Received Book. The original copy of the Stores Received Book is then returned to Receiving Officer who should then complete his other two copies in respect of the Bin Card number and pass on the original copy to the ledger section (in division) for further processing. The third copy will be attached to the monthly "Abstract of Stores Received" form No. N-11.

#### 4.7.3. Binning of Materials

4.7.3.1. The materials on receipt in the Central Stores should be recorded on the Bin Cards and the balances in the Bin Card brought up-to-date. The Bin Cards should be kept in the respective bins or in a bound register (like the Kalamazoo visible binder). It may also be convenient at some stores to adopt Card Index Cabinet System located centrally for each sub-store. Bin Cards form the most important *initial* record, and hence a great care should be taken to maintain them properly. A record of Bin Cards should be maintained in form N-9 to watch their losses. A new card should be issued only under the signature of the officer holding the stores. There should be a separate Bin Card for each type of item indicating transactions of receipt and issues, with respective Store Received Book or Store Issue Book and the number and the date. Each card should show the location of the articles in the space provided for the purpose e.g. File No. Rack No—. There should always be a separate store for all the combustible materials like Calcium Carbide, cotton waste etc. After the completion of all these entries the articles should be stored in the proper bins allocated to the items. As far as possible, bins should be arranged in the sequence of the store code numbers.

4.7.3.2. The recommended form No. N-10 of Bin Card is given in App. 4. It shows the unit of count or measurement, the opening balances, the proposed maximum and minimum balances and a record of the stock verification whenever contents of the bins are checked by the Store Inspector. It is further recommended that the issue rate from the ledger should be entered on the Bin Card.

4.7.3.3. The Bin Cards will serve the same purpose as the existing form No. 8 which is intended to be abolished.

#### **4.7.4. Issue of Stores**

4.7.4.1. Issues of stores in all cases should be made on the authority of an indent in form No. N-13. The indent should be prepared neatly and clearly in indelible ink or with a copying pencil in triplicate by the carbon-process as all subsequent accounting depends on it. One copy is to be retained by the Indentor and two presented at the stores. One copy is to be retained, by the Storekeeper and the other should accompany the stores.

4.7.4.2. The indents must be signed by the officer authorised to indent on the Store subject to such limitations as the Divisional Officer may impose. The indents should be registered, the Stores Issue Book and after issue of the articles, all the columns in respect of rates, Bin Card No. and materials issued should be filled up in the two copies presented to the store. The indents are then signed by the receiving officer on the Store's copy and by the issuing officer on the second copy in token of having received and issued the required materials. The second copy of the indent together with the materials covered by a Gate Pass if necessary should be handed over to the indentor or his agent who will present his copy at the gate for security arrangements. The security officer at the gate should check the store with the indent and affix his stamp 'Checked' on the indent and sign before allowing the materials to pass out of the Store compound keeping the Gate Pass as a Record.

4.7.4.3. From the copy of the indent retained in the Stores, Issue Book should be prepared. Normally three copies as under Stores Received Book should be adequate but this number may be varied depending upon the size of the store organisation and the accounting set up.

1. For posting ledgers.
2. For preparing abstract of issues.
3. Office Copy.

#### **4.7.5. Preparation of Indents for Stores**

The following instructions should be observed for the preparation indents:—

1. Blank space at the end of an indent should be crossed or scored out by drawing double line diagonally across the space.
2. The store-keeper should fill in carefully the column meant for materials issued, as in some cases it may be less than the indent quantity or may be nil.

3. Under no circumstances should any correction be made in the indent by the Storekeeper in respect of quantities issued except under the initial of the indenter or his agent.
4. In no case, should addition or alterations be made in an indent as there is no possibility of checking whatever the addition was made before or after the indent was presented. Storekeeper should not accept unattested alterations and additions but should refuse the issue of such indents.
5. Indents should be current only for 30 days from the date of indent where a partial supply is made against an indent, the balance of the quantities should be cancelled and a fresh indent accepted, if and when the supply is again demanded.
6. Indent books should be machine-numbered and kept in safe custody.
7. Separate indents should be required for each sub-head of store and for each work.
8. Normally only about 6 items should be indented on one copy of the indent to leave enough space to fill in other details.

#### 4.7.6. Accounts of Issues

4.7.6.1. According to the existing procedure (CPWA Code Para III) the issue transactions of the entire sub-divisions should be abstracted monthly in a single 'Abstract of Stock Issues' (Form No. 10) which is posted from the Register of Stock Receipt Issues (Form No. 8) entries being made only in respect of quantities. Several transactions of a month are not shown severally in the Abstract but a single transaction is shown for the total issue to each account or work. The entries are so arranged in the Form 10 as to group them by the Stock sub-head. On receipt of this account in the Divisional Office, value account of issue is prepared on the basis of the issue rates and the storage charges.

4.7.6.2. This procedure was suitable for small stores where the number of items of the transactions were not very large. For River Valley Projects stores, however, this system of preparing a consolidated monthly abstract of issues is found inconvenient, as it is impossible to compile the monthly account in the few days intervening the date of closing and the date of submission of the monthly account.

4.7.6.3. Having introduced the Store Issue Book Form No. N-14 for classified issues, we feel it unnecessary to have to prepare the issue of abstract showing also the items of stores classified.

- (i) By sub-head.
- (ii) Work and its sub-head.

We consider that an abstract of the Store Issue Book grouped by sub-heads of stock and each group classified by work and its sub-head would serve the same purpose yet simplifying the day-to-day work without putting extra strain by the end of the account month.

#### 4.7.7. Preparation of Abstract of Issues

4.7.7.1. The detailed procedure for the preparation of the Abstract of Issues will be as under:—

- (i) Each sectional store holder will prepare separate S.I.Bs. for different sub-heads of stores daily for the issues of the day based on the registered No. of the indents. The total value for a stock sub-head should be carried forward from page to page for an account month.
- (ii) The sectional store holder should prepare in addition an abstract of the indents issued in a sheet maintained separately for each work and its sub-head and post it under the proper sub-head of stock *vide* form No. N-15. He should post this form daily from S.I.Bs. and prepare an abstract thereof at the close of the month in a monthly abstract form No. N-16 to which one copy of the S.I.B. concerned will form its accompaniment.

4.7.7.2. At the end of a month, each section store-holder will submit a set of Store Issue Books and a copy of the monthly abstract of issues to the officer who compiles the account of the store. The officer will in turn, consolidate the abstracts of various sectional store-holders in similar monthly abstract form for his entire charge which will give the values of the store issued by store sub-heads, by work and its sub-heads, and by the Fundamental Heads of Account. This will form the basis of intimating the debit to various sub-divisions and divisions work-wise and give the necessary figures for periodical reconciliation of the stock account in as far as the issues by stock sub-heads are concerned.

4.7.7.3. The main advantage of this system is that the classification of the indents by works, their sub-heads and the sub-heads of stock is carried out from day-to-day so that the work remains up-to-date.

#### 4.7.8. Loan of Tools

4.7.8.1. To keep a watch on tools lent out we recommend the use of the Tool Card Form No. N-24.

4.7.8.2. The objects of this Card are:—

- (a) to provide a plant record of every tool, jig, gauge or other items of movable plant which require control;
- (b) to supply a record of plant items issued to operators; with the dates of issue and return.

4.7.8.3. The card is designed for two purposes; first to list the employees who have used a tool and in particular, to show the person actually in possession of this plant item, and second to list all items handed over to an individual and obtain that person's initials fixing responsibility in case of subsequent claims. The method of working is to make out one card

for each item of plant; and one card for each employee to distinguish the two types of cards, it is suggested that one to the top corners of the plant card should be cut off.

4.7.8.4. The plant cards are filled according to plant number and the employee's cards according to personnel number.

4.7.8.5. The presentation of the job card is the authority to draw cardools, and the storekeeper notes the employee's number on the plant with and the plant number on the personnel card. He stamps both cards with the date of issue and obtains the initials of the person receiving the card on the personnel card.

4.7.8.6. Should the tool be required, its location is known and should an employee leave the factory, it is possible to present a list of outstanding tools which should be returned to, before his departure. The transaction upon return completes the cycle, and by showing the stamp date to the employee, the latter is assured that his liability is cleared.

#### 4.8.1. RECONCILIATION OF ISSUES, RECEIPTS AND BALANCES

4.8.1.1. *Store Price Ledger.*—To watch the value account of the transactions we recommended the use of stock ledger envisaged in para 133 of C.P.W.A. Code. This ledger will form the fundamental basis for the reconciliation of the receipts, issues and balance of stock by its sub-heads as these ledgers would be posted independently of the Bin Cards from the Stores Received Book and Stores Issued Books.

4.8.1.2. It has been stated earlier that one copy of each of the Stores Issued Book and Stores Received Book should be routed through the ledger clerk to enable him to keep his posting up-to-date.

4.8.1.3. We have further suggested that each ledger should have a few pages at the end reserved to abstract the transactions of each of the articles in the ledger every month. At the time of periodical reconciliation with the financial account, a copy of the ledger abstract should be given to the accounts branch where, the total of all the ledger abstracts grouped by sub-heads can be taken without any laborious computations.

4.8.1.4. We further recommended that the financial reconciliation of the stock account should be carried out by one or two stock sub-heads each month so that the entire work does not come up at the end of a six or twelve-monthly period. This reconciliation under the system proposed by us would be relatively very simple. As store has not to be repriced at Market Rate, the reconciliation would amount to settling the discrepancies in the quantity account to bring out the differences between the ledger balances and the financial accounts.

4.8.1.5. As the issue rates are recommended to be fixed as standard the discrepancy between the financial account and the ledger account,

would be adjusted to the Project on a *pro rata* basis to be fixed by a competent authority.

4.8.1.6. If monthly reconciliation is taken up for one or two stock sub-heads, it would be possible to locate and set right the arithmetical errors side by side each month without accumulating all the work at the end of the six-monthly period.

4.8.1.7. We further recommended that the monthly review should be taken to bring out the discrepancies between the financial and the value amount of ledgers but we suggest that the adjustment of profit and loss should be deferred to the end of the yearly period.

4.8.1.8. The physical verification of the ground balances should also be so planned as to complete the particular stock sub-head each month so that the quantity account also can be reconciled at the same time as the value account. If and where this system is adopted it will not be necessary to maintain form No. 11 and 12 for six-monthly reconciliation as the same will be served by the Bin Cards and the price ledgers.

4.8.1.9. We invited views of various executive and accounts officers connected with the River Valley Projects. Almost all the officers have endorsed the views that if priced store ledgers are maintained, the existing form P.W.A. 11 and 12 would be superfluous. Accountant General, Madras and Andhra mention that this system is working very satisfactorily and that reconciliation of the ledger and financial account is carried out monthly.

4.8.1.10. The rules for the maintenance of Store Price Ledgers are given below:—

- (i) One page or more of the ledger should be devoted to one item as necessary.
- (ii) One ledger should be devoted to one stock sub-heads or category.
- (iii) Entries in the ledger for the receipts and issues should be initialled by the officer entrusted with the posting.
- (iv) A certificate should be given on every Stores Issue Book and Stores Received Book to the effect that entries are made in the ledger accordingly.
- (v) Ledger folios should normally be arranged according to the sequence of the Store Code numbers.
- (vi) The face sheet should give an index of the items in the ledger and their code No. and page.
- (vii) Arrangement should be made by the Divisional Officer to see that a fixed percentage of the entries on the receipts and issues of the ledger are checked with Store Received Books and indents by a responsible officer of the divisional staff, say Divisional Accountant, Store Keeper, etc.
- (viii) Ledgers should be kept in safe custody under lock and key.

- (ix) Ledgers may be in bound registers, each page being machine numbered. Alternatively they may be in loose leaves (like Kalamazoo binders) in which case each sheet should bear the signature of the Divisional or Sub-divisional Officer at the time of issue.

#### **4.8.2. Detached Store Sub-division**

4.8.2.1. It will sometimes happen that an independent store organisation subordinate to the main store will have to be maintained at the site of work. Sub-store will generally belong to a Sub-divisional Officer.

4.8.2.2. In such cases the Central Store should issue the materials to the sub-divisional store as 'transfer of stock' and the sub-division should maintain its own issues.

4.8.2.3. The sub-store should send monthly abstract of their own ledgers, to the divisional office for monthly reconciliation of the sub-heads concerned undertaken for reconciliation during the month.

4.8.2.4. The sub-divisional store, should be kept supplied with the revised issue rates every time the rates are revised in the divisional office. Normally all such receipts whether in the divisional office or at such sub-divisions should be treated as divisional receipts and then shown issued to the sub-divisions.

#### **4.8.3. Stock Taking**

4.8.3.1. The P.W.A. Code lays down that in the case of special stores of construction divisions, where there may be large concentration of stores their physical verification should be the duty of the executive authorities and should be performed by such agency and in such details as may be decided by the local administration in consultation with the Accountant General.

4.8.3.2. Local authorities have prescribed different regulations in their own P.W.A., Code to deal with the physical verification. Often these lay down that ground balances should be checked at the end of the six-monthly or yearly period. For large stores, such verification cannot be carried out within a few days at the end of a given period. It is necessary to spread the work throughout the year so that each section under various stock sub-heads can be checked at least once a year and preferably twice.

4.8.3.3. In order to achieve an independent check, it is desirable to have an officer of adequate status specially set apart for this work. The status of the officer will depend upon the size and value of the store. On big stores, one or more gazetted officers may be appointed whereas on relatively smaller stores a stock verifier working independently of the officer in-charge of the store may be adequate. The Chief Executive of the project would lay down rules specifying the duties of the verification officer which

would mention particular sections of stores to be checked once, twice, thrice in a year, depending upon the importance of the sections, their transactions and the possibility of discrepancies in the ground balance.

4.8.3.4. The verification officer should maintain a register in the following form to control the programme of checking:—

### CHECKING

Store	Code No. of Store	Rate of Check				Remarks
	1st cycle	2nd cycle	3rd cycle	4th cycle		

The verification officer should check whether any of the store checked by him has become unserviceable. If so, he should submit a report showing the articles, quantity and the conditions of such store, indicating the action necessary for its better preservation. Such unserviceable store should then be dealt with, in accordance with the Code rules.

4.8.3.5. *Instructions*—The following instructions should receive special attention:—

1. The subordinate in-charge of the store should render full assistance to the stock verifier in his work.
2. The Bin Cards should be brought up-to-date by the stores organisation before a section is put to verification, and the balances shown therein got certified as correct by Accounts Branch.
3. The stock verifier should prepare a list of the articles in the section to be verified from the Bin Cards and record, the Bin Card balances, the ground balance and the difference in a form No. N-19.
4. Articles of allied nature should be verified at the same time to see whether there is any inter-mixing of these.
5. The check should be carried out in the presence of a representative of the stock-holder so that the necessary assistance can be rendered to the verifier in identification and count of the articles and discrepancies minimised.
6. Where weighment of large quantities is necessary, the number or weight may alternatively be determined by weighment and count on the basis of an average sample weight or count of quantities selected at random for articles, coke, etc., the materials may be verified on the basis of stock measurements and standard weight per unit of volume. Small discrepancies likely to arise in sure methods of check may be ignored.



4.8.3.6. Four copies of the verification report should be prepared which should be utilised as under :—

- (i) to the Chief Executive of the Project ;
- (ii) to the officer holding the stock ;
- (iii) to the section stock-holder; and
- (iv) verifier's own copy.

4.8.3.7. The Verification Officer should initial and date the Bin Cards of articles checked by him. The officer in-charge of the store should scrutinise the discrepancies . If there are any arithmetical errors these may be set right under the initials of the verifier; the shortages and excesses should be dealt with in accordance with the para 134 of C.P.W.A. Code. The discrepancy report should be finalised and action taken within one month of checking.

#### 4.8.4. Treatment of Stores Deficiencies

4.8.4.1. Deficiencies should be carefully inquired into with a view to discovering the cause. This may consist of one or more faults, such as :—

1. Issue of materials without requisition.
2. Issue of more materials than requisitioned, either by failure to alter a requisition note to agree with issues, or by guessing quantities.
3. Misappropriations of goods from store.
4. Wastage of stores through careless handling, faulty protection, or natural causes.
5. Failure to make the necessary charge for goods sold, no requisition note having been issued.
6. By merely giving 'Good' measure or weight. It is simply the 'Scales Pull'.

4.8.4.2. Whatever the reason for the shortage, certain actions are necessary.

1. The deficiencies must be written off the stores accounts, and the Stores Control Account.
2. The authority for writing off, and clearing up, must emanate from a person of responsibility, preferably the head of the department.
3. They must be charged up to something, or to somebody, and what, or who this is, and can be determined only in the light of the fullest knowledge available.

4.8.4.3. Assuming the losses are *bona fide*, and as an indication of how they may be treated, it is suggested that efforts be made to find out what jobs have been undercharged (in quantities) with stores issued,

so that errors may be rectified. The Cost Accounts Section should be of great help in this connection.

#### 4.8.5. Writing out Surpluses and Deficiencies in Stores Accounts

4.8.5.1. It has already been recommended that surpluses and deficiencies be written out of the books without delay. The reasons for prompt action are : —

1. The Stores Accounts become inaccurate and exhibit a false view of the actual positions.
2. The Cost Accounts are also wrong and should be corrected.
3. If the seriousness of inaccuracies is not impressed on all who have been responsible for them, the full benefit of a system of stores accounting is not obtained, and there is no incentive on the part of the delinquents to be more efficient.
4. An unscrupulous storekeeper can, if he so wishes, rectify surpluses whether by pilfering, or by deliberate issue of materials without, or in excess of proper requisitions.
5. The storekeeper can also try to put the deficient balances right by giving short weight of measurement or by other means more or less suitable, according to his ingenuity.
6. Surpluses and deficiencies may balance one another as a whole or in part, and in consequence large disparities of both descriptions may be wholly or partly obscured.

4.8.5.2. The treatment of surpluses should be based on the results of an inquiry of the same description as that suggested in the case of deficiencies. Accounts that have been overcharged in issues should also be put right.

#### 4.9. OTHER STORES

4.9.1. Apart from stores held in stock under central stores, the following types of stores also have to be handled and their accounting done :—

- (i) Charged Stores.
- (ii) Returned Stores.
- (iii) Scrap, Empties and Surplus Stores.
- (iv) Tools and Plants.

#### 4.9.2. Charged Stores

With the Committee's recommendations for passing all stores through 'Stock' and discontinuance of M.A.S. Accounts on River Valley Projects, the above type of stores must disappear. If, however, such stores do appear these should be kept apart from the regular stores prominently marked as 'Charged Stores'. The transactions of issue of such stores

should also be passed through Stores Issue Book which should be marked prominently as 'Charged Stores'.

#### **4.9.3. Returned Stores**

4.9.3.1. There will be two types of materials returned to the store.

- (a) New Stores remaining unutilised on completion of works.
- (b) Old Stores salvaged from works.

4.9.3.2. Such articles should be returned to the stores so that their future utilisation could be planned. These should be presented to the store accompanied by return store note in form No. N-17. The Central Store will then deal with the articles so received in the same manner as the account in the S.R. B. form.

#### **4.9.4. Scrap, Empties and Surplus Stores**

These should be given the same treatment as outlined for 'Returned Stores'.

#### **4.9.5. Tools and Plant**

In case of Central Store Organisation being established on projects, the articles of Tools and Plant should also be handled by it and account kept according to the existing rules.

### **4.10. STORE MANAGEMENT**

#### **4.10.1. Location**

Store should be located at sites where from the minimum of carriage of materials to the various departments served is involved. They should preferably be close to the Railway Station. Very often store buildings not originally intended to serve for stores are used for storing the goods received in the earlier phase of a project. Many such buildings are a make-shift, but the exercise of ingenuity can lessen the disadvantages of this nature. It is desirable to plan out storage building carefully and rather on the liberal side to avoid damages and deterioration of the stores. We noticed that almost all the projects stores did not plan and construct their buildings adequately in advance and in almost all the cases the estimate of the space required enhancement.

#### **4.10.2. Space**

4.10.2.1. One ever-recurring and chronic difficulty is the lack of space. This may be alleviated by the use of gangways not wider than is necessary to handle, in and out, the large and awkward parts. In ordinary circumstances 2 feet and 2'-6" gangways will be sufficient.

4.10.2.2. The heavier goods should be stored in the lower bins which should be kept bigger. If the bins run higher than 6 ft. the lower bins should be strong enough to permit a man to climb the first three or four bins. Where necessary, portable ladders should be provided to approach the upper portion of racks so that the space can be utilised. Racks of 10' height should be suitable. There should be at least 4' clearance from roof to the top of bins to prevent damage due to sweating. The provision of extra space on the top also lessens the heat effects on men working at the top of the bins.

Ideally, only one type of item should be stored in each store bin but frequently many types of items have to occupy a bin due to lack of space. In such cases the bin should be partitioned so that different types of items are segregated. Where it is impracticable to partition the bins, the items selected to occupy the same bins should differ from one another as much as possible. Orderly piling of the items one upon another in tiers within the bin makes best use of the space in the bin and also helps in quick counting whenever required.

#### **4.10.3. Type of Bins and Racks**

Steel racks with bigger bins at the bottom and smaller at the top are recommended for the storage of spares, electrical materials, small tools and general stores of lighter types. Ready made steel racks to standard dimensions are available in the market. At some places masonry racks can be used with advantage for the storage of heavy goods like ferrous and non-ferrous metals, paints etc.

#### **4.10.4. Lighting**

Storage racks are generally built up high, because of the limitation of space. Natural lighting is, therefore, generally poor. The correct and prompt service requires good lighting of stores, and this can be assisted by painting in light colour the walls and ceiling such as the aluminium paints. The provisions of portable inspection lamps, which will shine right into any bin should invariably be made even with an adequate overhead lighting system.

#### **4.10.5. Cleanliness**

Dust collects quickly in stores, particularly where the floor is of concrete. Washing the floor is ineffective and the concrete should be treated with some sodium silicate product in order to keep down dust. A vacuum cleaner is desirable for this purpose.

#### **4.10.6. Protection of Stores**

All the stores after inspection should be wrapped in original wrappers after greasing. If these are torn out in the process of checking them, new wrappers should be provided. Special care should be taken in storing all the small spare parts so that they are absolutely

protected against (rust) etc. It is desirable to wrap assemblies in transparent coverings, and or paint the articles with anti-rust paint in order to save the trouble of greasing and degreasing. The store should be made absolutely leak and damp proof. It should be the duty of the officer in charge of store to see that proper rust proof paints and disinfectants are used freely to see that no damage is being done to any item of stores under his charge. The gaskets are very delicate parts to handle and are liable to be damaged by dampness works, etc. It is recommended that separate drawers in cabinets should be used to arrange the gasket of various sizes. The smaller one can easily be arranged in the space within the larger ones. Tyres, tubes and rubber goods should be placed in a dark and cool room to guard them against deterioration by heat and light to which rubber goods are so very sensitive.

#### **4.10.7. Lettering**

It is desirable that a uniform and well considered system should be used for numbering bins, compartments and stocks. The letters and numbers should be at least 3" high, and placed at eye level if possible. Numbers should be assigned in a uniform manner, and they should run from left to right uniformly throughout the store, and from bottom to top of the store so that the bin number also indicates in a general way its location. Colours may be used for identification of materials if desired.

#### **4.10.8. Fire Protection**

4.10.8.1. Special attention should be paid to the fire hazard. No oils, varnishes, inflammable compounds, celluloid, kerosene, petrol, packing materials etc., should be stored with other materials. Materials of this nature should be stored separately, at a safe distance from other stores so that the risk of spreading fire is minimised. Fire extinguishers and fire buckets should be placed at different places in all the stores in sufficient numbers for emergencies. Fire fighting drills be held to fight fire in emergencies. Fire fighting squads should be formed from amongst the staff who may be given a small allowance to keep them alive to the sense of their duty. The stock compound should be served with a net work of pipe line and fire-hydrants, supplied from water storage under adequate pressure to bring fire hoses into operation whenever needed. It would be desirable to consult fire-fighting experts and follow their advice about the layout and arrangement of fire-fighting.

4.10.8.2. Notice boards both in English and the regional language should be placed at the entrance of store houses and on other places where materials are placed, prohibiting smoking, of lighting fire in the store houses etc.

#### **4.10.9. Security Measures**

4.10.9.1. The methods and forms recommended in all phases of accounting for controlling these essential commodities have been designed

to eliminate or minimize losses from pilferage. Notable instances that have a very potent effect in this matter are :—

1. Checking invoices with the Stores ledger;
2. Checking invoices with the Stores Received Books ;
3. Checking invoices with order on suppliers;
4. Detailed stocks and stores account ;
5. Making frequent spot test checks on stores , etc. by internal audit or other staff with the Stores Ledger Accounts and Bin Cards;
6. Taking a complete periodical stock and comparing the finding with Stores Ledger Accounts;
7. Instituting periodical returns from departments, branches and stores to head office ;
8. Comparing and linking up stores received with the financial books ;
9. Internal automatic check by spreading the work over as many persons as practicable ;
10. Effecting checks on issues by reference to S.I.B.'s and the user ;
11. Branding by distinctive mark, plant, etc. for retention on the premises; and
12. In respect of issue to jobs a good check on consumption is effected by 'Measuring up' the work done. A competent person can compute with considerable accuracy the quantity of materials required in a given product, taking into account unavoidable wastage. The figures comprised in detail as to materials used (as shown by cost accounts) help to locate pilfering and unnecessary wastage by the workers on the job in question.

4.10.9.2. In certain cases, it may be thought appropriate to institute direct physical precautions against theft of materials by methods such as :—

- (a) the use of clothing of overall without pockets by those who handle stores of small dimensions but of appreciable value,
- (b) the examination of persons leaving the premises by inspectors or other persons, and
- (c) the checking of goods taken out of or off the premises, by doorman, yardman, etc., by a comparison of the declared contents of packets and the label thereon (filled in by one person and duly verified by another, adding his signature) with delivery and issue notes, invoices, or pass out orders held by the person removing the goods.

4.10.9.3. The foregoing remedies for avoiding or minimising pilfering are not equally applicable to all circumstances. The most appropriate method to adopt, would depend on factors such as :—

1. The nature of the stores, some are small and valuable, others less easy to steal and difficult to remove unnoticed;
2. The location of the stores building or compartments; and
3. The presence of other employees therein. (It is more difficult to pilfer articles if somebody else knows it). Each case should be considered on its merits.

4.10.9.4. The Security staff should be provided for all stores in adequate numbers and where necessary Police Guards should be provided. The store yard should also be well lighted at night.

#### 4.11. LACK OF TRAINED PERSONNEL

4.11.1. Raw officers and subordinates are often placed in-charge of large stores without knowing the A.B.C., of store management, or having familiarity even with the names of the stores. This lack of knowledge and experience coupled with the absence of Code numbers results in wrong physical issues of stores and in wrong accounting subsequently, creating confusion all over.

#### 4.12. INSUFFICIENCY OF STAFF

4.12.1. Some of the difficulties in this connection will disappear as soon as the store personnel are given proper training and proper rules and procedure for stores accounting and management are introduced. On projects having big stores involving thousands of daily transactions, accounting machines can be used with advantage resulting in speeding up of work and greater degree of accuracy. They are, however, difficult to maintain, are expensive in the initial cost and their hiring charges are high. Their use can, therefore, be recommended at present only to the projects which are largely mechanised and have costing cells.

## COST CONTROL

### 5.1. CONTENTS OF A PROJECT REPORT

5.1.1. A project report should be able to present to the reader a complete picture of the socio-economic effects of the undertaking and comprises items like the topography, geology, hydrology, climate, communication, soil characteristics, ground water conditions, engineering plans, estimates of quantities and cost, analyses of rates programme of work, schedule of the annual requirements of equipment, men, material and stores and funds, specifications of work and financial forecast. It should also be accompanied by the following documents :—

1. A schedule of basic wages.
2. A schedule of basic rates of materials.
3. A schedule of transport rates.
4. The equipment prices and their use rates.
5. The basic outputs of men and machines.
6. The standard methods and units of measurement.
7. The classification of accounts.
8. Estimates.
9. Codes for stores and accounts.

The first five of the above items have been dealt with elsewhere in this report. We will deal with the rest in this chapter.

### 5.2. STANDARD METHODS AND UNITS OF MEASUREMENTS

5.2.1. The units to be adopted for bidding purposes and for measurement and payments of work should conform closely to the Standard Estimating Practice. Typical units are given in Annexure 1.

5.2.2. The Institute of Engineers (India) has brought out a publication entitled 'The Standard Method of Measurements of Building & Constructional Works', which deals mainly with items relating to the Building Industry. We recommend that a comprehensive Manual on similar lines be got out for the River Valley Projects.

### 5.3. CLASSIFICATION OF ACCOUNTS

5.3.1. A standard classification of the items of work is essential for the correct compilation of accounts and reconciliation of figures between costing and accounts sections.



5.3.2. The present system of classification fails to meet the present-day requirements of the large River Valley Projects, which contain numerous and varied features that they cannot all be denoted by the 26 letters of the English alphabet and this handling very often leads to confusion and be responsible for the inability of the project officers to furnish cost figures for the various items of work in spite of their best efforts.

5.3.3. A simple system of classification of estimates and accounts is given in Appendix II.

#### 5.4. CODIFICATION OF ITEMS OF WORK AND STORES

5.4.1. Accounts and stores are not codified at present. They have to be described and result not only in waste of time in writing but may often also result in serious accounting mistakes, which become difficult to locate. It is, therefore, essential that a proper code be laid out for all items of stores and accounts and the same code be followed in the preparation of estimates. (App. II & Chapter 4 para 4.2.3. gives the code).

#### 5.5. THE ESTIMATE

5.5.1. Estimate being the foundation for cost control should be prepared with meticulous care by a competent engineer, thoroughly familiar with construction methods and costs. It should be prepared in such detail and in such a manner that may enable the cost engineer to split up the cost into the elements of work with a view to make comparison of actuals with the estimated figures possible. If this is not done, cost reports will not be readily assimilated and make comparison at a later stage difficult if not impossible, thereby rendering the cost section inoperative and ineffective.

5.5.2. The estimate indicates the probable cost and not the actual. The agreement of the former with the latter will depend upon the estimator's skill, the correct visualization of the work as also the accuracy of estimating methods employed by him. The preparation of an estimate of a real value is a skilled work and calls for the highest training, wide experience and sound judgment.

#### 5.6. PHYSICAL QUANTITIES

5.6.1. A River Valley Project involves expenditure in two forms *viz.*, structural and physical. The estimate takes off quantities in units of work from the drawings in terms of brick-work, concrete, stone masonry etc. These quantities "called structural quantities" are priced at a composite rates called "unit rates" or "item rates" for purpose of estimating. These quantities should also be converted into physical quantities such as materials, labour, plant use expendable stores etc., which can be precisely priced at prevalent wages and basic market rates of materials. Appendix IV contains a form N-33 recommended for estimating purposes.

5.6.2. The following items have a great bearing on the actual cost of a project:—

1. The Contract,
2. The Documentation,
3. The Contractor,
4. Planning the job,
5. The Organisation,
6. Cost Control;

and are dealt with in the succeeding paragraphs.

### 5.7. THE CONTRACT

5.7.1. Contract may be classified as follows :—

1. The lump-sum which provides for the payments to the contractor on the basis of a total amount to cover all work and services required by the plans and specifications. Its use is indicated where the types of construction are largely standardised and where a variety of operations is required. Plans & specifications should be comprehensive and should show in complete detail the requirements of the work. Work orders showing deviation after the contract is signed, prove expensive and even lead to controversies and disputes. Furthermore, when the plans are indefinite the contractor tries to inflate his bids to cover the worst case. If these hazards are avoided, the Government has the advantage of knowing in advance the exact cost of the work, and the measurement of work and payment thereof are considerably simplified.
2. The Unit-Price contract which includes a breakdown of estimate into number of units of each type of construction and a price for each unit. When the work requires large quantities of a relatively few types of construction, and the volume of work cannot be exactly determined in advance, the unit price contract has many advantages. It is elastic as reasonable variations may be made in amount of work to be done without formal deviation from orders as long as the changes are restricted to the tendered items. The plans and specifications must show the nature and details of the work, but its limits may be left more or less indefinite, the magnitude and scope of the work being indicated by the estimate. Under these conditions the contractor is not forced to gamble on uncertain conditions.
3. Cost-plus-a-percentage of cost contract provides for the contractor's profit on the basis of a fixed percentage of the actual cost of the work. In common with all negotiated contracts this type permits the beginning of construction before the plans are completely developed, resulting in an

important saving of time in the completion of urgent projects and the government may make any desired changes in the plans and specifications as the work progresses. It has the disadvantage to the government that the contractor's compensation is increased by an increase in construction on cost. Therefore, there is no incentive for the contractor to economise during construction.

4. Cost-plus-a-fixed fee : To eliminate the above defect the contract may be cost-plus-a-fixed fee type which provides for payment to the contractor the cost of the work plus a fixed amount as fee which is determined from a consideration of the character of the work and its estimated cost. Thereafter the fee remains fixed although the actual cost of the work may vary from the estimate.
5. As an added incentive to the contractor to keep the cost of the work at a minimum, a profit-sharing clause is sometimes added to the cost-plus-a-fixed fee contract. The profit-sharing provision allows the contractor to receive a share of any saving if the actual cost should be less than the original estimate.

5.7.2. The principal argument against cost-plus-a-percentage types of contracts is that the owner has no way of knowing in advance what the work will cost. This objection may be overcome to a considerable degree by placing a maximum limit on the cost of the work. That is to say the contractor is reimbursed for the actual cost of the work plus his fee, provided that the total amount does not exceed the maximum limit provided in the contract. If the total amount should exceed the maximum limit the contractor is held responsible for the excess and receives no compensation over the guaranteed ceiling price. This type of contract removes some of the uncertainties from the ordinary cost-plus-percentage contract but requires that the plans and specifications for the work be sufficiently developed to permit the establishment of a reasonable ceiling price.

5.7.3. A contractor may deliberately inflate the construction cost in order to obtain a corresponding increase in his fee. This may be done by padding payrolls, taking commissions on materials purchases, and the like. For these reasons we do not recommend the cost-plus-a-percentage forms of contracts for general use. Extra work and change orders may, however, sometimes be handled conveniently under this system.

## 5.8. SELECTION OF THE TYPE OF CONTRACT

5.8.1. It is advantageous to adopt a competitive bid contract when sufficient time is available to work out the plans and specifications in detail. Generally, however, the unit price form is used for all Civil Engineering contracts and is recommended for general adoption.

5.8.2. A negotiated contract will be indicated when it is desirable to begin work before the completion of detail plans and specifications thus assuring earlier completion of the work when the requirements of the project cannot be determined definitely in advance of the early phases of construction; or when the nature of the project is such that an accurate estimate cannot be made for bidding purposes.

5.8.3. It sometimes happens that the Government contemplating a construction project desires to deal with only one party for all services, both engineering design and construction, in connection with the work, this is a so-called "turn-key" or "package" job. This type of contract may be drawn either on a firm price or on one of the cost-plus forms and the planning, design, plans, specifications, and construction services, are included under one contract. Combined engineering and construction contracts of this nature are not in public interest.

## 5.9. THE DOCUMENTATION AND TENDERS

5.9.1. The specifications are an integral part of a project whether the work is to be executed through a contractor or by the departmental agency. Their composition, therefore, must be logical and systematic otherwise they will result in repetition, omissions and conflicting statements which lead to confusion and disputes with contractor during and after the construction and can thus considerably add to anticipated costs.

5.9.2. Looking to the number of controversies arising in the interpretation of contracts and specifications, we consider it necessary that greater attention be paid to contract documents to avoid all ambiguities. It would be recognised that the preparation of documents for River Valley Projects is best done by qualified quantity surveyors experienced in taking off and pricing.

5.9.3. We like to bring out one important aspect of contract documents. It often happens that junior officers knowingly or unknowingly make commitments to contractors which have a far-reaching effect on the contract while they have not the requisite authority to do so. On the other hand, the contractor seldom, if ever, places himself in the wrong, fortified as he usually is with advice from astute lawyers. It is, therefore, very necessary that agreements should contain a clause invalidating all commitments from any but the legally authorised sources. Also, on large projects legal advice should freely be available to the Contract as well as the Claims sections of the Project.

## 5.10. THE CONTRACTOR

5.10.1. One of the most important items for the successful execution of a work is the selection of the right type of contractor.

*Selection of Contractor.*—The selection of the contractor should be based primarily on the following considerations :—

- (a) Previous experience in the particular type of work.
- (b) Reputation for fairness and excellence in performance.
- (c) Quality and experience of personnel.
- (d) Available working capital.
- (e) Available plant and equipment.
- (f) Normal volume of work per hour.
- (g) Incompleted works in progress.
- (h) Available work capacity (difference between normal volume and incompleted work in progress).

Information along these lines should be collected and classified systematically preferably by some sort of questionnaire. Analyses of this data will usually indicate one or more contractors suitable for the work. A pre-selection of bidders is, therefore, recommended.

5.10.2. The necessity to advertise for bidders, to accept bids from all who are inclined to compete, and to award contracts to the lowest possible bidders, introduces problems in the awarding of contracts for public works which are not encountered in private construction, where the still of bidders may be selected without restriction. For a bidder to establish responsibility under these conditions, usually means the furnishing of required security and a record free from defaults or proved dishonesty. Thus incompetent and over-extended contractors and those with inadequate financial resources may be placed, more or less, on an equal footing with responsible bidders in the competition for the awarding of the contract.

5.10.3. The employment of unqualified contractor usually leads to difficulties during the operation of the contract. Also slow progress, unsatisfactory quality of work and excess cost may result. Moreover, incompetency is one of the very important factors in contractor's defaults which always cause inconvenience, delays and extra cost to the owner. To avoid or reduce these difficulties, the pre-qualifications of bidders is recommended. The object is to determine before the contractor is allowed to bid whether he is responsible and competent to satisfactorily complete a given construction contract.

5.10.4. The pre-qualification procedure requires the contractor to submit a formal application to bid. The application contains sufficient information on the lines outlined in para 5.10.1. The consideration of these factors will usually eliminate unfit contractors from the list of those permitted.

5.10.5. The chief advantages of pre-qualification are that lists of competent bidders will be established in advance when there is sufficient time to investigate contractors' qualifications. When all the bidders are qualified, the contract is simply awarded to the lowest bidder and the public official, who awards the contract, is saved the embarrassment of rejecting a low bid from an unqualified bidder. Contractors are saved the time and expense of preparing bid for him for work in which they are unqualified, by inexperience and lack of financial or other resources. Failures and defaults of contractors during construction are minimised by the elimination of unfit contractors, which results in the saving of time and cost in construction work.

## 5.11. ORGANISATION

5.11.1. After the estimate has been sanctioned and the agency for the execution of the work decided, a suitable project organisation has to be set up. A sound organisation should satisfy the following requirements :—

- (1) Separation of functions, such as accommodation procurement, engineering, laboratory control, etc.
- (2) Setting the line of functions with their logical subdivisions so that there is no over-lapping or conflict and so that no individual receives orders from more than one individual—his immediate superior. He may, however, receive aid and advice from Staff Officers or Assistants.
- (3) Clear cut distinction between line and staff functions and functional control.
- (4) Clear cut specifications of each job.
- (5) Suitable and adequate delegation of authority and responsibility of each member.
- (6) Selection for each position and most suitable person without fear, favour or political influence.

### 5.12. OBJECTIVE OF THE ORGANISATION

5.12.1. The objective of organisation is the actual superintendence of operations, and its prime purpose is to obtain the maximum production at the minimum expenditure. To achieve this end, it should know :—

1. How the actual production can be made approach the estimate.
2. The production that is actually being obtained.
3. The best production that can be obtained.

5.12.2. To make the actual production approach the best estimated demands competent planning, keeping men and machines in good working conditions, and above all, furnishing sufficient incentive to the workers to ensure their best performance. To determine the best production that can be obtained, time and motion studies are employed.

5.12.3. A typical organization chart for a large River Valley Project is given in Annexure 2.

### 5.13. PLANNING THE JOB

5.13.1. The construction of River Valley Projects is essentially a manufacturing process and as such it is affected like any other industry by all the problems of economics, management, labour and production. It, however, differs from the latter in one important respect *e.g.*, that while in the production of the most of the industrial commodities, manufacturing methods are more or less standardised to facilitate mass production in a centrally located manufacturing plant, and the finished product is transported to its place of use, in the construction industry the product is necessary for each construction job, also each project is peculiar in characteristics. It is particularly so with storage schemes, where the principal features of one project are vastly different from those of another.

### 5.14. FLOW DIAGRAMS

5.14.1. Flow diagrams are used more and more in the construction industry to show the position and capacity of each stationary machine or operation, including the method of transportation from one to another. The diagrams are of great use in planning the work. They are not to be drawn to scale and may be shown in plan or section. Simple diagram for cement mixing plant is shown in Annexure 19.

### 5.15. PLANNING CHARTS

5.15.1. Charts (Annexures 3—9) show diagrammatically the various steps used in planning expenditure on labour, equipment, materials and miscellaneous items of a project.

### 5.16. PLANNING, PLANT AND EQUIPMENT

5.16.1. The planning of a suitable equipment is an intricate job as it does often require a composite group of machines to work in harmony with each other so as to achieve the maximum efficiency in output and cost. Several combinations have to be investigated so as to arrive at the best, keeping an eye also on their availability in time. Equipment time schedules are worked out to show the various pieces of major equipment and the duration for which they are required. An illustrative chart showing the equipment schedule for a concrete dam is shown in Annexure 10.

### 5.17. PLANNING OF LABOUR

5.17.1. It is necessary to determine sequence of operations and trades so as to plan a proper labour requirements of a job. An illustrative chart, Annexure 15, shows a typical force report.

### 5.18. CONTROL OF EXPENDITURE

5.18.1. Exercise of control over expenditure is an integral part of good management. The cost is not an end in itself but the object should be to provide ways and means and whereby cost can be controlled and cut down. Cost control should increase efficiency by indicating waste, leakage of materials, waste of time and uneconomic overheads.

5.18.2. Most of the large River Valley Projects are being executed under a field organisation which works on a functional basis. Under such a set-up no divisional officer would know or can be held responsible for the overall cost of a project or that of any unit thereof. The work being divided on a functional basis, it has to be priced for each function and then collected to know the overall cost and the unit rates. Indirect or distributive costs constitute a large fraction of the total cost of a work, especially where a large amount of plant serving many parts of the project simultaneously has made the cost distribution mandatory. Therefore, the need for a *Cost Section* is now keenly felt on all large projects. There is a general concensus of opinion both among Engineers and Accounts Officer consulted by the Committee that there should be a *Cost Section* besides the present accounts organisation for each sizable project.



### 5.19. COST SECTION AND ITS FUNCTIONS

5.19.1. The Cost Section is to function as an independent fact-collecting agency and compiling data for presentation to executives in a form most serviceable to them. Its major objectives are (i) to furnish the maximum amount of information from both operation and cost angles, (ii) to present in the most practical way the facts that reveal actual performances and to aid in the attainment of high standards of efficiency, and therefore, of realisation of maximum economy, and (iii) to aid in determining operational policies. In short, cost accounting would aim at accounts for operators and project managers instead of accounts for accountants. It is thus more an adjunct to Engineering Departments particularly of estimating and planning them to the general accounting department.

### 5.20. COSTING SYSTEM TO BE FLEXIBLE

5.20.1. The Costing system should be flexible so that it can be readily adapted to changing conditions. It should be simple and practical to operate so that it may be conveniently kept up-to-date in the peculiar difficulties of construction jobs. We, therefore, consider that a complete review of the system and the forms in use should be carried out from time to time in order to eliminate any unnecessary features and to adapt the system to suit the conditions under which a project is executed.

5.20.2. The system will serve no useful purpose unless the data compiled is used by the technical personnel to study and assess the progress made on each job, and to compare the efficiency of labour and machine with the best attained under similar conditions.

### 5.21. CONDITIONS ESSENTIAL FOR AN EFFICIENT COSTING SYSTEM

5.21.1. The conditions essential for an efficient costing system are :—

- (i) that arrangements and designing of the cost accounting system should be suited to the organisational set-up and the methods of construction on a particular project, at all levels of management down to the smallest field of activity;
- (ii) that the costing organisation should be conversant with technical aspects of the work, to detect flaws in the original data and to offer constructive criticism to improve efficiency;
- (iii) that promptitude and utmost regularity in the supply of data to the organisation should be ensured; and
- (iv) that where the availability of actual data is not possible in time, best approximation should be made and subsequently corrected.

5.21.2. To secure the best results, it is desirable that the cost organisation should work under a competent Cost Engineer assisted by a trained staff. The Cost Engineer should be able to comment on (i) the operations which are costing more than the estimates, (ii) the possible avenues of saving, and (iii) the total ultimate cost of the project. This organisation should be responsible to the Chief Executive of the project, who should, on the basis of the cost reports and comments, be able to take effective and timely measures to control the cost of the project.

5.21.3. Promptitude in cost reports is an important requirement of a successful control system. The Project Manager needs information that makes possible correction of conditions while the work is being performed. Whether reports should be daily, weekly or monthly, will depend on the needs of a particular section of the project organisation. They must be simple, timely and up-to-date.

5.21.4. The success of cost department is largely dependent on the interpretation of operating results as determined from periodic cost reports which should clearly indicate whether variance is due to volume or labour costs. Control of physical standards which speak for themselves, is more valuable and it is our view that the Cost Accounting Section should lay greater emphasis on quantity engineering data than on rupee cost figures. Data related to labour output, plant output, material consumption account is more useful to the Engineers for the cost control and for framing a reliable basis for future planning and estimating. It, therefore, follows that estimates of physical quantities and performances, if prepared in a form comparable with costing procedure, would be helpful in establishing closer co-operation and understanding between the cost and operating departments and a greater recognition would result on the part of the cost section of the problems faced by the operating departments.

5.21.5. Certain assumptions would be essential to produce timely cost reports. Some of these are :—

- (i) Provision for repairs and overhauls of special equipment. Assumptions and procedure of accounting has already been dealt with in Chapter 6.
- (ii) Unpaid bills have to be accounted for cost purposes.
- (iii) The procedure of pricing the stores should be based on "Standard Rates" so that articles may be priced immediately as they are issued. Need for reflection of current prices in cost figures is not so important in Civil Engineering Works.

## 5.22. DISTRIBUTION OF COST

5.22.1. The distribution of cost relates to the assigning of expenditure, as represented by original documents such as pay rolls, invoices of the materials and supplies to each item of work in the same manner as

planned by the estimator. Intelligent cost distribution calls for a knowledge of the plan of construction, the purpose for which all labour and materials are used and construction methods followed in the field, besides a knowledge of construction accounting principles. This would emphasise the necessity of estimating and cost distribution adhering strictly to the standard classification of accounts.

### 5.23. COST REPORTS

5.23.1. In developing the usefulness of the cost reports different classes of executives and their needs must be understood and recognised. Junior Executives (Overseers) who are concerned with details of every day operations should have detailed reports in order to enable them to control cost. These men are in close contact with expenditure primarily for labour and materials on operations under their charge and with the daily output. The costing section and on small projects the overseers themselves, should be able to produce daily the cost per unit of physical quantities or structural quantities on the type or work under costing. These reports should help these Junior Executives to control wastes of all kinds by control on the activities of operators and machines placed under their charge. The scope of these reports is necessarily limited but these reports form the foundations of costing system and cost control. We may call the reports at this level as "Daily Output Reports".

5.23.2. Executive Engineers who have the overall responsibility for functions entrusted to them exert their influence on costs and operating results have to adapt the work to overall conditions of a project and find solutions for factors which retard output. By comparing actuals with estimated costs, variations are obtained which are analysed in the reports and causes. The Project Manager can thereby know the efficiency of men and machines on the job.

### 5.24. FIELD REPORT AND RECORDS

5.24.1. The Cost Section would require the following :—

- (i) Daily pay rolls and acquittance rolls with output report.
- (ii) Daily 'materials' report received, issued, and on hand.
- (iii) Daily equipment performance report.

5.24.2. The reports may be prepared by Assistant Executive Engineers, Foremen, Time-keepers or Clerks but should preferably be seen and signed by the Executive Engineers. In addition to this, each official should maintain a daily diary in which all essentials regarding the work under him are recorded. Similar weekly consolidated reports should be

prepared for the Chief Engineer's Office if it be other than the Project Manager. Monthly consolidated reports ought to be prepared for the Government.

#### 5.25. PAY ROLLS AND ACQUITTANCE ROLLS

5.25.1. Briefly speaking, we have recommended adoption of a Time-keeping System on the lines of the one used at Bhakra, the introduction of a Daily Time Card prepared by each Foreman, Labour Ledger and Identity Cards, each carrying a photograph of the workers.

5.25.2. The time of men on construction work cannot be distributed with the same accuracy as for a workman at a bench or machine all day probably working on only one operation. It is not difficult, however, for a foreman to keep distribution of each man's time to the nearest quarter or half an hour, and this is the greatest accuracy necessary. Even to the nearest hour is generally sufficient, as in the end inaccuracies will balance each other.

#### 5.26. DAILY 'MATERIALS' REPORT

5.26.1. The recommendations are that Stores Receipt Books and Stores Issue Books should replace measurement books and so far as the receipt and issue of stores as are concerned the Bin Cards and Stores Ledgers should be used instead of the Register of Daily Stock Receipt and Issue, half-yearly balance return of stock and half-yearly register of stock.

5.26.2. The collecting and recording of materials' costs will be done in the main office and checked against foreman's field reports.

5.26.3. Except for violent fluctuation in the market, prices of any principal commodities, prices of stores be kept fixed for the duration of the project. Any losses or gains on stores during the year should be adjusted by debits or credits to work at the end of the year. It is, therefore, simpler to report in most cases, the total work performed to the end of the week or month, leaving it to the office to determine individual weekly or monthly progress by deducting the quantities in the previous report from these in the last report.

#### 5.27. THE COLLECTING AND RECORDING OF MACHINE COSTS

5.27.1. Although mechanical equipment has been used in this country on large projects during the last century, it was being done on a comparatively small scale. Machines, however, play a very important role in the present day projects and cost colossal amounts. A proper system of collection of field data and its processing in the office is, therefore, very necessary for the well-being of the project.

5.27.2. The Cost Section should maintain an "Equipment Register" in form N-25 which will provide information regarding the type of equipment, equipment number, from whom purchased and data of purchase, size, capacity, original cost and a record of use rate/hr. or ownership cost/hr. The record should show the estimated economic life of machines and their cost from which the depreciation rate is determined to which a percentage for repairs and overhauls is added in tune with the recommendations in Chapter 3. This will ensure ownership cost record of all equipment on the job.

#### 5.28. DAILY REPORT

5.28.1. Daily reports show the work done during the day. It is easy to report because the Foreman or Time-keeper knows the number of the units performed during the day and where the work started and left off.

#### 5.29. DAILY REPORT FORMS

The following forms are recommended :—

- 5.29.1. Daily Time Check Sheet (Form No. 5.29.1.) gives at a glance the result of checking of the labour by the Time-keeper during the working hours.
- 5.29.2. Daily Equipment Report (Form No. 5.29.2.) gives the Number of hours each machine worked on a particular job.
- 5.29.3. Materials and Stores issued to any Foreman during the day are reported by the Foreman on Form No. 5.29.3.
- 5.29.4. Details of field repairs carried out on any machine during the day appear on Form No. 5.29.4.
- 5.29.5. Daily accident and breakdown report appears on Form No. 5.29.5.
- 5.29.6. Daily report for the use of automobiles is given in Form No. 5.29.6.
- 5.29.7. Daily output report for machine is given in Form No. 5.29.7.
- 5.29.8. Daily Mass Concrete Report is sent on Form No. 5.29.8.
- 5.29.9. Report on misc. items of work, e.g., laying and vibrating, form-work and creation, cleaning and curing, finishing et is made on Form No. 5.29.9.

## 5.30. UNITS OF DAILY MEASUREMENT OF WORK

5.30.1. The units of measurement of work done should be the same as those allocated for preparing the estimates. The kind and amount of information required for determining unit costs will depend on the nature of the work. On heavy masonry work such as dams and dock walls, it will be necessary to know the C.F.C. (hundred cubic feet) of concrete poured or masonry executed or the square feet of forms placed.

5.30.2. The following units are suggested for reporting work performed daily on several accounts :—

<i>Account</i>	<i>Approximation unit of measure</i>
1. Mechanical excavation	Number of loads (Cubic Yds.).
2. Hand excavation	Lin. ft. of trench, No. of footing.
3. Hauling aggregate and Steel hauling cement	Number of loads. Number of sacks.
4. Form-work Footings Columns Walls Beams & Girders  Slabs Sills	Number completed. Lin. feet of wall or No. of panels. Lin. feet of wall or No. of panels. No. of completed or Lin. ft. or bays.  No. of bays. No. of windows.
5. Concreting	No. of sacks of cement for each class of concrete, or by No. of batches produced.
6. Exterior curation walls	No. of bays.
7. Bearing walls and partitions	No. of tiles or bricks of Lin. ft. × height or No. of sacks of lime or cement.
8. Plastering	No. of sacks of plaster. No. of rooms.
9. Carpentry-posts, Joists, Rafters etc.	No. of pieces. No. of days or sq. ft. of area.
10. Flooring and Roofing	No. of days or sq. ft. of area.
11. Structural Steel	No. of days or sq. ft. of area.

### 5.31. ACCURACY REQUIRED

5.31.1 The time of a man on construction work cannot be distributed with the same accuracy as for workman at a bench or machine all day, probably working on only one operation. It is not difficult, however, for a foreman to keep distribution of each man's time to the nearest quarter or half an hour, and this is the greatest accuracy necessary. Even to the nearest hour is generally sufficient, as in the end inaccuracies will balance each other.

### 5.32. MONTHLY RECONCILIATION

5.32.1. Monthly reconciliation of figures of work and expenditure between Costing and Accounting Sections is most essential. The daily measurements of works on the basis outlined in para 5.30.2. give only the approximate results, which are good enough for executing daily check of the performance of the equipment and operations. For working out the unit rates, however, all measurements of works have to be taken into account on a specified day towards the end of the month, and furnished simultaneously to the Costing and Accounting Sections. To bring about reconciliation between figures for expenditure in two sections, those relating to the accounting side are brought up-to-date by taking into consideration the unliquidated liabilities, adjustments awaiting acceptance etc. This reconciliation should also cover Store Accounts and Workshop Accounts.

### 5.33. WEEKLY EQUIPMENT USE REPORT

5.33.1. On large projects using a big fleet of machines, the Project Manager should be kept posted as regards the machines working, lying idle or under repairs. A weekly chart showing these details is given in Annexure 14.

### 5.34. COST SCHEDULE

5.34.1. The costing is the reverse of the process of Estimating described in para 5.5. Typical charts and graphs for mass concrete, mixed plant, form-work, and total executive force, are shown in Annexures 11, 12 and 13, such charts should enable the Project Manager to lay his fingers exactly on the pulse and take timely action.

### 5.35. PROGRESS REPORTS

5.35.1. Monthly Progress Reports are necessary to keep the Project Manager and the State and Central Authorities informed of the actual progress of work, the actual cost, and the head of cost. It should be the responsibility of the Costing Section to furnish such reports punctually on the Forms shown in Annexures, 8, 9 and graphically in Annexure 18.

5.35.2. Form No. in Annexure 16 gives the figures by quantities and items of work.

5.35.3. Form No. in Annexure 17 gives the figures by expenditure on each item of work.

#### 5.36. MONTHLY VARIATION STATEMENT

5.36.1. The Monthly Progress Reports mentioned above should enable the Project Manager to judge whether the quantities of various items of work and their rates of cost are behaving, whether any or both of these show a tendency to run away from the estimated figures and what is likely to be their effect on the ultimate cost of the work. The Project Manager should submit a half-yearly review on the effects of variations on the ultimate cost of project with a view to enable to the higher authorities to decide, administrative approval is necessary.

5.36.2. A sample form for such forecast is given in Annexure 18.



## EXCAVATION, LOADING, HAULING AND COMPACTION UNITS

### 6.1. EXCAVATION, LOADING, HAULING AND COMPACTION UNITS

6.1.1. *Introduction.*—This chapter deals with the outputs, hourly use-rates and the unit rates of the earthwork by mechanical equipment, *viz.*, (i) Shovels, (ii) Draglines, (iii) Rooters, (iv) Dozers, (v) Drawn Scrapers, (vi) Motorised Scrapers, (vii) Belt-loaders, (viii) Dumper Trucks, (ix) Motor-graders, and (x) Sheepsfoot Rollers.

### 6.2. OUTPUTS AND PRODUCTION RATES, WORKING HOURS AND OPERATING EFFICIENCY

6.2.1. The working hour forms have been adopted for the basis of calculations, for the reasons already given. The actual productive time is less than 60 minutes in a working hour. On an average 10 minutes are taken as lost per hour in minor breakdowns, and a 50-minute hour is the accepted practice. The average production obtained in a working hour is governed by operating efficiency which is a function of the Job and Management factors. The Job factor is governed by the physical conditions of the job *e.g.* topography, working space, the surface, weather conditions and specifications. The Management factor covers conditions which pertain to the efficiency of operation and constitute items such as (i) selection, training and direction of men; (ii) selection, care and repairs of equipment; (iii) planning, laying out of the job, supervision and co-ordination of the operations. A table prepared by Frank A. Nikirk of U.S.A., after many years of critical study and research, is reproduced below :—

TABLE 6.2.1

Job Factor	Management Factors			
	Excellent	Good	Fair	Poor
Excellent	0.84	0.81	0.76	0.70
Good	0.78	0.75	0.71	0.65
Fair	0.72	0.69	0.65	0.60
Poor	0.63	0.61	0.57	0.52

6.2.2. A certain amount of scaling down in job and management factors is necessary in our case so long as we have to depend on foreign imports for machines and their spare parts, and there is somewhat still a dearth of skilled personnel in our country. We have, therefore, modified the above table as shown below and adopted the mean figure 0.65 for average operating efficiency in our calculations, as given below:—

TABLE 6.2.2.

Job Factor	Management Factors		
	Good	Fair	Poor
Good .. .. .	0.75	0.71	0.65
Fair .. .. .	0.69	0.65	0.60
Poor .. .. .	0.61	0.57	0.52

### 6.3. SHOVELS AND DRAGLINES

#### 6.3.1. The Peak Production

The peak production of a shovel or a dragline is a function of the depth of the cut, the angle of the swing, the bucket efficiency and the standard production. The standard or peak production means the rated capacity of the bucket divided by the cycle time of the shovel or dragline for a 90° swing and the optimum depth of cut. It is the basic production for ideal conditions without taking into account any of the factors affecting the output. The depth of cut is the optimum when the dipper comes up with a full load without undue crowding and the output is the greatest. The bucket efficiency is the ratio of the volume (Borrow-pit Measure) handled in one bucket load to the rated volume of the bucket; this depends on the swell characteristics of the soil.

6.3.2. As it is not always possible to predict the exact values of the angles of swing and depths of cut we have for estimating purposes adopted the optimum depth of cut and 90° swing in our computations.

6.3.3. The Power Crane Shovel Association of U.S.A. have quoted the following Tables 6.3.3.(i) and 6.3.3.(ii) giving the peak productions of shovels and draglines as adopted by Nikirk. The outputs are obtained by assuming the optimum depth of cut, 90° angle of swing, 60-minute

a working hour, the materials being loaded into proper sized hauling units.

TABLE 6.3.3.(i)

*Rated output of shovels in CFC units per min. hr., optimum depth of cut and 90° swing*

Sl. No.	Type of soil	Shovel dipper capacity in Cu. yd.					
		3/4	1	1½	2	2½	3½
1.	Moist loam or slight sandy clay	45	55	77	96	109	142
2.	Sand and gravel .. ..	42	54	73	89	105	136
3.	Good common earth .. ..	36	47	65	81	96	123
4.	Clay, hard and tough .. ..	30	39	57	72	84	109
5.	Rock, well blasted .. ..	26	34	49	62	74	99
6.	Clay, wet and sticky .. ..	19	26	39	50	62	84
7.	Rock, poorly blasted .. ..	14	20	31	43	53	73

TABLE 6.3.3.(ii)

*Rated output of dragline in CFC units per 60 min. hr., optimum depth of cut and 90° swing*

Sl. No.	Type of soil	Shovel dipper capacity in Cu. yd.					
		3/4	1	1½	2	2½	3
1.	Light moist clay or loam ..	35	43	59	72	82	105
2.	Sand and gravel .. ..	34	42	57	69	80	103
3.	Good common earth .. ..	28	36	51	62	72	92
4.	Clay, hard and tough .. ..	24	30	43	53	62	82
5.	Clay, wet and sticky .. ..	15	21	30	39	47	66

Average job production for a 50 min. hr., and 65% operating efficiency is tabulated below in Table 6.3.4. (i) & 6.3.4. (ii).

TABLE 6.3.4. (i)

*Job Production of shovels per working hour at 65% efficiency in CFC units Borrow-pit Measurement*

Sl. No.	Type of soil	Shovel dipper capacity in Cu. yd.					
		3/4	1	1½	2	2½	3
1.	Moist loam or light sandy clay ..	24	30	42	52	58	77
2.	Sand and gravel .. .. .	23	29	40	48	56	73
3.	Good common earth .. ..	19	25	35	44	52	66
4.	Clay, hard and tough .. ..	16	21	30	39	45	58
5.	Rock, well blasted .. .. .	14	18	26	34	40	53
6.	Clay, wet and sticky .. ..	10	14	21	27	34	45
7.	Rock, poorly blasted .. ..	8	11	17	23	29	40

TABLE 6.3.4. (ii)

*Job Production of draglines per working hour in CFC units Borrow-pit Measurement*

Sl. No.	Type of soil	Dragline dipper capacity in Cu. yd.					
		3/4	1	1½	2	2½	3
1.	Light moist clay or loam ..	19	23	32	39	44	57
2.	Sand and gravel .. .. .	18	23	31	37	43	55
3.	Good common earth .. ..	15	20	27	34	39	49
4.	Clay, hard and tough .. ..	13	16	23	29	34	44
5.	Clay, wet and sticky .. ..	8	11	16	21	25	35

6.3.5. These recommendations for output tally very closely with the actual outputs obtained on some of our projects, are given below. The recommendation of some standard authorities abroad is shown in Appendix 6.

TABLE 6.3.5. (i)

*Comparative Statement of output of shovels per hour in CFC unit (Borrow Measure)*

Sl. No.	Project	Soil	Output per hr. in CFC		Remarks
			Project actual	R. & C.C.	
1. $3\frac{1}{2}$ Cu. yds. <i>Shovel</i>					
(a)	Nangal Hydrel Channel ..	Light clay mixed with gravel.	51.7	58	Soil is taken as clay hard & tough.
(b)	Hirakud .. .. .	Semi-pervious	47*	58	Soil is taken as murum. *Embankment measure is 51.82 and the borrow measure is calculated.
2. $2\frac{1}{2}$ Cu. yds. <i>Shovel</i>					
(a)	Bhakra .. .. .	Rock Earth Claystone & Rock	37* 24.8*	40 29	*Worked out from the register of work for electric shovel assumed as rock poorly blasted.
(b)	Nangal .. .. .	Light clay with gravel Hard clay	42 30	45 45	Murum assumed.
(c)	Hirakud .. .. .	Semi-pervious	37	45	
(d)	Maithon .. .. .	Earth : Rock as 2:1	37	72	
3. $1\frac{1}{2}$ Cu. yds. <i>Shovel</i>					
(a)	Hirakud .. .. .	Semi-pervious	21	30	Murum assumed.

TABLE 6.3.5. (ii)

Comparative statement of output of Draglines in CFC units (Borrow) per hour

Sl. No.	Project	Soil	Output CFC per hr.		Remarks
			Project R.&C.C.		
1.	3½ Cu.yds.				
(a)	Tungabhadra (Andhra)	Shishy soft black cotton soil	39	35	Soil taken as clay wet and shishy.
2.	2½ Cu.yds.				
(a)	Harike .. .. .	Earth	40.6	39	
(b)	Sarda Hydel .. .. .	Wet earth Sandy soil	25	25	
(c)	Tungabhadra (Andhra) ..	Shishy soil	28	25	
3.	1½ Cu.yas.				
	Tungabhadra (Andhra) ..	Shishy soil	20	21	
4.	1 Cu.yd.				
	Harike .. .. .	Earth	19.5	20	
5.	¾ Cu.yd.				
(a)	Harike .. .. .	Earth	14	15	
(b)	Tungabhadra (Andhra) ..	Stiff black cotton soil	11	13	

#### 6.4. RIPPERS AND ROOTERS

6.4.1. Rippers and Rooters enable considerable economy in the breaking up of materials prior to dozing scraping etc. as well as in breaking or clearing out roots etc. in land clearance. Field observations show that the use of Ripper or Rooter prior to scraping shows fair increase in output. Another primary benefit is the reduced strain and wear on tractors and scoops resulting in a saving in fuel consumption and in better pay-loads. A Ripper or Rooter will break enough material to keep 3 to 6 tractors and scrapers employed. Field observations reveal that 1 hour of ripping may yield sufficient loosened dirt to keep a dozer employed from 4 to 15 hours.

6.4.2. In very hard soils it may be necessary to rip and then to cross-rip. In this case the output figures corresponding to the particular ripping width and depth and tractor speed should be halved to make allowance for this double work.

- 6.4.3. The depth of rooting depends upon the following factors :-
- The design and size of the roter which varied from 1' to 2'-6".
  - The size of the tractor—usually a tractor not smaller than 90 BHP is used.
  - The nature of the soil which will vary from hard tough clay to cemented conglomerate of disintegrated rock.
  - The number of twines used.

Sometimes a pusher tractor is added to assist the pulling tractor in rocky compacted materials.

Rooting is generally done in the 1st gear. The speed at governed R.P.M. in different gears and the draw-bar pull of 130 H.P. tractor are given below:—

TABLE 6.4.3.

*Draw-bar pull and speed of 130 H.P. tractor*

130 H.P. Tractor Gear	Speed at governed R.P.M.	Draw-bar pull (lbs.)
1st	1.6	29,900
2nd	2.3	21,700
3rd	2.9	15,700
4th	3.7	11,900
5th	4.8	8,600

6.4.4. The following table indicates the nature of duty that may be expected from a heavy roter.

TABLE 6.4.4.

*Performance of rooters in different types of soils*

Sl. No.	Nature of soil	No. of twines	Width at each rooting	Depth in feet	No. of turns recd.	Pushed tractor rec.
1	2	3	4	5	6	7
1.	Gravel and sand compact & cemented.	2 to 3	4 to 8	1 ft.	2 to 4	17
2.	Good common earth	3	8	2 ft.	1	—
3.	Clay, hard & tough	3	8	2 ft.	1 to 2	—
4.	Murum	2 to 3	4 to 8	1'-6"	1 to 2	Usually not
5.	Hard Murum	2 to 3	4 to 8	1 ft.	2 to 4	1
6.	Clay with boulders	3	8	1'-6"	1	—
7.	Clay wet & sticky	3	8	1'-6"	1	—

### 6.4.5. Production by Rooters

Taking a travel speed of 1.6 m.p.h. and an operating efficiency of 65% (wide and extensive areas) the following production per working hour is obtained:—

TABLE 6.4.5.

*Average output of Rippers in CFC Units  
(borrow measurement)*

Sl. No.	Soil	Vol. rooted per hour
1.	Compact cemented gravel	60-240
2.	Good common earth	1000
3.	Clay	500-1000
4.	Murum	180-750
5.	Hard murum	60-240
6.	Clay with boulders	750
7.	Clay wet	750

## 6.5. DOZERS

6.5.1. Before starting earthwork on any project it is necessary to grub the ground and clear the area of trees, stumps and bushes. Frequently both clearing and grubbing are carried out in one operation by using a tractor dozer assisted by a roter. The unit of measurement for grubbing and clearing site should preferably be the acre.

### 6.5.2. Stripping

This consists of removing the top vegetative soil to specified depths and where dirt is to be transported only a short distance say upto 200 ft. a tractor-dozer is used and for longer hauls a scraper. The unit of measuring stripping should be an acre although the C.yd. measure has been adopted on some of the projects. The size of the tractor required will depend upon the growth of jungle, the size of the boulders, the hardness of the soil and the terrain. Tractors smaller than 90 B.H.P. will generally be found unsuitable for this work.



6.5.3. The production of dozers will naturally vary with the field conditions. The following data may however be adopted in the absence of any experimental observations:—

TABLE 6.5.3.

*Production of Dozers for grubbing and clearing*

Size of tractor	Area grubbed and cleaned per hr. (acres)		
	Favourable conditions	Average conditions	Un-favourable conditions
1. 90 BHP tractor with a dozer .. .. .	0.66	0.40	0.16
2. 130 BHP tractor with a dozer .. .. .	0.80	0.5	0.2

6.5.4. Some manual labour will be required to burn or remove the shrubs, excavate out some stumps, collect stray roots etc. After accounting for the manual labour, petty establishment etc. the unit rate for clearing and grubbing will work out as given below in table:—

TABLE 6.5.4.

Item	Unit rate for grubbing and clearing
Grubbing and clearing areas, to remove all shrubs, stumps, trees not exceeding 6" in dia. boulders (not exceeding 2 C.yds.) and stacking them neatly in or outside the area so as to allow for a lead not exceeding 150 ft. including pitching up roots, branches, stumps and burning or otherwise, disposing off the wood, leaves etc. as directed.	
(a) Favourable working conditions .. .. .	Rs. 100 per acre
(b) Average working conditions.. .. .	Rs. 250 ..
(c) Difficult working conditions .. .. .	Rs. 400 ..

### 6.5.5. Dozer Outputs

Most jobs involve a number of strata *e.g.* a layer of top soil followed by a layer of common earth, followed by a sub-soil comprising clay and/or sand. Moreover a large portion is usually a mixture of one or more of the above. The thickness of each layer usually varies throughout the job.

Seasonal changes in moisture content also affect the volume change. Some materials will swell freely; others, like sand, will not. Thus any calculation of the number of dozer cycles, required to move a given volume of earth can only be approximate, as the time required will further vary according to (1) the condition of the tractors, (2) efficiency of the operators, (3) weather conditions, (4) moisture content, (5) type of soil, and (6) rigidity of inspection and control of specification.

The following data in table 6.5.5. pertaining to the design of American machines will be helpful for estimating out-turn.

TABLE 6.5.5.

*Dozer Capacity*

Sl. No.	Tractor H.P.	Blade width in feet	Capacity in CFC	Approximate wt. in lbs.
1.	130-160 .. .. .	11	0.85	5200
2.	85-100 .. .. .	10	0.65	4400
3.	65-75 .. .. .	8	0.51	2800

6.5.6. The following table 6.5.6. gives the output of dozers in "Good common earth" for a 50 minute working hour and 65 % operating efficiency.

TABLE 6.5.6.

*Job productions of dozer in good common earth (CFC Unit)*

Size of tractor	Lead one way in feet								Remarks
	50 ft.		100 ft.		150 ft.		200 ft.		
	AD	BD	AD	BD	AD	BD	AD	BD	
130 B.H.P.	34	27	21	17	15	12	12	10	AD-angle dozer.
90 B.H.P.	30	25	18	16	13	11	10	9	BD-bull-dozer.

Where the truck loads are to be pushed over the edge of a fill (lead about 50 ft.) the production in earth may be taken as 1.4 times that given in table 6.5.6.

## 6.6. SCRAPERS

## 6.6.1. Use of Scrapers

Scrapers combine the actions of excavation and haulage. They are mostly adaptable to plowable materials. In non-cohesive sand or gravel, it is difficult to load scrapers as the material will not pile up into the scraper, and the pay-load is considerably reduced. Wet and muddy soils make the discharging of the scraper difficult. For efficient working material should be free-flowing with very little or no rock and shale.

6.6.2 Tractor-drawn scrapers and motorised scrapers are used to excavate and haul large volumes of earth for such projects as dams, levees, highways, airports and canals. Their use depends considerably on the job conditions and economic use. They are particularly well suited for canal excavation and embankments not involving hard rocky material and providing large hauling area. For short hauls of 500 to 1500 ft. the crawler type tractor, pulling a rubber-tyred, self-loading scraper is mostly used. The Crawler tractor has a high draw-bar pull for loading the scraper, has a good grip on the ground, can operate over muddy haul roads, but has a low travel speed the maximum being about 6 m.p.h. As a drawn-scraper is a self-contained unit, its performance is better than that of other machines which have to depend upon another unit for loading *e.g.* an excavator, or a pusher tractor working with a motor-scraper. For longer haul distances of 1000 to 5000 ft. or more, the rubber-tyred tractor pulling a rubber-tyred self-loading scraper is more economical than the Crawler unit. While this motorized unit cannot deliver as great a tractive effort in loading the scraper as the Crawler type, it has a higher travel speed up to about 18 m.p.h. Usually a pusher tractor is used along with motorized units to facilitate easy scraping and thereby increase scraper outputs and cut down earthwork costs.

### 6.6.3 Equipment Combination

The following equipment combination in case of drawn scrapers will be generally found suitable for various types of soils.

TABLE 6.6.3

*Equipment Combination*

Sl. No.	Type of soil	Tractor B.H.P.	Scraper struck capacity in C.yd.	Pusher Tractor B.H.P.	Remarks
1	2	3	4	5	6
1.	Light loam or crumbly silt ..	90	10 to 12	Not reqd.	—
2.	Good common earth or clayey loam .. .. .	90 or 130	12 to 15	Do.	—
3.	Sand and gravel .. ..	Do.	10 to 12	90	—
4.	Murum .. .. .	130	15	130	Rooting desirable.
5.	Clay hard & tough .. ..	130	10 to 12	90	Do.
6.	Hard murum .. .. .	130	15	130	Rooting essential
7.	Clay with boulders .. ..	130	15	130	Do.
8.	Clay, wet & sticky .. ..	130	15	130	Do.

### 6.6.4 Speed of Hauling

The speed of hauling is a function of (i) the road resistance, (ii) B.H.P. to the weight ratio of the tractor, and (iii) grade resistance, due both to rolling resistance and grade resistance the speed on adverse grades goes down. The speed of 130 H.P. D-8 Crawler tractors in 5th gear is 4.8, m.p.h. 4th gear 3.7, 3rd gear 2.9, 2nd gear 2.3 and 1st gear 1.6 m.p.h. In the case of motorized scraper, for example D-W 21 caterpillar scraper, the speed in 5th gear is 20.2 m.p.h., 4th gear 12.2, 3rd gear 7.2, 2nd gear 4.2 and in 1st gear 2.2 m.p.h.

### 6.6.5 Time of Hauling

The time taken for the scraper to haul and return depends on the lengths of haul on the level and on the incline. As both these are variables differing from project to project, it will be reasonable to assume an average speed of haul which would cover the time gained on level grade when the machine goes at a greater speed than the average and that time lost while the machine is travelling at a lesser speed on the incline. In keeping with this assumption, we have adopted in our calculation an average speed of 4 m.p.h. in the case of drawn scrapers as they normally operate on short leads of about 500 to 1500 ft. and more on inclines. As motorised scrapers haul greater distances on level grades than that on inclines we have adopted an average speed of 15 m.p.h. in its case.

### 6.6.6 Lead

Lead is defined as the shortest practicable route and not necessarily the route taken actually to move the mass of the earth from one situation to the other.

We have adopted lead in terms of one way haul in feet and the cycle time in minutes as that required to haul and return through this distance plus the time taken in loading and unloading, turning and changing gears.

### 6.6.7 Drawn Scrapers

Fixed times are given below:—

TAB 6.6.7

*Fixed Time for Euclid-drawn Scrapers*

Sl. No.	Type of loading	Working conditions	Cycle time for loading 15 C.yd. struck scraper in minutes	Cycle time for loading 10 C.yd. struck scraper in minutes
1.	Back track loading	Favourable	1.75	1.45
		Average	2.40	2.10
		Unfavourable	3.00	2.70
2.	Chain loading or shuttle loading	Favourable	1.25	1.05
		Average	1.60	1.40
		Unfavourable	2.00	1.80

TABLE 6.6.8.

*Cycle Times and No. of Trips for 50 min. hr. Drawn Scrapers*

Sl. No.	Length of haul one way in Linear feet						Cycle time minutes	No. of trips in 50 mts.	Remarks
1.	500	..	..	..	..	..	4.7	10.6	Fixed time 2.25 minutes for loading & unloading and 1 min. for turns etc. Cycle time includes also return time. Average speed 4 m.p.h.
2.	600	..	..	..	..	..	5.0	10.0	
3.	800	..	..	..	..	..	5.5	9.1	
4.	1000	..	..	..	..	..	6.0	8.4	
5.	1200	..	..	..	..	..	6.6	7.6	
6.	1600	..	..	..	..	..	7.5	6.7	

**6.6.9 Swell Factor**

The pay-load of a scraper is affected by the swell characteristics of the soil. The swell factor is equal to 100 divided by (100 plus per cent of swell). The following table 6.6.9 has been drawn up with reference to the figures *vide* 'Estimating Production and Costs' by Euclids.

TABLE 6.6.9

*Values of Swell and Swell Factors of Soils*

Sl. No.	Soil	Percent of Swell	Swell factor (natural)	Swell factor for scrapers
1	2	3	4	5
1.	Light loam or crumbly silt .. .. .	20	0.83	0.93
2.	Sand and gravel .. .. .	18	0.85	0.95
3.	Good common earth or clay loam .. .. .	25	0.80	0.90
4.	Clay, hard & tough .. .. .	33	0.75	0.85
5.	murum .. .. .	18	0.85	0.95
6.	Hard murum .. .. .	33	0.75	0.85
7.	Clay, wet and sticky .. .. .	33	0.75	0.85

**NOTE :** Swell factor when loading scraper is more because of more compact loading.

**6.6.10 Production Rate**

Taking average load as the mean of the heaped and struck capacity and the swell factor as in table 6.6.9. and the number of trips per working hour as in table 6.6.8 the job production in different type of soils in 50 min. working hour and 65% efficiency are tabulated below in table 6.6.10 (i) and (ii).

TABLE 6.6.10 (i)

*Job Production in Light Loam*

Sl. No.	Length of haul one way in feet	130 BHP Tractor drawn 15/20 C.yd. scraper	90 BHP Tractor drawn 10/12.5 C.yd. scraper	Remarks
1	2	3	4	5
1.	500	30*	19	
2.	600	28	18	
3.	800	26	17	
4.	1000	24	16	
5.	1200	22	14	
6.	1500	19	12	

$$* \frac{17.5 \times 27 \times 0.93 \times 10.6 \times 65}{100 + 100} = 30$$

10.6 No. of trips in 50 min.

0.65 Efficiency factor.

17.5 is the average capacity.

27 is a multiplier to convert C.yds. into CFT.

0.93 is the Swell factor.

TABLE 6.6.10 (ii) (a)

Sl. No.	Soils	Output in CFC Borrow-pit Measure 15/2 C.yds. Scraper (Lead one way haul in feet)					
		500	600	800	1000	1200	1500
1.	Light loam or crumbly silt	30	28	26	24	22	19
2.	Sand & gravel	31	29	27	25	22	19
3.	Good common earth	29	27	25	23	21	18
4.	Clay, hard & tough	28	26	24	22	21	18
5.	Murum	31	29	27	25	22	19
6.	Hard murum	27	26	24	22	20	17
7.	Clay, wet and sticky	27	26	24	22	20	17

TABLE 6.6.10 (ii) (b)

10/12.5. C. yds. Scrapers

Sl. No.	Soils	Output in CFC Borrow-pit 15/2 C.yds. Scraper (Lead one way haul in feet)					
		500	600	800	1000	1200	1500
1.	Light loam or crumbly silt ..	19	18	17	16	14	12
2.	Sand & gravel .. ..	19	18	17	16	14	12
3.	Good common earth .. ..	18	17	16	15	14	12
4.	Clay, hard & tough .. ..	18	17	16	15	13	11
5.	Murum .. ..	19	18	17	16	14	12
6.	Hard murum .. ..	17	16	15	15	13	11
7.	Clay, wet & sticky .. ..	17	16	15	15	13	11

## 6.6.11 Motorised Scrapers :—Cycle Time

TABLE 6.6.11

Cycle Time and No. of Trips per 50 min. hr.

Sl. No.	Length of haul one way in linear feet	Cycle time in minutes	No. of trips in 50 min. hr.	Remarks
1.	1000 ft. .. ..	4.0	12.5	Fixed time nearly same as that of drawn scraper is 2.25 at loading & unloading & 1 min. for turns etc. Average speed 15 m.p.h.
2.	1500 ft. .. ..	4.4	11.4	
3.	2000 ft. .. ..	4.8	10.4	
4.	2500 ft. .. ..	5.2	9.6	
5.	3000 ft. .. ..	5.5	9.1	
6.	4000 ft. .. ..	6.3	7.9	
7.	5000 ft. .. ..	7.0	7.1	

**6.6.12 Production Rate of Motorised Scrapers**

Job production on the basis of 50 min. hr. and 65% efficiency, taking the average load as the mean of the heaped and struck capacity is the swell factor as given in table 6.6.9. and the number of trips per working hours as in table 6.6.11. has been worked out in table 6.6.12. (i) & 6.6.12 (ii).

TABLE 6.6.12. (i)

*Job Production of Motorised Scrapers*

(i) 15/20 C. yds. Capacity

Sl. No.	Soil	Output in CFC (Borrow Measurement) (One way haul in linear feet)						
		1000	1500	2000	2500	3000	4000	5000
1.	Light loam .. ..	36	33	30	27	26	23	20
2.	Sand & gravel .. ..	37	34	31	28	27	23	20
3.	Good common earth ..	35	32	29	26	25	22	19
4.	Clay, hard & tough ..	34	31	28	25	24	21	17
5.	Murum .. ..	37	34	31	28	27	23	20
6.	Hard murum .. ..	33	30	27	25	24	21	18
7.	Clay, wet & sticky ..	33	30	27	25	24	21	18

TABLE. 6.6.12 (ii)

(ii) 10/13 C. yds. Capacity

1.	Light loam .. ..	23	21	20	18	17	15	13
2.	Sand & gravel .. ..	23	21	20	18	17	15	13
3.	Good common earth ..	22	20	19	17	16	14	13
4.	Clay, hard & tough ..	21	20	19	17	16	14	12
5.	Murum .. ..	23	21	20	18	17	15	13
6.	Hard murum .. ..	21	19	18	16	16	14	12
7.	Clay, wet & sticky ..	21	19	18	16	16	14	12



## 6.7 BELT-LOADER

6.7.1 Belt-loader is an excavating and loading unit. It excavates loose material, elevates and loads it into vehicles. Rarely it is used to cast the excavation directly. Its economic use largely depends on the adequacy of transporting units. It is pulled by a tractor. It has a cutting edge which excavates the material which in turn is picked up by a moving belt so aligned that a constant flow of material travels up the belt and is discharged into the hauling unit. It has the advantage of less loading time and constant discharge of material. But it is suitable and economical under the following conditions:—

- (i) Where very high hourly production rate is required.
- (ii) Where soil is free from rock.
- (iii) Where uniform long and wide borrow-pits exist.
- (iv) Where a large quantity of earth is handled.
- (v) Where loading conditions are such that from five to ten loads of free flowing material may be obtained between loader turn arounds and that is relatively long and level.

The loading time of the loader will be about 0.6 to 0.8 minute under average conditions; but it is not related to production figures as the latter depends on the adequacy of hauling units of proper size.

6.7.2 Assuming that, properly matched equipment is made available, the output of a 54 inch belt-loader for 60 minute hour is as given below:—

TABLE 6.7.2

	Working conditions			Remarks
	Favourable	Average	Unfavourable	
Production in CFC units per hour borrow-pit measurement.	270	202	135-95	54-inch belt 60 min. hr.

For a 50 min. hour and operating efficiency of 65% the average job production of belt-loader will be as under:—

TABLE 6.7.2 (i)

*Average Job Production of Belt-loader*

	Working Conditions			Remarks
	Favourable	Average	Unfavourable	
Production in CFC units per hour borrow-pit measurement.	145	110	73-51	54-inch belt 50 min.hr. efficiency 65%

6.7.3 The auxiliary equipment required to obtain the outputs depends on the nature of the soil handled by the loader. In hard clays two pulling tractors or one pulling tractor and one pusher will be required in addition to rooting. A dozer constantly attending to levelling the borrow floor improves the operating efficiency and reduces wear and tear on the machines.

The combination of equipment required for different types of materials is indicated below in table 6.7.3.

TABLE 6.7.3

*Equipment Combination Belt-loader Operation*

Sl. No.	Soil	Machinery Combination				Remarks
		Belt-loader	Touring tractor	Rooter	Dozer	
1.	Light loam	1	1	—	—	
2.	Sand & gravel	1	1	—	—	If compact, 2 touring tractors, 1 dozer & 1 rooter are required to give good output.
3.	Good common earth	1	2	—	1/2	
4.	Clay, hard & tough	1	2	1	1	
5.	Clay, wet & sticky	1	2	1	1	Rooter useful for letting the soil dry before loading.
6.	Soft murum	1	2	1	1	

## 6.8 DUMPERS

6.8.1 The two types of dumpers commonly used on the projects are the rear dump and the bottom dump. Each type has its own advantage and use, depending on the job conditions. Dumpers can run on rough ground or on open wet sites unsuitable for lorries. Their economic length of haul is up to  $1\frac{1}{2}$  miles lead.

6.8.2 Rear dumpers are specially designed to haul heavy materials like rock, one shale or a combination of free-flowing and bulky materials and to withstand severe loading impact as it occurs in loading under a large shovel. They have maximum grade ability and can do rapid spotting in a restricted area.

6.8.3 Bottom dumpers are of a tractor trailer type and are largely used for hauling free-flowing materials such as loose sand and gravel, hard clay, broken shale etc. where dumping is unrestricted and the long adverse grades do not exceed 3% to 5%. They have a high manoeuvrability and a fast movement.

### 6.8.4 Rating of Dumpers

Usually dumpers are rated according to their capacity in struck measure, in heaped measure (generally 3 to 1 slope) and in terms of pounds of pay-load. It is important that not only the capacity in cu. yards but also in weight should be considered while considering the dumper capacities.

### 6.8.5 Production Rate—Cycle time

The production rate of dumpers or any hauling units varies with the length of the haul, load grade and road conditions *i.e.* on the cycle time in general. Time required for loading, dumping or unloading, turning and spotting constitutes the 'fixed' time while the haul and return times are 'variable'. The 'fixed' time constants pertaining to Euclid dumpers are tabulated in table 6.8.6. An average haul speed of 12 m.p.h. in case of rear dumps and 15 m.p.h. in case of bottom dumps can be taken to work out the hauling and returning time for different leads.

TABLE 6.8.6

*Turning, Dumping and Spotting Times for Various Job Conditions*

Sl. No.	Conditions	Rear Dump		Bottom Dump	
		Turn and dump in minutes	Spot in minutes	Turn and dump in minutes	Spot in minutes
	2	3	4	5	6
1.	Level ground ample space, dumping in transit	1.5	0.15	0.7	0.15
2.	Limited space, and some manoeuvring	2.0	0.30	1.0	0.50
3.	Constructed spaced manoeuvring to dump required	2.5	0.50	2.0	1.00

### 6.8.7 Outputs

The output of a dumper is directly related to the loading unit and the number of trips per hour. Generally, the capacity of the dumper should be 4 to 5 times that of the shovel or dragline. The material carried will have the swell factors as given in table 6.6.9. The swell factors in case of rock well-blasted is 0.57 and for shale or soft rock it is 0.75. An operating efficiency of 65% can be adopted in working out the output.

## 6.9 SHAPING AND COMPACTING EARTHWORK

6.9.1 This work is usually carried out by using a motorgrader or a bulldozer for spreading the soil a tractor-pulled sheeps-foot roller for compaction and a sprinkler truck for adding water where the natural moisture content is less than that required.

### 6.9.2 Graders

Two types of graders are used; the towed grader and the self-propelled. The towed grader is used where considerable force at low speed is desired as in ditching. The motorgrader is self-propelled and is designed for higher speeds in light work such as road maintenance and mixing of materials. It is generally gas or diesel powered with a 12 ft. wide hand-controlled or motorised wide blade.

On an average a motorgrader operates at 2 m.p.h. and can cover an effective blade width of about 8 ft. Its output is expressed in terms of the area in 8 ft. covered by its blade in an hour.

### 6.9.3 Sheeps-foot Rollers

Sheeps-foot rollers are universally used for developing suitable compaction on rolled-fill dams. They are suitable for use in soils free from large boulders and they compact plastic soils better than any other mechanical method and for compacting the fill.

6.9.4 They are usually assembled in units of 1, 2, 3 or 4 drums. The tamping feet on the drums which are staggered, distribute the weight of the drum and give better tamping effect. The weight of a single drum varies from about 2700 lbs. to 3470 lbs. as empty, depending on the size and the number of tamping feet on the drum. Provision is usually made for filling the drum with liquid and/or sand in order to add to its weight. The optimum tractor speed for the use of a sheeps-foot roller is approximately 2.5 m.p.h.

### 6.9.5 Average Hourly Output

The following hourly outputs in CFC units of borrow-pit measure can be attained in a working hour (50 min. hr.) with average operating efficiency of 65% in ordinary soils.

TABLE 6.9.5

*Average Output of Sheeps-foot Rollers*

No. of Dumps	1×1				1×2				1×3			
	6	8	10	12	6	8	10	12	6	8	10	12
Depth of layer												
4"	27	20	17	14	57	44	37	28	84	65	54	44
6"	40	30	23	20	87	65	50	44	13	97	76	65
8"	55	40	34	27	120	87	72	57	18	130	110	87
10"	67	53	40	34	144	107	85	72	220	163	130	110
12"	80	62	53	40	173	132	107	85	260	200	163	130

### 6.10 USE RATES OF EARTH-MOVING EQUIPMENT

6.10.1 In working out their use rates, we have assumed that the equipment is all new, that depreciation follows the straight line law and that the working hours form the basis of depreciation for all rated equipment. Maintenance and repair charges have been determined from table 3.12.3 while the fuel consumption has been taken from the formula:  $0.5 \times \text{BHP} \times 6/8.26$  which gives the optimum consumption for a 60 min. working hour. We have adopted 65% or 2/3rd of the figure given by this formula for actual consumption, the wages operators and unskilled labour have been taken as those recommended by us.

6.10.2 The detailed analysis of the use rates are given in Appendix 7 and abstract of the same is furnished below:—

TABLE 6.10.2

*Hourly Use Rate of Mechanical Equipment*

Sl. No.	Equipment	Hourly use rate in rupees
1	2	3
		(H.P.)
I.	<i>Belt-loader</i>	
	18 B.V. Belt loader 54" width .. .. .	248 55.0
II.	<i>Dump Track</i>	
	(a) 9.7 C. yds. 15 tons Rear Dump .. .. .	150-165 34.0
	(b) 14.8 C. yds. 22 tons Rear Dump .. .. .	250 52.0
	(c) 13 C. yds. struck Bottom Dump .. .. .	200 37.0
	(d) 17 C. yds. " " " .. .. .	260 47.0
III.	<i>Excavators</i>	
	(a) (i) $\frac{3}{4}$ C. yd. Shovel .. .. .	80 31.0
	(ii) $1\frac{1}{2}$ " " .. .. .	170 50.0
	(iii) $2\frac{1}{2}$ " " .. .. .	200 64.0
	(iv) $3\frac{1}{2}$ " " .. .. .	225 39.0
	(b) (i) $\frac{3}{4}$ C. yd. Dragline .. .. .	80 29.0
	(ii) $1\frac{1}{2}$ " " .. .. .	170 43.0
	(iii) $2\frac{1}{2}$ " " .. .. .	200 55.0
	(iv) $3\frac{1}{2}$ " " .. .. .	225 74.0
IV.	<i>Scrapers</i>	
	(a) 10/12.5 C. yds. Drawn Scraper .. .. .	— 14.0
	(b) 15/20 " " .. .. .	— 20.0
	(c) 10/13 " Motorised .. .. .	176 43.0
	(d) 15/20 " " .. .. .	225 56.0
V.	<i>Tractors</i>	
	(a) 81 HP Crawler Tractor .. .. .	81 25.0
	(b) 130 HP Crawler Tractor .. .. .	130 29.0
	(c) 81 HP Tractor Dozer .. .. .	81 28.0
	(d) 130 HP Tractor Dozer .. .. .	130 32.0
	(e) D-4 Tractor with Sheeps-foot Roller .. .. .	44 15.15
VI.	<i>Motor Graders</i>	
	115 HP .. .. .	115 25.0

## 6.11 UNIT RATE OF EARTHWORK BY MECHANICAL MEANS

6.11.1 The unit rate of earthwork involves the cost of excavation, transportation and compaction of a CFC of soil as measured at the borrow-pit. We have adopted the borrow measure in preference to the embankment measure as it is more precise. In the case of scrapers, however, borrow measurements are not always practicable and the volume of work done is calculated from the loose measure after applying the swell factor of the soil.

6.11.2 Most of the excavation work on projects is done by shovels and scrapers, although use of tractor dozers for dozing is considerable. In fact, a tractor dozer is a versatile unit performing many tasks *e.g.*, clearing, shipping, opening up cuts, dozing, push loading, back filling, etc. Draglines are mostly used on canal works. We have, therefore, confined our study of the earthwork rates by shovels and scrapers.

6.11.3 Using 1/3 hr. dozer per shovel the Tables 6.11.3 (i) and (ii) give the rates per unit of shovelling.

TABLE 6.11.3 (i)

*Cost per Hour of Working Shovels with Tractor Dozer*

Sl. No.	Shovel cu. yds.	Average Conditions			Rock work	
		Rate per hour		Total	Extra provision of 10% for repairs	Total rate per hour
Shovel	Tractor dozer 1/3rd					
		Rs.	Rs.	Rs.	Rs.	Rs.
1.	3	31	10	41	4.1	45
2.	1½	50	10	60	6.0	66
3.	2½	64	10	74	7.4	81
4.	3½	89	10	99	9.9	109

TABLE 6.11.3 (ii)

Cost of Shovelling Operation per CFC (Borrow Measure) in Different Soils

Sl. No.	Conditions	Size of shovels in cubic yards			
		3/4	1-1/2	2-1/2	3-1/2
1	2	3	4	5	6
<b>1. Average Conditions</b>					
	Hourly use rate <i>vide</i> table 6.11.3 (i)	Rs. 41	Rs. 60	Rs. 74	Rs. 99
(a)	Moist loam or sandy output CFC	24	42	58	77
	Rate per CFC	1.71	1.43	1.28	1.29
(b)	Sand & gravel output CFC ..	23	40	56	73
	Rate per CFC .. .. .	1.79	1.50	1.33	1.36
(c)	Common earth, output CFC ..	19	35	52	66
	Rate per CFC .. .. .	2.16	1.71	1.43	1.50
(d)	Clay hard & tough, output CFC	16	30	45	58
	Rate per CFC .. .. .	2.56	2.00	1.66	1.70
(e)	Clay, wet & sticky, output CFC	10	21	34	45
	Rate per CFC .. .. .	4.10	2.88	2.19	2.20
<b>2. Rocky Conditions</b>					
	Hourly use rate <i>vide</i> table 6.11.3 (i)	Rs. 45	Rs. 66	Rs. 81	Rs. 109
(a)	Rocks well blasted, output CFC	14	26	40	53
	Rate per CFC .. .. .	3.22	2.54	2.04	2.05
(b)	Rock poorly blasted, output CFC	8	17	29	40
	Rate per CFC .. .. .	5.63	3.88	2.80	1.32

**6.11.4 Analysis of Rate for Rock Work**Output of  $2\frac{1}{2}$  C. yds. shovel per hour : 34 CFC.Rear Dumper  $9\frac{7}{11}\cdot 4$ , average capacity: 10.5 C. yds.

Swell factor of blasted rock: 0.67.

Borrow measure of 10.5 C. yds:  $10.5 \times 0.67 \times 0.27 : 1.9$  CFC.

Hauling cycle: Loading time plus hauling &amp; returning time plus turning &amp; dumping and spotting.

Loading time: 
$$\frac{\text{Body capacity}}{\text{Shovel output per min.}} = \frac{1.9 \times 60}{34} = 3.4 \text{ min.}$$
Spotting time for truck : 0.3 min. (*vide* table 6.8.6)

Average travel speed : 12 m.p.h.



Hauling and return time for 2000, 3000, 5000, 6000 and 8000 feet are 3.8, 5.7, 11.4 and 15.2 minutes respectively.

Turning and dumping time: 2 min.

The cycle time and number of trips, output per hour of and the number of dumpers per shovel hour for different loads are given below in table 6.11.4 (i):

TABLE 6.11.4 (i)

Particulars	Lead One Way in Feet					
	1000	2000	3000	5000	6000	8000
Cycle Time in min. ..	4.2	6.1	8.0	11.8	13.7	17.5
Trips in 50 min. hr. ...	11.9	8.2	6.25	4.25	3.65	2.86
Output per hr. at 55% efficiency ..	14.7*	10	7.7	5.3	4.5	3.54
Dumper per shovel hour	2**	3	4	6	8	10
* $11.9 \times 0.65 \times 1.9 = 14.7$ .						
** $\frac{14.7}{34} = 2.4$						

11.9 = No. of trips in a 50 min. hour.  
0.65 = Efficiency factor.  
1.9 = CFC borrow measure of the Cap. 9/11.4 C. yd. dumpers.  
34.0 = Output of a shovel.  
14.7 = Output per hour of the dumper.

A motor grader and a water tanker is necessary to maintain the haul roads in good condition for efficient working of hauling units.

The total cost of equipment required per hour shovel output and the rate for excavating, transporting and dumping a CFC of blasted rock are given in Tables 6.11.4 (ii) & (iii) respectively.

TABLE 6.11.4 (ii)

Equipment Cost per Hour Output of Shovel in Blasted Rock

Lead one way haul in feet	Equipment Cost									
	2-1/2 C. yd. shovel		Tractor dozer		9.7 C. yds. Rear dump		115 h.p. Motor grader		Water tanker	Total amount
	Nos.	Amt.	Nos.	Amt.	Nos.	Amt.	Nos.	Amt.	Amt.	
1	2	3	4	5	6	7	8	9	10	11
ft.		Rs.		Rs.		Rs.		Rs.	Rs.	Rs.
1000	1	70	1/3	11	2	68	1/4	6	5	160
2000	1	70	1/3	11	3	102	1/4	6	5	194
3000	1	70	1/3	11	4	136	1/4	6	5	228
5000	1	70	1/3	11	6	204	1/4	6	5	296
6000	1	70	1/3	11	8	272	1/4	6	5	364
8000	1	70	1/3	11	10	340	1/4	6	5	432

TABLE 6.11.4 (iii)

Rate for Mucking per CFC of Blasted Rock by  $2\frac{1}{2}$  C. yds. Shovel and Hauling Near (9.7 C. yds).

Lead one way haul in feet	Equipment Cost	Output CFC
ft.	Rs.	
1000 .. ..	160	40
2000 .. ..	194	40
3000 .. ..	228	40
5000 .. ..	296	40
6000 .. ..	364	40
8000 .. ..	432	40

### 6.11.5 Analysis of Rate for Earthwork

Output of  $2\frac{1}{2}$  c. yds. shovel in good common earth } 52 CFC per hour.

Bottom dump of  $13/15.1$  c. yds. will have an average capacity of c.yds. The percentage of swell of common earth is 25% and the swell fact is  $100 : 0.8$ . The borrow measure of 14 c. yds. is therefore  $14 \times 0.8 : 11.2$  yds. or 3 CFC.

Loading time in minutes :  $\frac{3 \times 60}{52} = 3.46$  min.

Spotting time for loading muck 0.50 min.

Average travel speed of bottom dump } 15 m.p.h.

For leads 2000, 3000, 5000, 6000 and 8000 feet, the hauling and re turning time is 3.02, 4.53, 7.55, 9.06 and 12.08 minutes respectively.

Turning and dumping time: 1.00 min.

The cycle times, number of trips per hour, the average output and number of dumpers required to haul and hour output of shovel for different leads is tabulated below:—

TABLE 6.11.5 (i)

Lead one way haul in feet	1000 ft.	2000 ft.	3000 ft.	5000 ft.	6000 ft.	8000 ft.
Total cycle time in minutes.	3.01	4.52	6.03	9.05	10.56	13.58
Trips per 50 min. hr.	16.7	11.0	8.30	5.53	4.75	3.7
Output per hr. @ CFC 65% efficiency.	32.6	21.5	16.20	10.80	9.25	7.2
No. of dumpers per shovel hour.	1.6	2	3.0	5	6	7

Equipment charges for handling common earth equipment to an hour of  $2\frac{1}{2}$  c. yds. shovel are given in table 6.11.5 (ii) below:—

TABLE 6.11.5 (ii)

## Equipment Cost per Hour Output of Shovel

Lead one way haul in feet	2½ c. yds. shovel		Tractor dozer		13 c. yds. bottom dumps		115 h.p. motor grader.		Water tanker Amt.	Total amount
	Nos.	Amt.	Nos.	Amt.	Nos.	Amt.	Nos.	Amt.		
1	2	3	4	5	6	7	8	9	10	11
ft.		Rs.		Rs.		Rs.		Rs.	Rs.	Rs.
1000	1	64	1/3	10	2	74	1/4	6	5	159
2000	1	64	1/3	10	2	74	1/4	6	5	159
3000	1	64	1/3	10	3	111	1/4	6	5	196
5000	1	64	1/3	10	5	185	1/4	6	5	270
6000	1	64	1/3	10	6	222	1/4	6	5	307
8000	1	64	1/3	10	7	259	1/4	6	5	344

TABLE 6. 11. 5 (iii)

Rate per CFC of Common Earth Excavated and Loaded by  $2\frac{1}{2}$  C. yds. Shovel and Hauled by 13 C. yds. Bottom Dump

Load one way haul	Equipment cost	Output CFC	Rate per CFC
ft.	Rs.		Rs
1000	159	52	3
2000	159	52	3
3000	196	52	3.75
5000	270	52	5.0
6000	307	52	6.0
8000	344	52	6.5

6.11.6 In the case of other soils, the rates can be worked out on the same lines. Due to the different swell factor the output per hour of the dumpers will slightly vary. Its effect on the number of dumpers will require for different leads per shovel output is not very appreciable and so the equipment combination can be taken the same as in the case of common earth; the rates will be inversely proportional to the outputs. The rates for earthwork in different soils are given below in table 6.11.6 :

TABLE 6. 11. 6

Earthwork Rates by Shovels—Rate per CFC

Soils	Lead one way haul in feet					
	1000	2000	3000	5000	6000	8000
Moist loam or light sandy clay.	2.75	2.75	3.5	4.5	5.5	6
Sand & gravel .. ..	2.75	2.75	3.5	5	5.5	6
Good common earth ..	3	3	3.75	5	6	6.5
Clay, hard & tough ..	3.5	3.5	4.5	5.75	7	7.5
Clay, wet & sticky ..	4.6	4.6	5.75	7.5	9	10

**6.11.7 Earthwork by Tractor-drawn Scrapers**

The excavation and hauling rates of 10/12.5 c. yds. and 15/20 c. yds. scrapers are as per tables 6.11.7 (i) and 6.11.7 (ii) and the average rates are those given in table 6.11.7 (iii), worked out on the basis of outputs shown in tables 6.6.10 (ii)(a) and (b), the hourly rate of tractor scrapers being Rs. 39 and Rs. 49 respectively.

TABLE 6.11.7 (i)

*Unit Rates of Excavation and Transport by Tractor-drawn 10/12.5 C. yds. Scrapers*

Sl. No.	Soil	Lead one way haul in feet					
		500 Rate per CFC	600 Rate per CFC	800 Rate per CFC	1000 Rate per CFC	1200 Rate per CFC	1500 Rate per CFC
1	2	3	4	5	6	7	8
1.	Light loam or crumbly soil.	2.05	2.17	2.30	2.44	2.79	3.25
2.	Sand & Gravel ..	2.05	2.17	2.30	2.44	2.79	3.25
3.	Good common earth	2.17	2.30	2.44	2.60	2.79	3.25
4.	Clay, hard & tough	2.17	2.30	2.44	2.60	3.0	3.55
5.	Murum .. ..	2.05	2.17	2.30	2.44	2.79	3.25
6.	Hard murum ..	2.30	2.44	2.60	2.60	3.0	3.55
7.	Clay, wet & sticky	2.30	2.44	2.60	2.60	3.0	3.55

TABLE 6.11.7 (ii)

*Unit Rates of Excavation and Transport by Tractor-drawn 15/20 C. yds. Scrapers*

1.	Light loam or crumbly soil.	1.63	1.75	1.88	2.04	2.23	2.58
2.	Sand & gravel ..	1.58	1.69	1.81	1.96	2.23	2.58
3.	Good common earth.	1.69	1.81	1.96	2.12	2.34	2.72
4.	Clay, hard & tough	1.75	1.88	2.04	2.23	2.34	2.72
5.	Murum .. ..	1.58	1.69	1.81	1.96	2.23	2.58
6.	Hard murum ..	1.81	1.88	2.04	2.23	2.45	2.88
7.	Clay, wet & sticky	2.06	2.16	2.32	2.42	2.73	3.22

TABLE 6.11.7. (iii)

Average Rate per CFC of Working Tractor Scraper

Sl. No.	Soil	Lead one way haul in feet					
		500 Rate per CFC	600 Rate per CFC	800 Rate per CFC	1000 Rate per CFC	1200 Rate per CFC	1500 Rate per CFC
1.	Light loam or crumbly silt.	1.84	1.96	2.09	2.24	2.01	2.91
2.	Sand and gravel ..	1.84	1.93	2.06	2.20	2.01	2.92
3.	Good common earth.	1.93	2.06	2.20	2.36	2.07	2.99
4.	Clay, hard & tough	1.91	2.09	2.24	2.42	2.17	3.14
5.	Murum .. ..	1.82	1.93	2.06	2.20	2.51	2.92
6.	Hard murum ..	2.06	2.16	2.32	2.42	2.73	3.22
7.	Clay, wet & sticky	2.06	2.16	2.32	2.42	2.73	3.22

### 6.11.8 Other Units Assisting Tractor Scraper Operation

A pusher or a roter will be required to assist excavation when the soil is hard. A roter is not necessary in light loam, sand and gravel, common earth, but is required in hard and tough clay, murum, hard murum and wet and sticky clay. A pusher is not required in case of light loam and good common earth.

6.11.9 The number of pushers required per scraper is equal to cycle time of pusher/cycle time of scrapers. On an average a pusher tractor is required for four scrapers. The average cost of pushing is equal to the earthwork rate in table 6.11.7 (iii) use rate of pusher divided by the number of scrapers a pusher will serve  $\times$  the average use-rate of drawn scraper. This amounts to about Rs. 0.4 per CFC.

The average cost of rooting per CFC is about Re. 0.04.

6.11.10 The following table gives the rate per CFC (borrow measure) in different soils of tractor, scraper operation assisted by dozers and rooters where necessary:—

TABLE 6.11.10

*Rates of Earthwork by Tractor-Scrapers*

Sl. No.	Soils	Lead one way haul in feet					
		500	600	800	1000	1200	1500
1	2	3	4	5	6	7	8
1.	Light loam or crumbly silt.	1.84	1.96	2.09	2.24	2.00	2.90
2.	Sand & gravel ..	2.24	2.33	2.46	2.60	2.41	3.32
3.	Good common earth	1.93	2.06	2.20	2.36	2.07	2.99
4.	Clay, hard & tough	2.35	2.53	2.68	2.86	2.61	3.58
5.	Murum .. ..	2.26	2.37	2.50	2.64	2.95	3.36
6.	Hard murum ..	2.50	2.60	2.76	2.86	3.17	3.66
7.	Clay, wet & sticky	2.50	2.60	2.76	2.86	3.17	3.66

**6.11.11 Earthwork by Motor-Scrapers**

Rates for excavation and hauling by scrapers of 10/13 and 15/20 c. yds. in different soils are tabulated in tables 6.11.11 (i) and (ii) and their average in table 6.11.11 (iii) using the outputs mentioned in tables 6.6.12 (ii) (a) and (b) hourly rates of Rs. 43 and Rs. 56 respectively.

TABLE 6.11.11 (i)

*Unit Rate of Excavation and Hauling by Motor-scraper 10/13 C. yds. Capacity*

Sl. No.	Soils	Lead in one way haul in feet						
		1000	1500	2000	2500	3000	4000	5000
1	2	3	4	5	6	7	8	9
1.	Light loam or crumbly silt.	1.87	2.05	2.15	2.39	2.53	2.87	3.31
2.	Sand & gravel ..	1.87	2.05	2.15	2.39	2.53	2.87	3.31
3.	Good common earth	1.95	2.15	2.26	2.53	2.69	3.07	3.31
4.	Clay, hard & tough ..	2.05	2.15	2.26	2.53	2.69	3.07	3.31
5.	Murum .. ..	1.87	2.05	2.15	2.39	2.53	2.87	3.31
6.	Hard murum .. ..	2.05	2.26	2.39	2.69	2.69	3.07	3.58
7.	Clay, wet & sticky ..	2.06	2.26	2.39	2.69	2.69	3.07	3.58

TABLE 6.11.11 (ii)

*Unit Rate of Excavation and Hauling by Motor-Scraper 15/20 C. yds. Capacity*

Sl. No.	Soils	Lead in one way haul in feet						
		1000	1500	2000	2500	3000	4000	5000
1	2	3	4	5	6	7	8	9
1.	Light loam or crumbly silt.	1.56	1.71	1.87	2.07	2.15	2.44	2.80
	Sand & gravel .. ..	1.51	1.65	1.81	2.00	2.07	2.44	2.80
3.	Common earth .. ..	1.60	1.75	1.93	2.15	2.24	2.54	2.94
4.	Clay, hard & tough ..	1.65	1.81	2.00	2.24	2.33	2.66	2.30
5.	Murum .. ..	1.51	1.65	1.81	2.00	2.07	2.44	2.80
6.	Hard murum .. ..	1.71	1.87	2.07	2.24	2.33	2.66	3.11
7.	Clay, wet & sticky ..	1.71	1.87	2.07	2.24	2.33	2.66	3.11

TABLE 6.11.11 (iii)

*Average Rate per CFC of Using Motor-Scraper*

1.	Light loam or crumbly silt.	1.72	1.88	2.01	2.23	2.34	2.66	3.06
2.	Sand & gravel .. ..	1.60	1.86	1.98	2.20	2.30	2.66	3.06
3.	Common earth .. ..	1.73	1.96	2.10	2.34	2.47	2.81	3.13
4.	Clay, hard & tough ..	1.85	1.98	2.13	2.39	2.51	2.87	3.44
5.	Murum .. ..	1.69	1.86	1.98	2.20	2.30	2.66	3.06
6.	Hard Murum .. ..	1.83	2.07	2.23	2.47	2.51	2.87	3.35
7.	Clay, wet & sticky ..	1.83	2.07	2.23	2.47	2.51	2.87	3.35

6.11.12 On an average one pusher tractor is required to assist three scrapers; the share of pusher is about Re. 0.5 per CFC of earth moved. The cost of rooting, where necessary, is about Re. 0.04 per CFC.



The rates per CFC (Borrow measure) for Motor scraper operation in different soils assisted by dozers and roters where necessary are given below:—

TABLE 6.11.12

*Rates for Excavation and Hauling by Motorised Scraper*

Sl. No.	Soils	Lead one way haul in feet						
		1000	1500	2000	2500	3000	4000	5000
1	2	3	4	5	6	7	8	9
1.	Light loam or crumbly silt	1.72	1.86	2.01	2.23	2.34	2.66	3.06
2.	Sand and gravel ..	2.19	2.35	2.48	2.70	2.80	3.16	3.56
3.	Good common earth ..	1.78	1.95	2.10	2.34	2.47	2.81	3.13
4.	Clay, hard & tough ..	2.39	2.52	2.57	2.93	3.05	3.41	3.93
5.	Murum .. ..	2.23	2.39	2.52	2.74	2.84	3.20	3.60
6.	Hard murum .. ..	2.42	2.61	2.77	3.01	3.05	3.41	3.89
7.	Clay, wet & sticky ..	2.42	2.61	2.77	3.01	3.05	3.41	3.89

## 6.12 CONSOLIDATION OF LOOSE EARTH

### 6.12.1 Rate for Trimming, Watering and Compaction

The equipment used for trimming, watering and compaction of an earthen bank are tractor-dozers, water sprinkler trucks and rollers or tractor-drawn sheepsfoot rollers. A motor grader is sometimes used in addition to the dozer. In some cases watering is done by manual labour and the quantity of water depends on the job specifications and soil condition. On some projects where heavy scrapers dump the earth on bank, no rollers are used, as the compaction is supposed to be achieved by the weight of the scrapers and other hauling equipment on the bank.

6.12.2 About half-an hour of dozing is necessary for an hourly output of a shovel and the cost of watering is about Re. 0.25 per CFC.

### 6.12.3 Analysis of Rate of Consolidation

(a) Cost per CFC dozing } Re. 0.38.  
 @ Rs. 38 per hour }

(b) Cost of Water per CFC		Re. 0.25
(c) Cost of Rolling Output of twin drum sheepsfoot roller for 3" depth layer and 10 passes.	}	72 CFC per hr.
Use Rate per hour of D. 4 tractor drum roller		
Cost per CFC of rolling		Re. 0.21

*Abstract*

Cost per CFC (borrow)	
(a) Dozing	Rs. 0.38
(b) Watering	0.25
(c) Compaction	0.21
TOTAL	<u>0.84</u>

## 6.13 HYDRAULIC SLUICING

6.13.1 This Chapter will not be complete without a mention of one of the novel methods of moving earth other than those mentioned above. It is hydraulic sluicing.

6.13.2 It is a simple and effective way of moving earth by a stream of water at high pressure through portable nozzles called 'Hydraulic Giants' or 'Monitors' directed at the material. This method is very economic in such situations, as for example a hillside, not connected by haul roads by which earthmoving machines can reach the site.

6.13.3 This method is being effectively employed on the Bhakra Project, where 1,62,400 c. yds. was moved in 255 hours at a cost of Re. -/7/6 per c. yd. inclusive of erection, depreciation and operation charges.

## EARTHWORK BY HUMAN LABOUR

## 7.1 EARTHWORK AND CLASSIFICATION OF SOIL

7.1.1 Earthwork by manual labour is generally confined to a maximum lead of 300 feet except in places where the quantity of work involved is too small to justify the use of the machines.

7.1.2 The classification of soils in an ascending order of efforts given below (table 7.1.2):—

TABLE 7.1.2

Sl. No.	Type of Soil	Wt. per cft in borrow (lbs.)	Digging tools used in excavation	Local names
1	2	3	4	5
<i>Soil Characteristics</i>				
1.	Silt & sand	90-105	Hand Shovel	Sand, silt, sandy gravel.
2.	Ordinary soil	75-100	Hand shovel or spade	Soil, silt.
3.	Common earth	90-110	Spade	Average loam.
4.	Clay, light	100-115	Flat pick	Clayey and loamy sub-soil.
5.	Clay, heavy or hard soil	100-125	Pointed pick	Stiff clay, soft murum clay and boulder.
<i>Rock Characteristics</i>				
6.	Soft rock	130-150	Crowbar or wedges	Compact gravel, hard murum, Shale, Schist soft laterite & disintegrated rock.
7.	Hard rock	150-190	Blasting	Stone, massive hard rock, abraded massive rock.

## 7.2 SCHEDULE OF MANUAL OUTPUT AND RATES

7.2.1 Excavation can be (i) *the Surface Digging* in which case the depth of cutting is not more than 12", or (ii) the *Rough* from borrows, *i.e.* cutting hillside or removal of spoil, (iii) *Deep Digging* exceeding 12' depth and (iv) *Trenching in narrow*. Rates vary according to the nature of the work involved, but we shall confine our attention here to category (i) which is the most common.

7.2.2 The Table 7.2.2 gives the effort in man-days per CFC of digging and raising spoil from excavation including rough dressing in borrows. The range of excavation rates for various soils is given in col. 4 assuming an average wage rate for unskilled male *mazdoor* and *pro rata* share of the mate at Rs. 1.8 per day.

TABLE 7.2.2

*Digging not Exceeding 3' Depth and Raising of Spoils and Filling in Head-load Baskets or Borrows.*

Sl. No.	Type of soil	Range of labour effort per CFC (man-days)	Range of rates per CFC (Rs.)
1	2	3	4
1.	Sand and silt	0.25—0.4	0.45—0.72
2.	Top soil	0.4 —0.6	0.72—1.08
3.	Common earth	0.5 —0.8	0.9 —1.44
4.	Clay, light	0.7 —1.0	1.26—1.8
5.	Clay, heavy	0.85—1.2	1.5 —2.2
6.	Soft rock	1.4 —2.5	2.5 —4.5

NOTE:—These labours and rates do not include transporting.

## 7.3 REMOVAL OF SPOIL

7.3.1 Table 7.3.1 gives the effort needed and rate fixed per CFC of excavated materials by female @ Rs. 1.3 per diem for different leads.

TABLE 7.3.1

*Labour Effort Constants in Man-days and Rates in Rupees for Removal of Spoil per CFC*

Sl. No.	Horizontal distance between (CFR unit)	Removal of soil				Remarks
		Soil		Rock		
		Labour	Rate	Labour	Rate	
1	2	3	4	5	6	7
1.	.25	.13	.17	.17	.22	It is assumed that a person carrying soil can travel 200 ft. per minute and it takes .06 minute to unload a basket. For carrying rock the speed will be reduced to 150 ft./min.
2.	.50	.23	.30	.30	.39	
3.	1.0	.43	.58	.59	.77	
4.	1.5	.63	.82	.86	1.12	
5.	2.0	.83	1.08	1.14	1.48	
6.	2.5	1.03	1.34	1.43	1.86	

7.3.2 In case when the spoil has to be loaded into baskets from an existing heap and consolidated bank measured, the extra labour to be added would be 0.2 and 0.3 to columns 3 and 5 while 0.26 and 0.39 are to be added to the rates.

7.3.3 Table 7.3.3 gives rates (per CFC) of excavation in muck and over areas for leads between 50'—60' and digging not exceeding 3' depth.

TABLE 7.3.3

*Manual Operations*

Sl. No.	Type of soil	Range of labour effort (Man-days)	Rates at average wages at		
			Rs. 1.5	1.8	2.1
1	2	3	4	5	6
1.	Sand and silt .. ..	0.48-0.63	0.72-0.94	0.86-1.13	1.01-1.32
2.	Top soil .. ..	0.63-0.83	0.94-1.25	1.13-1.49	1.32-1.74
3.	Common earth .. ..	0.73-1.03	1.09-1.54	1.31-1.85	1.53-2.10
4.	Clay, light .. ..	0.93-1.36	1.4-2.04	1.63-2.45	1.95-2.85
5.	Clay, heavy .. ..	1.06-1.53	1.62-2.29	1.95-2.76	2.27-3.21
6.	Soft rock .. ..	1.70-2.8	2.55-4.20	3.06-5.04	3.57-5.88

7.3.4 Combining the two tables 7.2.2 and 7.3.1 we have the two tables 7.3.4 (i) and 7.3.4 (ii) giving fair labour constants and rates for excavation with various leads.

TABLE 7.3.4 (i)

*Rates of Earthwork by Manual Labour*

Sl. No.	Type of soil	Labour effort in man-days for digging and disposal of spoil for leads					
		0.25 CFR	0.5 CFR	1.0 CFR	1.5 CFR	2.0 CFR	2.5 CFR
1	2	3	4	5	6	7	8
1.	Sand and silt ..	0.38-0.53	0.48-0.63	0.68-0.83	0.88-1.03	1.08-1.23	1.28-1.43
2.	Top soil ..	0.53-0.73	0.63-0.83	0.83-1.03	1.03-1.23	1.23-1.43	1.43-1.63
3.	Common earth ..	0.63-0.93	0.73-1.03	0.93-1.23	1.13-1.43	1.33-1.63	1.53-1.83
4.	Clay, light ..	0.93-1.33	1.03-1.53	1.23-1.63	1.43-1.83	1.63-2.03	1.83-2.23
5.	Clay, heavy ..	1.13-1.63	1.23-1.73	1.43-1.93	1.63-2.13	1.83-2.33	2.03-2.53
6.	Soft rock ..	1.57-2.67	1.70-2.80	1.90-3.09	2.26-3.36	2.54-3.64	2.83-3.93

TABLE 7.3.4 (ii)

*Rates for Earthwork by Manual Labour*

Sl. No.	Type of soil	Rates of excavation for distances (CFR) from the excavation point					
		0.25	0.5	1.0	1.5	2.0	2.5
1	2	3	4	5	6	7	8
1.	Sand and silt ..	0.62-0.89	0.75-1.0	1.03-1.23	1.27-1.47	1.53-1.75	1.79-2.00
2.	Top soil ..	0.89-1.25	1.0-1.4	1.23-1.68	1.47-1.90	1.73-2.16	2.00-2.42
3.	Common earth ..	1.07-1.57	1.2-1.7	1.48-1.98	1.72-2.22	1.98-2.54	2.24-2.74
4.	Clay, light ..	1.43-1.87	1.56-2.1	1.84-2.38	2.08-2.62	2.34-2.88	2.60-3.14
5.	Clay, heavy ..	1.67-2.37	1.8-2.8	2.08-2.78	2.32-3.02	2.58-2.58	2.84-3.54
6.	Soft rock ..	2.72-4.72	2.89-4.89	3.27-5.27	3.62-5.62	3.98-5.98	4.36-6.36

7.3.5 Average rates for excavation in different soils for a lead between 50/60' and 3' depth would be as under (Table 7.3.5). The rates are primary.

TABLE 7.3.5

Sl. No.	Type of soil	Average rates digging 3' depth and lead 50'-60' Rs. per CFC	Remarks
1	2	3	4
1.	Sand and silt .. .. .	0.87	For every extra lead of 50' add Re. 0.25
2.	Top soil .. .. .	1.20	
3.	Common earth .. .. .	1.45	
4.	Clay, light .. .. .	1.83	
5.	Clay, heavy .. .. .	2.30	

#### 7.4 EXCAVATION RATES AND OUTPUT (MANUAL) FROM PROJECTS

7.4.1 The excavation rates have been tabulated below for different types of soils for .50 to .60 CFR lead and digging not exceeding 3' Rates have been obtained from applicable sanctioned schedule of rates or from observed recorded data.

7.4.2 Sanctioned rates of digging and disposal of spoil up to 60' lead and depth of excavation not exceeding 3' in various soils have been tabulated for a few projects.

TABLE 7.4.2 (i)

*Excavation by Manual Labour  
(Type of Soil : Silt and Sand)*

Sl. No.	Name of Project	Rate Rs. per CFC	Man-days per CFC	Weighted average wage rate	Remarks
1	2	3	4	5	6
1.	Nangal .. .. .	1.22	0.57	2.3	Rate as per table 7.3.4 (ii) = Re. 0.75 to 1.00
2.	Gangapur .. .. .	0.86	0.53	1.3	
3.	Lower Bhawani .. .. .	0.73	0.58	1.25	
4.	Malampuzha .. .. .	0.80	0.66	1.21	
5.	Peechi .. .. .	0.98	0.67	1.46	

TABLE 7.4.2 (ii)

Excavation by Manual Labour  
(Type of Soil : Common Earth)

Sl. No.	Name of Project	Rate Rs. per CFC	Weighted average wage rate	Man-days per CFC		Remarks
1	2	3	4	5		6
1.	Nangal .. .. .	1.49	0.70	2.125	Lead	Rates as per table 7.3.4 (ii) =Rs.1.20 -1.7
2.	Sarda Sagar .. .. .	2.00	1.14	1.75		Converted to 60' lead and 3' lift
		1.56	0.89		100' lead 5' Lift	
3.	Matatila .. .. .	1.6	1.097	1.46		109' Lead -do- 5' Lift
		1.2	0.82			
4.	Chambal (Raj.) (Kotah) ..	2.0	1.37	1.46		
		1.7	1.16			
5.	Gangapur .. .. .	1.22	0.73	1.625	60' Lead 3' Lift	
6.	Lower Bhawani .. .. .	1.00	0.80	1.25	"	
7.	Malampuzha .. .. .	1.09	0.90	1.21	"	
8.	Peechi .. .. .	1.20	0.83	1.46	"	

TABLE 7.4.2 (iii)

Excavation by Manual Labour  
(Type of Soil : Clay, Light)

Sl. No.	Name of Project	Rate Rs. per CFC	Man-days per CFC	Weighted average wage rate		Remarks
1	2	3	4	5		6
1.	Chambal (Kotah) .. .. .	2.30	1.57	1.46	60' Lead 3' Lift	Rates as per table 7.4.2 (ii) =Rs. 1.56-2.1
		2.00	1.37	—	100' Lead 5' Lift	Converted to 60' lead and 3' lift



TABLE 7.4.2 (iii)—contd.

1	2	3	4	5	6
2.	Hirakud .. ..	2.03	1.39	1.46	60' Lead 5' Lift
		1.81	1.24	—	
3.	Tungabhadra (Hyd.) ..	1.93	1.57	1.23	60' Lead 3' Lift
		1.85	1.5	—	50' Lead 5' Lift
4.	Pecchi .. ..	1.54	1.05	1.46	60' Lead 5' Lift
5.	Lower Bhawani .. ..	1.27	1.02	1.25	Lift

TABLE 7.4.2 (iv)

Excavation by Manual Labour  
(Type of Soil : Clay, Heavy)

Sl. No.	Name of Project	Rate Rs. per CFC	Man-days per CFC	Weighted average wage rate	Remarks
1	2	3	4	5	6
1.	Matatila .. ..	2.3	1.57	1.46	Lead Rates as per table 7.4.3 (ii) =Rs. 1.8 to 2.8
		1.9	1.30		100' Lead 5' Lift Converted to 60' lead and 3' lift.
2.	Chambal (Raj.) Kotah ..	2.8	1.92	1.46	
		2.5	1.71		100' Lead 5' Lift
3.	Hirakud .. ..	2.5	1.71	1.46	
		2.28	1.56		100' Lead 5' Lift
4.	Tungabhadra (And.) ..	2.12	1.93	1.10	
5.	Tungabhadra (Hyd.) ..	2.19	1.78	1.23	
		2.11	1.71	—	50' Lead 5' Lift
6.	Malampuzha .. ..	1.89	1.56	1.21	60' Lead 3' Lift

TABLE 7.4.2 (v)  
Excavation by Manual Labour  
(Type of Soil : Hard Gravelly Soil)

Sl. No.	Name of Project	Rate Rs. per CFC	Man-days per CFC	Weighted average wage rate	Remarks
1	2	3	4	5	6
1.	Nangal .. ..	3.14	1.48	2.125	Lead
2.	Sarda Hydrel .. ..	3.00	1.71	1.75	
		2.56	1.46		100' Lead 5' Lift
3.	Matatila .. ..	3.00	2.06	1.46	Converted to 60' lead and 3 lift
		2.6	1.78		100' Lead 5' Lift
4.	Hirakud .. ..	3.00	2.05	1.46	-do-
		2.78	1.90		100' Lead 5' Lift
5.	Tungabhadra (Andhra) .. ..	2.60	2.36	1.10	60' Lead 5' Lift
6.	Tungabhadra (Hyd.) .. ..	2.25	1.83	1.23	50' Lead 5' Lift
		2.17	1.76		-do-
7.	Malampuzha .. ..	2.14	1.77	1.21	60' Lead
8.	Peechi .. ..	2.18	1.49	1.46	3' Lift

TABLE 7.4.2 (vi)  
Excavation by Manual Labour  
(Type of Soil : Soft Rock)

Sl. No.	Name of Project	Rate Rs. per CFC	Man-days per CFC	Weighted average wage rate	Remarks
1	2	3	4	5	6
1.	Chambal (Raj.) Kotah .. ..	2.93	2.00	1.46	
		2.43	1.67		100' Lead 5' Lift
					Converted to 6' lead and 3' lift
2.	Mayurakshi .. ..	4.00	2.04	1.96	
		3.40	1.74		100' Lead 5' Lift
					-do-

TABLE 7.4.2 (vi)—contd.

1	2	3	4	5	6
3.	Hirakud .. .. .	4.5	3.08	1.46	
		4.28	2.93		100' Lead 5' Lift
4.	Gangapur .. .. .	3.36	2.07	1.625	Converted to 60' lead and 3' lift
5.	Tungabhadra (Andhra) ..	3.00	2.73	1.10	
6.	Tungabhadra (Hyd.) ..	3.32	2.70	1.23	
		3.24	2.63		50' Lead 5' Lift
7.	Lower Bhawani .. .. .	2.44	1.95	1.25	-do-
8.	Malampuzha .. .. .	2.89	2.39	1.21	
9.	Peechi .. .. .	3.68	2.52	1.46	

## 7.5. HAND SHOVELLING

7.5.1. The cost of hand shovelling depends upon the kind of material, lift, kind of shovel, and the skill and inclination of the workmen. All materials that can be shovelled either while loading or unloading should be measured and rated in CFC units for these functions. The range of output and average rates are given in Table 7.5.1. Rates for carriage should, however, be paid per ton on large works where arrangements for weighing trucks ought to be made.

TABLE 7.5.1.

*Shovelling of Materials (loading & unloading)*  
(Daily weighted wage rate=Rs. 2.0)

Kind of material	Unloading rates— Truck to ground or stack to to stack			Loading Rates— Ground to truck or wagon	
	Output per man Range	Output per shift Average (CFC)	Rates per CFC	Rates for lifts up to 4' per CFC	Rates for lifts 4'—6' per CFC
1.	2.	3.	4.	5.	6.
Cinders .. .. .	4-6	5	0.4	0.5	0.6
Sand or Surkhi .. .. .	3-5	4	0.5	0.6	0.7
Soil heaps .. .. .	3-4	3.5	0.6	0.7	0.8
Gravel .. .. .	2.5-3.5	3	0.7	0.8	0.9
Crushed stone in stacks .. .. .	2-3	2.5	0.8	0.9	1.0

## 7.5.2 Illustrative Example

Determine cost for unloading bankrum gravel from Railway wagon to platform.

Volume of gravel in CFC units	=	5
Rate per CFC for unloading (Col. 4)	=	Re. 0.7
Rate for unloading gravel per wagon	=	Rs. 3.5

## 7.6 TRANSPORT BY DONKEYS OR MULES

7.6.1 Donkeys or mules are often employed in transporting materials particularly in hauling dirt. Average rate of travel for these animals working over a shift of eight hours may be reckoned as 3 miles (16,000') an hour approximately. Load carried is usually one cu. ft. and the hire charge inclusive of the attendant labour is Rs. 2/8 per day—6 animals usually requiring one donkeyman and two assistant boys. The rate of haulage can now be derived for varying leads (Table 7.6.1.)

Loading and unloading time—2.0 minutes.

TABLE 7.6.1

Lead	Time taken per trip			No. of trips per day	Rate per CFC (Rs.)
	Haulage (min.)	Loading & unloading (min.)	Total (min.)		
1	2	3	4	5	6
200	1.50	2.0	3.5	137	1.8
300	2.25	2.0	4.25	113	2.1
400	3.0	2.0	5.0	96	2.6
500	3.75	2.0	5.75	84	3.0
600	4.5	2.0	6.50	74	3.4
700	5.25	2.0	7.25	66	3.8
800	6.0	2.0	8.0	60	4.2
900	6.75	2.0	8.75	55	4.6
1000	7.50	2.0	9.50	50	5.0
1500	10.25	2.0	12.25	39	6.4
2000	15.00	2.0	17.0	28	8.9
2500	18.75	2.0	20.75	23	10.8

## 7.7 CLEARING JUNGLE

7.7.1. Rates for light and thick jungle clearance with and without rooting out by manual labour are given in Table 7.7.1.

TABLE 7.7.1

*Analysis and Schedule of Rates for clearing Site by Manual Labour*

Item	Unit	No. of Labour	Rate (Rs.)	Per	Amount (Rs.)	Rate per Acre (Rs.)
Clearing scrub jungle without rooting out.	MFS	1	1.8	each	1.8	78
Clearing scrub jungle including rooting out.	"	2	1.8	each	3.3	157
Clearing light jungle without rooting out.	"	2	1.8	each	3.6	157
Clearing light jungle including rooting out.	"	4	1.8	each	7.2	314
Clearing heavy jungle without rooting out.	"	4	1.8	each	7.2	324
Clearing heavy jungle including rooting out.	"	8	1.8	each	14.4	627
Clearing thickly wooded and thorny jungle including rooting out.	"	9	1.8	each	16.2	706

## TRANSPORT

### 8.1 TRANSPORTING MATERIALS OF CONSTRUCTION

8.1.1 Transportation figures practically occur in all items of construction and very often these account for a large portion of the total cost. Some of the important means of transport which are in use on the projects are bullock carts, petrol and diesel trucks, tip wagons on trolley line pushed by hand or pulled by a steam or a diesel locomotive, dumpers, belt conveyors and ropeways. Transports by men or by donkeys have been discussed in the preceding chapter.

8.1.2 In transporting materials the operations involved are loading, carriage, and unloading at the delivery point. Stacking is excluded from the present study.

### 8.2 WEIGHTS OF PRINCIPAL CONSTRUCTION MATERIALS

8.2.1 The weights of principal construction materials are given in the engineering data books but weights for some local materials are recorded here (table 8.2.1.) and these would be utilised in our studies for transporting them.

TABLE 8.2.1  
*Weights of Local Structural Materials*

Sl. No.	Nature of materials	Weights		Remarks
		Lbs. per CFC	Tons per CFC	
1	2	3	4	5
1.	Quarried and crushed stone—			
	(i) Limé stone .. .. .	80	3.57	The data given is based on 45% voids.
	(ii) Granite .. .. .	92	4.11	
	(iii) Basalt .. .. .	95	4.24	
2.	Bank-rum shingle containing sand .. .. .	100	4.46	
3.	Gravel or shingle without sand .. .. .	94	4.20	
4.	Clean pit sand, dry .. .. .	90	4.02	
5.	Slaked Lime powder .. .. .	60	2.68	
6.	Unslaked Lime .. .. .	30	1.34	
7.	Surkhi ground, dry and loose .. .. .	72	3.21	
8.	Timber—			
	(i) Deodar .. .. .	36	1.6	
	(ii) Teak .. .. .	45	2.0	
	(iii) Sal .. .. .	47	2.1	

TABLE 8.2.1.—contd.

*Bricks*

Sl. No.	Size of Bricks	Weight per 1000 Nos. (ton)	No. of bricks per tons	Remarks
1	2	3	4	5
9.	9" × 4 $\frac{3}{8}$ " × 2 $\frac{3}{8}$ "	3.21	313	
10.	9" × 4 $\frac{1}{2}$ " × 1 $\frac{1}{4}$ "	1.57	637	
11.	12" × 6" × 2"	4.46	224	
12.	10" × 5" × 2 $\frac{1}{2}$ "	3.88	258	
13.	10" × 4 $\frac{7}{8}$ " × 2 $\frac{3}{4}$ "	4.16	240	

## 8.3 COST OF CARRIAGE BY CARTS

8.3.1 There are many types of carts in the country varying in their capacity and their rates of hire vary from Rs. 2/8/- to Rs. 6/10/- including labour charges of the driver, average being Rs. 5/-. Table 8.3.1. gives the rates prevalent in various localities.

TABLE 8.3.1

*Hire Rates of Carts per day (With Attendant and a Pair of bullocks)*

Station	State	Daily hire rate
1	2	3
Gangapur .. .. .	Bombay	4/8/- to 6/-/-
Tungabhadra .. .. .	Madras	5/8/-
Chambal .. .. .	Madhya Bharat	7/-/-
Hirakud .. .. .	Orissa	4/8/-
Bhakra-Nangal .. .. .	Punjab	6/-/-
Konar .. .. .	D.V.C.	6/10/-
Rihand .. .. .	U.P.	4/8/- to 5/8/-
Madhya Bharat .. .. .	Madhya Bharat	3/8/- to 4/8/-
Ahmed Nagar Divn. .. .. .	Bombay	4/8/-
Ghataprabha Divn. .. .. .	Bombay	5/-/- to 6/-/-
Trinulvali Divn. .. .. .	Madras	5/-/-
Jabalpur Circle .. .. .	Madhya Pradesh	2/8/- to 4/-/-
Berar and Nagpur Circle .. .. .	Madhya Pradesh	3/-/- to 5/1/-

8.3.2 Table 8.3.2 is extracted from C.P.W.D., schedule (1950 publication) for carriage by *Thelas*. These *Thelas* are big 4-wheeled carts pulled by a strong pair of bullocks and carry considerably more load than the usual bullock carts. The hire rate is Rs. 12/- per day.

TABLE 8.3.2

*Handling and Transporting Materials (Carriage by Carts)*

Lead in Miles	Number of trips per 8 hours	Cost per trips	Remarks
1	2	3	4
$\frac{1}{2}$	6.96	1/11/7	
1	5.16	2/5/3	
$1\frac{1}{2}$	4.10	2/14/10	
2	3.40	3/8/6	1. Number of trips $N = \text{trips per 8 hours.}$ $N = \frac{8}{\frac{2L}{S} + 4}$
$2\frac{1}{2}$	2.91	4/2/-	
3	2.54	4/11/7	where $L =$ Lead in miles, $S =$ Speed in miles per hour and $\frac{3}{4}$ hours is allowed for loading and unloading.
$3\frac{1}{2}$	2.25	5/5/4	
4	2.03	5/14/7	2. Speed assumed $2\frac{1}{2}$ miles per hour.
$4\frac{1}{2}$	1.84	6/8/4	3. Bullock cart charge @ Rs. 12 per 8-hour day.
	1.68	7/2/3	
$5\frac{1}{2}$	1.55	7/11/1	
6	1.44	8/5/4	

8.3.3. Based on the capacity of these *Thelas* and the above Table the derived rates are given over various leads (Table 8.3.3). The carriage rates are primary and the units of measure differ with nature of materials. Rates can be worked out similarly for smaller sizes of carts and their hire rates.

TABLE 8.3.3

Sl. No.	Lead in Miles	Cost per trip	Materials					
			Sand, lime murum, gravel, earth, ballast and building rubbish	Bricks	Cement, Steel, C.I. Pipes and other heavy materials	Timber	Tar, Bitumen	Coal
Capacity per trip			33½ FC	500 Nos.	1.5 Ton	50 FC	1½ Ton	Ton
Unit of Rate			CFC	1000 Nos.	Ton	CFC	Ton	Ton
1	2	3	4	5	6	7	8	9
1.	½	1/11/7	5/3	3/7	1/2	3/7	1/2	1/12
2.	1	2/5/3	7/-	4/11	1/9	4/11	1/9	2/5
3.	1½	2/14/10	8/13	5/14	1/15	5/14	1/15	2/15
4.	2	3/8/6	10/10	7/1	2/6	7/1	2/6	3/9
5.	2½	4/2	12/6	8/4	2/12	8/4	2/12	4/2
6.	3	4/11/7	14/3	9/7	3/2	9/7	3/2	4/12
7.	Above 3 miles per ½ mile	-/9/8	1/13	1/3	-/6/-	1/3	-/6/-	-/10/-

8.3.4 Transport by hand-pushed trolley on rails is often made use of on large projects. The rate for hauling 100 cubic feet of soil usually comes to Rs. 1/8/- per mile exclusive of the cost of tools and plant.

#### 8.4 TRANSPORTING MATERIALS BY MOTOR TRUCKS

8.4.1 Reference was made to State to supply approved freight rates by motor trucks both per ton and per truck per mile. The data



collected is tabulated in Table 8.4.1 Rates differ with type of roads which are classed as under :—

- Type A roads = Cemented, tarred, asphalted or metalled.  
 Type B roads = Gravel or *Kankar* roads.  
 Type C roads = Fair weather tracks.

TABLE 8.4.1

*Handling and Transporting Materials over Long Distances  
 (5 Ton Lorries—155" Base)*

Sl. No.	Source of data	Class of roads	Freight per ton per mile	Freight rate per truck per mile including operation labour 5 tons
1	2	3	4	5
1.	Transport Commissioner, U.P.	A B	0-4-8 0-7-9	1/1/6 (loaded) -/12/6 (empty) (b) 1/4/-
2.	State Motor Transport Controller, Delhi.	A	0-9-4	1/4/-
3.	Transport Commissioner, Rajasthan, Jaipur.	A B C	0-7-0 0-8-2 0-11-8	— — —
4.	G. M. Bombay State Road Transport Corporation.	A	0-8-0	-/11/90 (3% more on rough road.)
5.	Secretary, Transport Deptt. East Punjab.	A B	0-7-0 0-9-4	1/4/- 1/6/-
6.	State Transport Commissioner, Bihar.	A B	0-4-8 0-6-0	-/12/- -/12/-
7.	Secretary, State Transport Authority, Bombay.		0-8-0	(b) 1/-/-
8.	Secretary, State Transport Authority, Madhya Pradesh.	A	0-14-0 (Ceiling)	1/-/-
9.	Director, Transport Department, Travancore-Cochin	A C	0-6-6 (Ghat Section)	1/8/- 2/-/-

NOTE :—The rates are for long distances and do not include any charge for empty journey but include loading and unloading.

**8.4.2 Cost of Transport by Petrol Trucks (5-Ton)***Variable per mile :*

(a) Cost of truck exclusive of tyres and tubes	Rs.	17,500
Repair charges @ 60% over life-time	Rs.	10,500
<hr/>		
Life of Truck : 10,000 hours	Rs.	28,000
Assuming average speed over life-time of 15 m.p.h.		
Life in miles : 1,50,000		
∴ Depreciation and repairs per mile ..	Re.	0.187 (a)

(b) Cost of six tyres and tubes @ Rs. 325/- for each set.	Rs.	1,950
Repairs and casualties @ 20% .. ..	Rs.	390
<hr/>		
Total ..	Rs.	2,340

Life of tyres and tubes assumed to be 15,000 miles.		
∴ Cost of tyres and tubes per mile ..	Re.	0.156 (b)

Total ownership cost ..	Re.	0.343
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(c) Cost of operation materials per mile—		
(i) Petrol with consumption of 8 miles per gallon on the average and cost Rs. 2/8 per gallon.	Re.	0.350
(ii) Mobil oil with consumption of one gallon for every 400 miles on the average and cost Rs. 5/8 per gal.	Re.	0.015
(iii) Other oils and stores say equal to (b).	Re.	0.015

Total cost of operation materials per mile.	Re.	0.380 (c)
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Total a + b + c = Re. 0.723 per mile

*Constants per day of 8 hours :*

(d) Cost of staff per day of 8 working hours including allowance for idle days.		
Driver @ Rs. 4/8/- per day ..	Rs.	4.5
Cleaner @ Rs. 2/-/- per day ..	Rs.	2.0
<hr/>		
Sub-total ..	Rs.	6.5
Add 25% for idle days .. ..	Rs.	1.51
<hr/>		
Total ..	Rs.	8.01

(e) Cost of labour per day of 8 working hours for loading and unloading.		
6 male mazdoors @ Rs. 1.75 .. ..	Rs.	10.50

(f) Taxes and Insurance etc. per year—			
(i) Road Tax (varying for each State)	Rs.		300
(ii) Insurance .. .. .	Rs.		250
(iii) Driver's licence fee .. .. .	Rs.		10
			560
Total	Rs.		560

Assuming 250 working days in a year, cost per day.			
Total d+e+f .. .. .	Rs.		2.24
	Rs.		20.75

8.4.3. Based on the above data cost of transport of materials for various leads is given in Table 8.4.3.

TABLE 8.4.3.

*Cost of Transport by Petrol Trucks (5-Ton)*

Lead in Miles	Cost of variables (a+b+c= Re. 0.723 per mile) per round trip	Cost of constants (d+e+f =Rs. 20.75) per day of 8 hours	Number of trips per day	Cost of constants = Rs. 20.75 per trip (col. 3 ÷ 4)	Total cost per mile round trip (cols. 2+5)	Capacity per trip	Primary rate per CFC Rs.
1	2	3	4	5	6	7	8
<i>Rubble Stone</i>							
1.	1.446	20.75	8	2.594	4.040	CFC	4.0
2.	2.892	20.75	8	2.594	5.486	CFC	5.5
3.	4.338	20.75	7	2.964	7.302	CFC	7.3
<i>Bricks</i>							
							Primary rate per 1000 Nos.
1.	1.446	20.75	8	2.594	4.040	1250 No.	3.02
2.	2.892	20.75	8	2.594	5.486	1250 No.	4.4
3.	4.338	20.75	7	2.964	7.302	1250 No.	5.8
<i>Fine and Coarse Aggregates</i>							
							Primary rate per CFC
1.	1.446	20.75	7	2.964	4.410	CFC	4.4
2.	2.892	20.75	7	2.964	5.856	CFC	5.9
3.	4.338	20.75	6	3.458	7.796	CFC	7.8

NOTE :—1. Rates include cost of labour for loading & unloading.  
 2. Rates are applicable to type 'A' roads—cemented, oil bound and good metalled roads.  
 3. Add to the above 15, 20, 30% for class B, C & D type roads respectively.

TYPE :—B. Gravel, kankar and murum roads.  
 C. Rough metal roads.  
 D. Soft roads.

**8.4.4. Cost of Transport by Diesel Trucks (5-Ton)**

Analysis of rates for transport by 5-Ton Diesel Truck is given below :—

*Variables per mile*

(a) Cost of truck exclusive of tyres and tubes	Rs.	23,000
Repair charges @ 60% over life-time	Rs.	13,800
		<hr/>
Total .. ..	Rs.	36,800
Life : 12,000 hours		
Assuming average speed over life-time of 15 m.p.h.		
Life in miles : 1,80,000		
∴ Depreciation per mile .. .. .	Re.	0.204 (a)
		<hr/>
(b) Cost of six tyres and tubes @ Rs. 325/- per set.	Rs.	1,950
Repairs and casualties @ 20% ..	Rs.	390
		<hr/>
Total .. ..	Rs.	2,340
Life of tyres and tubes assumed to be 15,000 miles.		
∴ Cost per mile .. .. .	Re.	0.156 (b)
		<hr/>
Total ownership cost per mile ..	Re.	0.36
(c) Cost of operation materials per mile		
(i) Diesel with consumption of 10 miles per gallon on the average and cost Rs. 1/8/- per gallon.	Re.	0.150
(ii) Mobil oil with consumption of one gallon per every 300 miles on the average and cost Rs. 5/8 per gallon	Re.	0.019

(iii) Other oils and stores say equal to (b) per mile.	Re.	0.019
Total cost of operation materials per mile.	Re.	0.188 (c)
<hr/>		
Total a+b+c=	Re.	0.548 per mile.

*Constants per day of 8 hours**(d) Cost of staff per day of 8 working hours  
including allowance for idle days*

Driver @ Rs. 4/8/- per day .. ..	Rs.	4.5
Cleaner @ Rs. 2/- per day .. ..	Rs.	2.0
<hr/>		
Sub-Total .. ..	Rs.	6.5
Add 25% for idle days .. ..	Rs.	1.51
<hr/>		
Total .. ..	Rs.	8.01 (d)

*(e) Cost of labour per day of 8 working hours  
for loading & unloading.*

6 male mazdoors @ Rs. 1.75 .. ..	Rs.	10.50 (e)
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*(f) Taxes and Insurance etc. per year—*

(i) Road Tax .. ..	Rs.	300*
(ii) Insurance .. ..	Rs.	250
(iii) Driver's licence fee .. ..	Rs.	10
<hr/>		
Total .. ..	Rs.	560

Assuming 250 working days in a year, cost per day.	Rs.	2.24 (f)
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Total d+e+f=Rs. 20.75

\*This figure varies from State to State.

8.4.5. Based on the above data costs per unit of materials is given in Table 8.4.5.

TABLE 8.4.5

*Cost of Transport by Diesel Trucks (5-Ton)*

Lead in miles	Cost of variables (a+b+c= Re. 0.548 per mile) per round trip	Cost of constants (d+e+f =Rs. 20.75) per day of 8 hours	Number of trips per day	Cost of constants Rs. 20.75 per trip (col. 3÷4)	Total cost per mile per round trip (cols. 2+5)	Capacity per trip	Primary rate per CFC
1	2	3	4	5	6	7	8
<i>Rubble Stone</i>							
1.	1.096	20.75	8	2.594	3.690	CFC	3.7
2.	2.192	20.75	8	2.594	4.786	CFC	4.8
3.	3.288	20.75	7	2.964	6.252	CFC	6.3
<i>Bricks</i>							
							Primary rate per 1000 Nos.
1.	1.096	20.75	8	2.594	3.690	1250	3.0
2.	2.192	20.75	8	2.594	4.786	1250	3.8
3.	3.288	20.75	7	2.964	6.252	1250	5.0
<i>Fine and Coarse Aggregates</i>							
							Primary rate per CFC
1.	1.096	20.75	7	2.964	4.060	CFC	4.1
2.	2.192	20.75	7	2.964	5.156	CFC	5.2
3.	3.288	20.75	6	3.458	6.746	CFC	6.7

NOTE :—1. Rates include cost of labour for loading and unloading.  
 2. Rates are applicable to type 'A' roads—cemented, oil bound, and good metalled roads.  
 3. Add to the above 15, 20 and 30% for class B, C and D type roads respectively.

TYPE :—B. Gravel, kankar and murum roads.  
 C. Rough metal roads.  
 D. Soft roads.

## 8.5. FREIGHT RATES BY TRUCKS OVER PROJECTS

8.5.1. Study of freight rates over the projects is limited to a few projects only. The data given in Table 8.5.1. is for the different materials of construction over various leads.

TABLE 8.5.1.

*Freight Rates for Different Materials in Rupees*

Sl. No.	Name of Project	Lead in miles									
		$\frac{1}{2}$	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	10	11	12
<i>Rubble Stone per CFC</i>											
1.	Nangal .. ..	—	6.5	—	—	—	—	—	—	—	—
2.	Sarda Hydrel .. ..	—	6.0	—	—	—	—	—	—	—	—
3.	Matatila .. ..	—	5.0	9.0	12.0	15.0	17.0	19.0	21.0	23.0	25.0
4.	Mayurakshi .. ..	5.0	8.0	10.0	11.9	13.9	15.9	17.9	19.9	21.8	23.8
5.	Hirakud .. ..	—	8.0	10.0	12.0	13.5	15.0	16.5	18.0	19.5	21.0
6.	Gangapur .. ..	7.0	—	8.9	—	—	—	—	—	—	—
7.	Kakrapar .. ..	7.0	—	—	—	—	—	—	—	—	—
8.	Vaitarni .. ..	3.8	5.7	—	—	—	—	—	—	—	—
9.	Lower Bhawani .. ..	4.4	5.9	8.9	11.9	14.9	17.9	20.9	23.9	26.9	29.0
10.	Malampuzha .. ..	—	12.0	—	—	—	—	—	—	—	—
11.	Peechi .. ..	—	3.10	—	—	—	—	—	—	—	—
12.	Perinchani .. ..	2.6	—	—	—	—	—	—	—	—	—
<i>Ballast or Aggregate per CFC</i>											
1.	Sarda Hydrel .. ..	—	—	—	—	—	11.5	—	—	—	—
2.	Matatila .. ..	—	5.0	9.0	12.0	15.0	17.0	19.0	21.0	23.0	25.0
3.	Mayurakshi .. ..	—	8.3	10.4	12.5	14.6	16.8	—	—	—	—
4.	Hirakud .. ..	—	8.0	10.0	12.0	13.5	15.0	16.5	18.0	19.5	21.0

TABLE 8.5.1.—contd.

1	2	3	4	5	6	7	8	9	10	11	12
<i>Ballast or Aggregate per CFC—contd.</i>											
5.	Gangapur ..	—	—	8.9	—	—	—	—	—	—	—
6.	Kakrapar ..	—	—	—	14.0	—	—	—	—	—	—
7.	Bhadra ..	—	8.8	13.0	16.6	20.3	24.0	27.7	31.4	35.1	38.8
8.	Lower Bhawani ..	4.4	5.9	8.9	11.9	14.9	17.9	20.9	23.9	26.9	29.9
9.	Malampuzha ..	—	8.8	—	—	—	—	—	—	—	—
10.	Peechi ..	—	3.1	—	—	—	—	—	—	—	—
11.	Perinchani ..	2.6	—	—	—	—	—	—	—	—	—
<i>Sand, Shingle and Surkhi per CFC</i>											
1.	Nangal ..	—	—	9.4	13.6	15.0	—	—	19.3	21.0	—
2.	Sarda Hydrel ..	—	—	—	—	—	11.5	—	—	—	—
3.	Matatila ..	—	5.0	9.0	12.0	15.0	17.0	19.0	21.0	23.0	25.0
4.	Gandhi Sagar ..	—	—	—	—	—	—	9.8	—	—	—
5.	Hirakud ..	—	8.0	10.0	12.0	13.5	15.0	16.5	18.0	19.5	21.0
6.	Gangapur ..	—	4.7	8.0	—	—	—	—	—	—	—
7.	Kakrapar* ..	—	7.0	—	11.0	—	—	—	—	—	—
					to						
					15.0						
8.	Lower Bhawani ..	4.4	5.4	7.4	9.5	11.4	13.4	15.4	17.4	19.4	21.4
9.	Malampuzha ..	—	—	—	—	—	—	6.4	—	—	—
10.	Peechi ..	—	—	—	—	—	17.4	—	—	—	—
11.	Perinchani ..	—	—	—	—	8.5	—	—	—	—	—
<i>Bricks per 1000 Nos.</i>											
1.	Nangal ..	—	5.5	—	—	—	—	—	—	—	—
2.	Sarda Hydrel ..	—	—	—	—	—	11.0	—	—	—	—
3.	Matatila ..	—	5.0	9.0	12.0	15.0	17.0	19.0	21.0	23.0	25.0
4.	Mayurakshi ..	—	8.0	11.0	13.0	15.0	17.0	19.0	21.0	23.0	25.0
5.	Hirakud ..	—	8.0	10.0	12.0	13.5	15.0	16.5	18.0	19.5	21.0**
6.	Lower Bhawani ..	3.5	4.3	5.8	7.3	8.8	10.3	11.8	13.3	14.8	16.3†

\*25.38/10 miles.

\*\*10" × 5" × 3".

†8½" × 4½" × 1½".



TABLE 8.5.1.—concl'd.

1	2	3	4	5	6	7	8	9	10	11	12
<i>Cement per Ton</i>											
1. Nangal .. ..	..	—	1.0	1.9	2.6	—	—	4.2	—	—	—
2. Sarda Hydel ..	..	—	—	—	—	2.8	—	—	—	—	—
3. Matatila .. ..	..	—	—	5.0	—	—	—	—	—	—	—
4. Gandhi Sagar ..	..	—	—	—	—	1.13	—	—	13.6 for 30 miles	—	—
5. Mayurakshi ..	..	—	2.0	2.5	3.0	4.0	4.5	5.0	5.5	6.0	—
6. Hirakud .. ..	..	—	2.0	2.75	3.5	4.0	4.5	5.0	5.5	6.0	6.5
7. Gangapur .. ..	..	—	—	—	—	—	10.5	for 15 miles	—	—	—
8. Kakrapar .. ..	..	—	—	1.9	—	—	—	—	—	—	—
9. Lower Bhawani ..	..	1.1	1.4	1.9	2.4	2.9	3.4	3.9	4.4	4.9	5.4
10. Malampuzha ..	..	—	—	—	—	—	—	10.4	for 29 miles	—	—
11. Perinchani ..	..	—	—	—	—	—	64.1	for 130 miles	—	—	—
<i>Steel per Ton</i>											
1. Nangal .. ..	..	—	1.2	1.9	—	—	—	—	—	—	—
2. Sarda Hydel ..	..	—	—	—	—	3.7	—	—	—	—	—
3. Mayurakshi ..	..	—	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
4. Hirakud .. ..	..	—	2.0	2.75	3.5	4.0	4.5	5.0	5.5	6.0	6.5
5. Lower Bhawani ..	..	1.9	2.5	3.6	4.6	5.7	6.7	7.8	8.9	9.9	10.9

## 8.6. TRANSPORT BY STEAM LOCO AND DIESEL LOCO

8.6.1. The excavated soil from the foundation was transported by Steam & Diesel Locos in Tungabhadra and Sarda Hydel Projects. The rates as observed in respective cases are as follows, which are inclusive of loading and unloading charges.

*Steam Loco*

Sarda Hydel : Rs. 1.0 to 1.25 per CFC per mile.  
Tungabhadra (Andhra) : Rs. 2.0 per CFC per mile.

*Diesel Loco*

Sarda Hydel : Re. 0.75 to 1.0 per mile per CFC  
 Tungabhadra (Andhra) : Rs. 1.60 per mile per CFC

In the case of Sarda Hydel Project the rates do not include the share of laying and maintaining the track and Rolling Stock whereas in the case of Tungabhadra rates are inclusive of those charges. Rates as observed at Tungabhadra are workable. The full details as observed in Tungabhadra are given in Appendix 5.

8.6.2. The rates of transport of materials will vary with nature of the materials and their weight. Generally most of the materials could be transported at Re. 0.40 to 0.45 per ton per mile by Steam Loco, and Re. 0.36 to 0.40 per ton per mile by Diesel Loco.

## 8.7. HANDLING OF MATERIALS WITH OTHER EQUIPMENTS

8.7.1. Other types of equipment used for handling materials are belts, buckets, ropeway conveyors, etc.

8.7.2. Belt Conveyors are under operation on Bhakra and Panchet Hill Projects. Observed data in the case of Panchet Hill Project and estimated analysis in the case of Bhakra Dam Project are given below:—

*PANCHET HILL PROJECT**Operation of Belt Conveyor*

Quantity handled: 3,44,000 C.F.T. (Approximate)					
Working hours : 1,037					
1.	Labour (A) Operation	..	..	..	Rs. 2,323
	(B) General	..	..	..	Rs. 610
2.	Labour Field Maintenance	..	..	..	Rs. 472
3.	Material (a) P.O.L.	..	..	..	Rs. 419
	(b) Miscellaneous	..	..	..	Rs. 122
4.	Repairs and Overhauls @ 100% of depreciation	..	..	..	Rs. 3,501
5.	Depreciation at 3.38 per hour	..	—	..	Rs. 3,501
6.	Power	..	..	..	Rs. 778
	Total	—	—	Rs.	<u>11,726</u>
	Rate per CFC of rock		$\frac{11726}{3440}$	= Rs.	3.41

Rate per ton is Re. 0.77, the lead involved is not likely to exceed 1/4 mile.

The cost of transporting the aggregate in Bhakra Dam is Re. 0.51 per ton over a distance of 1.55 miles. The details of the estimated analysis are given below :—

*Aggregate Transport—Fatehwal to Neilla*

	Original Value	%	Residual Value
<i>(a) Plant Depreciation</i>			
1. Feeder .. .. .	12,000	20	2,400
2. Conveyors No. 3-7 7008'-30' wide			
Belt .. .. .	3,70,000		
Idlers .. .. .	2,00,000		
Drives .. .. .	1,74,000	10	17,400
Electric Motors .. .. .	45,000	50	22,500
Total .. .. .	8,01,000		42,300
Deduct .. .. .	42,300		
Cost chargeable to works .. .. .	7,58,700		
Depreciation per <sup>r</sup> ton .. .. .	7,58,700	0.111 per ton	
	66,81,800		
	7,09,200		
<i>(b) Erection plant per ton .. .. .</i>	66,81,800	0.106 per ton	
<i>(c) Labour per day</i>			
4 Foremen @ 20/- .. .. .	80		
4 Asstt. Foremen @ 12/- .. .. .	48		
4 Mechanics @ 8/- .. .. .	32		
8 Greasemen @ 3/- .. .. .	24		
20 Unskilled Coolies @ 2/8- .. .. .	50		
4 Electricians @ 8/- .. .. .	32		
Total .. .. .	266		
Labour per ton .. .. .	266	= 0.042 per ton	
	6360		

*(d) Electrical Energy*

340 units @ -/-/10 per unit .. ..	Rs. 17.7	
	17.7	
Electric energy per ton @ 67% .. ..	<u>6360</u>	= 0.003 × 2/3
		= 0.002
Total for 1-2		
(a)	0.111	
(b)	0.106	
(c)	0.042	
(d)	0.002	
(e)	0.207	
	<u>0.478</u>	per ton

## 8.8. TRANSPORT BY ROPEWAYS

8.8.1. Transport by ropeway is also used at Vaitarna and its data are reproduced below:—

*Ropeway :*

Length of Ropeway .. ..	13,400 ft.
Rise .. ..	40
Speed of Hauling Rope .. ..	9.2 feet/sec.
Capacity of one bucket .. ..	1 ton
Cost of ropeway with all accessories .. ..	Rs. 9,97,000
Rate per ton per 3 miles works out to be	Rs. 1.55.

## 8.8.2. Bokaro Thermal Station (D.V.C.)

The aerial ropeway covers a distance of  $5\frac{1}{2}$  miles between Bermo Colliery and the power station. It has been constructed at a total cost of Rs. 26,26,000. The total budget provision including cost of land, site clearing, etc., is Rs. 29.95 lakhs.

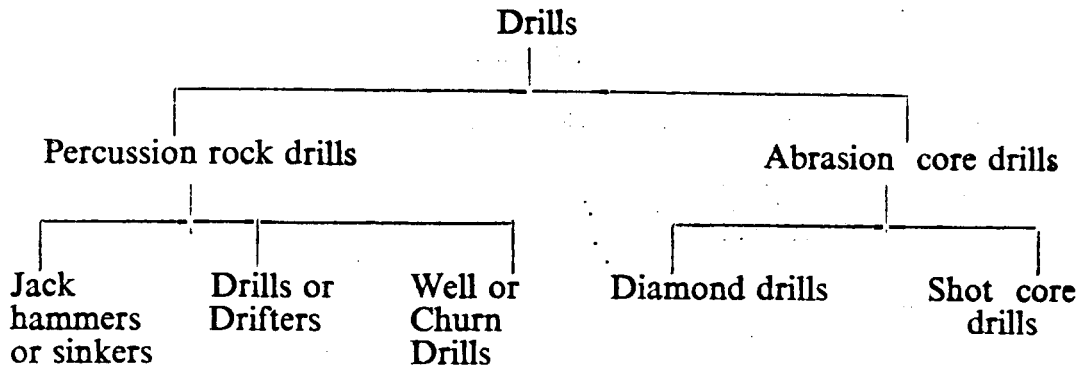
The estimated operation and maintenance cost is Rs. 7,51,000 per annum. Assuming 6 years life for the rope, 10 years for the bucket sheaves, etc., and 40 years for land, trestle foundation etc., it is estimated that the cost of transporting coal from the colliery to the power station will be about Re. -/15/- per ton. This works out to Re. -/2/9 per ton per mile.

CHAPTER 9

DRILLING AND QUARRYING.

9.1. TYPES OF DRILLS

9.1.1. Drills may be divided into two main groups and further sub-divided as shown below :—



9.2. DRILLING PERFORMANCES

9.2.1. Table 9.2.1. gives the relative drilling performances for various types and sizes of drills.

TABLE 9.2.1.  
Drilling Performance (feet per hour)

Diameter of hole (inches)	Class or rock	Rock Drills		Core Drills	
		Jack-hammer	Wagon drill	Diamond drill	Shot drill
1 (Core 1-1/8)	Soft to medium	10 to 12 5 to 10	25 to 35 20 to 25	3 to 7 2 to 4	
2-3/8 (Core 1-5/8)	Soft to medium	8 to 15	25 to 30		
2-3/8 (Core 1-1/5)	Hard	3 to 8	15 to 25		
3 (Core 2-1/8)	Soft to medium hard				
4 (Core 3)	Soft to medium hard		5 to 10 3 to 5		1 to 2
6 or 5½ with (Core 4-3/4)	Soft to medium hard		3 to 6 1 to 3		¾ to 2½ ½ to ¾
12	Soft to medium hard		1 to 4		
36	Soft to medium hard				½ to 1 ¼ to ½

9.2.2. Record of drilling holes for grouting rock foundations in projects have been tabulated in Table 9.2.2.

TABLE 9.2.2.  
Drilling Performance for Grouting Rock Foundations

Sl. No.	Name of Project	Type of rock drilled	Particulars of hole			Use rate per hour of drilling machine	Rate per F.R. in Rs.
			Dia. (in.)	Depth (ft.)	Depth per hr. (ft.)		
1	2	3	4	5	6	7	8
<i>Jack Hammer</i>							
1.	Bhakra	.. From sandstone to siltstone and other foundation mixed with shale	2½ to 3½	0 to 16 : 16	5.0	42.3	8.5
2.	Matatila	.. Granite	1.09 to 1.48	0 to 35 : 35	9.4	5.5	
<i>Core Drill</i>							
3.	Bhakra	.. From sandstone and other foundation mixed with shale	1.7/8 A.X. hole	16 to 30 : 14	4.0	79.4	19.8
4.	Bhakra	.. ..	..	30 to 150 : 120	3.0	64.0	21.9
5.	Bhakra	.. ..	..	150 to 200 : 50	1.6	48.1	30.0
6.	Bhakra	.. ..	..	200 to 300 : 100	1.2	43.3	36.1
7.	Bhakra	.. ..	..	50 to 100 : 50	5.0	92.0	18.0
8.	Bhakra	.. ..	3 N.X. hole	0 to 75 : 75	2.4	74.7	31.0

TABLE 9.2.2---contd.

1	2	3	4	5	6	7	8
9.	Matatila	Granite	1-7/8 A.X. holes	3 to 22 & 64 to 75 in. depth	1.0	59.0	59.0
10.	Matatila	Granite	2-3/8 B.X. holes	0 to 3 & 42 to 56 in. depth	1.0	69.6	69.6
11.	Matatila	Granite	3 X.X. holes	0 to 4 & 32 to 39	1.0	84.4	84.4
12.	Tungabhadra (Andhra)	Epidiorite	3½	20.3	0.3	5.4	18.0
13.	Tungabhadra (Andhra)	Epidiorite	3½	40.0	0.3	5.2	17.3
14.	Tungabhadra (Andhra)	White pegmatite	3½	25.0	0.8	6.1	7.6
15.	Tungabhadra (Andhra)	Pegmatite	5½	20.0	0.4	7.1	17.8
16.	Tungabhadra (Andhra)	Hard epidiorite	2½	—	0.3	7.3	24.3
17.	Tungabhadra (Andhra)	Pegmatite	2½	43.0	0.7	5.9	8.4
18.	Bhakra	Sand-stone & other founda- tion mixed with shale	36	30.0	0.2	47.0	235.0
19.	Tungabhadra (Andhra)	Pegmatite or epidiorite	—	40.0	0.6	9.8	16.2
20.	Tungabhadra (Andhra)	Epidiorite	2½	30.0	0.4	6.7	16.8
21.	Tungabhadra (Andhra)	Pegmatite	2½	20.0	0.7	6.9	9.9
22.	Tungabhadra (Hyd.)	UCRS masonry	—	—	1.5	16.3	10.7
23.	Tungabhadra (Hyd.)	UCRS masonry	1-7/8	—	1.5	19.3	12.8
24.	Tungabhadra (Hyd.)	UCRS masonry	3	—	1.5	24.3	16.2
25.	Matatila	Granite	2½	0 to 12 : 12	1.5	9.5	6.4
26.	Gangapur	Rock	1 to 1½	—	6.7	26.7	4.0
27.	Tungabhadra (Andhra)	Epidiorite	2 to 3½	18.3	0.6	4.5	7.5
28.	Tungabhadra (Andhra)	Epidiorite	1½ to 3½	20.0	1.3	5.4	4.1

## 9.3. DRILLING FOR BLASTING

9.3.1. Data regarding drilling for blasting by Jack hammer as furnished by the various projects is given below :—

TABLE 9.3.1.

*Jack Hammer Drilling & Blasting*

Sl. No.	Name of Project	Type of rock drilled	Dia. of hole in inches	Full depth of hole in ft.	Depth of hole per hr.	Rate of drilling machine	Rate per F.R. in Rs.
1	2	3	4	5	6	7	8
*1.	Matatila ..	Granite	1.3	0 to 15	12.5	7.5	0.6
2.	Gangapur ..	Granite	2 to 2½	—	15.8	17.9	1.1
**3.	Vaitarna ..	Basalt	1.3 to 1.5	20	12.5	9.1	0.7

\* 6 working hours per shift.

\*\* Assuming shift hrs. to be 3 hrs. labour includes blasting also.

9.3.2. Drilling cost will vary according to the type of rock drilled. A typical analysis of cost of drilling in basalt is given below. In the case of hard and abrasive rock like granite or sandstone the cost will increase by 25 to 30% depending on the nature of rock. About 6 r. ft. of drilling in basalt is required to blast 100 c. ft.

**Analysis of rate for drilling one r. ft. in Basalt**

Drilling 20 ft. deep holes from 40 mm. at top to 33 mm. at bottom with Carbide tipped Conomont drills.

(a)	Average set of 3 sets of Conomont drills of different lengths.	Rs.	90
	Average r. ft. drilled by the drills allowing for breakages.		500'
	Cost of drill per r. ft. of drilling .. .. .	Re.	0.18
(b)	Sharpening charge L.S. .. .. .	Re.	0.04
(c)	Pipes & pipe fittings .. .. .	Re.	0.08
(d)	Machinery charges : Depreciation of Jack hammer @ 3% per month.	Rs.	30



Depreciation per hr. @ 200 hrs. per month .. Re. 0.15  
(A Jack hammer can drill 100 r. ft. in 8 hrs.)

Depreciation per r. ft.  $\frac{8 \times 0.15}{100}$  = Re. 0.012

Repairs @ 40% of depreciation .. .. Re. 0.005

(e) Air Charges :

Using 315 CFM air compressor  
supplying air to 4 Jack hammers

Use-rate of air compressor : Rs. 14/-

Cost of air supplied to 1 Jack hammer .. } Rs. 3.5  
Hence, cost of air for 0.08 hour of Jack }  
hammer per r.ft. } Re. 0.28

(d) Labour per r. ft. : Re. 0.11

*Abstract*

(a) Cost of drill .. .. .	Re. 0.18
(b) Sharpening charges .. .. .	Re. 0.04
(c) Pipes and pipe fittings .. .. .	Re. 0.08
(d) Machinery charges .. .. .	Re. 0.017
(e) Air charges .. .. .	Re. 0.28
(f) Labour .. .. .	Re. 0.11
<b>Total rate of drilling per r. ft. ..</b>	<b>Re. 0.707</b>

#### 9.4. AIR COMPRESSORS

9.4.1. The portable diesel compressors commonly used are of 210, 315 and 500 c. ft. per minute capacity. Stationary compressors particularly the electrical ones are preferable to the portable types on large works. Detailed analysis of use-rates of air compressors is given below (Table 9.4.1):

TABLE 9.4.1.

<i>Air Compressor—Portable</i>	
210 CFM Diesel Compressor (55 H.P.)	
(a) Cost of compressor .. .. .	Rs. 25,100
Life in working hours .. .. .	10,000
Depreciation per working hour .. .. .	Rs. 2.61
(b) Repairs & maintenance cost @ 80% of depreciation .. ..	2.09
(c) P.O.L. charges	
2.25 diesel oil & Rs. 1.6 per gal. .. .. .	3.40
Lubricants & grease .. .. .	0.75
Sundries such as cotton waste, etc. .. .. .	0.75
	4.90

(d) Labour-charges		
½ No. driver @ Rs. 4.5 per day per shift .. .. .		0.30
1 No. helper @ Rs. 3.0 per day per shift .. .. .		0.40
		<hr/>
		0.70
Add 25% for idle days and leave reserve labour rate per working hour.		0.18
	Re.	<hr/>
		0.88

**Abstract**

Depreciation .. .. .	Rs.	2.61
Repairs & maintenance .. .. .		2.09
Fuel charges .. .. .		4.90
Labour charges .. .. .		0.88
		<hr/>
		10.48

Use rate per working hour : 10.48 say Rs. 10.5

**315 GFM Diesel Compressor (78 H.P.)**

(a) Depreciation per working hour :		
Cost of the compressors .. .. .	Rs.	38,300
Life in working hours .. .. .		10,000
Depreciation per hour .. .. .	Rs.	3.83
(b) Repairs & maintenance @ 80% of depreciation charges .. .. .	Rs.	3.07
(c) P.O.L. charges :		
3 Cls. Diesel oil @ Rs. 1.5 per gal. .. .. .		4.50
Lubricants and grease .. .. .		1.05
Sundries such as cotton waste, etc. .. .. .		0.70
		<hr/>
	Rs.	6.25
(d) Labour charges :		
½ No. driver @ Rs. 4.5 per day per shift .. .. .		0.30
1 No. Helper @ Rs. 3 per day per shift .. .. .		0.40
		<hr/>
		0.70
Add 25% for idle days & leave reserve .. .. .		0.18
		<hr/>
Labour rate per working hour .. .. .		0.88

**Abstract**

Depreciation .. .. .		3.83
Repairs & maintenance .. .. .		3.07
Fuel charges .. .. .		6.25
Labour .. .. .		0.88
		<hr/>
Use-rate per working hour. .. .. .		14.03
		Say Rs. 14/-

**500 CFM Stationary Electric Compressor**

(a) Depreciation per working hour :		
Cost of the compressor .. .. .	Rs.	31,200
Depreciation @ 1% per month .. .. .		3.12
Assuming 26 days in a month and 8 hrs. per shift per day i.e., 200 working hours, depreciation rate per working hour		
		<hr/>
	312	
	<hr/>	
	200	Rs. 1.56

(b) Repairs & maintenance @ 80% of depreciation rate .. .. .	Rs.	1.25
(c) Power charges:		
Rated h.p. of the engine : 120 h.p.		
Power consumption per hour 89.5 kWh at full load		
Power charges for 89.5 kWh Re. 0.125 per unit .. .. .		11.2
Lubricants & other sundries .. .. .		0.8
		<hr/>
Total Power & oil charges per hr. .. .. .		12.00
(d) Labour charges:		
½ No. operator @ Rs. 6/- per day per shift .. .. .		0.38
1 No. Helper @ Rs. 3/- per day per shift .. .. .		0.38
½ No. Foreman @ Rs. 12/- per day per shift .. .. .		0.38
Chowkidar @ Rs. 1.75 per day of 2 shifts .. .. .		0.11
		<hr/>
		1.25
Add 25% for non-working season & leave reserve .. .. .		0.31
		<hr/>
Labour charges per hour .. .. .		1.56
<i>Abstract</i>		
Depreciation .. .. .		1.56
Repairs & maintenance .. .. .		1.25
Power charges .. .. .		12.00
Labour .. .. .		1.56
		<hr/>
Use rate per working hour 16.37 say Rs. 16.50. .. .. .		16.37

500 CFM Diesel Compressor (127 H.P.)

(a) Depreciation per working hour:		
Cost of the compressor .. .. .		58,000
Life in hours .. .. .		10,000
Depreciation per hour .. .. .		5.8
(b) Repairs & maintenance @ 80% of depreciation .. .. .		4.64
(c) P.O.L. Charges:		
4.5 gls. of diesel oil @ 1.5 .. .. .		6.76
Lubricants & grease .. .. .		1.00
Sundries such as cotton waste .. .. .		0.75
		<hr/>
		8.50
(d) Labour charges:		
½ No. driver @ Rs. 4.5 per day per shift .. .. .		0.30
1 No. helper @ Rs. 3/- per day per shift .. .. .		0.40
Add 25% for idle days and leave reserve .. .. .		0.18
		<hr/>
		0.88
<i>Abstract</i>		
Depreciation .. .. .		5.80
Repairs & maintenance .. .. .		4.64
Fuel charges .. .. .		8.50
Labour charges .. .. .		0.88
		<hr/>
Use-rate per working hour Rs. 19.82 say Rs. 20/- .. .. .		19.82

9.4.2. Table 9.4.2. shows an abstract of the foregoing Table 9.4.1.

TABLE 9.4.2.

*Abstract of the Use Rates of Compressors*

Sl. No.	Type	Size	Rate per working hour				Use-rate per hour	Cost of 1000 cft. of air
			Depre- ciation	Repairs etc.	Fuel etc.	Lab- our		
1.	Diesel portable	210 CFM	2.6	2.1	4.9	0.9	10.5	0.83
2.	do.	315 „	3.8	3.1	6.2	0.9	14.0	0.74
3.	do.	500 „	5.8	4.6	8.5	0.9	19.8	0.66
4.	Electrical stationery	500 „	1.6	1.3	12.0	1.6	16.5	0.55

9.4.3. The use-rates of air compressors, used on some of the projects from which information became available, are tabulated in Table 9.4.3.

TABLE 9.4.3.

*Use-Rates of air Compressors used on Projects*

Sl. No.	Project		Rate per working hour				Use-rate per work- ing hour	Remarks
			Depre- ciation	Repairs etc.	Fuel etc.	Lab- our		
1. Diesel Portable 315 CFM								
(a)	R. & C.C.	..	3.8	3.1	6.2	0.9	14.0	
(b)	Bhakra	..	3.9	6.3	6.2	1.1	17.5	
(c)	Gandhi Sagar	..	3.7	5.0	3.0	1.6	13.3	
(d)	Kotah Barrage	..	2.8	2.8	5.2	3.1	13.9	Assuming 100% of depreciation
2. Diesel Portable 500 CFM								
(e)	R. & C.C.	..	5.8	4.5	8.5	0.9	19.8	
(f)	Bhakra	..	4.5	7.2	5.6	1.1	18.4	Portable compressor
3. Electrical Stationary 500 CFM								
(g)	R. & C.C.	..	1.6	1.3	12.0	1.6	16.5	
(h)	Gandhi Sagar	..	2.3	1.7	12.0	2.1	18.1	

9.4.4. Variations are mainly due to non-standard practices and it is suggested that the method of arriving at use-rates shown in the Table 9.4.1. should be adopted on all the projects.

### 9.5. AIR CONSUMPTION OF PNEUMATIC TOOLS

9.5.1. Table 9.5.1. gives the air consumption of pneumatic tools operated by compressed air. Consumption is expressed in c. ft. of free air per minute, at 90 PSI and standard conditions.

TABLE 9.5.1.

*Air Consumption of Pneumatic Tools*

Sl. No.	Tool	CFM
1.	Drills, rock Jack-hammers 30 lb. weight	60
	45 "	85
	55 "	95
	80 "	125
	Augurs	85
2.	Drifters (Wagon drills) 65 lb. weight	125
	100 "	155
	140 "	200
3.	Hoists, 500-1000 lb. capacity 1.5 (consumption/ft. of lift)	
	2000 lb.	2.0
	3000 lb.	3.0
	4000 lb.	6.5
	6000 lb.	8.5
4.	Pavement Breakers	
	30 lb. weight	45
	55 lb. weight	50
	85 lb. weight	75
5.	Sump Pumps	
	Upto 100 ft. head	65
	Upto 185 ft. head	115
6.	Tampers, back-fill	
	25 lb. weight	30
	38 lb. weight	35
7.	Trench diggers	
	25 lb. weight	35
	45 lb. weight	45

### 9.6. BLASTING

9.6.1. When rock excavation or stone quarrying is to be done on a large scale, blasting would cost less per 100 cubic feet by means of machine drills and dynamite than by hand drills and gunpowder. Ordinarily, however, the cost is about the same, and the advantage in the addition of the former method lies in better speed, convenience and good control.

Details of materials and amount of labour required for blasting 100 cft. of basalt rock are given below :—

TABLE 9.6.2.

*Analysis of rates for Blasting Rock*

	Rs.
1. Gelatine 2.25 lb. at Rs. 1.5 per lb. .. .. .	3.38
2. Detonators 4 Nos. at Rs. 6 per 100 Nos. .. .. .	0.24
3. Labour	
3.1 Blaster 0.01 at Rs. 4.5 each .. .. .	0.05
3.2 helper or quarry 0.20 at 3.5 each .. .. .	0.70
	4.37
Say Rs. 4.50	

9.6.3. The building stones suitable for hydraulic works are the harder type such as quartzite, granite, trap and basalt weighing 140/145, 165, 180 and 185 lb. per cu. ft. respectively. Table 9.6.3. indicates their use on the various masonry dams recently built or under construction.

TABLE 9.6.3.

Name of Dam	Type of stone	Specific gravity
Gandhi Sagar	Quartzite (Vindhyan & stone) and Gond- wane sandstone	140 (2.24) 140/145 (2.4)
Kotah Barrage, Jawai		
Konar		
Tiliaya		
Panchet		
Maithon	Granite	165 (2.65)
Hirakud		
Matatila		
Tungabhadra		
Bhadra		
Tunga anicut		
Peechi, Perinchani		
Lower Bhawani		
Malampuzha		
Vaitarna	Basalt and trap	185 (2.88)
Gangapur		
Kakrapar		

## 9.7. COMPARATIVE RATES FOR ROCK EXCAVATION

9.7.1. Comparative statement of rates per CFC for rock excavation on various projects is given in Table 9.7.1. (i).

TABLE 9.7.1. (i)

*Actual Rates of Rock Excavation per CFC on Projects*

Sl. No.	Project	Type of rock	Rate per CFC of Rock in Rs.		
			Drilling	Blasting	Total
1	2	3	4	5	6
1.	Bhakra .. .. .	Mixed Rock	2.54	5.60	8.44
			4.20	4.50	8.70
2.	Gangapur .. .. .	Deccan trap	4.32	3.52	7.84
			4.20	4.50	8.70
3.	Gandhi Sagar .. .. .	Highly abra- sive foliated quartzite	15.77	6.45	22.22
			12.60	6.60	19.10
4.	Kakrapar .. .. .	Deccan trap	4.75	6.0	10.75
			4.20	4.5	8.70
5.	Kotah .. .. .	Laminated quartzite	5.97	3.26	9.23
			4.20	4.50	8.70
6.	Peechi .. .. .	Granite	8.00	5.75	14.75
			6.30	5.62	11.92
7.	Vaitarna .. .. .	Basalt	3.53	7.03	10.58
			4.20	4.50	8.70

NOTE—The above figures in each line are as per R. & C. C.

## TUNNELLING

### 10.1. COST STUDY

10.1.1. The cost study for tunnelling has been divided into two portions, namely rock excavation and concrete lining and the data has been collected from the following four projects :—

1. Ramsagaram Tunnel (Tungabhadra Project)
2. Bhakra Dam Diversion Tunnels (Punjab)
3. Bhor and Thal Ghat Tunnels (Central Railway)
4. Budni Barkhera Tunnel (Central Railway)

### 10.2. RAMSAGARAM TUNNEL

10.2.1. The tunnel is in the shape of a horse-shoe with vertical sides of 8'-3" and 16' diameter semi-circular roof, inverted bed 1 ft. below the flat bottom. It is built for the passage of water for irrigation purpose. The particulars are given below :—

Length	1105'
Height, finished	17'-3"
Height, excavated	19 feet to 20 feet
Width, finished	16 feet
Width, excavated	18'-8" to 20'-0"
Area, finished	246 square feet
Area, excavated	313 to 340 square feet



Area of waterway	204 square feet
Area of lining	67 square feet (minimum)
<i>Lining (with masonry and concrete)</i>	
Bottom (invert)	9' thick, 1:3:5 C.C.
Sides	1'-4' thick, 1:3:5 C.C. and R.R. Masonry in 1:6 C.M. Plastered smooth in 1:4 C.M. $\frac{3}{4}$ " thick.
Top arch	1'-0" from spring level in 1:3:5 C.C.
Full supply depth	13.25 feet
Fall	1/1250
Velocity	8.75 feet per second
N (Coefficient of friction)	0.014
Discharge	1785 Cusecs
Discharge required	1745 Cusecs

10.2.2. The "Method of Driving" the tunnel adopted was bottom heading in one stage and stopping the top in second stage. The "Drilling Pattern" adopted was generally the "Burns Cut" and with  $7\frac{1}{2}$  feet depth of drill holes, an advance of  $5\frac{1}{2}$  to 6 feet per round was obtained. "Blasting" was done by the use of delay-action detonators, fired electrically. These were of half a second interval delay-action. "Mucking" was done mostly manually and partly by a mine loader, with one cu. yard trucks on double line of tram track pushed by manual labour from inside, out of the tunnel into the open cut from where the trucks were hoisted up by derricks and further pulled by diesel loco to the unloading site. The muck had to be hoisted up only as bed excavation was in progress in the approach flumes.

10.2.3. The cost of tunnel excavation works to Rs. 238.5 per CFC of designed cubic contents of the tunnel, and Rs. 207 per CFC of actual excavated quantity. Expenditure on preliminaries and experimental work done has been excluded. Items 8 and 9 of the data Table 10.2.4. relate to expenditure on special supports and protective works used to deal with the loose rock met with, not anticipated originally at the time of estimating.

10.2.4. The analysis of expenditure on the Ramsagaram tunnel is given in Table 10.2.4.

TABLE 10. 2. 4.

Sl. No.	Particulars	Rate of rock excavation (actual) per CFC (Rs.)	Total Expenses (Rs.)
1	2	3	4
1.	Installation & transhipment of 25-ton derrick in the rear face, 4-ton derrick in the front face & cranes for loading & unloading ..	4.9	19,200
2.	Laying of tramway track including preparing the tracks at site and transhipment from various places, the trucks hooks rails ..	6.9	27,000
3.	(a) Installation of water supply arrangements including conveyance of pantoon tanks & cost of pipe line .. .. .	2.9	11,500
	(b) Maintenance of water supply including the water tanker 1500 gallons capacity for 1½ years .. .. .	5.4	21,300
4.	(a) Installation of air compressor including testing, conveyance and transhipment .. .. .	0.5	2,100
	(b) Laying 6" & 4" compressed air mains, from compressor house to the front & rear faces and initial laying inside the tunnel including the cost of 6" & 4" pipes & their conveyance from Headworks and freight		
	6" Pipe line .. .. . Rs. 8,700		
	4" " " .. .. . Rs. 8,800		
	TOTAL ..		17,500
	<i>Credit for Pipes—</i>		
	6" Pipes .. .. . Rs. 4,800		
	4" Pipes .. .. . Rs. 6,000		
			10,800
		1.7	6,700
5.	Installation of ventilating equipment including the cost of conveyance & cost of 10" diameter air ducts Rs. 10,900. Rs. 4,800		
	Deduct cost of 10" diameter Pipes $600 \times 8 =$ .. .. . Rs. 6,100	1.6	6,100
6.	Installation of drill sharpening equipment .. .. .	0.3	1,200
7.	(a) Installation of electrification including transporting the generator to site .. .. .	3.4	13,300
	(b) Maintenance .. .. .	10.3	40,000

TABLE 10.2.4.—contd.

1	2	3	4
8.	(a) Temporary wooden supports for the roof from L.S. 168 to 190 in the rear face for loose portion .. .. .	1.7	6,500
	(b) Steel centering from L.S. 210 to 226 in the rear face: 19,300		
	Credit $1500 \times 7 = \frac{10,500}{8,800}$ .. .. .	2.2	8,800
	(c) Temporary supports to the pilot tunnel from 226 to 260	0.5	2,000
	(d) Temporary supports at L.S. 380 .. .. .	0.1	300
9.	Steel supports for crevice roof supports from L.S. 210 to 236	2.5	9,700
10.	Manufacturing drilling accessories and staging and bending blow pipe, etc. .. .. .	1.1	4,100
11.	Removing of bed muck & clearing the under breakages .. .. .	2.1	8,300
12.	Tunnel dewatering (Special) .. .. .	1.7	6,800
13.	Share of Excavation of tunnel by contractor .. .. .	103.00	4,03,900
14.	Petty supervision .. .. .	11.1	33,000
15.	Photographic & accident expenses .. .. .	2.3	9,150
16.	Cost of machinery tools & spares debited to the work		
	Cost of machinery & tools : Rs. 1,86,197		
	Cost of spares .. .. . 92,367		
	<u>2,78,564</u>		
	Credits .. .. . 1,68,500		
	<u>1,10,064</u>	25.2	1,10,064
17.	(a) Machinery sheds, stores		
	sheds .. .. . Rs. 34,290		
	Credits expected .. .. . 5,000		
	<u>29,290</u>	7.5	29,290
	(b) Sheds for Foreman, Drillers, Masons, Carpenters & Labour .. .. . 33,900		
	Credits .. .. . 520		
	<u>33,380</u>	8.5	33,380
	<b>TOTAL .. .. .</b>	<b>207.3</b>	<b>8,14,084</b>

### 10.3. BHAKRA DIVERSION TUNNEL

10.3.1. The two tunnels have been excavated at Bhakra, one on each side for the river of diversion of the river water for constructing the dam. The rock met with varied from jointed sandstone to indurated clay. The method adopted for excavation was heading and bench method of mucking and drilling in which drilling could proceed on the heading while the bench was being mucked. The quantity of explosive used was 3.5 lb. average per CFC of excavated material in the two tunnels.

10.3.2. The following statement (10.3.2.) shows the working rate of excavation of the left diversion tunnel (as supplied by the Project authorities for departmental work from 16.10.50 to 30.4.53).

TABLE 10.3.2.

Sl. No.	Description	Rate per CFC (Rs.)
1	2	3
<b>1. Labour</b>		
(i)	Excavation including, drilling blasting and barring .. ..	21.0
(ii)	Labour for ribbing including welding and packing .. ..	3.7
(iii)	Timber erection and dismantling .. ..	1.1
(iv)	Mucking, i.e. working of shovels, Euclids Dumpers, etc. .. ..	13.1
(v)	Cost of explosives .. ..	6.9
(vi)	Clearing dumping site by bulldozers .. ..	2.1
(vii)	Stock and lubricant .. ..	1.3
(viii)	Laying pipe line & maintenance .. ..	0.4
(ix)	Accidents .. ..	0.6
(x)	Hutting .. ..	Nominal
<b>2. Material</b>		
(i)	Timber .. ..	3.7
(ii)	Steel including fabrication .. ..	30.5
<b>3. Machinery</b>		
(i)	Compressed air .. ..	9.9
(ii)	Lighting charges including stock & work charges .. ..	6.6
(iii)	Depreciation of machinery .. ..	4.6
(iv)	Repair to jack hammers, jack rods including working of drill sharpening machine .. ..	1.1
<b>4. Miscellaneous</b>		
(i)	Ramps and paths .. ..	0.9
(ii)	Pumping including electric charges .. ..	6.8
<b>5. Supervisory charges</b>		
(i)	Tunnel foreman, pay and allowance .. ..	1.8
(ii)	Work charged establishment .. ..	1.3
(iii)	Contingencies .. ..	0.8
<b>TOTAL</b> ..		<b>118.2</b>

10.3.3. Detailed analysis of rate for rock excavation in the right dam tunnel as provided by the project is given in Table 10.3.3.

TABLE 10.3.3.

A. Labour		Expenditure per month
		(Rs.)
For six wagon drills and six jack hammers.		
(i)	Drillers on 6 wagons drills for 2 shifts. @ Rs. 108 p.m. = $6 \times 2 \times 2 \times 108$ .. .. .	2,592
	Fitters in 6 wagon drills for 2 shifts @ Rs. 108 p.m. = $6 \times 2 \times 1 \times 108$ .. .. .	1,296
	Drillers for jack hammers @ Rs. 108 p.m. = $6 \times 3 \times 2 \times 108$ .. .. .	3,888
(ii)	<b>Blasting labour</b>	
	2 Blasters @ Rs. 108 p.m. .. .. .	216
	2 Helpers @ Rs. 65 p.m. .. .. .	130
	10 skilled mazdoors for making tamping balls @ Rs. 65 p.m. .. .. .	650
(iii)	<b>Laying and linking pipe line</b>	
	For 2 shifts pipe fitters @ Rs. 95 p.m. = $2 \times 1 \times 95$ .. .. .	190
	Skilled mazdoors @ Rs. 65 p.m. = $2 \times 2 \times 65$ .. .. .	260
(iv)	<b>Making paths and ramps inside the tunnel</b>	
	Work mistri for 2 shifts @ Rs. 80 p.m. = $2 \times 1 \times 80$ .. .. .	160
	Skilled coolies for 2 shifts @ Rs. 65 p.m. = $2 \times 10 \times 65$ .. .. .	1,300
(v)	<b>Supervisory and other staff for two shifts</b>	
	1 Foreman @ Rs. 360 p.m. = $2 \times 1 \times 360$ .. .. .	720
	2 Supervisors @ Rs. 120 p.m. = $2 \times 2 \times 120$ .. .. .	480
	8 Work mistris @ Rs. 100 p.m. = $2 \times 8 \times 100$ .. .. .	1,600
	2 Chowkidars @ Rs. 52 p. m. = $2 \times 2 \times 52$ .. .. .	208
	2 Store Attendants Rs. 52 p.m. = $2 \times 2 \times 52$ .. .. .	208
	8 Fitters @ Rs. 108 p.m. = $2 \times 8 \times 108$ .. .. .	1,728
	4 Khalasis @ Rs. 50 p.m. = $2 \times 4 \times 50$ .. .. .	400
	15 Muckers @ Rs. 68 p. m. = $2 \times 15 \times 68$ .. .. .	2,040
	1 Gubliman @ Rs. 75 p.m. = $2 \times 1 \times 75$ .. .. .	150
	1 Time keeper @ Rs. 100 p.m. = $2 \times 1 \times 100$ .. .. .	200
	Total .. .. .	18,416

Total labour expense per month: Rs. 18,416

∴ Labour expense per day, assuming 25 working

$$\text{days in a month} = \frac{18,416}{25}$$

Rs. 736.6

#### B. Materials

(i)	Repairing parts of 6 jack hammers and 6 wagon drills @ Re. 0.5 per hour per machine for 5 hours = $12 \times 5 \times 0.5$ .. .. .	30.0
(ii)	6 Bits for 6 jack hammers @ Rs. 2.5 each = $6 \times 2.5$ .. .. .	15.0
	6 Forged bills for 6 wagon drills @ Rs. 1.5 each = $6 \times 1.5$ .. .. .	9.0
(iii)	Rods worth Rs. 40,000 work issue for 72,65,700 F.C. of rock excavation.	

$$\text{Hence per CFC} = \frac{40,000}{72,657} = 0.55$$

TABLE 10. 3.3. —contd.

Hence per 6,000 F.C. @ Re. 0.55 per CFC .. .. .	33.75
(iv) Lubrication for 12 machines @ Re. 0.75 per machine per shift ..	9.0
(v) <i>Explosives</i>	
20 wagon drill holes @ 8 lb. each .. .. .	160 lb.
30 wagon drill holes @ 6 lb. each .. .. .	180 lb.
	<u>340 lb.</u>
Cost of 340 lb. @ Rs. 2.0 per lb. .. .. .	680.0
<i>Detonators</i>	
For 20 wagon drill holes @ 2 Nos. each .. .. .	40
For 30 jack hammers holes @ 1 No. each .. .. .	30
	<u>70</u>
7 Nos. detonators @ Re. 0.75 each .. .. .	52.5
Total cost of material per day of 2 shifts .. .. .	<u>829.25</u>
<b>C. Machinery charges</b> .. .. .	64
Total rock excavated : 222 C. yds.	
As one Euclid carries 3 1/2 C. yds.	6
∴ No. of Euclids : 222 ÷ 3 1/2 : 64 Nos.	
One Marion Shovel can run 6 Euclids per hour.	
Hence working hours of shovel = $\frac{64}{6} = 11$ hours	
As one dumper takes 20 minutes for disposal of loaded muck	
∴ Working period of dumper = $64 \times \frac{20}{60} : 22$ hours.	
∴ Cost of working of marion shovel for 11 hours	
@ Rs. 40/- per hour. .. .. .	440
Cost of working dumpers 22 hours @ Rs. 22 per hour .. .. .	484
Dozer for levelling etc. of muck for 12 hours @ Rs. 34 per hour .. .. .	408
∴ Total machinery charges per day of 2 shifts .. .. .	<u>1,332</u>
<b>D. Supply of air charges</b>	
6 hours working of 6 wagon drills	
& 6 Jack hammers is assumed.	
Each wagon drill takes 300 CFM/hour.	
∴ Air consumed = $6 \times 6 \times 300 = 10,800$ C.F.M.	
Each Jack hammer takes 150 C.F.M./hour.	
∴ Air consumed = $6 \times 6 \times 150 = 5,400$ C.F.M.	
Total = 16,200 C.F.M.	

TABLE 10.3.3.—concl'd.

**E. Other workshop charges**

1 Chageman per shift for 2 shifts @ Rs. 140 p.m. =2×1×140 .. .. .	280
4 Fitters per shift for 2 shifts @ Rs. 108 p.m. =2×2×108 .. ..	864
4 Khalasis per shift for 2 shifts @ Rs. 65 p.m. =2×4×65 .. ..	520
Total .. ..	1,664
∴ Workshop charges per day = 1664/25 .. .. .	66·5

**10.3.4. Abstract of expense per day of 2 shifts**

	Rs.
1. Labour charges .. .. .	736·60
2. Materials—Petty Stores & Explosives .. .. .	829·25
3. Machinery charges .. .. .	1332·00
4. Air charges .. .. .	486·00
5. Other workshop charges .. .. .	66·50
	3450·35
Add 25% due to breakdown of machinery, lights, pumping & air .. .. .	862·59
Total .. ..	4312·94

Say Rs. 4313.

Output is 6000 F.C. or 222 C. yds. per day  
 ∴ Rate per C.F.C. or rock  
 excavators = 4313/60

Rs. 71·9

Say Rs. 72 per C.F.C.

**10.4. BHOR & THAL GHAT TUNNEL**

10.4.1. The tunnelling work involved in Bhor & Thal Ghat was carried out under contract and therefore no analysis of rates is available. However, the construction of these tunnels was carried out in connection with the doubling of Budni-Barkhera line on Itarsi-Bhopal section and was carried out through the departmental agencies. The details of cost as

supplied by the Central Railway are given in Table 10.4.1. The method employed consisted of driving a pilot tunnel and then enlarging later after the pilot was completed.

TABLE 10.4.1.

Sl. No.	Type section	Heading			Enlarging		
		Qty. in cft.	Rate per 100 cft. (Rs.)	Cost (Rs.)	Qty. in cft.	Rate per 100 cft. (Rs.)	Cost (Rs.)
1	2	3	4	5	6	7	8
1.	Crown lined single line tunnel wholly on straight and without side lining (cost per ft. length) .. .. .	64	160	102	416	160	666
2.	Crown lined single line tunnel wholly on straight with side lining (cost per ft. length) ..	64	160	102	566	160	906
3.	Straight portion of crown lined single line tunnel is partly on straight and partly on curve 50 and without side lining (cost per ft. length) .. ..	64	160	102	426	160	682
4.	Straight portion of crown lined single line tunnel where tunnel is partly on straight and partly on curve 50 and without side lining (cost per ft. length) ..	64	160	102	586	160	938
5.	Crown lined single line tunnel on curve 50 and without side lining (cost per ft. length) ..	64	160	102	466	160	746
6.	Crown lined single line tunnel on curve 50 and with 64 side lining (cost per ft. length) ..	64	160	102	616	160	986
7.	Unlined single line tunnel on straight (cost per ft. length)	64	160	102	296	160	474
8.	Unlined single line tunnel on curve 50 (cost per ft. length)	64	160	102	321	160	514
9.	Portal for unlined tunnel on 50 curve (cost per ft. length)	—	—	—	295	160	472
10.	Cost of man refuge in an unlined tunnel .. .. .	—	—	—	182	160	292
11.	Cost of trolley refuge in an unlined tunnel .. .. .	—	—	—	1,100	160	1,760



## 10.5. BUDNI BARKHERA TUNND

10.5.1. In the Budni Barkhera Tunnel a statement has been extracted based on the job costing done by the Railway Department as shown in Table 10.5.1.

TABLE 10.5.1.

Depreciation	Pilot heading Rs.	Top half breakout Rs.	Benching lower half Rs.
(a) Labour in drilling & blasting .. .. .	12 6 0	6 3 0	4 8 0
(b) Drilling tools replaced .. .. .	3 2 0	2 11 0	2 3 0
(c) Explosives .. .. .	18 15 0	9 1 0	8 0 0
(d) Mucking labour .. .. .	19 0 0	21 3 0	14 13 0
(e) Proportionate cost of Jambo for drillings. (1,880/-)	1 3 0	—	—
(f) Multipurpose shield in top half break out (4,200/-)	—	1 6 0	—
(g) Support work .. .. .	18 10 0	53 7 0	2 0 0
(h) Mechanical services for compressed air, water & lighting .. .. .	17 10 0	10 9 0	8 4 0
(i) Lighting charges .. .. .	11 8 0	9 12 0	5 0 0
(j) Proportionate ownership and maintenance cost per shift .. .. .	15 9 0	12 8 0	5 3 0
Plant compressor .. .. .	14 1 0		
Generator .. .. .	4 1 0		
Pneumatic tools .. .. .	9 0 0		
Pump .. .. .	4 0 0		
	31 2 0		
(k) Workshop services .. .. .	13 0 0	7 10 0	5 7 0
(l) Accommodation of labour, offices, etc. .. .. .	14 0 0	14 0 0	14 0 0
(m) Supervision at site .. .. .	8 11 0	6 8 0	3 0 0
	153 10 0	154 14 0	72 6 0
Cost per Lft. of Tunnel excavation.		Proportionate cost	
Heading area 106 sq. ft. ....		162 14 0	
Top half breakout 208 sq. ft. ....		322 2 0	
Lower half benching 263 sq. ft. ....		190 6 0	
Total .. .. .		Rs. 675 6 0	

Cost per 100 cft. of tunnelling excavation = Rs. 117/-

## 10.6. LINING OF TUNNELS

10.6.1. The cost of erection of temporary supports of either timber or steel has been included in the rates for excavation already discussed in the preceding paragraph.

10.6.2. Table 10.6.2. gives details of the cost of cement concrete lining for Bhakra diversion tunnels and Budni-Barkhera railway tunnels.

TABLE 10.6.2.

Sl. No.	Specification	Bhakra		Budni Barkhera (Central Rly.)
		Right Diver-sion Tunnel	Left Diver-sion Tunnel	
1	2	3	4	5
1.	Coarse Aggregate			
	(a) Quantity per CFC .. .. .	0.9	—	0.8
	(b) Amount in Rs. .. .. .	21.8	16.1	28.8
2.	Fine Aggregate			
	(a) Quantity per CFC .. .. .	0.4	—	0.5
	(b) Amount in Rs. .. .. .	7.0	12.8	11.7
3.	Cement			
	(a) Quantity in cwts. .. .. .	14.3	—	18.0
	(b) Amount in Rs. .. .. .	58.8	70.7	90.0
4.	Total cost of material .. .. .	87.6	99.5	129.7
5.	Cost of labour .. .. .	24.0		*131.5
6.	Miscellaneous cost .. .. .	31.1	88.0	& 109.5
7.	Share of lant cost .. .. .	26.4		
8.	Rate of cement concrete per CFC .. .. .	167.0	187.5	*341.3 to 319.3

\*The higher rate of lining is for arch roof of tunnel and lower rate for sidewalls.

10.6.3. Table 10.6.3. shows primary cost of cement concrete lining per CFC in other projects. Details are not available.

TABLE 10.6.3.

Sl. No.	Project	Rate per CFC		
		Lining of sides	Lining of arch roof	Overall average
1.	Ramsagaram .. .. .	—	—	332
2.	Bhor Ghat .. .. .	261	385	—
3.	Thal Ghat .. .. .	186	355	—

## BRICKWORK AND LINING OF CANALS

### 11.1. PRICE OF BRICKS

11.1.1. The price of bricks varies from Rs. 20/- to Rs. 30/- per thousand of standard well-moulded and well-burnt common bricks while the rates for the larger size varies from Rs. 35/- to Rs. 45/-. These prices are ex-kiln and cost in transporting would be proportional to the haulage involved.

11.1.2. Standard size of bricks in most parts of the country is  $9" \times 4\frac{3}{8}" \times 2\frac{11}{16}"$  so that 4 courses and 4 joints of brickwork would rise to 12" height. In some States and in Irrigation Department the brick size is  $10" \times 5" \times 2\frac{3}{4}"$ . Joints vary from  $\frac{1}{4}"$  to  $\frac{1}{2}"$ . Tolerances of  $\frac{1}{8}"$  in length and  $\frac{1}{16}"$  in other directions are common.

11.1.3. The number of standard bricks per CFC of brickwork shall vary with the size of bricks and the quantity of mortar used or thickness of mortar joints. Table 11.1.3. gives the number of standard bricks required per CFC for various thicknesses of mortar joints.

TABLE 11.1.3.

*Number of bricks per CFC (exclusive of wastage)*

Size of brick	Thickness of joints		
	$\frac{1}{4}"$	$\frac{5}{16}"$	$\frac{3}{8}"$
$9" \times 4\frac{3}{8}" \times 2\frac{11}{16}"$ .. .. . (Standard brick)	1350	1300	1270
$10" \times 5" \times 2\frac{3}{4}"$ .. .. .	1040	1000	975

### 11.2. MORTAR MATERIALS

11.2.1. Mud is the cheapest binder and will continue to be used and ought to find favour on the construction of camps which are likely to be demolished and the salvaged bricks utilised elsewhere. Regarding other binders it may be stated in general, that cement improves the strength

of mortar while lime improves its workability. The use of lime along with cement in the mortar is said to aid the retention of moisture in it for the more complete hydration of cement in the mix and also to introduce as high degree of plasticity enabling handling of mortar with ease and providing a uniform bedding for the bricks.

11.2.2. The quantity of dry mortar mix required for 1000 bricks and per CFC of masonry in a 1-1/2 brick wall has been tabulated below in Table 11.2.2. for various thicknesses of joints. Allowance has been made for normal wastage in mortar.

TABLE 11.2.2.

*Mortar (in cft.) for brickwork in 1½ brick wall (Standard bricks)*

Thickness of joints in inches .. .. .	1/4"	5/16"	3/8"
Mortar per 1000 bricks .. .. .	14	17	21
Mortar per CFC of brick work .. .. .	19	22	25

11.2.3. Brick walls usually would require relatively less or more mortar per unit of brickwork depending on their thickness. If mortar content for 1-1/2 brick wall is taken as 1000 then the relative indices of mortar required for other thicknesses of brick walls may be applied from the following Table 11.2.3.

TABLE 11.2.3.

Thickness of walls in brick sizes ..	½	1	1½	2	1½	3
Percentage indices for mortar ..	92	95	100	103	105	108

11.2.4. Weights of materials used and mortar are given below:—

(1) Stone-lime in small lumps from kiln	44 lb. per	FC
(2) Fine and dry pit sand	90	" "
(3) Medium sand	95	" "
(4) Coarse sand	100	" "
(5) Ashes	50	" "
(6) Lime-sand mortar 1:2 to 1:3 proportion	114	" "
(7) Cement-sand mortar 1:3 hand-made stiff well mixed	124	" "
(8) Cement-coalash mortar 1:2 mixed stiff and fresh.	107	" "

11.2.5. The quantities of the various ingredients of mortar are given below:—

TABLE 11.2.5.

Type of mix	Ratio	Ingredients per FC			Labour mixing/FC man-day
		Cement Cwts.	Lime Mds.	Sand FC	
LSM	1:2	—	.27	1.0	.012
	1:3	—	.20	1.1	"
	1:4	—	.15	1.2	"
CLM	1:1:4	.20	.14	1.0	.015
	1:1:6	.15	.10	1.1	"
	1:1:8	.12	.08	1.2	"
CS	1:2	.40	—	1.0	0.12
	1:3	.29	—	1.1	"
	1:4	.22	—	1.2	"
RCM	1:5	.21	—	1.3	"
	4:1:10	.34	—	1.0	.02
	4:1:15	.25	—	1.1	.06
	4:1:20	.19	—	1.2	.05

L=lime, S=Surkhi

### 11.3. PRICES OF MORTAR MATERIALS

11.3.1. Prices will vary at different times and in different localities. e.g., sand may cost anything like Rs. 5/- to Rs. 15/- CFC (average Rs. 10/-), stone lime from Rs. 1/8 to 4/- per md. (average Rs. 3/- per md). and cement Rs. 4/8 to Rs. 6/- (average Rs. 5/-) at different places.

11.3.2. The data for labour and plant needed for mortar mixing are given in the Table 11.3.2.

TABLE 11.3.2.

Nature of Mortar	Plant hour per CFC	Labour days per CFC
Lime, Sand (LSM)	4	1.00
Cement, Lime Sand (CLM)	4.5	1.25
Cement, Sand (CM)	5	1.33
Cement, Surkhi, Sand (RCM)	6.0	1.50
Lime, Ashes or Surkhi	6.5	1.66

11.3.3. Cost of mortars per FC hand mixed and those of mechanically mixed are indicated below. The prices have been derived on the basis of assumed wages and rates.

TABLE 11.3.3.

*Cost of Mortars per FC mixed by (a) Manual Labour (b) Mechanical Mixing*

Type of mix	Ratio	Material	Labour	Cost per FC
<i>(a) Manual labour for mixing</i>				
LSM	1:2	0.91	0.021	0.93
	1:3	0.71	0.021	0.73
	1:4	0.57	0.021	0.59
CLM	1:1:4	1.57	0.029	1.60
	1:1:6	1.16	0.029	1.19
	1:1:8	0.96	0.029	0.99
CM	1:2	2.10	0.021	2.12
	1:3	1.56	0.021	1.52
	1:4	1.22	0.021	1.24
RCM	4:1:10	1.80	0.035	2.20
	4:1:15	1.36	0.035	1.40
	4:1:20	1.07	0.035	1.11
<i>(b) Mechanical mixing</i>				
LSM	1:2	0.91	0.06	0.97
	1:3	0.71	0.06	0.77
	1:4	0.57	0.06	0.63
CLM	1:1:4	1.57	0.07	1.64
	1:1:6	1.16	0.07	1.23
	1:1:8	0.96	0.07	1.23
CM	1:2	2.10	0.073	2.173
	1:3	1.56	0.073	1.633
	1:4	1.22	0.073	1.293
RCM	4:1:10	1.80	0.086	1.886
	4:1:15	1.36	0.086	1.446
	4:1:20	1.07	0.086	1.166

#### 11.4. LABOUR OUTPUT IN BRICKWORK

11.4.1. The number of bricks laid per day or cubic feet of masonry performed per day per mason will depend upon the kind of brick face, thickness of joints, quality of mortar, thickness of wall, number of openings, corners, panelling pillars, working conditions, etc. Table 11.4.1. gives range and average number of bricks laid per person per day for common straightforward brickwork.



TABLE  
Basic Rates of Constituents

Sl. No.	Name of Project	Rates of materials in rupees (Issue Rates)					
		Cement Cwt.	Tiles or Bricks 1000 Nos.	Stone Slab 2" thick CFS	1-1/2" Aggregate CFC	3/4" Aggregate CFC	Sand CFC
1	2	3	4	5	6	7	8
1.	Nangal Hydel Canal (Concrete 1:3:6)	4/12/-	—	—	9/-/-	12/-/-	2/-/-
2.	Nangal Hydel, Rupar (Tile Size 12" × 6" × 2")	4/7/-	41/-	—	—	—	2/-/-
3.	Sarda Sagar (Brick Size 10" × 5" × 2½)	5/4/-	29/4/-	—	—	—	3/-/-
4.	Harike (Tile Size 12" × 6" × 2")	4/9/-	42/-/-	—	7/8/-	12/5/-	1/15/-
5.	Tungabhadra (Andhra)	5/4/-	—	25/12/-	20/-/-	42/1/-	25/-/-
6.	Tungabhadra (Hyd.)	5/4/-	—	28/5/-	—	34/-/-	17/2/-

NOTES : 1. The rates of materials do not include carriage and are issue rates.  
2. Sand is River Sand and its lead in case of Tungabhadra (Andhra) is 26 miles.  
3. Sand Lead for Tungabhadra Project (Hyd.) is not given.

TABLE  
Break up of Rates of Brick

Sl. No.	Name of Project	Mix of Mortar	Brick Tiles			Sand		
			Qty. Nos.	Rate inclusive of carriage per 1000Nos.	Amount (Rs.)	Qty. in FC	Rate inclusive of carriage per CFC	Amount (Rs.)
1	2	3	4	5	6	7	8	9
1.	Nangal Hydel (Rupar) 12" × 6" × 2" Double Layer Tile lining in bed	1:4 c.m.	908	51.75	47.16	36.3	16.0	5.83
2.	-do- on slopes	1:4 c.m.	908	51.75	47.16	36.3	16.0	5.83
3.	Harike 12" × 6" × 2" Double Layer Tile lining in bed	1:4 c.m.	908	47.0	42.68	36.3	6.5	2.36
4.	Sarda Sagar Hydel 10" × 5" × 2-1/2" Double Layer Tile lining in bed and slopes	1:4 c.m.	1100	39.25	43.18	40.0	10.0	4.00
5.	Tungabhadra (Hyd.) 9" thick U.C.R.S.in slopes	1:8 c.m.	100	10.29	10.29	40.0	11.14	4.46

Break up of rates of U.C.R.S.



## 11.7.4. (i)

## for Canal Lining at Projects

Carriage rates (Rs.)		Carriage rates over long leads		Mixer charges per CFC Rs.	Mixer charges per hour Rs.	Weighted average wage rate Rs.	Remarks
Per Ton for 1st Mile	Per CFC 1st Mile	Per Ton per Mile	Per CFC per Mile				
9	10	11	12	13	14	15	16
1/1/-	6/8/-	-/8/-	1/-/-	2/11/-	—	2.3	
1/1/-	6/8/-	-/8/-	1/-/-	—	—	2.3	*Rates by
—	—	*1/-/-	*1/8/-	—	—	2.3	trolley excluding
1/-/-	6/8/-	-/7/10	-/15/-	—	—	2.3	depreciation and
1/10/-	5/4/-	—	—	—	—	1.8	laying trolley.
1/1/-	4/-/-	—	—	9/6/-	3/-/-	1.8	Mixer use rate
							@ Rs. 3/-/- is
							equal to Rs.
							2/11/- per CFC
							with 10/7 mixer.

## 11.7.4. (ii)

## Tile lining rate per CFC

Qty. in cwt.	Cement		Labour	Soaking tank curing & water arrange- ments	T.&P Sundries pro- file for Sub- grade	Total rate in Rs. per CFC 100 CFT	Rate in Rs. CFS 100 Sq. ft.	Thick- ness of lining	Remarks
	Rate inclusive of carriage per cwt.	Amount (Rs.)							
10	11	12	13	14	15	16	17	18	19
7.95	4.59	36.49	25.8	5.9	—	121.2	53.37	5"	(1) Excess labour for slope
7.95	4.59	36.49	32.4	5.9	9.13	136.94	60.33	5"	lining Rs. 4.75 per CFC.
7.95	4.77	37.95	23.25	—	—	106.25	47.12	5"	(2) Rate for CFS
7.40	5.5	40.70	38.60	—	5.5	132.00	66.00	6"	on slope Rs. 49.2
<i>Masonry lining (Rate per CFC)</i>									
3.98	5.57	22.17	25.12	—	—	62.00	46.5	9"	

TABLE 11.7.4. (iii)

Break up of Rates of Concrete Lining rate per CFC

Sl. No.	Item	Name of Project					
		Nangal Hydel canal		Tungabhadra (Andhra)		Tungabhadra (Hyderabad)	
		5" thick in bed	6" thick in slopes	4-1/2" thick in bed	4-1/2" thick in slopes	4" thick in bed (Blasting of Agg. by Govt.)	Precast c.c. slab 2" thick
1.	Mix of Concrete	1:3:6	1:3:6	1:6:10	1:3-1/2:5	1:6:10	1:4:5
2.	(a) Aggregates 1/2" size, Quantity in FC.	46.6	47.0	77.1	77.7	100	85.7
	Rate inclusive of carriage per CFC ..	24.26	24.26	40.06	40.06	—	34.3
	Amount (Rs.)	11.3	11.4	30.9	31.1	12.86	29.4
	(b) Aggregates 3/4" size, Quantity in FC.	46.6	47.0	19.3	19.4	—	—
	Rate inclusive of carriage per CFC ..	27.26	27.26	54.0	54.0	—	—
	Amount (Rs.)	12.7	12.9	10.9	10.5	—	—
3.	Sand, Quantity in FC ..	46.6	47.0	57.8	58.2	50.0	69.0
	Rate inclusive of carriage per CFC ..	18.06	18.06	35.0	35.0	17.16	10.3
	Amount (Rs.)	8.4	8.5	20.2	20.4	8.58	7.5
4.	Cement, Quantity Cwts. ..	12.68	12.70	7.74	13.52	6.66	13.9
	Rate inclusive of carriage ..	4.85	4.85	5.15	5.15	5.35	5.57
	Amount (Rs.)	61.5	61.6	39.9	69.6	35.67	76.5
5.	Labour ..	15.17	19.75	10.3	31.2	26.1	143.1*
6.	Plant use ..	2.75	2.75	2.72	16.8	—	9.37
7.	Form work ..	13.7	20.0	—	33.8	—	—
8.	Slurry ..	17.9	15.0	15.6	16.5	—	—
9.	Curing ..	1.8	1.5	—	—	4.3	—
10.	Sundries ..	—	—	—	—	0.73	—
11.	Total Rate (Rs.) per CFC AV.	145.2	153.4	130.0	229.9	889.3	265.8
12.	Rate (Rs.) per CFS AV.	61.0	76.7	48.75	87.75	29.6	44.12

\*Includes (i) labour for concreting, (ii) fixation of blocks, (iii) 1 : 6 c.m. mortar, quantity of which is not given, (iv) conveyance of precast slabs.

Rates include washing of aggregates also.

## STEEL WORKS AND GATES

### 12.1. HYDRAULIC GATES

12.1.1. Hydraulic gates can be classified into:—

- (i) Category 1, where the operating member moves on sliding surfaces, or
- (ii) Category 2, where the operating member moves on wheels or rollers, or
- (iii) Category 3, where the operating member rotates about a fixed or movable point to engage with the sealing element.

12.1.2. Ordinary low head and bulk head gates belong to the first category and are the most common. For higher heads, mounting of wheels and rollers becomes necessary to keep down frictional resistance in the operation of gates. Radial and drum gates are examples of the third category and are used for regulating the flow over the spillway.

12.1.3. All these types of gates are built essentially in steel with a lining on the water face. The allied structures comprise the operating platforms, bridges, hoists and the controlling devices.

### 12.2. INDIGENOUS MANUFACTURE

12.2.1. Until lately, all gates and hoists for the River Valley Projects used to be imported from abroad at a prohibitive cost. Recently, however, the technique of steel fabrication has developed so fast in the country, both in the public and private sectors, that there is hardly any need now for the import of such structures.

12.2.2. Notable examples of the public enterprise are Government Workshops at Amritsar, Madras, Izatnagar (U.P.), and the Tungabhadra Project which have turned out quality products at competitive rates. In the private sector, a number of reputable firms exist in the country which can undertake such jobs on competitive prices, but their chief difficulty in the past has been that they do not get sufficient load for their shops due to preference shown to foreign manufacturer. It is, therefore, recommended that a Central Agency should watch the interests of this important engineering undertaking in the country, both in the private and the public sectors.

12.2.3. Table 12.2.3. indicates the extent of work done within the country. Fuller details are given in appendix (9).

TABLE 12.2.3.

Sl. No.	Name of project	Nature	Year of Manufacture	Cost per ton		Hoisting Gear	Total
				Gate Leaves	Embed- ed parts		
1	2	3	4	5	6	7	8
				Rs.	Rs.	Rs.	
1.	Nangal Dam ..	Regulator	1954	—	—	—	1,340
2.	Tilaiya, D.V.C. ..	Spillway	1952	—	—	—	4,200
3.	Bokaro D.V.C. ...	Spillway Emergency	1952 1952	—	—	—	2,600
4.	(i) Kopai .. (Mayurakshi)	Weir Sluice Regulator	1950 " "	—	—	—	1,700
	(ii) Dwarka .. (Mayurakshi)	Weir Sluice Regulator	1951 " "	—	—	—	1,400
	(iii) Bakraswar (Mayurakshi)	Crest Sluice Regulator	1951 " "	—	—	—	2,000
	(iv) Brahamani (Mayurakshi)	Weir Sluice Regulator	1953 " "	—	—	—	2,150
5.	(i) Hirakud .. (Mani Dam)	Spillway	1955	—	—	—	2,000
	(ii) Hirakud Bargarh canal	Regulator	1955	2,900	1,400	18,000*	4,300
6.	Tungabhadra ..	Spillway Sluice Penstock	1952-54 1952-53 1953-54	1,360 4,600 4,800	800 1,600 1,620	45,000* 57,600* 64,500*	2,160 6,100 6,420
7.	Jawai ..	Spillway	1954-55	1,450	1,000	16,000*	2,450
8.	Lower Bhawani	Spillway	1954	5,216	1,528	13,200*	6,744

\*Prorata share of the hoisting gear is not included.

12.3. BREAK-UP OF COST

12.3.1. Statements showing break-up of cost of manufacturing gates, etc. in the Tungabhadra and Amritsar Workshops are given below in Tables 12.3.1. (i) & 12.3.1. (ii):—

TABLE 12.3.1. (i)

Statement of Break-up of cost of Hydraulic gates  
(Manufactured by Tungabhadra Workshop)

Sl. No.	Details of Gate	Steel %	Other material and consumables	Labour %	Centage charges %	Percentage of centage over labour col. 6/5×100
1	2	3	4	5	6	7
<i>Gate Leaf</i>						
1.	Bargarh Sluice Gate, Hirakud Project.	17½	19½	37	26	70
2.	Low level Sluice Gate, Tungabhadra.	10	28	35	27	77
3.	Penstock Gate, Tungabhadra Project.	10½	40	30	20	67
4.	Jawai Spillway Gates, Rajasthan.	40	13	22	25	114
5.	Spillway Gates, Tungabhadra Project.	33	28	19	20	105
<i>Embedded Metal</i>						
6.	Bargarh Sluice embedded parts, Hirakud.	36	20	18	36	144
<i>Hoist</i>						
7.	Bargarh Hoist, Hirakud.	14	34	27	25	93
<i>Operation Bridge</i>						
8.	Operation Bridges, Tungabhadra Project.	45	12	18	25	139

TABLE 12.3.1. (ii)

Statement of Break-up of cost of Nangal Canal Head Regulator Gates  
(Manufactured by Government Central Workshops, Amritsar)

Sl. No.	Details of Gate	Material (Steel) %	Labour %	Centages charges %	Percentage of Centage over labour (Col : 5/4×100)
1	2	3	4	5	6
1.	Canal Head Regulator Gates, Nangal	47	12	41	342

12.3.2. The Executive Engineer incharge of the Tungabhadra workshop reports that item (2) low level sluice gate for Tungabhadra was the first one manufactured in the shop when the cost worked out to Rs. 4,600 per ton. Subsequently with improved methods it was possible to make similar sluice gates @ Rs. 2,900/- per ton although the basic rates for steel had increased during the period.

#### 12.4. THE OVERHEAD CHARGES

12.4.1. The overhead charges comprising factory charges in the various shops, general charges and office charges with direct labour base are also shown in the previous table, but a further split up is given in Table 12.4.1. for Amritsar Workshop.

TABLE 12.4.1.

*Workshop Overhead Charges in percentage over cost of Direct Labour  
For quarter ending 3/55  
(Govt. Central Workshops, Amritsar)*

Sl. No.	Name of Shops	Direct Labour	Percentages of Overhead (Actual)			
			Factory	General	Office	Total
1	2	3	4	5	6	7
1.	Machine shop .. .. .	100	481	148	43	672
2.	Tool Room & Heat Treatment shop.	100	140	33	43	216
3.	Steel & Welding shop .. .. .	100	181	88	43	312
4.	Smithy shop .. .. .	100	181	82	43	306
5.	Iron & Brass foundry .. .. .	100	190	91	43	324
6.	Mill wright shop .. .. .	100	311	122	43	476
7.	Carpenter shop .. .. .	100	148	64	43	255
8.	Painter shop .. .. .	100	93	46	43	182
9.	Fitter shop .. .. .	100	159	61	43	263
10.	Factory as a whole .. .. .	100	234	92	43	369

#### 12.5. DETAILS OF ACTUAL EXPENSE

12.5.1. Details of actual expense on various elements for gates manufactured in the three shops are recorded.

TABLE 12.5.1. (i)

*Tungabhadra Workshop*

##### A. Low Level Sluice

1. Project .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	Tungabhadra
2. Type of Gate and purpose served .. .. .	.. .. .	.. .. .	.. .. .	.. .. .	Low level sluice gate
					Fixed wheel
					Life gate

TABLE 12.5.1.(i)—contd.

3. Size .. .. .	6' × 12'
4. Maximum lead for which designed .. .. .	83'
5. Type of water seals .. .. .	Music note for side seals and flat rubber bottom.
6. Whether rollers provided, if so what type, fixed or moving.	Fixed Rollers
7. Weight of Gate Leaves .. .. .	9½ tons including 3 tons ballast.
8. Weight of embedded parts .. .. .	21 tons (with C.I. Lining)
9. Cost per ton of embedded parts .. .. .	Rs. 1,500/- (including C.I. Lining)
10. Cost per ton of Gate leaves .. .. .	Rs. 4,600/-
11. Type of Hoisting Gear provided and the method of operating the same.	Hope drum, Hoist power & manually operated
12. Capacity of Hoisting Gear .. .. .	30 tons
13. Cost of Hoisting Gear per ton of weight and per ton of capacity.	Rs. 4,000/- per ton. Rs. 1,920/- per ton.
<b>B. Emergency Embedded Parts</b>	
(a) 1. Weight .. .. .	5½ tons
2. Cost .. .. .	Rs. 7,000/-
3. Cost/ton .. .. .	Rs. 1,273/-
<b>Emergency Gates</b>	
(b) 1. Weight .. .. .	9 tons each
2. Cost .. .. .	Rs. 30,000/- each
3. Cost per ton .. .. .	Rs. 3,333/-
<b>C. High Level Sluice—50 ft. head</b>	
1. Vent size .. .. .	6 ft × 12 ft.
2. Total weight of sluice gate, hoists and built in parts ..	20 tons
3. Total cost.	Rs. 64,000/-
4. Cost per ton .. .. .	Rs. 3,200/-
<b>D. Penstock Cut-off</b>	
1. Penstock (Diam.) .. .. .	11 ft.
2. Discharge .. .. .	760 cusecs
3. Power developed .. .. .	9000 kW
4. Nominal size of gate .. .. .	10½ ft. × 17 ft.
5. Weight of built-in parts .. .. .	12 tons
6. Weight of gate including hoists .. .. .	20 tons
7. Weight of 2 speed hoists 30/40 ton capacity .. .. .	10 tons
8. Total weight of all above .. .. .	42 tons
9. Total cost .. .. .	Rs. 1,38,000/- (including erection)
10. Cost per ton of total weight .. .. .	Rs. 3,280/-
<b>E. Spillway Gates</b>	
1. Size .. .. .	60 ft. × 20 ft.
2. Discharge .. .. .	19,000 cusecs
3. Weight of built-in parts .. .. .	10 tons
4. Weight of operation bridge .. .. .	18 tons
5. Weight of gates .. .. .	49 tons
6. Weight of chain hoists 25/35 tons capacity .. .. .	12 tons
7. Weight of gates, built-in parts, operation bridge and hoists.	39 tons
8. Total cost .. .. .	Rs. 1,64,400/-
9. Cost per ton .. .. .	Rs. 1,850/-

TABLE 12.5.1. (ii) Madras P.W.D. Workshop

**A. Embedded steel-work for Grooves at sides and still beams for the surplus Gates for the Lower Bhawani Project**

<i>Size of Gates</i>	..	..	..	..	..	40 ft. × 20 ft.
1. Steel materials 100 cwt. @ 23/- per cwt. (approx.)	..	..	..	..	..	Rs. 2,300/-
2. Other materials such as bolts and nuts, paint, electrodes etc. including handling charges.	..	..	..	..	L.S.	Rs. 1,400/-
3. Labour (Fitter, Welder, Turner, etc.)	..	..	..	..	..	Rs. 1,400/-
4. Machine and forges	..	..	..	..	..	Rs. 460 -
5. Centage (Indirect charges)	..	..	..	..	..	Rs. 2,150/-
6. Contingencies	..	..	..	..	..	Rs. 330/-
Total for vent						Rs. 7,640/-
Weight of each unit						5 tons.
Total for 1 vent						Rs. 7,640/-
Cost per ton..						Rs. 1,528/-

**B. Manufacturing Surplus Gates for vents 36'-0"***Excluding Roller Assembly and Posts*

1. Steel materials 536 cwt. @ 21/8/-cwt. average	..	..	..	..	..	Rs. 11,524/-
2. Other materials such as rivets, bolts and nuts, paint, electrodes etc. including handling charges.	..	..	..	..	..	Rs. 4,711/-
3. Labour (Fitter, Welder, Blacksmith Rivetter etc.) contingencies etc. and including general charges @ 30%.	..	..	..	..	..	Rs. 14,300/-
4. Materials storage 1%	..	..	..	..	..	Rs. 165/-
Total cost						Rs. 30,700/-
Total weight..						26.8 tons
Cost/ton						Rs. 1,144/-

**C. Manufacturing Post Frames at Madras for one vent**

1. Steel material 55.4 cwt. @ 22/- cwt.	..	..	..	..	..	Rs. 1,226/-
2. Other materials, such as electrodes, paint, bolts and nuts, etc. including handling charges.	..	..	..	..	..	Rs. 834/-
3. Labour (Fitter, Turner, Welder, Mechanics)	..	..	..	..	..	Rs. 1,020/-
4. Machining	..	..	..	..	..	Rs. 200/-
5. Centage (Indirect charges)	..	..	..	..	..	Rs. 1,354/-
6. Contingencies	..	..	..	..	..	Rs. 366/-
Total for one vent						Rs. 5,000/-
Total weight..						2.77 tons
Cost/ton						Rs. 1,805/-

**D. Manufacturing Roller Assembly at Madras Workshop for one vent**

1. Steel materials	..	..	..	..	..	Rs. 200/-
2. Direct debit for bearing	..	..	..	..	..	Rs. 340/-
3. Labour (Fitter, Mechanic etc.)	..	..	..	..	..	Rs. 40/-
4. Machining	..	..	..	..	..	Rs. 15/-
5. Centage (Indirect charges)	..	..	..	..	..	Rs. 50/-
6. Contingencies	..	..	..	..	..	Rs. 51/-
Total for one set of rollers						Rs. 650/-



**E. Manufacturing Roller Path Assembly at Madras Workshop**

1. Steel materials 120 cwt. (approx.) @ Rs. 21/8/- cwt. ..	Rs. 2,580/-
2. Other materials such as bolts and nuts, electrodes, paint, etc. including handling charges.	Rs. 1,959/-
3. Labour (Fitter, Welder, Machanics) .. .. .	Rs. 1,840/-
4. Centage (Indirect charges) .. .. .	Rs. 2,423/-
5. Machining .. .. .	Rs. 500/-
6. Contingencies .. .. .	Rs. 398/-
<b>Total .. .. .</b>	<b>Rs. 9,700/-</b>
<b>Cost per ton.. .. .</b>	<b>Rs. 1,617/-</b>

**F. Top Deck Bridge for Hoist Gear Manufactured at L.B.P. Workshop**

1. Steel materials cost (184 cwt.) @ Rs. 21/8/- per cwt. ..	Rs. 3,859/-
2. Other materials such as paints, electrodes, including handling charges.	Rs. 738/-
3. Storage .. .. .	Rs. 46/-
4. Labour charges including general charges (Fitter Welder, Painter etc.) .. .. .	Rs. 3,380/-
5. Contingencies, 30% .. .. .	Rs. 1,014/-
<b>Total for one vent .. .. .</b>	<b>Rs. 9,037/-</b>
<b>Total weight.. .. .</b>	<b>9.2 tons</b>
<b>Cost per ton.. .. .</b>	<b>Rs. 982/-</b>

**G. Hoist Gear Complete Assembly at Madras Workshop for one vent**

1. Steel materials 90-3/4 cwt. @ Rs. 22/8/- cwt. average ..	Rs. 2,042/-
2. Other materials such as bolts and nuts, rivets, paints, electrodes etc. including handling charges.	Rs. 4,768/-
3. Labour (Fitter, Welder, Turner etc.) .. .. .	Rs. 1,820/-
4. Machines for forges .. .. .	Rs. 900/-
5. Centage (Indirect charges) .. .. .	Rs. 3,116/-
6. Contingencies.. .. .	Rs. 554/-
<b>Total for one vent .. .. .</b>	<b>Rs. 13,200/-</b>
<b>Total weight.. .. .</b>	<b>4.54 tons</b>
<b>Cost per ton.. .. .</b>	<b>Rs. 2,900/-</b>

**H. Transport and Conveyance including loading etc. for one vent**

1. From P.W. Workshop, Madras to Railway wagon at Salt Containers loading and unloading.	Rs. 980/-
2. Rly. Freight for about 1,8,3,15 cwt. or say 60 tons ..	Rs. 2,600/-
3. Loading & unloading at Mottupalayam at site .. ..	Rs. 200/-
4. Mottupalayam to site @ Rs. 84 for trip, 20 trips.. ..	Rs. 1,680/-
5. Contingencies.. .. .	Rs. 40/-
<b>Total for one vent .. .. .</b>	<b>Rs. 5,500/-</b>
<b>Weight .. .. .</b>	<b>59 tons</b>
<b>Cost per ton.. .. .</b>	<b>Rs. 93/-</b>

**J. Erection**

1. Labour (Foreman, Fitter, Erector, gang <i>mazdoor</i> etc.) for six months.	Rs. 5,340/-
2. Erection materials such as Manilla rope, pulleys etc. ..	Rs. 660/-
<b>Cost per ton .. .. .</b>	<b>Rs. 6,000/-</b>
<b>Rs. 102/-</b>	

TABLE 12.5.1. (iii)

## Amritsar Workshop

Statement showing weight and rates per ton of Gates and Hoists

Sl. No.	Item	Approx. weight in tons	Rate per ton	Rate per sq. ft. for gate area
1	2	3	4	5
1.	Canal head Regulator, Nangal .. .. .	831.5	1341.0	367.0
2.	Nangal Dam .. .. .	6200.0	1420.0	373.0
3.	Silt Ejector @ R.D. 9575-N.C.H. .. .. .	31.0	1668.75	165.0
4.	Silt Ejector @ R.D. 72720-UBDC mainline .. .. .	20.75	1733.5	100.0
5.	Gates & Gearing for Escapes Charn Ganga .. .. .	61.0	1823.2	145.0
6.	Gates Canal Charan Ganga .. .. .	105.0	1640.6	88.0
7.	Gates Canal Nakian Drainage Syphon .. .. .	100.0	1814.4	90.0
8.	Gates Escape —Do— .. .. .	62.0	1831.6	140.0
9.	Automatic Radial Gate for Ganguwal Spillway for Power House No. 1 .. .. .	147.0	3322.0	630.00
10.	Draft Tube Gate for Ganguwal P.H. No. 1 .. .. .	109.0	1362.5	100.0
11.	Gates & Gearing for Bhakra Canals .. .. .		Plate Rate.	155.0
12.	Intake Radial Gate for Ganguwal Power House No. 1 .. .. .	213.0	1707.0	188.0

## STONE MASONRY

### 13.1. STONE MASONRY CLASSIFICATION

13.1.1. Stone Masonry can be classified under the following heads:—

1. Rubble stone masonry, composed of rough undressed stone as it comes from the quarry.
2. Hammer dressed and square stone masonry comprising stones squared and dressed on beds and joints by means of hammers. The stones may be laid in course straight, broken, or random.
3. Ashlar or cut stone masonry is generally used for face work. It may or may not be laid in courses.
4. Dry stone masonry in which no mortar is used. Riprap, pavements, retaining and breast walls are examples.

13.1.2. The various classes of masonry are generally used in combination on works viz. the face masonry of dams is laid in squared stone or ashlar and the hearting comprises the uncoarsed rubble. Combined rates of masonry to include classes of masonry and pointing (Table 13.1.2.) show that stone masonry dams built in the last decade have cost Rs. 125 to 233 per CFC.

### 13.2. UNCOARSED RUBBLE STONE MASONRY

13.2.1. Uncoarsed rubble masonry forms the bulk in a stone masonry dams. Table 13.2.1. gives the comparative primary and overall rates of U.C.R. hearting masonry for the various projects. A detailed statement is appended (Appendix 10).

### 13.3. ESTIMATING STONES

13.3.1. The units of measurement for all kinds of masonry is CFC (%CFT). The quantity of rough rubble stone per CF in a rubble masonry wall is 120 cft. but in case of large dams where the mortar used is considerably more than that in ordinary walls the quantity of rough stone required is about 100 F.C. of which 2/3rd may be large slightly dressed

TABLE

## 1. Projects under

Sl. No.	Name of Project	Height of Dam above A.O. Bed Level Foundation	Qty. of Masonry in CFC Executed	Primary rate in lakhs			Total in Lakhs
				Hearting EXPR	Face in Lakhs	Pointing	
1.	Matatila .. ..	— 110'	115150*	(127.3)	—	0.5	127.8
2.	Hirakud .. ..	200' 130'	92129	—	—	—	129.0
3.	Bhadra .. ..	245' 187'	36200	—	—	—	45.4
4.	Gandhisagar ..	212' 202'	2486000	—	—	—	—

## 13.1.2.

*Execution*

Combined primary rate per CFC	On cost	Total cost per CFC	Remarks
110.8	(15%) 16.6	127.4	*Qty. as per latest Revised Estimate for complete DAM (2 stages). Amount also as per Revised Estimate. R.R. Masonry in C.M. 1:4; 1:5. Actual expr. qty. executed so far is not available. On cost percentage is based on this latest Revised Estimate figs. (for indirect & over head charges).
140.0	(30%) 42.0	182.0	Figs. are as per estimate-contract rate for R.R. work in Power Dam is Rs. 75 per CFC. Cement supplied free by the Department. For extra lead & lift over the initial lead & lift extra rate is paid. For face work also, extra amount is paid. On cost percentage is as per estimated figures.
125.4	(35%) 44.0	169.4	Amount & qty. executed as per Proforma IV (actual). Period not given. R.R. Masonry in Lime Surkhi Mortar 1:4 proportion. The primary rate does not include lift charges (P. 312). On cost percentage is as per estimated figure.
133.86	(22%) 29.45	163.3	Qty. is as per actual executed—Primary Rate is as per analysis given by the Project Authority for R.R. in R.C.M. 1:2-3/4. Rate is without any lift charges. Work is still in initial stage. These are two proportions executed viz. R.R. in R.C.M. 1:2-3/4 & 1:4. On cost percentage is as per estimated figure.

TABLE

## 2. Projects

Sl. No.	Name of Project	Height of Dam above Bed Level	Qty. of Masonry in CFC Executed	Primary Rate in Lakhs			Total in Lakhs
				Hearting EXPR	Face in lakhs	Pointing	
		Foundation					
1.	Kakrapar .. ..	601' 451'	22951	26.3	3.0	—	29.6
2.	Mayurakshi .. ..	155' —	90450	—	—	—	112.43
3.	Tungabhadra (Andh.)	160' 150'	152608	—	—	—	264.3
4.	Tungabhadra (Hyd.) .. ..	160' 150'	152608 (assumed)	—	—	—	293.23
5.	Lower Bhawani .. ..	204' 140'	131722	141.2	14.3	1.3	156.7
6.	Peechi .. ..	— 130'	19912	—	—	—	37.30
7.	Perinchani .. ..	—	17762	17.25	0.33	0.2	17.78

## 13.1.2.

*Completed*

Combined Primary Rate per CFC	On Cost	Total Cost per CFC	Remarks
			Figures & qty. and amount are as per <i>Proforma II</i> (actual) supplied by the Project. On cost percentage is based on estimated figures.
128·8	(45%) 58·0	186·8	R.R. in C.H. 1:4
124·3	(20%) 24·86	149·16	Qty. & amount are as per latest figure sent on 23/11/55 by S.E. On cost percentage is as per estimated Figure R.R. Masonry in various R.C.M. 1:2-3/4 to 1:5. On cost percentage is as per estimated figure.
173·18	(35%) 60·6	233·78	Qty. & amount are as per Andhra. On cost percentage is as per estimated Figure R.R. Masonry in R.C.M. 1:3-3/4, 1:4, 1:5; Lime Surkhi mortar 1:1:1, 1:2:2:, and Face Stone Masonry.
192·2	(35%) 67·27	259·47	Amount is as per Ex. Engr. in 4/54. Reservoir constn. Dn. On cost percentage is as per estimated Fig. R.R. in R.C.M. 1:2-3/4, 1:4 and Face Stone Masonry.
119·9	(19%) 22·6	141·6	Qty. & amount are as per <i>Proforma IV</i> (actual). Figs. are not final as the final adjustments are still to be made on various expr. On cost is as per estimated Fig. R.R. Masonry in C.M. 1:6, 1:2, 1:5, 1:4, 1:2-3/4; & R.C.M. 1:5, 1:4, 1:2-3/4, and Face Masonry. On cost percentage is as per estimated figure.
187·3	(12·25%) 23·0	210·3	Qty. & amount are collected by Sri Varadharajan (actual). On cost percentage is as per Sri Varadharajan's calculations. R.R. in C.M. 1:2-3/4, 1:5, 1:4, Face Stone Work.
100·1	(44%) 44·0	144·1	Qty. & amount are as per <i>Proforma IV</i> (actual). On cost percentage is as per actual Fig. R.R. in C.M. 1:2-1/2, 1:3, 1:4, 1:5 & 1:6 and Face Stone Masonry.

TABLE 13.2.1.

*Rates of U.C.R. Masonry on River Valley Projects*

Sl. No.	Projects	1:2 $\frac{3}{4}$ RCM		1:4 CM		1:4 RCM		1:5 CM	
		Primary Rate per CFC	Overall Rate per CFC	Primary Rate per CFC	Overall Rate per CFC	Primary Rate per CFC	Overall Rate per CFC	Primary Rate per CFC	Overall Rate per CFC
1	2	3	4	5	6	7	8	9	10
1.	Matatila ..	—	—	—	—	—	—	99	111
2.	Gandhisagar ..	131	154	—	—	112	131	—	—
3.	Hirakud ..	—	—	139	163	—	—	—	—
4.	Kakrapar ..	—	—	—	—	93	126	—	—
5.	Tungabhadra (Andhra) ..	134	181	—	—	116	157	—	—
6.	Tungabhadra (Hyderabad)	165	223	—	—	148	200	—	—
7.	Lower Bhawani	104	117	100	111	100	111	95	105
8.	Malampuzha ..	104	124	94	111	—	—	88	103
9.	Peechi ..	—	—	170	185	—	—	147	160
10.	Perinchani ..	—	—	87	115	—	—	78	102

NOTE : U.C.R. Masonry in mortars other than those specified above being of relatively small quantities have been deleted from our study.

stone and 1/3rd as small stones and spalls. The quantity and weight of stones used per CFC would depend on the individual and collective volume of large stones and on their density. The larger the size of the individual stones the greater would be the quantity of stone going into the masonry and the heavier the density the greater the weight to be handled.

13.3.2. The waste of stone in case of veneer would be as much as 20% in cutting and dressing at site while there would be very little in the case of rubble masonry provided the stone is passed at the quarry. For the same reason that concrete aggregate should be graded, the stone should also be of all sizes from spalls to the largest that can be economically handled.

13.3.3. The quantities of stone and other constituents used for CFC masonry for hearting of dams are given in Appendix 10.



## 13.4. COST OF STONE

13.4.1. The cost of stone per CFC in stacks at the quarry site for a number of projects has been given below:—

TABLE 13.4.1.

*Comparative Statement of Quarrying Rubble (Stack measurements) per CFC*

Sl. No.	Projects	Nature of Work	Drilling Labour	Drilling Total	Blasting Material	Blasting Labour	Mucking	Grand Total Rs.
1	2	3	4	5	6	7	8	9
1.	Matatila .. ..	Hard granite	0.45	2.96	4.95	0.416	—	16.32
2.	Mayurakshi .. ..	—	—	—	—	—	—	17.8
3.	Hirakud .. ..	Granite	4.44	5.54	2.83	9.58	—	17.95
4.	Tungabhadra (Andh.) ..	—do—	3.50	4.22	1.04	6.56	3.0	14.82
5.	Tungabhadra (Hyd.) ..	Granite free to veins & cracks	3.213	0.51	2.71	7.51	1.05	14.78
6.	Bhadra .. ..	—	—	5.00	4.00	1.00	13.00	23.00
7.	Lower Bhawani ..	Hard granite	—	—	—	—	—	8.23
8.	Malampuzha .. ..	—do—	—	—	—	—	—	11.00
9.	Perinchani .. ..	Hard & tough granite	—	—	—	—	—	14.13

13.4.2. Table 8.4.5. gives an analysis of figures for carriage of stone from quarry to site of work.

13.4.3. Cost of dressing of stone for coarsed masonry will vary with the types of masonry which are described in para 13.1.1. and is included under respective labour constants. The quantity of rough stone required for coarsed masonry would be 150 F.C. for ordinary walls.

## 13.5. MORTAR FOR HYDRAULIC WORKS

13.5.1. The proportions for the mortar used in stone masonry may vary from 1:2 to 1:5 for cement mortar, 1:1:3, 1:1:4, 1:1:5 and 1:1:6 for cement, lime and sand mortar to 1:2:4, 1:2:5, 1:2:6 to 1:2:9 when large proportion of lime is desired. Proportions are by volume, although there is a tendency to introduce proportions by weight. When *surkhi* is used as an admixture to cement it is known as red cement mortar. Generally, *surkhi* powder finely ground is mixed in the proportion 1:14 in cement quantity. Measures of sand is for dry sand only. If the sand is wet, bulkage allowance must always be taken into account.

13.5.2. The amount of mortar required will depend on the size of individual stone and the type of masonry. Table 13.5.2. gives minimum and maximum quantities of mortar required per CFC of masonry depending on the size of individual stones used.

TABLE 13.5.2.

*Mortar per CFC Masonry (UCR)*

Kind of Masonry	Mortar in (F.C.) per CFC Masonry		
	From	To	Average
1	2	3	4
Rubble .. .. .	40	50	45
Squared-stone coarsed .. .. .	25	40	32.5
Cut stone Ashlar .. .. .	15	25	20

## 13.6. COST OF MORTAR MATERIALS

13.6.1. The issue rates of cement on projects have been dealt with in Chapter 3 and their variations in cost explained.

13.6.2. The rate for manufacturing sand may be anything like Rs. 40/- to 60/- per CFC of solid rock or at 35% voids it would be Rs. 26/- to 39/- per CFC approximately for crushed sand.

13.6.3. Comparative table of the cost of sand used on various projects is given in Table 13.6.3.

TABLE 13.6.3.

Comparative Statement of Rate of Sand per CFC on River Valley Projects

Sl. No.	Name of Project	Sand			Remarks
		Rate per CFC Quarry Site (Rs.)	Carriage Charges	Issue Rate at Site of Work	
1	2	3	4	5	6
1.	Matatila .. .. .	5.0	17.0	22.0	Contract rate. Lead not given.
2.	Gandhisagar .. .. .	25.1	11.2	36.3	Quarried under very difficult conditions. Lead 6 miles.
3.	Mayurakshi .. .. .	1.0*	7.0	8.0**	*For local river sand included in the contract rate. **Inclusive of Transport. Lead not given.
4.	Kakrapar .. .. .	10.0	2.4	12.4	Lead $1\frac{1}{2}$ to $\frac{3}{4}$ mile (carried by donkey).
5.	Tungabhadra (Andhra) .. .. .	8.1	16.9	25.0	Transport by railway wagon for 26 miles.
6.	Tungabhadra (Hyd.) .. .. .	—	—	25.9	Average rate at Dam-site with average lead 11.4 miles by Rly. wagon, storage & wastage etc. included.
7.	Lower Bhawani .. .. .	—	—	11.5	Inclusive of lead charges for $5\frac{1}{2}$ —6 miles.
8.	Malampuzha .. .. .	1.5	12.8	14.3	Quarry site lead charges 6 miles.
9.	Peechi .. .. .	4.0	17.4	21.4	Lead 5 miles. Contract rate.
10.	Perinchani .. .. .	3.3	11.7	14.0	Lead 5 miles. Contract rate.

13.6.4. Cost of grinding *surkhi* mortar as observed in Bhadra Project is given in Table 13.6.4. This does not include Tools and Plant charges.

TABLE 13.6.4.

Item	Place	
	Right Bank	Left Bank
1	2	3
Total qty. of mortar ground .. .. .	25,420 cyds.	9,237 cyds.
Total power charges .. .. .	17,373 9 0	7,374 12 0
Total cost of stock articles issued .. .. .	18,386 7 0	13,362 7 0
Total labour charges .. .. .	15,363 9 0	4,506 8 0
Total water supply charges .. .. .	1,243 4 0	235 2 0
<b>TOTAL CHARGES .. .. .</b>	<b>52,366 13 0</b>	<b>25,478 13 0</b>
<i>Remarks</i>		
Rate per cyd. .. .. .	2 0 11	2 12 2
Average rate per cyd. = $\frac{2-0-11 + 2-12-2}{2} = 2-6-7$		
Rate per CFT = 0-1-5 without plant charges.		

13.6.5. Comparative strength and cost of labour employed per CFC for different kinds of masonry on various projects is indicated in Table 13.6.5.

TABLE 13.6.5.

Sl. No.	Name of Project	Labour used per CFC of Masonry				Cost	Remarks
		Skilled		Unskilled			
		No.	Avg.	No.	Avg.		
1	2	3	4	5	6	7	8
1.	Matatila .. .. .	2.5	3.7	7.6	1.4	19.6	Contract rate between RL 905 to RL 935.
2.	Gandhisagar .. .. .	1.0	4.0	6.4	2.3	18.5	Labour without lift charges.
3.	Mayurakshi .. .. .	—	—	—	—	28.0	Includes mixing, laying, curing, hire charges of machines.
4.	Kakrapar .. .. .	1.25	5.0	4	1.5	12.3	Includes basic lead of 50 to 100 ft. & 5 to 10 ft. lift.

Table 13.6.5.—contd.

1	2	3	4	5	6	7	8
5.	Tugabhadra (Hyd.)	—	—	—	—	22.8	Break-up not given.
6.	Tungabhadra (Andh.)	2.0	3.0	9.2	1.0	15.1	No lift & lead included.
7.	Bhadra	2.5	3.0	10.0	2.0	27.5	Do.
8.	Lower Bhawani	—	—	—	—	16.3	Including curing charges, break-up not given.
9.	Malampuzha	—	—	—	—	16.0	Do.
10.	Perinchani	—	—	—	—	17.0	Labour contract includes for all lead and lift.

### 13.7. LEAD AND LIFT

13.7.1. The cost of lead for materials has already been dealt with elsewhere and comparative cost of transport on various projects tabulated.

#### 13.7.2. *Hauling Mortar (Manual)*

Extra labour involved on account of lifting mortar, water, etc. as the work goes up can be expressed in the form of multipliers.

TABLE 13.7.2.

Heights from ground up to	20'	.....	1.0
	20' to 40'	.....	1.2
	40' to 60'	.....	1.3
	60' to 80'	.....	1.4
	80' to 100'	.....	1.5
	and so on		

#### 13.7.3. *Hauling Stone*

On large works the stone would be lifted up by crane. Data collected in respect of crane working in Tungabhadra is given below; the price of harbour crane stated to be Rs. 26,000/- is very low and this price has been assumed at Rs. 1,34,000 — the present market price.

#### *Depreciation charges per hour*

Cost of the crane including cost of repairs & renewals at 35% and railway transport charges.	} Rs. 1,83,900
Depreciation per working hour :	$\frac{183900}{15000} = \text{Rs. } 12.26$

*Erection charges*

Total expenditure incurred on erection Rs. 9,000

Quantity of masonry likely to be tackled.	}	4000 CFC

	9000	
∴ Erection charges per unit	$= \frac{9000}{4000}$	=Rs. 2.25

Taking one week or 6 working days the labour charges are as below :—

(i) Labour charges for rehandling materials	Rs. 120.00
(ii) Machine crew.	Rs. 505.7
(iii) Depreciation charges for 6 days, 47=1/2 hours :	
$47.5 \times 12.26$	Rs. 582.50
(iv) Cost of consumables	Rs. 104.75
(v) Erection charges at 2.25 per unit of masonry $96 \times 2.25 = 216$ .	Rs. 216.00
	<hr/> Rs. 1074.00

	1074
Working cost per day of 8 hours	$= \frac{1074}{6}$

= 179.0

	179.0	
Working cost per CFC	$= \frac{179.0}{16}$	= Rs. 11.2

In the non-spillway section the height over ground level to be tackled is about 80 ft. For lifts under than this separate trestle arrangements or longer boom length would be required. Lift charges will vary according to the height and section of the dam. In Hirakud contract rate for lift charges is *Rs. 2.5 for every lift of 10 ft. by manual labour.* For lift if 50 ft. and less the manual operation will be cheaper and for lift more than 50 ft. working by crane is advisable.

## 13.8. RIP-RAP

13.8.1. This item consists of a protective layer of stone laid on slopes and filled with spalls. The stones are bedded, one against the other. The slopes of soils where rip-rap is used shall not be steeper than their angles of repose. There are occasions when rip-rap is grouted with cement mortar as grout filler. The stone may comprise boulders collected from a stream bed or a natural quarry or alternatively it may be obtained by blasting from a stone quarry. The data collected from the projects is given in Table 13.8.1.

## STONE MASONRY

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TABLE 13.8.1.

Sl. No.	Name of Project	Unit	Stone	Carriage	Laying	Unit Rate
1	2	3	4	5	6	7
1.	*Hirakud .. .. .	100 cft.	3/-	9/7	3/7	20/14
2.	**Gangapur .. .. .	„	8/15	9/15	3/7	23/15
3.	†Malampuzha .. .. .	„	10/-	9/12	7/8	30/-
4.	‡Lower Bhawani .. .. .	„	26/9	—	8/-	34/12
5.	§Konar (DVC) .. .. .	„	18/-	12/10	6/9	37/3

\* Rockfilling hand packed U/S & D/S toe.

\*\* Also includes Rs. 1/7 as overhead charges.

† Also includes Rs. 2/12/- as miscellaneous charges.

‡ Also includes -/13/- as incidental charges.

§ Original rate.

## CONCRETE AND FORMWORK

### 14.1. BETTER CONCRETE

14.1.1. More recently, as the knowledge of 'Better Concrete' has widened, we find a growing tendency on the part of the Engineers to specify their concrete only in terms of strength. Such a move is decidedly in the right direction as this would lead to better quality and greater economy, in the use of cement and other ingredients of concrete. Many a treatise, explaining in detail the production of concrete of a predetermined strength from available materials, are now available.

14.1.2. For producing concrete of a particular strength, a somewhat more complicated concreting plant than the common mechanical mixer will be required, but the added expense of the same is found to usually off-sets by the more economical use of cement which becomes permissible. A testing laboratory is also an essential complement.

### 14.2. PROPORTIONING OF INGREDIENTS

14.2.1. In the proportioning and measuring of the several ingredients entering into concrete, recourse should first be had to the specifications which would vary with the requirements of strength and use. (Table 14.2.1.). Representative proportions of concrete mixes by volume, the order being cement, sand and coarse aggregate are shown below for various uses of concrete in construction.

14.2.2. Conventional quantities of constituents for the above-concrete mixes are tabulated in Table 14.2.2.

### 14.3. FORMWORK

14.3.1. Proper design of forms will secure adequate safety with economy. The factors which affect design are :

1. The consistency of concrete.
2. The rate of filling between the forms.
3. The method of placing concrete.
4. The method of taping or vibrating.
5. The depth of drop and distribution of steel in case of reinforced concrete.



TABLE 14.2.1.  
Cement Concrete Mixes

Type	Quality	Proportion	Use
1	2	3	4.
A	Rich	1:1½:3	R.C.C. special parts e.g. arches, copings, mouldings, stairs, columns, engine beds, piles etc., occasional use in P.C.C.
B	Standard	1:2:4	R.C.C. generally, roof slabs, lintels, beams, pillars, & P.C.C. in face work of dams and spillways, workshop floors etc.
C	Medium	1:2½:5	P.C.C. generally, abutments, piers, thin retaining walls, sironng foundations, etc.
D	Lean	1:3:6	P.C.C. only used for good foundation, mass concrete work, backing to masonry works, spillways and thick training walls.
E	Weak	1:4:8	P.C.C. only used in ordinary foundations, mass concrete in compression, for hearting in dams of low height etc.
F	Cheap	1:5:10	P.C.C. as substitute for brick masonry retaining walls to earth, precast blocks for walls, in foundation to temporary and unimportant structures.
G	Poor	1:8:16	P.C.C. in bottoming to concrete foundation as a cheap backing, substituting poor soils in foundations, etc.

TABLE 14.2.2.  
Conventional Material Constants for Various Concrete Mixes

Proportion		Description of Coarse Materials	Cement cwts.	Sand Dry FC	Coarse Materials FC	Total Aggregates FC
Cement, fine & coarse aggregates	Cement & aggregates					
1	2	3	4	5	6	7
1:1.5:3	1:4:5	Shingle	22.0	41	82	123
		Broken stone	21.3	43	86	129
1:2:4	1:6	Shingle	17.2	43	86	129
		Broken stone	18.1	45	90	135
1:2.5:5	1:7:5	Shingle	14.2	44	88	132
		Broken stone	14.9	46	92	133
1:3:6	1:9	Shingle	12.0	45	90	135
		Broken stone	12.65	47	94	141
1:4:8	1:12	Shingle	9.25	46	92	138
		Broken stone	9.70	48	97	145
1:5:10	1:15	Shingle	7.60	47	94	141
		Broken stone	8.05	50	100	150
1:8:16	1:24	Shingle	4.82	48	96	144
		Broken stone	5.11	51	102	153

- NOTE: 1. Add after testing for bulkage of sand to quantities given in col. 5.  
 2. The aggregates for each mix should be proportioned after sieve analysis of their piles.  
 3. Variation of 5% on the above quantities may be the tolerance on the constants on account of the variation in densities of stone.  
 4. Waste in transit or handling on large works should not exceed 2½%.

14.3.2. The unit of measurement for forms should be actual area in square feet of the surface of the concrete in contact with the forms. The estimated materials should include materials for struts, posts, bracing, horizontal runners, wedges, bolts, wire, ties, oiling, cleaning and repairing but as also materials for staging and bridging.

14.3.3. Cost of forms is generally about 5 to 10% of the cost of concrete in dams construction while it is as high as 25-50% in case of structural parts of buildings. Where large quantities are involved, small saving in the unit cost amount to a large sum on the whole work which can be possible only if the forms are well planned for the job. Forms should preferably be manufactured in penal sections or other shapes which can be used several times, the greater number of uses obtainable with metal forms would generally result in a lower cost for use than with lumber. The cost of erection and stripping may be considered as uniform for each use, although there would be some saving in subsequent use. Small salvage value of formwork at the completion of the job may be ignored in calculating costs.

14.3.4. In order to resist the internal pressure resulting from the concrete some positive method of holding the forms in position is necessary. These methods will vary with the nature of work. In most cases, however, the ties used would be left inside the concrete and their cost should therefore be included in the unit cost.

#### 14.4. WOODEN FORMS FOR ROOF SLABS

14.4.1. Simple flat centering for concrete floors or roofs for 12 ft. height requires 10-20 c. ft. (15 F.C. average) timber per CFS. The quantity of timber required will increase in the height is increased mainly because of increase in the height of the vertical posts. Labour will also increase for greater heights. Analysis of rate for formwork for roof slabs is given below assuming 6 uses:

(i) 1-1/2" boards machine planned one side cages shot delivered on site (Rate includes wastage) C.F.S.	150/-	Rs.
(ii) 4 Nos. $\times 12.0 \times 4" \times 4" = 5.3$ F.C. posts for up-right. $45 \times 10'-0" \times 9" \times 3" = 2.2$ F.C. tiles and braces.		
	15 F.C. @ 8/-	120/-
(iii) Wedges and cleats say 16 including top and bottom @ -/12/- each.		12/-
(iv) Clamps, dogiron, clamps strips 1/8 cwt. @Rs. 35/- per cwt.		4/6
		<hr/>
		286/6

Preparing the initial shuttering.	31/4
	317/10
Assume 6 uses of the above.	
Therefore use and waste of materials per F.S.	Rs. 52/15
(v) (2.0) Carpenter and (5.0) labourer repairing and fixing @ 5/- and 1/12 and stripping.	Rs. 18/12
(vi) Add for oiling etc. to prevent concrete sticking to shuttering.	Rs. 2/-
TOTAL	Rs. 73/11
Say :	Rs. 74/-
(vii) Add for sundry materials.	Re. 1/-
GRAND TOTAL	Rs. 75/- per CFC

14.4.2. For different types of shuttering work the labour in erecting and striking per CFS would pay.

#### 14.5. P.G.I. COVERED TIMBER PLANKS OVER TIMBER FRAMES

14.5.1. The shuttering in panels of 6'×3' fixed to planks with wooden framework can, if well constructed be used at least eight times and on this basis the rate per C.F.S. is analysed below. The forms will have to be of a heavier construction than that dealt with in previous para 14.4.1. and would require 20—30 F.C. (25 F.C. average) lumber per hundred sq. ft. P.G.I. sheets 24 gauge in addition. The repairs, however, will not call for great deal of new timber.

#### 14.5.2. Analyses of (Primary) rates per C.F.S.

##### A. Formwork and planking.

1. Planking 100 F.S.×1½ of hardwood=12.5 @ 12/-	Rs. 15-0/
2. Cut sized for a panel of 6'×3'	
6-¾'×2×5"=1.4 F.C.	
4×3-1/4"×2-1/4"×5"=.94	
2.34 per 18 F.S.	
or 2.34×100/18=13 F.C. @ 8/-	
	Rs. 104/-
	Rs. 254/-
Preparation of shuttering	Rs. 254/-

B. G.I. Plain sheets (24 gauge) 100 F.S.=106 lbs. @ 25/- per cwt.	Rs. 31/4 Rs. 23/-
C. 5 lbs. Nails for fixing 100 sft. of sheet @ -/8/- lb.	Rs. 2/8/-
Assume 8 uses. Cost per use and waste.	Rs. 310/12/- Rs. 38/14
D. Steel for anchoring bolts and ties including labour 36 lbs @ -/15/- per lb.	Rs. 12/4
E. Share of bulli supports etc. 20% of Rs. 35/-	Rs. 7/-
F. Erection and stripping	Rs. 18/12/-
G. Miscellaneous	Rs. 2/-
	<u>Rs. 78/14/-</u>

#### 14.6. MANUFACTURE OF HEAVIER TYPE OF SHUTTERING FOR USE OF DAMS

14.6.1. Based on the data furnished by the Superintending Engineer, Konar, the cost of manufacturing steel shuttering and then using it eight times inclusive of labour in erecting and stripping is given below:—

##### *Steel Shuttering-Analysis working w/krh Crane*

##### (a) Steel

	Quantity (tons)	Rate		Cost (Rs.)
(1) M S. Plate 1/8"	57.0	Rs. 423/-	per ton	24,111/-
(2) M.S. Plate 12 gauge	23.7	Rs. 423/-	"	10,025/2/-
(3) M.S. Angle 2½" × 2½" × 4½"	52.81	Rs. 378/12	"	20,001/13/-
(4) M.S. Angle 2½" × 2" × ¼"	16.00	Rs. 378/12	"	6,060/-
(5) M.S. Channel 4" × 2"	67.35	Rs. 389/-	"	26,199/8/-
(6) Do. 5" × 2½"	35.5	Rs. 389/-	"	13,908/8/-
(7) Do. 3" × 1½"	20.25	Rs. 389/-	"	7,875/4/-
(8) M.S. Flat 2½" × ¼"	20.37	Rs. 378/-	"	7,699/14/-
(9) 2" dia. G.I. pipe	3.52	Rs. 1/7 per r. ft.		506/-
				<u>1,16,287/11/-</u>

Say: 1,16,300/-/-

(b) Fabrication charges 293 tons @ 300/- per ton	87,900/-/-
(c) Transportation @ -/12/- per ton/mile, distance 1.5 miles, both way 3 miles.	2/4/-
Loading, unloading and any other rehandling charges	-/12/-

Rate per ton 3/-/-

∴ 293 tons = 293 × 3 = Rs. 879/-

Bolts and nuts 1/2" dia. 3-1/2" long. Total No. required for 8 sets, 33,000. Total weight—90 cwts. @ 70/-

6,300/-

(e) Slotted pins and wedges 1/2" dia. 2 1/2" long-32,000 @ 1 1/4/- each	40,000/-
(f) Tube and nuts 5/5" dia. 27000 @ 25/-	67,500/-
(g) Tube nuts 1" dia. 750 Nos. @ 22/-	16,500/-
	<hr/>
	33,53,791/-
	67,303/-
(h) M.S. Rods 5/8" dia. and 1" dia. for anchorage 250 tons at Rs. 700/-	1,35,000/-
	<hr/>
	4,03,303/-
Total shuttering work to be done	11,336 Units
Cost per unit = $\frac{4,03,303}{11,330}$ = Rs. 35.5	

*Labour cost with crane*

Shuttering one sub-block 50' x 40' x 5"  
 Total area=900 sq.ft.  
 Shuttering time : 12 hours.

*Machines*

	Rs.
Cost of 35-ton crane .. .. .	2,74,000
life in hours—16,000	
(a) ∴ Depreciation per hour .. .. .	17.13
(b) Major repairs and maintenance	
@ 60% of depreciation .. .. .	10.28
(c) Labour—Operator and maintenance .. .. .	2.256
P.O.L. charges .. .. .	7.875
Total use rate per hour .. .. .	37.54
Taking crane use 10 Hrs. Per 9 Units. Cost per unit .. .. .	41.71
	<hr/>

*Labour*

1/4 Foreman @ Rs. 300/- p.m. . . . .	7.50
8 Khalasis at Rs. 2.0 .. .. .	24.00
8 Male Mazdoors at 1.75 .. .. .	21.00
3 Carpenters at Rs. 5/- .. .. .	22.50
	<hr/>
	75.00
Materials :—Linseed oil 1.5 Gals. at Rs. 8.5 .. .. .	12.75
	<hr/>
	87.75
∴ Cost per unit .. .. .	9.75
1. Capital cost of materials etc. per unit .. .. .	35.50
2. Machineries (P. & H. Crane) .. .. .	41.71
3. Labour and materials. .. .. .	9.75
	<hr/>

86.96

Say: Rs. 87/- per C.F.S.

14.7. COST OF STEEL FORMWORK AT MAITHON

14.7.1. Cost of manufacturing heavy steel shuttering for Maithon Dam is Rs. 1,428/- per CFS shuttering and it is expected that these

B. G.I. Plain sheets (24 gauge) 100 F.S.=106 lbs. @ 25/- per cwt.	Rs. 31/4 Rs. 23/-
C. 5 lbs. Nails for fixing 100 sft. of sheet @ -/8/- lb.	Rs. 2/8/-
	<hr/> Rs. 310/12/-
Assume 8 uses. Cost per use and waste.	Rs. 38/14
D. Steel for anchoring bolts and ties including labour 36 lbs @ -/15/- per lb.	Rs. 12/4
E. Share of bulli supports etc. 20% of Rs. 35/-	Rs. 7/-
F. Erection and stripping	Rs. 18/12/-
G. Miscellaneous	Rs. 2/-
	<hr/> Rs. 78/14/- <hr/>

#### 14.6. MANUFACTURE OF HEAVIER TYPE OF SHUTTERING FOR USE OF DAMS

14.6.1. Based on the data furnished by the Superintending Engineer, Konar, the cost of manufacturing steel shuttering and then using it eight times inclusive of labour in erecting and stripping is given below:—

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(4) M.S. Angle 2½" × 2" × ¼"	16.00	Rs. 378/12	6,060/-
(5) M.S. Channel 4" × 2"	67.35	Rs. 389/-	26,199/8/-
(6) Do. 5" × 2½"	35.5	Rs. 389/-	13,908/8/-
(7) Do. 3" × 1½"	20.25	Rs. 389/-	7,875/4/-
(8) M.S. Flat 2½" × ¼"	20.37	Rs. 378/-	7,699/14/-
(9) 2" dia. G.I. pipe	3.52	Rs. 1/7 per r. ft.	506/-
		TOTAL	1,16,287/11/-
		Say: 1,16,300/-/-	
(b) Fabrication charges 293 tons @ 300/- per ton			87,900/-/-
(c) Transportation @ -/12/- per ton/mile, distance 1.5 miles, both way 3 miles.			2/4/-
Loading, unloading and any other rehandling charges			-/12/-
		Rate per ton	3/-/-
∴ 293 tons = 293 × 3 = Rs. 879/-			
Bolts and nuts 1/2" dia. 3-1/2" long. Total No. required for 8 sets, 33,000. Total weight—90 cwts. @ 70/-			6,300/-

(e) Slotted pins and wedges 1/2" dia. 2½" long-32,000 @1/4/- each	40,000/-
(f) Tube and nuts 5/5" dia. 27000 @ 25/-	67,500/-
(g) Tube nuts 1" dia. 750 Nos. @ 22/-	16,500/-
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	33,53,791/-
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(h) M.S. Rods 5/8" dia. and 1" dia. for anchorage 250 tons at Rs. 700/-	1,35,000/-
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	4,03,303/-
	11,336 Units
Total shuttering work to be done	
Cost per unit = $\frac{4,03,303}{11,330}$ = Rs. 35.5	

*Labour cost with crane*

Shuttering one sub-block 50' × 40' × 5"  
 Total area = 900 sq.ft.  
 Shuttering time : 12 hours.

*Machines*

	Rs.
Cost of 35-ton crane .. .. .	2,74,000
life in hours—16,000	
(a) ∴ Depreciation per hour .. .. .	17.13
(b) Major repairs and maintenance	
@ 60% of depreciation .. .. .	10.28
(c) Labour—Operator and maintenance .. .. .	2.256
P.O.L. charges .. .. .	7.875
Total use rate per hour .. .. .	37.54
Taking crane use 10 Hrs. Per 9 Units. Cost per unit .. .. .	41.71

*Labour*

¼ Foreman @ Rs. 300/- p.m. . . . .	7.50
8 Khalasis at Rs. 2.0 .. .. .	24.00
8 Male Mazdoors at 1.75 .. .. .	21.00
3 Carpenters at Rs. 5/- .. .. .	22.50
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	75.00
Materials :—Linseed oil 1.5 Gals. at Rs. 8.5 .. .. .	12.75
	<hr/>
	87.75
∴ Cost per unit .. .. .	9.75
1. Capital cost of materials etc. per unit .. .. .	35.50
2. Machineries (P. & H. Crane) .. .. .	41.71
3. Labour and materials. .. .. .	9.75
	<hr/>
	86.96

Say: Rs. 87/- per C.F.S.

14.7. COST OF STEEL FORMWORK AT MAITHON

14.7.1. Cost of manufacturing heavy steel shuttering for Maithon Dam is Rs. 1,428/- per CFS shuttering and it is expected that these

will be used thirty-four times with minor occasional repairs. Details of cost of manufacture are :—

Sl. No.	Item	Unit	Quantity	Rate	Amount
1.	Steel.				
1.1	M.S. Plate of sizes .. ..	Ton	0.52	527.00	274.04
1.2	Structural sections.				
1.2.1.	Channels .. ..	"	0.37	549.06	104.00
1.2.2.	Angles .. ..	"	0.012	527.00	6.32
1.2.3.	Joints .. ..	"	0.039	527.00	20.56
1.3.	Other materials .. ..	L.S.	—	—	183.38
1.4.	Bolts, nuts and edges etc. .. ..	Ton	0.32	856.25	276.00
2.	Fabrication .. ..		—	—	141.31
Total					1105.60

$$3. \text{ Depreciation} = \frac{\text{Total Amount}}{\text{Number of uses}} = \frac{1105.60}{34}$$

Use rate per panel of 78 sq. ft. = Rs. 32.5  
Use rate per CFS = Rs. 42/-

#### 14.7.2. Analysis for steel formwork per CFS of concrete surface

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	Depreciation of CFS steel shuttering.	CFS	—	—	42.0	
2	Fixing and removing	—	—	—	—	
2.1	Cost of materials for anchorage. (Supporting, pipes, hooks, sal, ballah, cotton waste, etc).	—	—	—	75.0	
2.2	Crane charges.	—	—	—	43.0	
2.3	Labour fixing and removal.	—	—	—	75.0	
2.4	Linseed Oil etc.	—	—	—	—	
3.	Miscellaneous	—	—	—	0.1	
3.1	Petty repairs	—	—	—	0.1	
3.2	Transportation of materials from workshop to worksite.	—	—	—	8.0	
3.3	Clearing	—	—	—	—	Included in crane & labour charges.
3.4.	Add proportionate cost of :					
	Construction of carpentry workshops and fire hydrants.	—	—	—	3.8	
	Shops cost of wooden panels	—	—	—	10.8	
	Shop cost of drainage gallery panels.	—	—	—	13.4	
	Shop cost of operating gallery panels.	—	—	—	11.0	
TOTAL PRIMARY COST					283.2	per CFS



## 14.8. CONCRETING EQUIPMENT

14.8.1. A complete concreting plant from crushing aggregate to laying concrete is a combination of several units and its output is linked up with that of the weakest unit. It is, therefore, essential that the entire plant should have a complete and continuous co-ordination among the units.

14.8.2. In planning a large crushing operation the economics of the related quarrying of the rock are directly involved and govern the selection of the crushing machinery. A careful study of the best combination for primary and secondary crushing may justify the installation of a larger crusher to receive larger pieces of rock from the quarry thus reducing secondary blasting and increasing the output.

14.8.3. A crushing and screening plant should be designed with some excess capacity over the expected continuous consumption, because the intermittent feed into the primary crusher may cause serious overloads on the belt conveyors and screens.

## 14.9. THE CRUSHING EQUIPMENT

14.9.1. A modern stone and sand crushing plant usually consists of the following component parts: Primary Crusher, Scalping Screen, Secondary Crusher, Belt Conveyors, Sizing Screens, Sand Mills, Sand Screens, Classifiers or Washer, Storage Piles and Reclaiming system. The primary crusher of the jaw or gyratory type is installed with its top below the level of the quarry floor to permit direct loading from dumpers, wagons or railroad cars into a hopper above the crusher. A jaw crusher can generally take large pieces but has considerably less capacity than a gyratory crusher.

14.9.2. The secondary crusher for breaking down oversize rock is usually of the gyratory or cone type, which can be adjusted to smaller settings. In order to reduce the load on the secondary crusher, it is a standard practice to scalp out the acceptable sizes of crushed aggregate and deliver only the oversize to the secondary. Vibrating scalping screens for this class of service are very satisfactory.

14.9.3. Where the product from the primary crusher goes to a screening and secondary crushing operation the feed to the secondary crusher should be as constant as possible, and for this reason a surge pile beyond the primary crusher is desirable. From this pile a mechanical or vibrating feeder and belts deliver the crushed material at a uniform rate to succeeding operations.

14.9.4. The revolving screen is one of the simplest types and usually has relatively long life. However, it is more suitable for smaller installations or in connection with large natural gravel-pit operations.

Heavy duty single or multi-deck vibrating screens have now been developed for rock sizes up to 6 and 8 inches which, as a rule, are superior in operation, space requirements, in screening efficiency.

14.9.5. Sand may be produced either by direct grinding, attrition grinding, or by impact grinding. The most important elements to be met in a sand manufacturing process are sizes of the particles, gradation, shape and cleanliness. These factors dictate special precautions in the selection of sand making machinery.

#### 14.10. COST OF CRUSHING AND SCREENING

14.10.1. The data for crushing Basalt rock, obtained from Cost Accounting by HCC on Vaitarna Project, is given below :—

- (1) C-1 Primary Crusher Jaw type Hadfield 200 tons capacity.
- (2) Secondary Crusher C-2 Gyratory type 100 tons capacity.

	Owner- ship Cost (Rs.)	Spares (Rs.)	Total (Rs.)	Life in Working hrs. (thousand)	Depre- ciation & Spares	Operat- ing Cost
	2	3	4	5	6	7
Primary crusher with conveyors and civil engineering work for erection.	4,51,684	3,73,000	8,24,684	20	41.23	46.96
do.- secondary crusher with belts, screens, bins etc. kubit breakers	12,10,193	7,20,000	19,30,193	18	107.23	68.06
Rod mills, marcy one of 12 ft. and second of 8 ft. length.	2,32,699	90,000	3,22,699	18	17.92	17.85

14.10.2. The above crushing units were worked for 7,000, 10,000 and 12,000 hours to crush 1,66,44,000 cft. of solid rock into aggregate (coarse and fine sand). The total cost is :—

Equipment	Use-rate per hour	Hour	Cost (Rs.)
1	2	3	4
1. Primary	41.23	7,000	6,17,330
	46.96		
	88.19		
2. Secondary	107.23	10,000	17,52,900
	68.06		
	175.29		
3. Rod Mills	17.92	12,000	4,29,240
	17.85		
	35.77		
TOTAL COST			27,99,470

$$\therefore \text{Cost of crushing \% Cft. of Basalt solid rock into aggregates. of } 6'' \times 3'' \times 1\frac{1}{2}'' \times \frac{3}{8}'' \text{ and below.} = \frac{27.99}{1.66} = \text{Rs. } 17.45$$

$$\therefore \text{Cost of crushing aggregates per CFC with 45\% voids.} = \frac{17.45 \times 100}{140} = \text{Rs. } 12.5$$

Note : (a) The plant was used for crushing sand also otherwise cost of crushing would have been less.  
 (b) In the case of abrasive stones viz. Granite and sandstone, the above cost would increase up to 30%, according to the nature of the stone crusher.

14.10.3. The cost of crushing stone into coarse aggregates per CFC is indicated in Table 14.10.3. All rates relate to stack measurements.

TABLE 14.10.3

Sl. No.	Projects	Type of Rock	Cost of crushing per CFC at Crusher (Stack with 40% voids)	Remarks
1	2	3	4	5
1.	Nangal	Shingle	10.0	Crushing round boulders.
2.	Maithon	Sandstone	24.5	
3.	Tilaiya	Sandstone	22.4	
4.	Hirakud	Granite	30.6	
5.	Vaitarna	Basalt	12.5	

## 14.11. WASHING AGGREGATES (MECHANICAL)

14.11.1. For primary washing of aggregates up to 6 or 8 inches in size and containing considerable clay, special scrubbers are used. These are large revolving cylinders with vanes and paddles which lift and tumble the gravel over itself in a bath of water. Another type for washing stone and gravel is the log washer which operates as a screw washer does for sand. Further effective means of washing the aggregates as they go through a screening plant may be obtained by directing sprays or jets of water on the aggregate as it flows over the screens. An important point here is that high pressure is less effective in washing the aggregate as compared with greater volume at lower pressure. In some cases there is danger of washing out too many fines, from the 100 mesh screens, a size which is of considerable importance in making good concrete.

## 14.12. TRANSPORT FROM STOCK-PILES TO BATCHING AND MIXING PLANT

14.12.1. For transporting materials from stock-piles to batching plant, use is made either of a continuous belt conveyor (or skip buckets operated by hoist cable). For this purpose at Maithon Dam (D.V.C.) reclamation tunnel has been laid under the full length of storage piles. Two belt conveyors have been installed. One is horizontal running under the stock-piles and other is inclined at 17.5 degrees to reach the bins in the batching plant. Working cost of the operation depends to a great extent on the working of the batching plant. If the latter cannot work continuously at optimum output, conveyor belts will have to remain idle intermittently, thereby increasing labour cost per unit of work.

14.12.2. Analysis of cost for transport from stock-piles to batching and mixing plant is given below :—

## A. Depreciation

	Rs.	
Cost of discharge gates	57,500	
Cost of conveyor belts and screens	2,67,500	
Cost of steel structure	16,260	
	<hr/>	
	3,41,260	
Life in hours 10,000		
∴ Depreciation per hour	34.1	
B. Repairs and maintenance at 80% of depreciation.	27.3	
C. Energy—Total H.P. 85 @ -/1/- per unit.	4.1	
(a) Electrical Materials	1.0	} Rs. 6.1
(b) Sundry Materials	1.0	
D. Labour Operation and maintenance per hour		
3 operators (1 for gate and 2 for 2 belts) @ Rs. 4/8/-	1.70	
3 Helpers @Rs.3/- per day per shift	1.12	
3 Mazdoors @Rs. 1/8/-	0.56	
1/2 Foreman @Rs. 12/- per day per shift	0.75	
2 Fitters @Rs. 5/-	1.25	
1 Mechanic @Rs. 5/-	0.62	
	<hr/>	
	Rs. 6.00	
	<hr/>	

Total cost per hour = 34.1 + 27.3 + 6.1 + 6.0 = 73.5

Output	32.40 CFC/hr.
∴ Cost per CFC	2.26
Add for erection, dismantling etc. as obtained at Maithon.	2.41
For dozing	0.86
	<hr/>
∴ Total per CFC	5.53
	<hr/>

14.13. BATCHING AND MIXING

14.13.1. There have been radical improvements in batching and mixing equipment in recent years on account of the demand for better speed and control in manufacturing concrete. Automatic batching and recording has been introduced on some of the dams under construction.

14.13.2. The tilting mixer is the only type that can satisfactorily handle mixes containing cobbles. The mixer should be so located and arranged as to permit the operator to view the mixing operation during the processing rather than to judge the qualities of the mix after it is dumped. The mixing cycle of batch mixer of 2 cyds., and up, including charging the mixer mixing the concrete and discharging it, the maximum period required is 3 minutes.

14.13.3. Analysis of cost of batching and mixing operation is given below. The figures for the cost of plant is based on Maithon Project figures.

*Operation of Batching and Mixing Plant (for cost of mixing)*

	Rs.
1. Cost of Batching Plant with 3 mixers of 3 cyds each at site	7,45,900
2 Life—16,000 hrs.	
3. Depreciation per hr.	46.6
4. Repair and Maintenance @60%	28.0
5. Labour and Field maintenance per hr.	6.7
6. P.O.L. etc. per hr.	
(a) Electric Energy	2.5
(b) Electric Material	0.8
(c) P.O.L.	0.3
(d) Sundries	0.5
	<hr/>
Total cycle rate per hr.	85.4
Expected average output per 100 cyds. or 27 CFC per hour	
∴ Use rate per CFC	3.16
Cost of water	0.03
Cost of erection and dismantling	2.00
	<hr/>
	5.19

14.13.4. Analysis of cost of conveying mixed concrete from batching plant to pick up point by Diesel Locomotive and 6 cyds. buckets is given below :—

	Rs.
1. Cost of Diesel Locomotive (B.H.P.) 55	44,000
2. Life—12000 hrs.	
3. Depreciation per hour.	3.67
4. Repairs & Maintenance	3.67
5. Labour operation & Field maintenance per hour with POL.	7.00
Total cycle rate per hour.	14.34
Output per hour 3 Locomotives on the site and 2 always working and giving an output of 27 CFC or 13.5 CFC per Loco.	
∴ Use rate per CFC	1.31
Cost of Flat Wagon and Bucket per CFC	1.00
Cost and maintenance of Trolley Line	0.35
	2.66
Say, Rs. 2.66 per C.F.C.	

14.13.5. Analysis of cost of Revolving Crane operation for lifting concrete bucket and placing is given below :—

	Rs.	
1. Cost of the 2 No. electric revolving crane 40 Ton capacity	1,73,500	
2. Life, 12000 hours each—24000 hours.		
3. Depreciation per hour.	72.25	
4. Repairs and Maintenance per hour @ 60%.	43.40	
5. Labour operation and Field maintenance per hour.	7.09	
6. P.O.L. etc. per hour.		
(a) Electric Energy	62.50	
(b) Electric Material	0.95	
(c) P.O.L.	2.38	
Total Cycle rate per hour	188.57	
Output per hour the same as batching plant	27.00	CFC
∴ Use rate per CFC	7.00	
Cost of erection and dismantling Crane.	2.04	
Cost of Steel Structure 1000 Tons, after allowing salvage value.	6.60	
Maintenance of structure.	0.11	
Erection and dismantling of steel structure, 1000 Tons @ Rs. 300 per ton and distributed over the whole concrete 87000 CFC.	3.45	
Total rate per CFC	1,920	

14.13.6. Analysis of cost of vibrating concrete per CFC is given below :—

1. Cost 8 Nos. Electric Vibrators with frequency changers .. .. .	Rs.	40,000
		40,000
2. Life—10,000 hours.		
3. Depreciation per hour .. .. .	Rs.	4.00
4. Repairs and Maintenance per hour 100% .. .. .	Rs.	4.00
5. Labour Operation and field maintenance per hour 2 Labourer per vibrator .. .. .	Rs.	1.50
6. Cost of P.O.L. with electrical mixing and sundries .. .. .	Rs.	02.0
		11.50

Output per vibrator, on the assumption that 4 vibrators work continuously for 27.0 CFC per hour.

$$\therefore \text{Use Rate per CFC} = \frac{11.50}{6.75} = 1.7$$

#### 14.14. ADMIXTURE

14.14.1. In U.S.A., since 1944, millions of cubic yards of air-entrained concrete have been placed in the construction of dams. The use of air entraining agents permitted an appreciable reduction in the cement content and the water/cement ratio. Beside special cements, which are generally more economical than portland cement have been lately used in the United States and laboratory investigations have indicated that the concrete containing these cements blended with portland cement compared favourably with concrete containing portland cement along.

14.14.2. As an element of cost of concrete the admixtures do not form an appreciable percentage and it is not considered necessary to discuss their price difference. However, the cost incurred on their use has not been added to the cost of cement element in the analysis of mass concrete rates.

#### 14.15. OVERALL RATES OF MASS CONCRETE

14.15.1. Overall rates of mass concrete (Table 14.15.1.) inclusive (i) of all leads and lifts (ii) burden in addition to (i) and (iii) formwork in addition to (ii) are given. They vary from Rs. 228 to Rs. 329 per CFC.

TABLE 14.15.1  
Overall rates of mass concrete for CFC

Sl. No.	Name of project	Cement quantity per CFC Cwt.	Quality of concrete in CFC	Cost in rupees (Lakhs)	Primary expense per CFC			Burden				Rate per CFC exclusive of form-work (10+12)	Form-work inclusive of cost per CFC	Total rate per CFC inclusive of form-work	
					Depart-ment	Cont-ract	Con-tract	% on col. (6)	Am-ount	% on col. (7)	Am-ount				Total col. (10+12)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Maithon (Dam)														
	Class 'A' 300 lbs/Cyd.	9.9	64071	100	169	—	169	42	71	—	—	71	240	38	278
	Class 'B' 460 lbs/Cyd.	15.2	18862	36	197	—	197	42	83	—	—	83	280	38	318
2.	Panchet Hill (Dam)														
	Class 'A' 398 lbs/Cyd.	13.2	30267	48	186	—	186	40	74	—	—	74	260	42	302
	Class 'B' 506 lbs/Cyd.	16.7	29087	47	205	—	205	40	82	—	—	82	287	42	329
3.	Tilaiya (Dam)	14.0	38408	67	195	—	195	36	70	—	—	70	265	6	271
4.	Konar (Dam)	13.0	91800	224	—	244	244	—	—	9	22	22	266	4	270
5.	Hirakud (Dam) 1:3:6	14.53	185270	338	119	59	178	30	36	11	6	42	220	21	241
6.	Vaitarna (Dam)	12.0	191000	416	—	218	218	—	—	2	4	4	222	6	228



## 14.16. FORMWORK

14.16.1. Formwork for concrete are fabricated from lumber, plywood, steel and aluminium, either separately or in continuation. If the form materials is not going to find its re-use, the forms would prove to be prohibitive in price. If, however, the forms are to be used 2-3 times then it will prove to be economical to manufacture them in timber only. Where they are required to be used many times it would pay to use durable materials. Special plywood for formwork is used when very smooth surface is required, and this is not necessary for concrete dams, as they are costly.

A combined table for mass concrete inclusive and exclusive of formwork is given in Table 14.15.1.  
14.16.1.

## ANALYSIS AND SCHEDULE OF RATES

## 15.1. INTRODUCTORY

15.1.1. We have dealt with before the principal items of work and have reproduced the data which we had collected. We will give here their analysis of rates.

## 15.2. BASIC SCHEDULE OF WAGES

15.2.1. The labour rates given in Table 15.2.1. will be applied to pricing the labour element in the analysis of rates. The rates for skilled and semi-skilled labour should be considered inclusive of all necessary tools which are normally carried by them.

TABLE 15.2.1

*Basic wages per day of 8 working hours*

Item	Description of labourers	Rate
<i>Un-skilled Labour</i>		
1.	Bhisty including mussack .. .. .	Rs. 2.5
2.	Chokidar .. .. .	1.75
3.	Mate (1 for 10 Mazdoors) .. .. .	2.0
4.	Mazdoor Man [Grass cutter, Stone breaker or Packer Driver for donkeys (1 for 10) mules, camels (1 for 3 camels or mules or for bullocks)] ..	1.75
5.	Mazdoor Woman 18 years and above .. .. .	1.25
6.	Mazdoor Boy (not less than 15 yrs. and under 18 years) .. .. .	1.0
7.	Wadar Cooly Male .. .. .	2.5
8.	Wadar Cooly Female .. .. .	1.5
9.	Wadar Cooly Boy .. .. .	1.0
<i>Semi-skilled and skilled</i>		
10.	Blaster .. .. .	4.5
11.	Crow Bar Man .. .. .	3.5
12.	Fitter Coly and Greaser .. .. .	2.0
13.	Cleaner (Mech. Plant & Transport) .. .. .	2.0

TABLE 15.2.1—contd.

14.	Fireman (any static or mobile machinery)	3.0
15.	Glazier	3.0
16.	Hammerman	2.5
17.	Moulder (bricks or tiles)	2.5
18.	Pump Attendant	2.0
19.	Quarryman	3.5
20.	Roof Tiler or Thatcher	2.5
21.	Sawyer	3.5
22.	Well Sinker	4.0
23.	Lime Washer	2.0
24.	Carpenter Boy, Bellows Boy	2.0
25.	Mason (Stone) II	3.5
26.	Brick layer, Plaster Floor II or Wall Tiler	4.0
27.	Carpenter II	4.0
28.	Fitter II	3.0
29.	Blacksmith II	3.5
30.	Mechanic II	5.0
31.	Painter II	3.0
32.	Plumber II	4.0
33.	Turner II	3.5
34.	Welder II	4.5
<i>Artisans and Technicians</i>		
35.	Armature Winder	6.0
36.	Blacksmith I	5.0
37.	Boiler Attendant	3.5
38.	Brick-layers Plasterer I	5.0
39.	Carpenter I	5.0
40.	Driller (Well boring)	4.5
41.	Driver (Mechanical transport)	4.5
42.	Driver (Engine Static)	4.5
43.	Dresser	5.0
44.	Fitter I (Structural)	4.5
45.	Line-man	4.5
46.	Mason (Stone) I	5.0
47.	Mechanic I	6.0
48.	Painter I	4.0
49.	Pattern Maker	5.5
50.	Plumber I	5.0
51.	Switch board Attendant	2.5
52.	Turner I	5.0
53.	Welder I	6.0
54.	Wireman and Electrician	4.5
55.	Foreman Monthly Rated Labour 200—10—300—20—400	
56.	Operators (100—8—140—10—200)	

## 15.3. BASIC SCHEDULE OF PRICES

15.3.1. The rates given in Table 15.3.1. have been applied to work-out the material component of the rates.

TABLE 15.3.1.

*Basic Schedule of Materials Rates*

Sl. No.	Item with description	Unit	Rate	Remarks
1	2	3	4	5
<i>A. Cement &amp; Steel</i>				
1.	Portland Cement	Cwt.	5/	Ex-Project Godown
2.	Steel Rolled Sections	..	20/-	Do.
3.	Mild Steel Bars	..	24/-	Do.
4.	B.S.W. Binding Wire	..	30/-	Do.
<i>B. Oils</i>				
5.	Petrol	Gal.	2/12	Do.
6.	Diesel Oil	..	1/8	Do.
7.	High Speed Diesel Oil	..	1/2	Do.
8.	Mobile Oil	..	4/-	Do.
9.	Lubricating Oil	..	4/-	Do.
10.	Grease	Lb.	-/8/-	Do.
11.	Cotton Waste	..	-/5/-	Do.
12.	Gear Oil	Gal.	5/-	Do.
<i>C. Rubber Goods</i>				
<i>Indian Prices</i>				
<i>Ply</i>				
13.	6.0×16	6	Tractor Tyre	Each 101/15
			Tractor Tube	.. 12/2
14.	6.0×19	6	Tractor Tyre	.. 114/2
			Tractor Tube	.. 12/10
15.	7.5×16	8	Trailer Tyre	.. 166/12
			Trailer Tube	.. 25/-
16.	7.5×16	8	Ribbed Earthmover Tyre	.. 186/10
			Ribbed Earthmover Tube	.. 17/2
17.	7.5×18	6	Tractor Tyre	.. 143/5
			Tractor Tube	.. 17/5
18.	10.0×28	6	Tractor Tyre	.. 282/2
			Tractor Tube	.. 42/5
19.	11.0×28	6	Ground Grip Tyre	.. 402/8
			Ground Grip Tube	.. 40/4
20.	11.0×36	6	Ground Grip Tyre	.. 434/15
			Ground Grip Tube	.. 62/5

TABLE 15.3.1.—contd.

1	2		3	4	5
	<i>Ply</i>				
21.	12·0×24	16	Rock Grip Tyre	Each	1037/4
			Rock Grip Tube	"	61/3
22.	13·0×24	8	Grader Tyre	"	781/7
			Grader Tube	"	70/7
23.	14·0×24	20	Power Grip Tyre	"	1406/-
			Power Grip Tube	"	114/8
24.	18·0×24	16	Ground Grip Tyre	"	2478/10
			Ground Grip Tube	"	207/7
25.	18·0×24	24	Earthmover Tyre	"	3261/2
			Earthmover Tube	"	207/7
26.	18·0×24	24	Earthmover Tyre	"	3979/14/-
			Earthmover Tube	"	207/7
27.	18·0×25	16	Ground Grip Tyre	"	2478/10
			Ground Grip Tube	"	207/7
28.	18·0×25	20	Ground Grip Tyre	"	3261/2
			Ground Grip Tube	"	207/7
29.	18·0×25	24	Ground Grip Tyre	"	3879/14
			Ground Grip Tube	"	207/7
30.	21·0×25	20	Ground Grip Tyre	"	3717/-
			Ground Grip Tube	"	256/8
31.	21·0×25	20	Ground Grip Tyre	"	3816/14
			Ground Grip Tube	"	256/8
32.	21·0×25	24	Ground Grip Tyre	"	4383/4
			Ground Grip Tube	"	256/8
<i>U.K. Prices</i>					
33.	8·2×20	12	Rock Grip Tyre	"	417/7
34.	9·0×20	12	Rock Grip Tyre	"	479/14
35.	9·0×24	12	Grader Tyre	"	576/15
36.	10·0×24	14	Rock Grip Tyre	"	656/3
37.	10·0×20	14	Rock Grip Tyre	"	580/12
38.	11·0×20	4	Rock Grip Tyre	"	660/8
39.	12·0×24	8	Earthmover Tyre	"	543/12
			Earthmover Tube	"	49/13
40.	14·0×24	8	Earthmover Tyre	"	758/10
			Earthmover Tube	"	63/11
41.	14·0×24	16	Earthmover Tyre	"	1165/2
42.	16·0×20	16	Earthmover Tyre	"	1363/15
			Earthmover Tube	"	119/4
43.	16·0×20	20	Earthmover Tyre	"	1667/14
			Earthmover Tube	"	119/4
44.	18·0×24	24	Rock Grip Tyre	"	4030/11
			Rock Grip Tube	"	202/10
45.	18·0×25	24	Rock Grip Tyre	"	4030/11
			Rock Grip Tube	"	202/10
46.	21·0×29	20	Ground Grip Tyre	"	4065/5
			Ground Grip Tube	"	260/9
47.	21·0×29	24	Ground Grip Tyre	"	4620/7
			Ground Grip Tube	"	260/9
48.	24·0×25	18	Ground Grip Tyre	"	5095/13
			Ground Grip Tube	"	340/8

TABLE 15.3.1—contd.

1	2	3	4	5
<i>U.S.A. Prices</i>				
<i>Ply</i>				
49.	9·0×24	10	Rib Tread Road-builder Tyre	Each 524/5
			Rib Tread Road-builder tube	" 40/4
50.	10·0×24	10	Road Builder Tyre	" 619/11
			Road Builder Tube	" 33/2
51.	12·0×28	6	Road Builder Tyre	" 685/11
			Road Builder Tube	" 57/1
52.	14·0×24	10	Road Builder Tyre	" 923/13
			Road Builder Tube	" 63/11
53.	14·0×32	16	Road Builder Tyre	" 1743/6
			Road Builder Tube	" 78/4
54.	16·0×24	16	Earthmover Tyre	" 2398/8
			Earthmover Tube	" 200/5
55.	24·0×25	24	Ground Grip Tyre	" 6418/1
			Ground Grip Tube	" 340/8
56.	24·0×25	30	Ground Grip Tyre	" 7380/13
			Ground Grip Tube	" 340/8
57.	24·0×29	24	Ground Grip Tyre	" 8170/2
			Ground Grip Tube	" 534/6
58.	24·0×29	36	Ground Grip Tyre	" 10035/12
			Ground Grip Tube	" 534/3
59.	27·0×33	30	Rock Grip Tyre	" 13128/15
			Rock Grip Tube	" 910/9
60.	27·0×33	36	Rock Grip Tyre	" 15219/-
			Rock Grip Tube	" 910/9
61.	27·0×33	30	Ground Grip Tyre	" 12809/-
			Ground Grip Tube	" 910/9
62.	30·0×33	40	Ground Grip Tyre	" 18910/14
			Ground Grip Tube	" 1192/12
<i>D. Explosives</i>				
63.	Gelignite		Lb.	1/8 Ex-Project Godown
64.	Fuse Wire or Coil		Coil	2/-
65.	Detonators		100 Nos.	6/-
<i>E. Principal Building Materials</i>				
66.	Rubble Stone inclusive of over burden removal and stocking.		CFC	18/- At quarry with 40% Void.
67.	Rubbles Stone for Pitching		"	12/-
68.	Boulders		"	5/-
69.	Gravel & Shingle		"	8/- At quarry
70.	Stone Aggregate $\frac{1}{4}$ " to $\frac{3}{4}$ "		"	30/- Do.
71.	Stone Aggregate 1" to 2"		"	27/- Do.

TABLE 15.3.1—contd.

1	2	3	4	5
72.	Stone Aggregate above 2"	CFC	25/-	At quarry
73.	Quarried Sand	"	10/-	Do.
74.	Crushed Sand	"	35/-	
75.	Stone Dust	"	35/-	
76.	Bricks 1st Class	1000 Nos.	22/-	At kiln
77.	Bricks IIrd Class	"	18/-	Do.
78.	Bricks IIIrd Class	"	15/-	Do.
79.	Brick Ballast of Sizes	CFC	20/-	Do.
80.	Brick Bats	"	12/-	Do.
81.	Unslaked Lime	Md.	3/-	Site of work
82.	(a) Surkhi (Coarse)	CFC	30/-	Do
	(b) Surkhi (Fine)	"	75/-	Do.
83.	Scantlings Teak Wood (CP)	Cft.	12/-	Do.
84.	Scantlings Salwood	"	6/-	Do.
85.	Planks Teak Wood	"	15/-	Do.
86.	Planks Salwood	"	8/-	Do.
87.	<i>Asbestos Cement Products</i>			
	(a) Plain Sheets	Sft.	-/7/-	
	(b) Corrugated Sheets	"	-/8/9	
	(c) Corrugated Sheets Super 13	"	-/8/3	
	(d) Corrugated Sheets big 6	"	-/8/9	
	(e) Corrugated Sheets Trafford	"	-/8/6	
	(f) Ridges 3' × 6 $\frac{3}{4}$ "	Pair	6/3/-	
88.	<i>Ballies Sal</i>			
	(a) 3" dia. 8' to 10' long	Score	31/-	
	(b) 4" dia. 12' long	"	41/-	
	(c) 5" dia. 12' long	"	51/-	
	(d) 6" dia. 12' long	"	77/-	
	(e) 7" dia. 12' long	"	129/-	
	(f) 8" dia. 12' long	"	180/-	
89.	<i>Bitumen</i>			
	(a) For hot application (Asphalt, maxphalt, cutbacks, etc.)	Ton	412/-	
	(b) For cold application (Asphalt, maxphalt, cutbacks, etc.)	"	397/-	
99.	Bhusa	Md.	3/-	

TABLE 15.3.1—concl'd.

1	2	3	4	5
91.	<i>Bamboos of Sizes</i>			
	(a) 1" dia	Score	4/-	
	(b) 2" dia	"	6/-	
	(c) 3" dia	"	8/8	
92.	Baskets (Cane) 18" internal dia	Each	1/6	
93.	Board insulated	F.S.	6/-	
94.	Board laminated (Sitapur)	"	3/8/-	
95.	Bleaching Powder	Lb.	1/8/-	
96.	Celotax sheeting	F.S.	-/6/3	
97.	Coal Steam	Ton	41/-	
98.	Charcoal	Md.	6/8/-	
99.	Coke	"	2/4/-	
100.	Coal Dust	"	1/8/-	
101.	Coal Tar	Gl.	1/4/-	

TABLE 15.3.2.

*Trade Price of Mechanical Equipment*

Sl. No.	Type of equipment	Size or capacity	Price in Rs.
1	2	3	4
1.	<i>Air Compressors</i>		
	(a) Portable	(i) Diesel	210 C.F.M. 23,700 315 C.F.M. 34,800 500 C.F.M. 52,700
	(b) Stationary	(ii) Diesel	210 C.F.M. 22,850 315 C.F.M. 33,700 500 C.F.M. 51,700 600 C.F.M. 73,500
		(iii) Electrical	315 C.F.M. 19,100 500 C.F.M. 28,400
2.	Batching and Mixing Plant with 3 Nos. of 3 C. yd. Mixers		7,26,200
3.	Bins, Cement (with accessories like indicators, valves etc.)	20" dia. 1244 cft. capacity	64,000



TABLE 15.3.2—contd.

1	2	3	4
4.	Boilers : Vertical, Crosstube .. .. .	10 H.P.	11,200
		12 H.P.	12,800
5.	Radial Cableway with hoist motors and other accessories with civil engineering works .. .. .	2100' span 85' height fixed headmast 10 Ton Gross load Skips and Slings.	7,00,000
6.	Core drilling machine (Diamond Core Drills) .. .. .	Max. Depth.	
	(a) Power operated .. .. .	500 ft.	15,600
		1000 "	25,500
		2000 "	33,000
	(b) Air operated. .. .. .	500 "	18,000
7.	Concrete Buckets .. .. .	3 Cyd.	—
		4½ "	10,500
		6 "	15,000
8.	Cranes (a) Crawlers .. .. .	17 Ton	1,00,000
		25 "	1,34,000
		35 "	2,49,000
		50 "	3,14,000
	(b) Pneumatic Tyred .. .. .	20 "	2,04,000
		30 "	2,12,000
	(c) Truck mounted .. .. .	20 "	1,87,800
9.	Crusher (a) Jaw .. .. .	150 to 200 Ton per/hr. 48" × 36"	2,20,000
	(b) Gyratory .. .. .	200 Ton per/hour	
10.	Engines, Diesel .. .. .	75 H.P.	12,000
		115 H.P.	17,000
		190 H.P.	29,000
11.	Electric light plant, Diesel Drive .. .. .	12 K.W.	12,500
		20 K.W.	14,500
		25 K.W.	26,500
12.	Excavators (a) Diesel .. .. .	¾ Cyds.	1,10,000
	(i) Shovels .. .. .	1½ "	2,11,000
		2 "	2,32,500
		2½ "	3,54,000
		3½ "	5,17,000
	(ii) Draglines .. .. .	3½ "	1,10,500
		1½ "	1,97,000
		2 "	3,10,000
		2½ "	3,22,000
		3½ "	4,58,000
	(b) Electrical .. .. .		
	(i) Shovels .. .. .	¾ "	1,35,000
		1½ "	2,27,800
		2½ "	3,24,500
		3½ "	5,64,000
	(ii) Draglines .. .. .	¾ "	1,39,000
		1½ to 2 "	2,19,000
		2 to 2½ "	2,58,600

TABLE 15.3.2—contd.

1	2	3	4
13.	Grader .. .. .	75 H.P.	84,000
		104 H.P.	87,000
14.	Hoists (a) Air Hoist .. .. .	10 Cwt.	2,900
	(Total Lift 15')	20 "	3,000
	(b) Chain Hoist .. .. .	9 Cwt.	1,560
	(c) Electric Hoist .. .. .	1 Ton	6,850
15.	Loaders .. .. .	9 B.V.	2,13,000
		10 B.V.	2,40,000
16.	Locomotives, Diesel .. .. .	55 B.H.P.	40,000
17.	Mixers, Concrete .. .. .	10/7 Cft.	7,300
		1 1/2 Cyd.	27,500
		2	67,000
18.	Pile Driver (Complete plant with all steel frame mounted on swivelling jucking rail, wheels, hammer, double-hammer, drum steam and Boiler with 50 ft. and single acting (S.A.) Hammers .. .. .	2 Ton	91,500
19.	Pile Hammers (Single acting complete with valves) .. .. .	2 Ton.	12,200
		2 1/2 Ton	13,600
		3 Ton.	16,000
20.	Pneumatic Tools .. .. .		
	(a) Drifters .. .. .	3 1/2 Bore	4,500
	(b) Jack Hammers .. .. .	37 Lbs.	680
		48 "	780
		55 "	920
	(c) Pumps-Sum .. .. .	(a) 133 G.P.M. at 10' Total head and 21 G.P.M. at 100' total head.	980
		(b) 189 G.P.M. 5' Total head 300 P.M. at 60' total head	1,130
	(d) Vibrators .. .. .	2 1/2 Casing	575
	(e) Wagon drills .. .. .	Light duty	10,000
		Heavy duty	17,000
21.	Pumps		
	(a) Concrete Pump, Diesel .. .. .	10 Yds.	42,900
		24 "	48,500
	(b) Cement Grout Pump .. .. .	—	—
	(c) Cement Pump .. .. .	20 to 22 Tons per hr. 76'/distance	52,500
	(d) Centrifugal Pumps .. .. .	2,200 G.P.H.	2,000
	(maximum head 150')	3,000 G.P.H.	3,400
22.	Rollers		
	(a) Sheepsfoot .. .. .	Single drum	3,900
		Twin drum	6,200
	(b) Road rollers .. .. .	6 to 8 Tons	31,100
	(Diesel) .. .. .	8 to 10 "	38,500
23.	Blast Out-fit (with dust collector) .. .. .	44" x 40"	38,500
24.	Scrappers .. .. .	10/13 Cyds.	1,54,000
	(a) Motorised .. .. .	11 Cyds.	43,900
	(b) Towed .. .. .	16 Cyds.	55,000

TABLE 15.3.2.—concl'd.

1	2	3	4
25.	Screens-vibrating—		
	(a) Single Deck .. .. .	48" × 96"	(a) 7,700
	(b) Double Deck .. .. .	48" × 120"	(b) 9,200
		60" × 120"	(a) 8,250
			(b) 10,000
		60" × 160"	(a) 8,850
			(b) 12,400
			(a) 12,100
			(b) 12,300
26.	Tractors .. .. .	90 B.H.P.	80,500
	(a) Crawlers .. .. .	130 B.H.P.	1,08,100
		25 B.H.P.	13,500
		45 B.H.P.	18,750
		55 B.H.P.	20,000
27.	Trucks—Dumpers ..		
	(a) Bottom Dump .. .. .	13 Cyds.	1,49,500
		17 Cyds.	1,97,600
	(b) Rear Dump .. .. .	6·6 Cyds.	1,10,000
		10 Tons	
		9·7 Cyds.	1,35,000
		15 Tons	
		14·8 Cyds.	2,04,000
		22 Tons.	
28.	Well-drilling Machine ..	From 6" dia. holes—750' 8"— 500' to 16"— 100'-	
29.	Welding Machine .. .. .	(a) Continuous output of 200A	12,000
	(Diesel Engine Drive Welding Set) .. .. .	(b) -do- 300A	13,000

- NOTES : 1. The prices listed are approximate.  
 2. The prices for F.O.R. Indian Port.  
 3. They are subject to variation, trade discount and the like.

## 15.4. USE RATES AND OUTPUTS OF MACHINES

15.4.1. Table 15.4.1. gives the hourly use rates of mechanical equipments.

15.4.2. Outputs of various machines have been dealt with in Chapter 6.

TABLE 15.4.1.

*Hourly Use Rate of Mechanical Equipment*

Sl. No.	Equipment	Hourly Use Rates in Rs.
1	2	3
1.	<i>Air Compressors</i>	
	(a) 210 C.F.M. Diesel, Portable .. .. .	10.5
	(b) 315 C.F.M. Diesel, Portable .. .. .	14.0
	(c) 500 C.F.M. Diesel, Portable .. .. .	20.0
	(d) 500 C.F.M. Electrical, Stationary .. .. .	16.5
2.	<i>Belt Loader</i>	
	18 B. V. Belt Loader .. .. .	55.0
3.	<i>Dump Truck</i>	
	(a) 9.7 Cyd. 15 Tons Rear Dump .. .. .	34.0
	(b) 14.8 Cyd. 22 Tons Rear Dump .. .. .	52.0
	(c) 13 Cyd. Struck Bottom Dump .. .. .	37.0
	(d) 17 Cyd. Struck Bottom Dump .. .. .	47.0
4.	<i>Excavators</i>	
	(a) <i>Shovel</i>	
	(i) $\frac{3}{4}$ Cyd. Shovel .. .. .	31.0
	(ii) $1\frac{1}{2}$ Cyd. Shovel .. .. .	50.0
	(iii) $2\frac{1}{2}$ Cyd. Shovel .. .. .	64.0
	(iv) $3\frac{1}{2}$ Cyd. Shovel .. .. .	89.0
	(b) <i>Draglines</i>	
	(i) $\frac{3}{4}$ Cyd. Dragline .. .. .	29.0
	(ii) $1\frac{1}{2}$ Cyd. Dragline .. .. .	43.0
	(iii) $2\frac{1}{2}$ Cyd. Dragline .. .. .	55.0
	(iv) $3\frac{1}{2}$ Cyd. Dragline .. .. .	74.0
5.	<i>Scrapers.—</i>	
	(a) 10/12.5 Cyd. Drawn Scraper .. .. .	14.0
	(b) 15/20 „ -do- .. .. .	20.0
	(c) 10/13 „ Motorised .. .. .	43.0
	(d) 15/20 „ -do- .. .. .	56.0
6.	<i>Tractors</i>	
	(a) 81 H.P. Crawler Tractor .. .. .	25.0
	(b) 130 H.P. Crawler Tractor .. .. .	29.0
	(c) 81 H.P. Tractor Dozer .. .. .	28.0
	(d) 130 H.P. Tractor Dozer .. .. .	32.0
	(e) D-4 Tractor with Sheepsfoot Roller .. .. .	15.15
7.	<i>Motor Grader</i>	
	115 H.P. .. .. .	25.0

## 15.5. LABOUR AND MATERIAL CONSTANTS

Labour and material constants for various items are given below :—

15.5.1. *Earthwork by Manual Labour.*

TABLE 7.2.2.

Sl. No.	Type of Soil	Range of labour effort per CFC	Range of rates per CFC
1	2	3	4
1.	Sand and silt .. .. .	0.25—0.4	0.45—0.72
2.	Top soil .. .. .	0.4—0.6	0.72—1.08
3.	Common earth .. .. .	0.5—0.8	0.9—1.44
4.	Clay, light .. .. .	0.7—1.0	1.26—1.8
5.	Clay, heavy .. .. .	0.85—1.2	1.5—2.2
6.	Soft rock .. .. .	1.4—2.5	2.5—4.5

TABLE 7.3.1.

*Labour Effort Constants in Man-days and Rates in rupees for removal of Spoil per CFC.*

Sl. No.	Horizontal distance between (CFR units)	Removal of Spoil				Remarks
		Soil		Rock		
		Labour	Rate	Labour	Rate	
1	2	3	4	5	6	7
1.	0.25	0.13	0.17	0.17	0.22	It is assumed that a person carrying soil travels 200 ft. per minute and it takes 0.06 minute to unload a basket. For carrying rock the speed be reduced to 150 ft. per minute.
2.	0.50	0.23	0.30	0.30	0.39	
3.	1.0	0.43	0.58	0.59	0.77	
4.	1.5	0.63	0.82	0.86	1.12	
5.	2.0	0.83	1.08	1.14	1.48	
6.	2.5	1.03	1.34	1.43	1.86	

TABLE 7.3.3.

*Rates of Earthwork (CFC) by Manual Labour*

Sl. No.	Type of Soil	Range of labour effort (man-days)	Rates at average wages		
			Rs. 1.5	Rs. 1.8	Rs. 2.1
1	2	3	4	5	6
1.	Sand & silt .. ..	0.48-0.63	0.72-0.94	0.86-1.13	1.01-1.32
2.	Top soil ... ..	0.63-0.83	0.94-1.35	1.13-1.49	1.32-1.74
3.	Common earth .. ..	0.73-1.03	1.09-1.54	1.31-1.85	1.53-2.16
4.	Clay, light .. ..	0.93-1.36	1.4-2.04	1.63-2.45	1.95-2.85
5.	Clay, heavy .. ..	1.06-1.53	1.62-2.29	1.95-2.76	2.27-3.21
6.	Soft rock .. ..	1.70-2.3	2.55-4.20	3.06-5.04	3.57-5.88

TABLE 7.3.4. (i)

*Rates of Earthwork (CFC) by Manual Labour*

Sl. No.	Type of Soil	Labour effort in man-days for digging and disposal of spoil for leads					
		.25	.5	1.0	1.5	2.0	2.5
1	2	3	4	5	6	7	8
1.	Sand & silt .. ..	0.38-0.53	0.48-0.63	0.68-0.83	0.88-1.03	1.08-1.23	1.28-1.43
2.	Top soil .....	0.53-0.73	0.63-0.83	0.83-1.03	1.03-1.23	1.23-1.43	1.43-1.63
3.	Common earth .. ..	0.63-0.93	0.73-1.03	0.93-1.23	1.13-1.43	1.33-1.63	1.53-1.83
4.	Clay, light .. ..	0.93-1.33	1.03-1.53	1.23-1.63	1.43-1.83	1.63-2.03	1.83-2.23
5.	Clay, heavy .. ..	1.13-1.63	1.23-1.73	1.43-1.93	1.63-2.13	1.83-2.33	2.03-2.53
6.	Soft rock .. ..	1.57-2.67	1.70-2.80	1.90-3.09	2.26-3.36	2.54-3.64	2.83-3.93

15.5.2. *Transpor*

TABLE 8.2.1.

*Weights of Local Construction Materials*

Sl. No.	Nature of materials	Weights		Remarks
		Lbs. per FC	Tons per CFC	
1	2	3	4	5
1.	Quarried or crushed stone			
	(i) Limestone .. .. .	80	3.57	The data given is based on 45% voids.
	(ii) Granite .. .. .	92	4.11	
	(iii) Basalt .. .. .	95	4.24	
2.	Bankrum shingle containing sand .. .. .	100	4.46	
3.	Gravel or shingle without sand .. .. .	94	4.20	
4.	Clean pits & dry .. .. .	90	4.02	
5.	Slaked lime powder .. .. .	60	2.68	

15.5.3. *Drilling and Quarrying*

TABLE 9.2.1.

*Drilling Performance (feet per hour)*

Diameter of hole (inches)	Class of rock,	Rock Drills		Core Drills	
		Jack-hammer	Wagon drill	Diamond drill	Shot drill
1½ (Core 1 1/8)	Soft to medium	10 to 12	25 to 35	3 to 7	
2¾ (Core 1-5/8)	Soft to medium	5 to 10	20 to 25	2 to 4	
2¾ (Core 1-1/5)	Hard				
3 (Core 2-1/8)	Soft to medium hard	3 to 8	15 to 25		
4 (Core 3)	Soft to medium hard		5 to 10 3 to 5	1 to 2	
6 or 5½ (Core 4-3/4)	Soft to medium hard		3 to 6 1 to 3	¾ to 2½ ½ to ¾	
12	Soft to medium hard		1 to 4		
36	Soft to medium hard			¼ to 1 ¼ to ½	

TABLE 9.5.1.

*Air Consumption of Pneumatic Tools*

Sl. No.	Tool	CFM
1.	Drills rock jackhammers	
	30 lb. Weight .. .. .	60
	45 " .. .. .	85
	55 " .. .. .	95
	80 " .. .. .	125
	Augurs .. .. .	85
2.	Drifters (Wagon drills)	
	85 lbs. Weight .. .. .	125
	100 -do- .. .. .	155
	140 -do- .. .. .	200
3.	Hoists-500--1000 lbs. capacity 1.5 (consumption/ft. of lift)	
	2000 lb. .. .. .	2.0
	3000 lb. .. .. .	3.0
	4000 lb. .. .. .	6.5
	5000 lb. .. .. .	8.5
4.	Pavement Breakers	
	30 lbs. Weight .. .. .	45
	55 -do- .. .. .	50
	85 -do- .. .. .	75
5.	Sump Pumps	
	Up to 100 ft. head .. .. .	65
	Up to 185 ft. head .. .. .	115
6.	Tampers-backfill	
	25 lbs. Weight .. .. .	30
	32 lbs. -do- .. .. .	35
7.	Trench diggers	
	25 lbs. Weight .. .. .	35
	45 lbs. -do- .. .. .	45

TABLE 9.6.2.

*Analysis of Rates for Blasting Rock*

1.	Gelatine 2.25 lbs. at Rs. 1.5 per lb. .. .. .	3.38
2.	Detonators 4 Nos. at Rs. 6 per 100 Nos. .. .. .	0.24
3.	<i>Labour</i>	
	3.1. Blaster 0.01 at Rs. 4.5 each .. .. .	0.05
	3.2. helper or quarry man 0.02 at 3.5 each .. .. .	0.70
		4.37
	Say, Rs. .. .. .	4.5

15.5.4. *Brickwork and Lining of Canals*

TABLE 11.1.3.

*Number of Bricks per CFC (exclusive of wastage)*

Size of Brick	Thickness of joints		
	1/4"	5/16"	3/8"
9" × 4-3/8" × 2-11/16" (Standard Brick) .. .. .	1350	1200	1270
10" × 5" × 2 1/4" .. .. .	1040	1000	975



TABLE 11.2.2.

*Quantity of Mortar used in a 1½' thick wall*

Thickness of joints in inches	1/4"	5/16"	3/8"
Mortar per 1000 bricks .. .. .	Cft. 14	Cft. 17	Cft. 21
Mortar per CFC of brickwork .. .. .	19	22	25

TABLE 11.2.5.

*Quantities of various ingredients of Mortar*

Type of Mix.	Ratio	Ingredients per FC				Labour mixing/FC (man-day)
		Cement Cwt.	Lime Mds.	Sand FC	Surkhi FC	
LSM	1:2	—	0.27	1.0	—	0.012
	1:3	—	0.20	1.1	—	"
	1:4	—	0.15	1.2	—	"
CLM	1:1:4	0.21	0.14	1.0	—	0.015
	1:1:6	0.15	0.10	1.1	—	"
	1:1:8	0.12	0.08	1.2	—	"
CK	1:2	0.49	—	1.0	—	0.012
	1:3	0.29	—	1.1	—	"
	1:4	0.29	—	1.2	—	"
	1:5	0.21	—	1.3	—	"
RCM	4:1:10	0.34	—	1.0	0.08	0.02
	4:1:15	0.25	—	1.1	0.06	"
	4:1:20	0.19	—	1.2	0.05	"

TABLE 11.3.2.

*Plant and Labour required for CFC Mortar*

Nature of mortar	Plant hour per CFC	Labour days per CFC
Lime, Sand (LSM) .. .. .	4	1.00
Cement, Lime, Sand (CLM) .. .. .	4.5	1.25
Cement, Sand (CM) .. .. .	5	1.33
Cement, Surkhi, Sand (RCM) .. .. .	6.0	1.50
Lime, Ashes or Surkhi.. .. .	6.5	1.66

TABLE 11.4.1.

Approximate Rate of laying Bricks for Heights not exceeding 10 ft.  
(Common Brickwork)

Sl. No.	Thickness of walls	No. of bricks laid with struck joints (per day per mason)					
		On one face			On two faces		
		From	To	Average	From	To	Average
		1	2	3	4	5	6
1.	$\frac{1}{2}$ Brick Wall	300	500	400	250	400	325
2.	$1\frac{1}{4}$ -do-	400	600	500	300	570	400
3.	$1\frac{1}{2}$ -do-	500	800	650	400	600	500
4.	2 -do-	600	1000	800	500	700	600
5.	$2\frac{1}{2}$ -do-	700	1200	950	550	750	650
6.	3 -do-	800	1400	1100	600	800	700

11.4.2. The amount of work done per day by a helper can be any one of the following to his credit.

1. Mix 100 to 120 F.C. of mortar.
2. Deliver 3000 to 5000 bricks to a distance of 50'.
3. Deliver mortar 150 to 250 F.C.
4. Two good helpers can handle 100 to 200 ton of pole staging.

#### 15.5.5. Stone Masonry

Recommended quantities of mortar per CFC of masonry are given in table below :—

TABLE 13.5.2.

Mortar per CFC Masonry (UCR)

Kind of Masonry	Mortar in (CFC) per CFC Masonry		
	From	To	Average
	2	3	4
Rubble	40	50	45
Squared-stone Coarsed	25	40	32.5
Cut-stone Ashlar	15	25	20

13.7.2. *Hauling Mortar (Manual)*

Extra labour involved on account of lifting mortar water etc., as the work goes up can be expressed in the form of multipliers.

TABLE 13.7.2.

Heights from ground up to	20'	.....	1.0
	20 to 40	.....	1.2
	40 to 60	.....	1.3
	60 to 80	.....	1.4
	80 to 100	.....	1.5
	and so on.		

15.5.6. *Concrete*

Convention of material constants for various concrete mixes are given below in Table 14.2.2.

TABLE 14.2.2.

Proportion cement, fine & coarse aggregates	Proportion cement & aggregates	Description of coarse materials	Cement Cwt.	Sundry FC	Coarse materials FC	Total aggregates FC
1:1.5:3	1:4:5	Shingle	22.0	41	82	123
		Broken Stone	21.3	43	86	129
1:2:4	1:6	Shingle	17.2	43	86	129
		Broken Stone	18.2	45	90	135
1:2.5:5	1:7:5	Shingle	14.2	44	88	132
		Broken Stone	14.9	46	92	133
1:3:6	1:9	Shingle	12.0	45	90	125
		Broken Stone	12.65	47	94	141
1:4:8	1:12	Shingle	9.25	46	92	138
		Broken Stone	9.70	48	97	145
1:5:10	1:15	Shingle	7.60	47	94	141
		Broken Stone	8.05	50	100	150
1:8:16	1:24	Shingle	4.82	48	96	144
		Broken Stone	5.11	51	102	153

- NOTES : 1. Add after testing for bulmage of sand to quantities given in Col. 5.  
 2. The aggregates for each mix should be proportioned after sieve analysis of their piles.  
 3. Variation 5 % on the above quantities may be tolerance on the constants on account of the variation in densities of stone.  
 4. Waste in transit or handling on large works should not exceed 2½ per cent;

## 15.6. RATES FOR PRELIMINARY WORK

15.6.1. The rates of expenditure on preliminary surveys as stipulated by the Survey of India are given below for guidance :—

Air mapping .. .. .	Re. -/10/8	per acre
Detailed ground contour survey .. ..	Rs. 1/10/-	-do-
Land use Survey and Planning .. ..	Re. -/12/6	-do-
Forest Survey .. .. .	Re. -/10/6	-do-
Upland Irrigation survey including drilling, test pits, canal layouts, dam design .. ..	Rs. 1/8/-	-do-

15.6.2. Analysis and schedule of rates for site clearance by Manual Labour are given in Table 15.6.2.

TABLE 15.6.2.

Item	Unit	No. of labour	Rate Rs.	Per	Amount Rs.	Rate per acre Rs.
1	2	3	4	5	6	7
Clearing scrub jungle without rooting out ..	MFS	1	1.8	Each	1.8	78.4
Clearing scrub jungle including rooting out ..	MFS	2	1.8	Each	3.6	156.8
Clearing light jungle without rooting out ..	MFS	2	1.8	Each	3.6	156.8
Clearing light jungle including rooting out ..	MFS	4	1.8	Each	7.2	313.6
Clearing heavy jungle without rooting out ..	MFS	4	1.8	Each	7.2	313.6
Clearing heavy jungle including rooting out ..	MFS	8	1.8	Each	14.4	627.2
Clearing thick & thorny jungle including rooting out .. .. .	MFS	9	1.8	Each	16.2	705.6

NOTE : Labour Constant relates to a particular project.  
No yardstick can be laid down for general application.

15.6.3. Analysis and schedule of rates for site clearance and reclamation work by machines are given below :—

TABLE 15.6.3.

Sl. No.	Details of Expenditure	Tractor (84 H.P.)	Tractor (190 H.P.)	Tractor (130 H.P.)
		1950-52	1950-52	1950-52
		Cost per hour Rs.	Cost per hour Rs.	Cost per hour Rs.
1	2	3	4	5
1.	Salaries and Wages .. .. .	7.2	6.3	4.8
2.	Stores consumed .. .. .	4.3	3.6	3.4
3.	P.O.L. consumed .. .. .	8.6	8.7	6.1
4.	Contingencies .. .. .	0.4	0.5	0.2
5.	Transportation charges .. .. .	2.6	3.8	1.0
6.	Depreciation .. .. .	14.9	13.7	11.7
7.	Maintenance charges .. .. .	0.4	0.4	0.4
8.	Repairs and renewals reserves .. .. .	14.1	12.8	11.0
9.	Rehabilitation charges .. .. .	0.2	0.2	0.2
10.	Preliminary expenses .. .. .	0.8	0.8	0.8
11.	Interest on capital .. .. .	4.3	4.3	4.3
12.	Audit charges .. .. .	0.1	0.1	0.1
13.	Direction charges .. .. .	1.6	1.2	1.0
14.	Deficiency in workshop .. .. .	0.4	0.4	0.4
		59.9	56.8	45.4
	Total hour ploughed .. .. .	52,230	18,979	22,520
	Total Average .. .. .	51,809	21,311	22,119
	Average per hour .. .. .	0.99	1.1	1.0
	Cost per Acre (Rs.) .. .. .	60.5	49.0	45.4

NOTE : The data given above is obtained from the reclamation work executed by the Central Tractor Organization in Bundelkhand (U. P.).

## 15.7. TRANSPORT RATES

15.7.1. Cost of transport of materials by petrol trucks is given below :—

TABLE 8.4.3.

*Cost of transport by petrol trucks (5 tons)*

Lead in miles	Cost of variable (a+b+c=Rs. 0.723 per mile) per round trip	Cost of constants (d+e+f=Rs. 20.75) per day of 8 hrs.	No. of trips per day	Cost of constants (Rs. 20.75) per trip. Col. 3/4	Total cost per mile round trip Col 2+5	Capacity per trip	Primary Rate per CFC Rs.
1	2	3	4	5	6	7	8

*Rubble Stone*

1.	1.446	20.75	8	2.594	4.040	CFC	4.0
2.	2.892	20.75	8	2.594	5.486	CFC	5.5
3.	4.338	20.75	7	2.964	7.302	CFC	7.3

*Bricks*

							Primary rate per 1000 Nos.
1.	1.446	20.75	8	2.594	4.040	1250 No.	3.2
2.	2.892	20.75	8	2.594	5.486	1250 No.	4.4
3.	4.338	20.75	7	2.964	7.302	1250 No.	5.8

*Fine and Coarse Aggregates*

							Primary rate per CFC
1.	1.446	20.75	7	2.964	4.410	CFC	4.4
2.	2.892	20.75	7	2.964	5.856	CFC	5.9
3.	4.338	20.75	6	3.458	7.796	CFC	7.8

NOTES: 1. Rates include cost of labour for loading and unloading.

2. Rates are applicable to type 'A' roads-Cement, Oil bound, and good metalled roads.

3. Add to the above 15, 20 and 30% for class B, C and D type roads respectively.

TYPE : B. Gravel, *kankar* and murum roads.

C. Rough metal Roads.

D. Soft Roads.

15.7.2. Cost of transport of materials by diesel trucks (5 tons) is given below :—

TABLE 8.4.5.

Lead in miles	Cost of variables (a+b+c= Rs. 0.54) per mile per round trip	Cost of constants (d+e+f= Rs. 20.75) per day of 8 hrs.	Number of trips per day	Cost of constants (Rs. 20.75) per trip (Col. 3/4)	Total cost per mil round trip (Col. 2+5)	Capacity per trip	Primary Rate per CFC. Rs.
1	2	3	4	5	6	7	8
<i>Rubble Stone</i>							
1.	1.096	20.75	8	2.594	3.690	CFC	3.7
2.	2.192	20.75	8	2.594	4.786	CFC	4.8
3.	3.288	20.75	7	2.964	6.252	CFC	6.3
<i>Bricks</i>							
						Nos.	Primary rate per 100 Nos.
1.	1.096	20.75	8	2.594	3.690	1250	3.0
2.	2.192	20.75	8	2.594	4.786	1250	9.8
3.	3.288	20.75	7	2.964	6.252	1250	5.0
<i>Fine &amp; Coarse Aggregates</i>							
							Primary rate per CFC
1.	1.096	20.75	7	2.964	4.060	CFC	4.1
2.	2.192	20.75	7	2.964	5.156	CFC	5.2
3.	3.288	20.75	6	3.458	6.746	CFC	6.7

- NOTES : 1. Rates include cost of labour for loading and un-loading.  
 2. Rates are applicable to type 'A' roads-cemented, oil bound and good metalled roads.  
 3. Add to the above 15, 20, and 30 per cent for Class B, C & D type roads respectively.

TYPE : B. Gravel, *kankar* and murum Road.  
 C. Rough & metal Roads  
 D. Soft Roads.

## 15.8. EARTHWORK BY MACHINES

15.8.1. Cost of mucking rock by 2½ cyds. shovel and 9.7 cyds. dumper is given below :—

TABLE 6.11.4.(iii)

Rate per CFC of Blasted Rock excavated and loaded by 2½ cyds. Shovel and hauled by Rear Dumper (9.7 cyds.)

Load one way haul in feet	Equipment Cost (Rs.)	Output CFC	Rate per CFC (Rs.)
1000	160	34	4.7
2000	194	34	5.7
3000	228	34	6.7
5000	296	34	8.7
6000	264	34	10.7
8000	432	34	12.7

15.8.2. Earthwork rates by shovels per CFC are tabulated below :—

TABLE 6.11.6.

Soils	Lead one way haul in feet					
	1000	2000	3000	5000	6000	8000
Moist loam or light						
Sandy clay .. ..	2.75	2.75	3.5	4.5	5.6	6
Sand and Gravel ..	2.75	2.75	3.75	5	5.6	6
Good common earth	3	3	3.75	5	6	6.5
Clay, hard and tough ..	3.5	3.5	4.5	5.75	7	7.5
Clay, wet and sticky ..	4.5	4.5	5.75	7.5	9	10

15.8.3. Rates of Earthwork by Tractor-Scrappers per CFC are tabulated below :—

TABLE 6.11.10.

Sl. No.	Soils	Lead one way haul in feet					
		500	600	800	1000	1200C	1500
1	2	3	4	5	6	7	8
1.	Light loam or crumbly silt ..	1.85	1.96	2.09	2.24	2.0	2.90
2.	Sand and Gravel	2.24	2.33	2.46	2.60	2.41	3.32
3.	Good common earth .. ..	1.93	2.06	2.20	2.36	2.07	2.99
4.	Clay, hard and tough .. ..	2.35	3.53	3.68	2.86	2.61	3.58
5.	Murum .. ..	2.26	2.37	2.50	2.64	2.95	3.36
6.	Hard murum .. ..	2.50	2.60	2.76	2.86	3.17	3.66
7.	Clay, wet and sticky .. ..	2.50	2.60	2.76	2.86	3.17	3.66



15.8.4. Rates for Earthwork by Motorised Scrappers are tabulated below :—

TABLE 6.11.12

*Rates for Excavation and Hauling by Motorised Scrapper*

Sl. No.	Soils	Lead one way haul in feet						
		1000	1500	2000	2500	3000	4000	5000
1	2	3	4	5	6	7	8	9
1.	Light or crumbly silt ..	1.72	1.83	2.01	2.23	2.34	2.66	3.06
2.	Sand and gravel ..	2.19	2.35	2.43	2.70	2.80	3.16	3.56
3.	Good common earth	1.78	1.95	2.10	2.34	2.47	2.81	3.13
4.	Clay, hard and tough	2.39	2.52	2.67	2.93	3.05	3.41	3.98
5.	Murum .. ..	2.23	2.39	2.52	2.74	2.84	3.20	3.60
6.	Hard murum .. ..	2.42	2.61	2.77	3.01	3.05	3.41	3.89
7.	Clay, wet and sticky ..	2.42	2.61	2.77	3.01	3.05	3.41	3.89

15.8.5. The rates for consolidation of earthwork by sheepsfoot rollers are given below :—

*Analysis of rate of consolidation*

(a) Cost of per CFC dozing @ Rs. 32 per hour ..	..	Re. 0.38
(b) Cost of water CFC .. .. .	..	Re. 0.25
(c) Cost of Rolling output of twin drum sheepsfoot roller for 8" depth layer and 10 passes .. .. .	..	72 CFC per hr.
Use rate per hour D.4 of tractor drawn roller .. ..	..	Rs. 15.1
Cost per CFC of rolling .. .. .	..	Re. 0.21

## 15.9. EARTHWORK BY MANUAL LABOUR

15.9.1. The analysis of rates for earthwork by manual labour is given below :—

TABLE 7.3.4.(iii)

Sl. No	Type of soil	Rates of excavation for distance (CFR)					
		0.25	0.5	1.0	1.5	2.0	2.5
1	2	3	4	5	6	7	8
1.	Sand & silt ..	0.62-	0.75-	1.03-	1.27-	1.53-	1.79-
		0.89	1.0	1.23	1.47	1.75	2.00
2.	Top soil ..	0.89-	1.0-	1.23-	1.47-	1.73-	2.00-
		1.25	1.4	1.68	1.90	2.16	2.42
3.	Common earth ..	1.07-	1.2-	1.48-	1.72-	1.98-	2.24-
		1.57	1.7	1.98	2.22	2.54	3.74
4.	Clay, light..	1.43-	1.56-	1.84-	2.08-	2.34-	2.60-
		1.87	2.1	2.38	2.62	2.88	3.14
5.	Clay, heavy ..	1.67-	1.8-	2.08-	2.32-	2.58-	2.34-
		2.37	2.8	2.78	3.02	2.58	3.54
6.	Soft rock ..	2.72-	2.89-	3.27-	3.62-	3.98-	4.36-
		4.72	4.89	5.27	5.62	5.98	6.36

15.9.2. The following is the analysis of rates of transport by donkeys :—

TABLE 7.6.1.

Lead	Time taken per trip			No. of trips per day	Rate per CFC (Rs.)
	Haulage (min.)	Loading & unloading (min.)	Total (min.)		
200	1.50	2.0	3.5	137	1.8
300	2.25	2.0	4.25	113	2.1
400	3.00	2.0	5.0	96	2.6
500	3.75	2.0	5.75	84	3.0
600	4.50	2.0	6.50	74	3.4
700	5.25	2.0	7.25	66	3.8
800	6.00	2.0	8.00	60	4.2
900	6.75	2.0	8.75	55	4.6
1000	7.50	2.0	9.50	50	5.0
1500	10.25	2.0	12.25	39	6.4
2000	15.00	2.0	17.00	28	8.9
2500	18.75	2.0	20.75	23	10.8

## 15.10. DRILLING AND BLASTING

15.10.1. The analysis of rates of drilling and blasting is given below :—

9.3.2. Drilling cost will vary according to the type of rock drilled. A typical analysis of cost of drilling in Basalt is given below. In the case of hard and abrasive rock like Granite or Sandstone, the cost will increase by 25 to 30% depending on the nature of rock. About 6 Rft. of drilling in Basalt is required to blast 100 cft.

**Analysis of rate for Drilling one Rft. in Basalt**

Drilling 20 ft. deep holes from 40 mm. at top to 33 mm. at bottom with Carbide tipped Coromont drills.

(a) Average cost of 8 sets of Coromont drills of different length.	Rs. 90
Average rft. drilled by the drills allowing for breakages. 550 ft.	
Cost of drill per rft. of drilling.	Re. 0.18
(b) Sharpening charge L.S.	Re. 0.04
(c) Pipes & Pipe fittings	Re. 0.08
(d) Machinery charges :	
Depreciation of Jackhammer @3% per month	Rs. 30
Depreciation per hour @200 hrs. per month	Re. 0.15
A jackhammer can drill 100 rft. in 8 hrs.	$\frac{8 \times 0.15}{100} =$
Depreciation per rft.	Re. 0.012
Repairs @ 40% of depreciation.	Re. 0.005
(e) Air Charges.	
Using 315 C.F.M. air compressor	
Supplying air to 4 Jackhammers	
Use-rate of air compressor	Rs. 14
Cost of air supplied to 1 Jackhammer	Rs. 3.5
Hence, cost of air for 0.08 hour of Jack hammer per rft.	$0.08 \times 3 =$
	Re. 0.28
	Re. 0.11
(f) Labour per rft.	

**Abstract**

(a) Cost of drill	Re. 0.18
(b) Sharpening charges	Re. 0.04
(c) Pipes & pipe fittings	Re. 0.08
(d) Machinery charges	Re. 0.17
(e) Air charges	Re. 0.28
(f) Labour	Re. 0.11
Total rate drilling per rft.	Re. 0.707

## 15.11. BRICKWORK AND LINING

15.11.1. Typical analysis for rate of common brickwork in walls is given below :-

TABLE 15-11-1

*Analysis of Cost per CFC of Brick Masonry*

1. Size of Bricks: 9" × 4-3/8" × 2-11/16"

2. Brief Specifications : Cement Mortar 1 : 4. Thickness of joint 5/15" (single storey)—Height not exceeding 15 ft. in superstructure.

Sl. No.	Items	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Brick I Class</i>	Nos.				
	1.1. Cost ex-kiln .. ..	1000	1350	22.0	29.70	Tables 11.1.3, & 15.3.1. 4% breakage of bricks.
	1.2. Transport to the site of work 3 miles .. ..	1000	1350	5.0	6.75	Table 8.4.5.
2.	<i>Sand</i>					
	2.1. Cost of quarrying or manufacture .. ..	CFC	0.31	10.0	3.10	Table 15.3.1.
	2.2. Transport to the site of work 3 miles .. ..	CFC	0.31	6.7	2.08	Table 13.4.5.
	2.3. Storage & handling up to mills. .. ..	CFC	0.31	2.0	0.62	
3.	<i>Cement</i>					
	3.1. Cost ex-project godown	Cwt.	5.7	5.0	28.59	Tables 11.2.5. & 15.3.1.
	3.2. Transport to the site of work	—	—	—	—	—
	3.3. Storage and handling up to mills .. ..	Cwt.	5.7	0.02	0.11	



TABLE 15.11.2

*Analysis of Cost per CFC of Brick Masonry*

1. Size of Bricks : 9" × 4-3/8" × 2-11/16"
2. Brief specifications : R.C.M. 4:1:20; Thickness of joint 5/16" (single storey)—  
Height not exceeding 15 ft.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Brick I Class</i>	Nos.				
1.1.	Cost ex- klin.	1000	1350	22.0	29.70	Tables 11.1.3., 15.3.1. 4% breakage of bricks.
1.2.	Transport to the site of work 3 miles	1000	1350	5.0	6.75	Table 8.4.5.
	<i>Sand</i>					
2.1.	Cost of quarrying or manufacture.	CFC	0.31	10.0	3.10	Table 15.3.1.
2.2.	Transport to the site of work 3 miles	CFC	0.31	6.7	2.08	Table 8.4.5
2.3.	Storage & handling up to mills.	CFC	0.31	2.0	0.62	
	<i>Cement</i>					
3.1.	Cost ex-project godown	Cwt.	4.9	5.0	24.50	Tables 11.2.5., 15.3.1.
3.2.	Transport to the site of work	—	—	—	—	
3.3.	Storage & handling up to mills.	Cwt.	4.9	0.02	0.10	

TABLE 15.11.2—contd.

1	2	3	4	5	6	7
4.	Water .. .. .	CFC		—	1.00	
5.	Admixtures—Surkhi ..					
	5.1. Purchase or manufacturing cost .. .. .	} CFC	1.3	30.00	0.39	
	5.2. Transport to the site of work .. .. .		FC			
	5.3. Storage & handling up to mills .. .. .	CFC	1.3	2.00	0.03	
			FC			
6.	Mixing of Mortar					
	Male Mazdoor .. .. .	FC	2.6	0.035	0.91	Table 11.3.3
	Female Mazdoor .. .. .					
7.	Lead and Lift					
	7.1. Scaffolding .. .. .	CFC	1.0	1.0	1.00	
	7.2. Lead & lift of bricks. .. .. .	} CFC	1.0	1.5	1.50	
	7.3. Lead & lift of mortar .. .. .					
8.	Laying and Curing including Soaking					
	8.1. Cleaning & racking .. .. .	} No.	No.	1.75	0.22	
	Male mazdoor .. .. .					
	8.2. Soaking .. .. .		1/8			
	8.3. Cost of laying including handling, site lead & lift for one storey. .. .. .					
	Mason I Class .. .. .	No.	1.25	5.0	6.25	Table 15.2.1.
	Mason II Class .. .. .	No.	1.25	3.5	4.38	
	Male Mazdoor .. .. .	No.	2.0	1.75	3.50	
	Female Mazdoor .. .. .	No.	2.0	1.25	2.50	
	Bhishti or water carrier .. .. .	No.	0.5	2.5	1.25	
8.4.	Wetting. Bhishti or water carrier. .. .. .					Included under item 8.3

Total Primary Rate

89.78

Say, Rs. 90 per CFC

TABLE 15.11.3

*Analysis of Cost per CFC of Brick Masonry*

1. Size of Bricks: 9" × 4-3/8" × 2-11/16"
2. Brief specifications : Lime-sand mortar (2 S.M.) 1:3, thickness of joint : 5/16" (single storey)—Height not exceeding 15 ft. (in superstructure).

Sl. No.	Items	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Brick I Class</i>	Nos.				
	1.1. Cost ex-kiln .. ..	1000	1350	22.0	29.70	Tables 11.1.3, 15.3.1. 4% breakage of bricks.
	1.2. Transport to the site of work 3 miles .. ..	1000	1350	6.0	6.75	Table 8.4.5.
2.	<i>Sand</i>					
	2.1. Cost of quarrying or manufacture .. ..	CFC	0.29	10.0	2.90	Table 15.3.1.
	2.2. Transport to the site of work 3 miles .. ..	CFC	0.29	10.0	2.90	Table 8.4.5.
	2.3. Storage & handling up to mills .. ..	CFC	0.29	2.0	0.58	
3.	<i>Lime</i>					
	3.1. Cost ex-project godown	} Cwt.	5.2	3.0	15.60	Tables 11.2.5., 15.3.1.
	3.2. Transport to the site of work					
	3.3. Storage and handling up to mills. .. ..	Cwt.	5.2	0.02	0.10	
4.	<i>Water</i> .. ..	CFC	—	—	1.00	



TABLE 5.11.3.—contd.

1	2	3	4	5	6	7
5.	Grinding of Mortar	.. CFC	0.29	2.00	2.32	
						61.03
6.	Lead and Lift					
6.1.	Scaffolding	.. CFC	1.0	1.0	1.00	
6.2.	Lead & lift of bricks	}	CFC	1.0	1.5	1.50
6.3.	Lead & lift of mortar					
7.	Laying and Curing including Soaking					
7.1.	Cleaning & racking	}	No.	1/8	1.75	0.22
	Male mazdoor					
7.2.	Soaking					
7.3.	Cost of laying including handling, site lead & lift for one-storey					
	Mason I Class	.. .. No.	1.25	5.0	6.25	Table 15.2.1.
	Mason II Class	.. .. No.	1.25	3.5	4.38	
	Male Mazdoor	.. .. No.	2.0	1.75	3.50	
	Female Mazdoor	.. .. No.	2.0	1.25	2.50	
	Bhishti or water carrier	.. No.	0.5	2.5	1.25	
7.4.	Wetting					
	Bhishti or water carrier	..	Included under item 7.3			
			Total Primary Rate			81.63
			Say, Rs. 82 per CFC			

TABLE 15.11.4

*Analysis of Cost per CFC of Brick Masonry*

1. Size of Bricks: 9" × 4-3/8" × 2-11/16"

2. Brief specifications : Cement, Lime &amp; Sand Mortar (CLM) 1:1: 6. Thickness of joint : 5/16" (single storey)—Height not exceeding 15 ft. (in superstructure).

Sl. No.	Items	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Brick I Class</i>	Nos.				Tables
1.1.	Cost ex-kiln	1000	1350	22.0	29.70	11.1.3., 15.3.1. 4% break- age of bricks.
1.2.	Transport to the site of work 3 miles	„	1350	5.0	6.75	Table 8.4.5.
2.	<i>Sand</i>					
2.1	Cost of quarrying or manufacture	CFC	0.29	10.0	2.90	Table 15.3.1.
2.2	Transport to the site of work 3 miles	„	0.29	6.7	2.08	Table 8.4.5.
2.3.	Storage & handling up to mills	„	0.29	2.0	0.52	
	<i>Cement</i>					
3.1.	Cost ex-project godown.	} Cwt.	3.9	5.0	19.50	Tables 11.2.5., 15.3.1
3.2.	Transport to the site of work					
3.3.	Storage and handling up to mills	„	3.9	0.02	0.08	
4.	<i>Water</i>	CFC	—	—	1.0	

TABLE 15.11.4—contd.

1	2	3	4	5	6	7
<i>5. Admixtures—Lime</i>						
5.1. Purchase or manu- facturing cost.	}	IND	2.6	3.0	7.80	Tables 11.2.5., 15.3.1.
5.2. Transport to the site of work						
5.3. Storage & handling up to mills. .. ..		IND	2.6	0.02	0.05	
<i>6. Mixing of mortar</i>						
Male Mazdoor .. ..		FC	26.0	0.29	0.75	Table 11.3.3.
Female Mazdoor .. ..						
<i>7. Lead and Lift</i>						
7.1. Scaffolding .. ..	}	CFC	1.0	1.0	1.00	
7.2. Lead & lift of bricks		CFC	1.0	1.5	1.50	
7.3. Lead & lift of mortar						
<i>8. Laying and Curing including Soaking</i>						
8.1. Cleaning & racking Male mazdoor	}	No.	No. 1/8	1.75	0.22	
8.2. Soaking						
8.3. Cost of laying including handling, site lead & lift for one storey.						
Mason I Class .. ..		No.	1.25	5.0	6.25	Table 15.2.1.
Mason II Class .. ..		No.	1.25	3.5	4.38	
Male Mazdoor .. ..		No.	2.0	1.75	3.50	
Female Mazdoor .. ..		No.	2.0	1.25	2.50	
Bhishti or water carrier ..		No.	0.5	2.5	1.25	
8.4. Wetting Bhishti or water carrier		Included under item 8.3				
					Total Primary Rate	
					91.79	
Say, Rs. 92 per CFC						

TABLE 15.11.5.

## Analysis of Cost per CFS of Tile-lining

1. Size of Tiles : 12" × 6" × 2"

2. Brief specifications : 2 layers in bed, Bottom layer 3/8" in CM 1 : 5, sandwiched layer 5/8" in CM 1:3, 1/4" layer of cement plaster on sandwiched layer in CM 1:3, vertical joints 1/4" thick in CM 1:5 for bottom layer and CM 1:3 for top layer joints.

Sl. No.	Items	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Bricks Class I</i>					
1.1.	Cost ex-kiln	Nos. 1000	380	35.0	13.30	Table 15.3.1; 5% breakage & 3/8" vertical joints.
1.2.	Transport to the site of work 3 miles	1000	380	6.25	2.38	25 % extra bricks transportation rate.
2.	<i>Sand</i>					
2.1.	Cost of quarrying or manufacture	CFC	0.12	10.20	1.20	Table 15.3.1.
2.2.	Transport to the site of work 3 miles	CFC	0.12	6.7	0.80	Table 8.4.5.
2.3.	Storage & handling up to mills	CFC	0.12	2.0	0.24	
3.	<i>Cement</i>					
3.1.	Cost ex-project godown	Cwt.	2.8	5.0	14.00	Table 15.3.1.
3.2.	Transport to the site of work.					
3.3.	Storage and handling up to mills	Cwt.	2.8	0.02	0.06	

TABLE 15.11.5—contd.

1	2	3	4	5	6	7
4.	Water	: .. .. CFC	—	—	0.50	
5.	Mixing of mortar					
	Male Mazdoor	} .. FC	12.0	0.21	0.25	Table 11.3.3.
	Female Mazdoor					
6.	Laying and Curing including Soaking					
	6.1. Cleaning & racking	} No.	No. 1/8	1.75	0.22	
	6.2. Soaking					
	6.3. Cost of laying including handling site lead and lift for one storey.					
	Mason I class	.. .. No.	0.75	5.0	3.75	Table 15.2.1.
	Mason II class	.. .. No.	0.75	3.5	2.68	
	Male Mazdoor	.. .. No.	1.00	1.75	1.75	
	Female Mazdoor	.. .. No.	1.00	1.25	1.25	
	Bhishti or water carrier	.. No.	0.50	2.5	1.25	
	6.4. Wetting					
	Bhishti or water carrier	.. Included under item 6.3.				
			Total Primary Rate		43.63	
			Say, Rs. 44 per CFC			

NOTE : For lining on slopes Re. 0.5 extra may be allowed for every 3 ft. height or part thereof.

## 15.12. STONE MASONRY

15.12.1. Typical analysis of rates for stone masonry in various proportions of mortar are given below :—

TABLE 15.12.1

*Analysis per CFC of Stone Masonry for hearing in Dams—Height up to 100 feet.*

Brief Specifications:—R.R. Masonry in CM 1:4.

Sl. No	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
<b>1. Rubble</b>						
	1.1. Quarrying	CFC	1.0	18.0*	18.0	*Table 15.3.1.
	1.2. Dressing Masons	No.	1.0	3.5*	3.5	*Table 15.2.1.
	1.3. Transport to the site of work say 3 miles	CFC	1.0	7.4*	7.3	*Table 8.4.5.
<b>2. Sand</b>						
	2.1. Quarrying or manufacturing.	CFC	0.54	10.0*	5.4	*Table 15.3.1.
	2.2. Transport to site of work say 3 miles.	CFC	0.54	7.3*	3.9	*Table 8.5.4
	2.3. Storage & handling up to mills	CFC	0.54	2.0	1.1	
<b>3. Cement</b>						
	3.1. Cost at source of supply	} Cwt.	9.0	5.0	45.0	Table 15.3.1.
	3.2. Transport to site of work					
	3.3. Storage & handling up to mills	Cwt.	9.0	0.02	0.2	

TABLE 15.12.1—contd.

1	2	3	4	5	6	7	
4.	<i>Water and Curing</i>	.. ..	CFC	1.0	4.0	4.0	
5.	<i>Mixing of mortar</i>						
	By manual labour						
	Male Mazdoor	.. ..					
	Female Mazdoor	.. ..	CFC	0.45	2.5	1.1	
	Bhishti or water carrier						
6.	<i>Lead and Lift</i>						
6.1.	Scaffolding	.. ..	CFC	1.0	0.25	0.3	
6.2.	Lead & lift of stone and mortar by crane weighted lead 100'	.. ..	No.	0.5	15.0	7.5	Table 13.7.2.
6.3.	Do. 80' lift	.. ..	CFC	1.0	11.2	11.2	Para 13.7.3.
7.	<i>Cost of laying including Handling</i>						
	Mason I Class	.. ..	No.	1.0	5.0*	5.0	*Table 15.2.1
	Mason II Class	.. ..	No.	1.0	3.5	3.5	
	Male Mazdoor	.. ..	No.	2.0	1.75	3.5	
	Female Mazdoor	.. ..	No.	2.0	1.25	2.5	
	Bhishti or water carrier	.. ..	No.	0.2	2.5	0.5	
				Total Primary Rate		123.5	
				Or say, Rs.		124	

- NOTES : 1. Transport by 'A' class road only provide  
 2. Rate of Rs. 10.0 per CFC of sand provided, includes washing charges also.  
 3. Bond stones and extra for face masonry not included.  
 4. Lift only up to 100' height and lead for 100' only.

TABLE 15.12.2.

*Analysis per CFC of Stone Masonry for hearting in Dams—Height up to 100 ft.*

Brief Specifications : R.R. Masonry in C.M. 1:3

Sl. No.	Item	Unit	Qty.	Rate	Amount	Remarks
1	2	3	4	5	6	7
<b>1. Rubble</b>						
1.1.	Quarrying .. ..	CFC	1.0	18.0	18.0	Table 15.3.1.
1.2.	Dressing Masons ..	No.	1.0	3.5	3.5	Table 15.2.1.
1.3.	Transport to the site of work say 3 miles .. ..	CFC	1.0	7.3	7.3	Table 8.4.5.
<b>2. Sand</b>						
2.1.	Quarrying or manufacturing .. ..	CFC	0.54	10.0	5.4	Table 15.3.1.
2.2.	Transport to site of work say 3 miles .. ..	CFC	0.54	7.3	3.9	Table 8.4.5.
2.3.	Storage & handling up to mills .. ..	CFC	0.54	2.0	1.1	
<b>3. Cement</b>						
3.1.	Cost at source of supply	} Cwt.	12.0	5.0	60.0	Table 15.3.1.
3.2.	Transport to site of work					
3.3.	Storage & handling up to mills .. ..	Cwt.	12.0	0.02	0.2	





TABLE 15.12.3.

*Analysis per CFC of Stone Masonry for hearting in Dams—height up to 100 ft.*

Brief specifications : Random Rubble Masonry in C.M. 1 : 2-3/4

Sl. No.	Item	Unit	Qty.	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Rubble</i>					
1.1.	Quarrying .. ..	CFC	1.0	18.0	18.0	Table 15.3.1.
1.2.	Dressing Masons, ..	No.	1.0	3.5	3.5	Table 15.2.1.
1.3.	Transport to the site of work say 3 miles .. ..	CFC	1.0	7.3	7.3	Table 8.4.5.
2.	<i>Sand</i>					
2.1.	Quarrying or manufacturing .. ..	CFC	0.54	10.0	5.4	Table 15.3.1.
2.2.	Transport to site of work say 3 miles .. ..	CFC	0.54	7.3	3.9	Table 8.4.5.
2.3.	Storage & handling up to mills .. ..	CFC	0.54	2.0	1.1	
3.	<i>Cement</i>					
3.1.	Cost at source of supply	} Cwt.	13.1	5.0	65.5	Table 15.3.1.
3.2.	Transport to site of work					
3.3.	Storage & handling up to mills .. ..	Cwt.	13.1	0.02	0.3	
4.	<i>Water and Curing</i> .. ..	CFC	1.0	4.0	4.0	

TABLE 15.12.3—contd.

1	2	3	4	5	6	7
<b>5. <i>Mixing of Mortar</i></b> (By manual labour)						
	Male Mazdoor Female Mazdoor Bhishti or water carrier	} CFC	0.45	2.5	1.1	
<b>6. <i>Lead and Lift</i></b>						
6.1.	Scaffolding .. ..	CFC	1.0	0.25	0.3	
6.2.	Lead & lift of stone mortar by crane weighted lead 100' .. ..	No.	0.5	15.0	7.5	Table 13.7.2.
6.3.	-do- lift 80' .. ..	CFC	1.0	11.2	11.2	Para 17.7.3.
<b>7. <i>Cost of laying including Handling.</i></b>						
	Mason I Class .. ..	No.	1.0	5.0	5.0	Table 15.2.1.
	Mason II Class .. ..	No.	1.0	3.5	3.5	
	Male Mazdoor .. ..	No.	2.0	1.75	3.5	
	Female Mazdoor .. ..	No.	2.0	1.25	2.5	
	Bhishti or water carrier ..	No.	0.2	2.50	0.5	
Total Primary Rate					144.1	
			Or say, Rs.		144	

- NOTES : 1. Transport by 'A' class road only provided.  
 2. Rate of Rs. 10.0 per CFC of sand provided, includes washing charges also.  
 3. Bond stones and extra for face masonry not included.  
 4. Lift only up to 100 ft. height and lead for 100 ft. only.

TABLE 15.12.4.

*Analysis per CFC of Stone Masonry for hearting in Dams—height up to 100 ft.*

Brief Specifications : Random Rubble Masonry in red cement mortar 1 : 2 $\frac{3}{4}$

Sl. No.	Item	Unit	Qty	Rate	Amount	Remark
1	2	3	4	5	6	7
1.	<i>Rubble</i>			Rs.	Rs.	
1.1	Quarrying ..	CFC	1.0	18.0	18.0	Table 15.3.1.
1.2	Dressing Masons ..	No.	1.0	3.5	3.5	Table 15.2.1.
1.3	Transport to the site of work say 3 miles ..	CFC	1.0	7.0	7.0	Table 8.4.5.
2.	<i>Sand</i>					
2.1	Quarrying or manufacturing .. ..	CFC	0.54	10.0	5.4	Table 15.3.1.
2.2	Transport to site of work say 3 miles .. ..	CFC	0.54	7.3	3.9	Table 8.4.5.
2.3	Storage & handling up to mills .. ..	CFC	0.54	2.0	1.1	
3.	<i>Cement</i>					
3.1	Cost at source of supply	} Cwt.	10.45	5.0	52.3	Total 15.3.1.
3.2	Transport to site of work					
3.3	Storage & handling up to mills .. ..	Cwt.	10.45	0.02	0.2	
4.	<i>Water land Curing</i> .. ..	CFC	1.0	4.0	4.0	

TABLE 15.12.4.—contd.

1	2	3	4	5	6	7
5. <i>Admixtures (Surkhi)</i>						
5.1	Purchase or manufacturing cost .. ..	} CFC	0.086	Rs.	Rs.	Table 15.3.1.
5.2	Transport to site .. ..			7.5	2.5	
5.3	Storage & handling up to mills					
6. <i>Mixing of Mortar (By manual labour)</i>						
	Male Mazdoor .. ..	} CFC	0.45	2.5	1.1	
	Female Mazdoor .. ..					
	Bhishti or water carrier .. ..					
7. <i>Lead and Lift</i>						
7.1	Scaffolding .. ..	CFC	1.0	0.25	0.3	
7.2	Lead & lift of stone & mortar by crane, weighted lead 100' .. ..	No.	0.5	15.0	7.5	Table 13.7.2.
7.3	-do- lift 80' .. ..	CFC	1.0	11.2	11.2	
8. <i>Cost of laying including handling</i>						
	Mason I Class .. ..	No.	1.0	5.0	5.0	Table 15.2.1.
	Mason II Class .. ..	No.	1.0	3.5	3.5	
	Male Mazdoor .. ..	No.	2.0	1.75	3.5	
	Female Mazdoor .. ..	No.	2.0	1.25	2.5	
	Bhishti or water carrier .. ..	No.	0.2	2.5	0.5	
Total Primary Rate					133.3	
Or say, Rs.					133	

- NOTES :--1. Transport by 'A' class road only provided.  
2. Rate of Rs. 10.0 per CFC of sand provided includes washing charges also.  
3. Bond stores and extra for face masonry not included.  
4. Lift only up to 100' height and lead for 100' only.

TABLE 15.12.5.

*Analysis per CFC of Stone Masonry for hearting in Dams—height up to 100 ft.*

Brief Specifications : Random Rubble Masonry in red cement mortar 1 : 4.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	2	3	4	5	6	7
	<b>1. Rubble</b>			- Rs.	Rs.	
	1.1 Quarrying	CFC	1.0	13.0	18.0	Table 15.3.1.
	1.2 Dressing Masons	No.	1.0	3.5	3.5	Table 15.2.1.
	1.3 Transport to the site of work say 3 miles	CFC	1.0	7.3	7.3	Table 8.4.5.
	<b>2. Sand</b>					
	2.1 Quarrying or manufacturing	CFC	0.54	10.0	5.4	Table 15.3.1.
	2.2 Transport to site of work say 3 miles	CFC	0.54	7.3	3.9	Table 8.4.5.
	2.3 Storage & handling up to mills	CFC	0.54	2.0	1.1	
	<b>3. Cement</b>					
	3.1 Cost at source of supply	} Cwt.	8.1	5.0	40.5	Table 15.3.1.
	3.2 Transport to site of work					
	3.3 Storage and handling up to mills	Cwt.	8.1	0.02	0.2	
	<b>4. Water and Curing</b>	CFC	1.0	4.0	4.0	

TABLE 15.12.5.—contd.

1	2	3	4	5	6	7
5. <i>Admixtures (Surkhi)</i>						
5.1	Purchase or manufacturing cost	} CFC		Rs.	Rs.	
5.2	Transport to site .. ..		0.025	75.0	1.9	
5.3	Storage and handling up to mills.					
6. <i>Mixing of Mortar (By manual labour)</i>						
	Male Mazdoor .. ..	} CFC	0.45	2.5	1.1	
	Female Mazdoor .. ..					
	Bhishti or water carrier.					
7. <i>Lead and Lift</i>						
7.1	Scaffolding .. ..	CFC	1.0	0.25	0.3	
7.2	Lead and lift of stone & mortar by crane, weighted lead 100' ..	No.	0.5	15.0	7.5	Table 13.7.2.
7.3	Weighted lift 80' ..	CFC	1.0	11.2	11.2	Table 13.7.3.
8. <i>Cost of laying including handling</i>						
	Mason I Class .. ..	No.	1.0	5.0	5.0	
	Mason II Class .. ..	No.	1.0	3.5	3.5	
	Male Mazdoor .. ..	No.	2.0	1.75	3.5	
	Female Mazdoor .. ..	No.	2.0	1.25	2.5	
	Bhishti or water carrier ..	No.	0.2	2.5	0.5	
				Total Primary Rate	Rs. 120.9	
				Or say, Rs.	121	

- NOTES : 1. Transport by 'A' class road only provided.  
 2. Rate of Rs. 10.0 per CFC of sand provided, includes washing charges also  
 3. Bond stones and extra for face masonry not included.  
 4. Lift only up to 100' height and lead for 100' only.

TABLE 15.12.6.

*Analysis of Cost per CFC of Stone Rip-Rap or Pitching*

Brief specifications : Hand-packed

Sl. No.	Item	Unit	Qty.	Rate	Amount	Reference
1	2	3	4	5	6	7
1.	Rubble stone at quarry including spalls .. .. .	CFC	1.15	Rs. 12.0	Rs. 13.80	
<b>2. Labour</b>						
2.1	Mason II Class .. .. .	No.	0.5	3.5	1.75	
2.2	Male Mazdoor .. .. .	No.	1.5	1.75	2.63	
2.3	Female Mazdoor .. .. .	No.	1.5	1.25	1.87	
2.4	Other workcharged establishment .. .. .	—	—	—	—	
3.	Carriage of rubble stone & spalls from quarry to worksite say 3 miles .. .. .	CFC	1.15	7.3	8.40	Table 8.4.5.
4.	Sundries & T. & P .. .. .	L.S.	—	—	0.53	
Total Primary Rate					28.98	
Say, Rs. 29 per CFC						



TABLE 15.12.7.

Analysis per CFC of Stone Masonry Facework (Tungabhadra—Andhra)

Brief specification : —Frace stone masonry in R.C.M. 1 : 2½ (Cement & Surkhi mixed by weight)

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1. Rubble						
1.1	Quarrying	} .. CFC	1.05	Rs.	Rs.	
1.2	Dressing Masons			138.0	144.90	
1.3	Transport to the site of work	.. .. CFC	1.05	20.63	21.63	Lead <sub>n</sub> not given
2. Sand (By Lorry).						
2.1	Quarrying or manufacturing including haulage	.. CFC	0.53	8.125	4.31	
2.2	Transport to site of work (By Rly Wagon, 26 Miles)	CFC	0.55	16.875	8.94	
2.3	Storage & handling up <sup>2</sup> to mills.					
3. Cement						
3.1	Cost of source of supply	Cwt.	9.55	5.0	47.75	
3.2	Transport to site of work	Cwt.	9.55	0.10	0.96	
3.3	Storage and handling up to mills	.. .. Cwt.	9.55	0.09	0.86	
4. Water				Cost is negligible		
5. Admixture, Surkhi						
5.1	Purchase or manufacturing cost	.. .. Cwt.	2.16	2.33	5.05	
5.2	Transport to site	.. .. Cwt.	2.16	0.14	0.31	
5.3	Storage and handling up to mills	.. ..				

TABLE 15.12.7.—contd.

1	2	3	4	5	6	7
6.	<i>Mixing Mortar</i>					
	(a) By manual labour				Rs.	Rs.
	Male Mazdoor.					234.7
	Female Mazdoor ..					
	Bhishti or water carrier					
	or					
	(b) By mixer or manual					
	labour .. .. .	CFC	0.42	3.0		1.26
	Depreciation .. ..					0.84
	Electric charges .. ..					1.63
	Repairs .. .. .					
	Consumable Materials					
	Operation Labour					
	Other Labour					
	(i) Male Mazdoor					
	(ii) Female Mazdoor					
	(iii) Bhishti or water carrier					
7.	<i>Lead and Lift</i>					
	7.1 Scaffolding					2.25
	7.2 Lead & Lift of Stone					2.25
	7.3 Lead & Lift of Mortar					
8.	<i>Cleaning and Curing</i>				5.14	This include cost of Cement slurrywire brush pumping, watering including running & maintenance of pumps & cost of hose pipes.
	8.1 Cleaning & Slurry ..					
	(a) Cement for slurry mortar .. .. .					
	(b) Cleaning .. .. .					
	Male Mazdoor .. .. .					
	* ? Cost of laying including handling .. .. .					
	Mason I Class ... .. No.		1.0	3.38		3.38
	Mason II Class .. .. No.		1.0	2.63		2.63
	Male Mazdoor .. .. No.		3.0	1.50		4.50
	Female Mazdoor .. .. No.		6.0	0.75		4.50
	Bhishti or water carrier .. No.		0.16	0.75		0.13
	8.3 Wetting					
9.	<i>Petty Supervision</i>					
	Contingencies .. .. .					0.72
10.	<i>Miscellaneous like template, etc.</i>					1.62
				Primary Rate		265.56
	Sundry & Overhead charges .. @ 35%					92.96
				Total		358.52
				Or say,	Rs.	359

## 15.13. CONCRETE

15.13.1. Typical analysis of rates of concrete by manual labour and mechanical means are given below :—

TABLE 15.13.1.

*Analysis of Cost per CFC of Cement-Concrete by Manual Labour*

Brief specifications : 1:2:4 (1:6), aggregate is of broken stone of size up to 3/4" gauge.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Reference
<b>1. Coarse Aggregate</b>						
1.1	Quarrying & breaking stone to size up to 3/4" gauge	CFC	0.90	Rs. 30.0	Rs. 27.0	Tables 14.2.2. & 15.3.1.
1.2	Transport from quarrysite to worksite—3 miles ..	CFC	0.90	6.7	6.9	Table 8.4.5.
<b>2. Sand</b>						
2.1	Quarrying .. ..	CFC	0.45	10.0	4.5	Tables 14.2.2. & 15.3.1.
2.2	Transport from quarrysite to worksite—3 miles	CFC	0.45	6.7	3.0	Table 8.4.5.
<b>3. Cement</b>						
3.1	Ex-godown .. ..	Cwt.	18.1	5.0	90.5	Tables 14.2.2. & 15.3.1.
<b>4. Labour</b>						
4.1	Mixing, laying and vibrating etc. up to 10 ft. lift and 50 ft. lead. .. ..	CFC	1.0	15.0	15.0	
4.2	Curing inclusive of cost of water .. ..	CFC	1.0	0.5	0.5	
5.	<b>Sundries</b> .. ..	CFC	1.0	1.0	1.0	
Total Primary Rate					147.5	
Say, Rs. 148 per CFC						

TABLE 15.13.2.

*Analysis of Cost per CFC of Cement-Concrete by Manual Labour*Brief Specifications : 1:2:4 (1:6), aggregate is of broken stone of size  $1\frac{1}{4}$ " gauge.

1. Primary rate per CFC per Table 15.14.1. . . . .	Rs. 148-0
2. Deduct cost due to difference in rate of coarse aggregate @ Rs. 30-27 = 3-0 per CFC of aggregate . . . . .	Rs. 2-7
	Rs. 145-3
	Say, Rs. 145 per CFC

TABLE 15.13.3.

*Analysis of Cost per CFC of Cement Concrete 1:1.5:3 (1:4.5) by manual labour with broken stone of size up to  $\frac{3}{4}$ " gauge*

1. Primary rate per CFC per Table 15.14.1. . . . .	Rs. 148-0
2. Add cost due to difference in quantity of cement 3-2 cwt. @ Rs. 5 per cwt . . . . .	Rs. 16-0
	Rs. 164-0
3. Deduct cost due to difference in quantity of sand 2 FC @ Rs.10 per CFC . . . . .	Re. 0-2
4. Deduct cost due to difference in quantity of coarse aggregate 4 FC @ Rs. 30 per CFC . . . . .	Rs. 1-2
	Rs. 1-4
	1-4
	Rs. 162-6
	Say, Rs. 163 per CFC

TABLE 15.13.4.

*Analysis of Cost per CFC of Cement-Concrete 1:2-5:5 (1:7-5) by manual labour with broken stone of size 1-1/2" gauge*

1. Primary rate per CFC per Table 15.13.2. . . . .	Rs. 145-0
2. Add cost due to difference in quantity of sand 1 FC @ Rs. 10 per CFC . . . . .	Re. 0-1
3. Add cost due to difference in quantity of aggregate 2 FC @ Rs. 27 per CFC . . . . .	Re. 0-5
	Rs. 145-6
4. Deduct cost due to difference in quantity of cement 3-2 cwt. @ Rs. 5-0 per cwt. . . . .	Rs. 16-0
	Rs. 129-6
	Say, Rs. 130 per CFC

TABLE 15.13.5.

*Analysis of Cost per CFC of Cement-Concrete 1:3:6 (1:9) by manual labour with broken stone of size 1½" gauge*

1. Primary rate per CFC per Table 15.13.2. .. .. .	Rs.	145·0
2. Add cost due to difference in quantity of sand 2 FC @ Rs. 10 per CFC .. .. .	Re.	0·2
3. Add cost due to difference in quantity of aggregate 4 FC @ Rs. 27 per CFC .. .. .	Rs.	1·1
	Rs.	<u>146·3</u>
4. Deduct cost due to difference in quantity of cement 5·4 cwt. @ Rs. 5 per cwt. ... .. .	Rs.	27·0
	Rs.	<u>119·3</u>
	Say, Rs.	119 per CFC

TABLE 15.13.6.

*Analysis of Cost per CFC of Cement-Concrete 1:4:8 (1:12) by manual labour with broken stone of size 1½" gauge*

1. Primary rate per CFC per Table 15.13.2. .. .. .	Rs.	145·0
2. Add cost due to difference in quantity of sand 3 FC @ Rs. 10 per CFC .. .. .	Re.	0·3
3. Add cost due to difference in quantity of aggregate 7 FC @ Rs. 27 per CFC .. .. .	Rs.	1·9
	Rs.	<u>147·2</u>
4. Deduct cost due to difference in quantity of cement 8·4 cwts. @ Rs. 5 per cwt. ... .. .	Rs.	42·0
	Rs.	<u>105·2</u>
	Say, Rs.	105 per CFC

TABLE 15.13.7.

*Analysis of Cost per CFC of Cement-Concrete 1:5:10 (1:15) by manual labour with broken stone of size 1½" gauge*

1. Primary rate per CFC per Table 15.13.2. .. .. .	Rs.	145·0
2. Add cost due to difference in quantity of sand 5 FC @ Rs. 10 per CFC .. .. .	Re.	0·5
3. Add cost due to difference in quantity of aggregate 10 FC @ Rs. 27 per CFC .. .. .	Rs.	2·7
	Rs.	<u>148·2</u>
4. Deduct cost due to difference in quantity of cement 10 cwt. @ Rs. 5 per cwt. ... .. .	Rs.	50·0
	Rs.	<u>98·2</u>
	Say, Rs.	98 per CFC

TABLE 15.13.8.

*Analysis of Cost per CFC of Cement-Concrete 1:8:16 (1:24) by manual labour with broken stone of size 1½" gauge*

1. Primary rate per CFC per Table 15.13.2. . . . .	Rs.	145.0
2. Add cost due to difference in quantity of sand 6 FC @ Rs. 10 per CFC . . . . .	Re.	0.6
3. Add cost due to difference in quantity of aggregate 12 FC @ Rs. 27 per CFC . . . . .	Rs.	3.2
	Rs.	148.8
4. Deduct cost due to difference in quantity of cement 13 cwt. @ Rs. 5 per cwt . . . . .	Rs.	65.0
	Rs.	83.8
		Say, Rs. 84 per CFC

TABLE 15.13.9.

*Analysis of Cost per CFC of Cement-Concrete by manual labour*

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	<i>Coarse Aggregate</i>			Rs.	Rs.	
1.1	Quarrying and sieving shingle . . . . .	CFC	0.86	8.0	6.9	Tables 14.2.2 & 15.3.1.
1.2	Transport from quarry-site to worksite, lead 3 miles . . . . .	CFC	0.86	6.7	5.8	Table 8.4.5.
2.	<i>Sand</i>					
2.1	Quarrying . . . . .	CFC	0.43	10.0	4.3	Tables 14.2.2. & 15.3.1.
2.2	Transport from quarry-site to worksite—3 miles . . . . .	CFC	0.43	6.7	2.9	Table 8.4.5.
3.	<i>Cement</i>					
3.1	Ex-godown . . . . .	Cwt.	17.2	5.0	86.0	Tables 14.2.2. & 15.3.1.
4.	<i>Labour</i>					
4.1	Mixing, laying and vibrating etc. . . . .	CFC	1.0	15.0	15.0	
4.2	Curing inclusive of cost of water . . . . .	CFC	0.5	0.5	0.5	
5.	<i>Sundries</i> . . . . .	CFC	1.0	1.0	1.0	
				Total Primary Rate Rs.	127.4	
				Say, Rs.	122 per CFC.	

TABLE 15.13.10.

*Analysis of Cost per CFC of Cement-Concrete 1:1.5:3 (1:4.5) by manual labour with shingle as coarse aggregate*

1. Primary rate per CFC per Table 15.13.9. . . . .	Rs.	122.0
2. Add cost due to difference in quantity of cement 4.8 cwt. @ Rs. 5 per cwt. . . . .	Rs.	24.0
	Rs.	146.0
3. Deduct cost due to difference in quantity of sand 2 FC @ Rs. 10 per CFC . . . . .	Re.	0.2
4. Deduct cost due to difference in quantity of shingle 4 FC @ Rs. 8 per CFC . . . . .	Re.	0.3
	Re.	0.5
	Re.	0.5
	Rs.	145.5
	Say, Rs.	146 per CFC.

TABLE 15.13.11.

*Analysis of Cost per CFC of Cement-Concrete 1:3:6 (1:9) by manual labour with shingle as coarse aggregate*

1. Primary rate per CFC per Table 15.13.9 . . . . .	Rs.	122.0
2. Add cost due to difference in quantity of sand 2 FC @ Rs. 10 per CFC . . . . .	Re.	0.2
3. Add cost due to difference in quantity of shingle 4 FC @ Rs. 8 per CFC . . . . .	Re.	0.3
	Rs.	122.5
4. Deduct cost due to difference in quantity of cement 5.2 cwt @ Rs. 5 per cwt. . . . .	Rs.	26.0
	Rs.	96.5
	Say, Rs.	97 per CFC.

TABLE 15.13.12.

*Analysis of Cost per CFC of Cement-Concrete 1:4:8 (1:12) by manual labour with shingle as coarse aggregate.*

1. Primary rate per CFC per Table 15.13.9. . . . .	Rs.	122.0
2. Add cost due to difference in quantity of sand 3 FC @ Rs. 10 per CFC . . . . .	Re.	0.3
3. Add cost due to difference in quantity of shingle 6 FC @ Rs. 6 per CFC . . . . .	Re.	0.5
	Rs.	122.8
4. Deduct cost due to difference in quantity of cement 7.9 cwt. @ Rs. 5 per cwt. . . . .	Rs.	39.5
	Rs.	83.3
	Say, Rs.	83 per CFC.

TABLE 15.13.13.

*Cost Analysis for mass concrete by mechanical means for Dams above 100 ft. height having total quantity of concrete above 400,000 cu. yds.*

Sl. No.	Item	Unit	Qty.	Rate	Amount	Remarks
1	2	3	4	5	6	7
<b>1. Coarse Aggregate</b>						
1.1	Quarrying (without overburden) ..	CFC	0.94	Rs. 9.61	Rs. 9.03	
1.2	Transport to crushers (mention lead) 3 miles	CFC	0.94	7.80	7.33	Table 8.4.5.
1.3	Crushing, processing and conveyance to stockpiles .. .. .	CFC	0.94	12.5	11.75	Para 14.10.1.
1.4	Transport from stockpiles to batching plant .. .. .	CFC	0.94	5.53	5.20	Table 14.12.2.
<b>2. Sand</b>						
2.1	Quarrying ..	CFC	0.47	10.0	4.70	Table 15.3.1.
2.2	Transport to site (mention lead) 3 miles	CFC	0.47	17.8	3.67	Table 8.4.5.
2.3	Crushing and processing, if any .. .. .	CFC	0.47	5.0	2.35	
2.4	Working					
2.5	Transport from stock piles to batching plant	CFC	0.47	5.53	2.60	Table 14.12.2.
<b>Cement</b>						
3.1	Cost ex-factory ..					
3.2	Rail or road transport and handling to site of work (mention lead) .. .. .	Cwt.	10.0	5.0	50.0	Table 15.3.1.
3.3	Storage and handling up to batching plant	Cwt.	10.0	0.15	1.50	
<b>4. Water</b>						
	With cost of hours ..	CFC	—	—	2.00	
<b>5. Admixture</b>						
5.1	Cost of purchase or manufacture ..	—	—	—	—	
5.2	Cost of transport ..	—	—	—	—	
5.3	Storage and handling up to batching plant	—	—	—	—	



TABLE 15.13.13.—contd.

1	2	3	4	5	6	7
6.	<i>Batching, mixing &amp; laying</i>			Rs.	Rs.	
6.1	Batching & mixing	CFC	1.0	5.19	5.19	Para 14.13.3.
6.2	Placing including transport from batching plant and vibrating	CFC	1.0	23.56	23.56	Paras 14.13.4; 14.13.5, and 14.13.6.
6.3	Cleaning, slurry curing and finishing ..					
(a)	Cement for slurry mortar .. ..	CFC	—	—	5.00	
(b)	Sand blasting and cleaning with air and water ..	CFC	—	—	2.50	
6.4	Compressed air for batching plant and other sundries ..	CFC	—	—	1.00	
7.	<i>Other Items</i>					
7.1	Pre-cooling plant and expenses ..	—	—	—	—	
7.2	Embedded system and operation cost	—	—	—	—	
8.	<i>Workshop charges</i> ..	CFC	—	—	1.50	
				Total Primary Rate		138.88
				Say, Rs.		139

- NOTES
1. Overburden of the quarry not included.
  2. Indirect expenses excluded.
  3. The analysis is for basalt rock and for other varieties proportionate increase to be applied.
  4. Cost of electric power is assumed as -/1/- per unit, near the site.
  5. Formwork and cooling of concrete not included.

## OBSERVATIONS

## 16.1. INTRODUCTORY

16.1.1. Studies presented in Section B of Part I of the Report would provide the reader with the data relating to the rates of the various projects as made available to the Committee. The Projects can be grouped into 3 classes according to the Construction Agency employed *viz.*, the piecework contracts, the item rate contracts, and departmental agency.

TABLE 16.1.1.

*Agencies employed for Execution of Works*

Sl. No.	Type of project	Construction Agencies			Remarks
		Piecework	Unit rate contract	Departmental execution	
1	2	3	4	5	6
1.	Concrete Dams	—	Konar Vaitarna Rihand	Tilaiya Hirakud Bhakra Maithon Panchet Hill	
2.	Stone Masonry Dams	Hirakud Tungabhadra Peechi Perinclani Lower Bhawani Bhadra Massanjore Gandhisagar Matatila			
3.	Earth Dams and Dykes	Panchet Hill Hirakud	Konar	Gangapur Nangal Hydel Sardasagar Matatila Maithon Lower Bhawani Panchet Hill Hirakud	

16.1.2. In the case of piecework, and single contract execution the project authorities have expressed their total inability to furnishing breakup of rates, as they have made no time and motion studies.

16.1.3. As regards the departmental execution of works, the project authorities cooperated with us to the farthest extent possible consistent with the shape and condition of their accounts. They generally found it difficult to fill up the proformas sent to them but these can serve as a useful guide for future studies, and form Appendix 10.

## 16.2. THE BURDEN

16.2.1. This subject has been dealt with at length in Chapter 2. Figures for the average burden on projects, split up into various elements, are given in Table 16.2.1. The Cost column shows the names of projects where the departure from these figures is most pronounced.

TABLE 16.2.1.

Sl. No.	Items of Burden	Average (%) expense on the projects		Projects on which the expense (in brackets) has been above the average
		Dams	Canals	
1	2	3	4	5
<i>Indirect Charges</i>				
1.	K-Buildings .. ..	8.65	3.63	Perinchani (18.5) Hirakud Canals (5.6) Kakrapar (14.1) Durgapur (14.6) Durgapur Canal (6.2)
2.	Service Roads etc. ..	3.04	0.74	Bhakra-Nangal (6.9) Lower Bhawani (6.0) Hirakud (6.1) Kakrapar (7.1)
3.	Water supply etc. ..	1.62	0.31	Tungabhadra (Hyd.) (4.4) Panchet Hill (4.3)
4.	Electricity Telephones etc.	1.86	0.26	Maithon (5.4) Tilaiya (6.4)
5.	Worksite amenities ..	1.13	0.44	Tungabhadra (Hyd.) (2.8) Bhadra Canals (1.5)
6.	Ordinary T & P ..	1.84	1.73	Gangapur (3.6) Matatila (2.7) Tungabhadra (Hyd.) (6.1) Panchet Hill (2.9) Malampuzha (2.5) Durgapur (3.1)
7.	Loss on stock .. ..	0.85	0.30	Tungabhadra (Hyd.) (2.6)
8.	Maintenance .. ..	0.36	0.44	Bhakra-Nangal (2.0) Gandhisagar (2.0)
9.	Miscellaneous .. ..	0.71	0.59	Bhadra (3.3) Tungabhadra (And.) Canal (1.2)
<i>Overheads</i>				
10.	Establishment .. ..	12.7	9.47	Gangapur (31.3) Tungabhadra (Hyd.) (16.3) Perinchani (22.1) Maithon (16.8) Panchet Hill (14.2) Tilaiya (14.4) Kakrapar (21.6)
11.	Consulting fees .. ..	0.26	0.04	Bhakra-Nangal (1.7) Maithon (1.2)
12.	Audit & Accounts ..	1.13	0.88	Mayurakshi (2.4) Mayurakshi Canal (1.4)

## 16.3. COMMENTS ON THE BURDEN

16.3.1. It will be noticed that the divergence in the figures for the elements of the burden is fairly wide, and a certain amount of control is needed on the project authorities to avoid waste and to provide a uniform standard for amenities and services. Using averages as the basis until better yardsticks are available, we would recommend the following scale for adoption on future projects.

TABLE 16.3.1.

Sl. No.	Item of work	Allowance as percentage of direct cost		Remarks
		Dams	Canals	
1	2	3	4	5
<i>A. Indirect charges.</i>				
1.	Buildings .. .. .	5 to 10	3 to 6	Depending inversely on the size of the project
2.	Service Roads .. .. .	3 to 4	$\frac{1}{2}$ to 1	
3.	Water supply .. .. .	1 to 2	$\frac{1}{2}$	
4.	Lighting .. .. .			
5.	Compensation for accidents .. .. .	$\frac{3}{4}$	$\frac{1}{2}$	
6.	Worksite amenities .. .. .	2 to 3	1 to $1\frac{1}{2}$	
7.	Small T & P .. .. .	1		
8.	Testing .. .. .	$\frac{1}{2}$	$\frac{1}{8}$	
9.	Losses on stock .. .. .	$\frac{1}{2}$ to 1	$\frac{1}{4}$ to $\frac{1}{2}$	
10.	Maintenance during construction .. .. .	1	$\frac{1}{2}$ to 1	
11.	Miscellaneous .. .. .	$\frac{1}{2}$ to 1	$\frac{1}{2}$ to 1	
	TOTAL .. .. .	16 to 24	8 to 12	
<i>B. Overheads</i>				
1.	Establishment, Furniture, Stationery Bills etc. .. .. .	10	$7\frac{1}{2}$	
2.	Consultants' fee .. .. .	$\frac{1}{4}$ to $\frac{1}{2}$	Nil.	
3.	Audit & Accounts .. .. .	1	1	
	TOTAL .. .. .	11	$8\frac{1}{2}$	

## 16.4. EARTHWORK BY MACHINES

16.4.1. The output rates obtained for work by machines are governed by their use-rates and outputs. We have worked out the average expected outputs of the various machines in Chapter 6. The efficiency of a production can be judged against these yardsticks.

16.4.2. Tables 16.4.2. (i) and (ii) would show that the actual productive efficiency of Shovel and Draglines obtained over the various projects as against the averages.

TABLE 16.4.2 (i)

*Comparative Statement of Output of Shovels per hour in C.F.C. Units (borrow measure)*

Sl. No.	Project	Soil	Output per hour in CFC			Remarks
			Project Actual	R.&C.C.	Efficiency in %age	
1	2	3	4	5	6	7
1.	<i>3½ Cyds. Shovel</i>					
	(a) Nangal Hydrel Channel	Light clay mixed with gravel	51.7	58	89	Soil is taken as clay, hard & tough.
	(b) Hirakud	Semi-pervious	47*	58	81	Soil is taken as murum. *Embankment measure is 51.82. The borrow measure is calculated.
2.	<i>2½ Cyds. Shovel</i>					
	(a) Bhakra	Rock	37*	40	92	*Worked out from the register of works for electric shovel.
		Mixed rock	24.8*	29	86	*Assumed as rock, poorly blasted.
	(b) Nangal	Light clay with gravel	42	45	94	
	(c) Hirakud	Semi-pervious	37	45	82	Murum assumed
	(d) Maithon	Earth rock as 2:1	37	72	51	
3.	<i>1½ Cyds. Shovel</i>					
	Hirakud	Semi-pervious	21	30	70	Murum assumed

COMMENTS: The above table Shows that the Maithon and Hirakud projects have a large leeway to make

TABLE 16.4.2 (ii)

Comparative Statement of Outputs of Draglines in CFC units (borrow) per hour

Sl. No.	Project	Soil	Output in CFC per hour			Remarks
			Project	R.&C.C.	Efficiency %age	
1	2	3	4	5	6	7
1.	3½ Cyds.					
	Tungabhadra (Andhra)	.. Slushy soft black cotton soil	39.0	35	110	
2.	2½ Cyds.					
	(a) Harike	.. Earth	40.6	39	104	
	(b) Sarda hydel	.. Wet earth, sandy soil	25	25	100	Soil taken as clay, wet & sticky.
	(c) Tungabhadra (Andhra)	.. Slushy soil	28	25	112	
3.	1½ Cyds.					
	Tungabhadra (Andhra)	Slushy soil	20	21	96	
4.	1 Cyd.					
	Harike	.. .. Earth	19.5	20	98	
5.	¾ Cyd.					
	(a) Harike	.. .. Earth	14	15	94	
	(b) Tungabhadra (Andhra)	.. Stiff black cotton soil	11	13	85	

COMMENTS: The above figures for efficiencies are more or less satisfactory.

### 16.5. VARIATION IN USE RATES OF MACHINES

16.5.1. It will be seen from the Table 16.5.1. that in the absence of any standard practice or rules on the subject of the 'Lives of Machines' each project has adopted whatever figure it could lay hands on. We have probed deeper into the subject and made a comparative study of the standards laid down in U.K., U.S.A., Canada, France, Germany, New Zealand, Australia, and Japan and our recommendations are contained in Tables 3.7.6 (i) and (ii).

16.5.2. Figures for expenditure on the repairs and overhaul of equipment are not being maintained on any project, and hence no comments are possible. We have, however, given yardstick (Table 3.12.3.) based on foreign practice to be used provisionally until Indian statistics are available.

16.5.3. While the figures for the actuals are not known the provision for the operation of equipment, as assumed by the projects, can be split up into the following for comparative studies :

- (a) Life, Depreciation and Repairs.
- (b) Labour, Fuel and Lubricants.

16.5.4. We have studied the following equipment:—

1. Shovels.
2. Draglines.
3. Tractor Dozers.
4. Motorised scrappers and Graders, and their combinations.

### 16.6. SHOVELS

16.6.1. Table 16.6.1. (i) gives a comparative study of life, depreciation and repairs.

Table 16.6.1. (ii) gives figures of provision under Labour and Fuel and Lubricants.

TABLE 16.6.1.(i)

*Life, Depreciation and Repairs of Shovel*

N. B. : The bottom figures in each line are on the basis of Rates & Costs Committee recommendations regarding life and percentage of repairs and maintenance.

Sl. No.	Equipment/Project	Cost in lakhs	Life hours	Depreciation per hr.	Repairs (major & minor) per hr.	%age of repairs over depreciation	Total depreciation & repairs
1	2	3	4	5	6	7	8
1.	<i>3½ Cyds. Shovel</i>						
	(a) Bhakra ..	4.3	22000	19.31	33.63	200	57.94
			15000	28.4	28.4	100	56.90
	(b) Nangal ..	3.8	30000	12.67	7.60	60	20.27
			15000	25.34	25.34	100	50.68
	(c) Hirakud ..	3.6	16000	22.55	22.55	100	45.10
			15000	24.00	24.00	100	48.10
2.	<i>2½ Cyds. Shovel</i>						
	(a) Bhakra ..	3.4	22000	15.56	35.08	225	50.64
			15000	22.80	22.80	100	45.60
	(b) Nangal ..	3.8	30000	12.53	7.52	60	20.05
			15000	25.06	25.06	100	50.12
	(c) Hirakud ..	2.0	16000	15.10	15.10	100	30.20
			15000	16.00	16.00	100	32.00
	(d) Maithon ..	3.1	16000	22.50	22.50	100	45.00
			15000	24.00	24.00	100	48.00
	(e) Panchet Hill ..	3.5	16000	21.70	21.70	100	43.4
			15000	23.10	23.10	100	46.2
3.	<i>1½ Cyds. Shovel</i>						
	(a) Bhakra ..	3.0	17000	17.94	31.38	175	49.32
			12000	25.40	25.40	100	50.80
	(b) Hirakud ..	1.53	—	12.60	12.60	100	25.20
			12000	13.00	13.00	100	26.00
	(c) Maithon ..	1.5	12000	20.80	20.80	100	41.6
			12000	20.80	20.80	100	41.6
	(d) Panchet Hill ..	2.5	12000	20.80	20.80	100	41.6
			12000	20.80	20.80	100	41.6
4.	<i>¾ Cyds. Shovel</i>						
	Bhakra ..	1.1	17000	6.20	13.94	225	20.14
			10000	10.50	10.50	100	21.00



TABLE 16.6.1. (ii)

*Fuel & Lubricants etc. and Labour Charges of Shovels*

N.B.—The bottom figures in each line are on the basis of Rates &amp; Costs Committee recommendations

Sl. No.	Equipment/Project	Fuel & Lubricants etc.		Labour per hr.	Total (4 & 5)
		HSD oil gls./hr.	Total Amount (Rs.)		
1	2	3	4	5	6
1.	<i>3½ Cyds. Shovel</i>				
	(a) Bhakra .. .. .	6.00	16.12	4.31	20.43
		5.5	11.25	1.80	13.05
	(b) Hirakud .. .. .	4.00	8.35	2.25	10.60
		5.5	11.25	1.80	13.05
2.	<i>2½ Cyds. Shovel</i>				
	(a) Bhakra .. .. .	5.82	15.10	2.25	17.35
		5.00	10.6	1.80	12.3
	(b) Nangal .. .. .	5.00	11.50	4.81	16.31
		5.00	10.5	1.8	12.3
	(c) Hirakud .. .. .	4.00	8.82	1.99	10.81
		5.00	10.50	1.80	12.3
	(d) Maithon .. .. .	7.50	15.00	2.64	17.64
		5.00	10.50	1.80	12.3
	(e) Panchet Hill .. .. .	8.10	20.20	—	—
		5.00	10.50	—	—
3.	<i>1½ Cyds. Shovel</i>				
	(a) Bhakra .. .. .	3.00	10.50	3.38	13.88
		4.00	9.00	1.80	10.8
	(b) Hirakud .. .. .	4.00	8.37	1.91	10.78
		4.00	9.0	1.80	10.8
	(c) Maithon .. .. .	4.25	10.00	—	—
		4.00	9.00	1.80	10.8
	(d) Panchet Hill .. .. .	4.50	6.20	—	—
		4.00	9.00	—	—
4.	<i>¾ Cyds. Shovel</i>				
		1.75	7.12	3.40	10.57
	(a) Bhakra .. .. .	2.00	5.25	1.80	7.05

16.6.2. The above tables will show that:—

*Bhakra*:—It has assumed excessive figures for the life of the equipment, giving low figures for depreciation. Their figures for repairs are again on the high side but the two together tally closely with our recommendations.

The labour charges there, are rather high and can be explained partly by the difficult terrain, and partly by the 3 shift working, which is uneconomical for shovel operations. Their expenditure on fuel and lubricants is also on the high side and requires looking into.

*Nangal*:—Life assumed is excessive. The rate of depreciation is low. Labour charges are high. Expenditure on P.O.L. on 2½ and 3½ Cyds. shovel are on the low side and need attention.

*Maithon*:—Life assumed is nearly correct, so is the provision for repairs and overhaul. Their expenditure on labour is 50% higher than justified and is that under P.O.L. The corresponding figures for production are low, indicating a serious state of affairs.

*Panchet Hill*:—The position here is similar to that at Maithon as regards the use rates. Figures for production are not available and no comments can, therefore, be given.

*Harike*:—The life assumed is 60% higher as usual and the figures for expenditure on labour and P.O.L. figures for repairs are reasonable. Figures for production are satisfactory.

## 16.7. DRAGLINES

16.7.1. Table 16.7.1. (i) gives the life rate and depreciation allowance for repairs. Table 16.7.1.(ii) gives figures for expenditure under labour and P.O.L.

### 16.7.2. Comments

It will be seen that:—

*Maithon*:—The life assumed is 50% higher than ours while the figures for repair are 25% higher. Data for labour and P.O.L. are not available, nor are the figures for productivity.

*Sarda Hydel*:—The life assumed is nearly correct, but the provision for repairs is rather low, for charges labour are high. Expenditure on P.O.L. is on the low side. Their output is reasonable.

TABLE 16.7.1 (i)

*Life, Depreciation & Repairs of Draglines*

Sl. No.	Equipment/Project	Cost in lakhs	Life in hours	Depreciation per hour	Repairs (major & minor)	Percentage repair over depreciation	Total dep. & repairs per hr.
1	2	3	4	5	6	7	8
1.	<i>3½ Cyds. Shovel</i>						
	Tungabhadra (Andhra)	3.7	24000	15.53	3.90	25	19.43
			15000	24.92	19.94	80	44.86
2.	<i>2½ Cyds. Shovel</i>						
	(a) Harike	3.2	24000	13.30	13.94	105	27.84
			15000	21.20	16.96	80	38.16
	(b) Sarda Hydrel	2.6	14000	19.75	9.90	50	29.65
			15000	18.40	14.72	80	33.12
	(c) Tungabhadra (Andhra)	2.8	18000	15.75	3.95	25%	19.80
			15000	19.00	15.20	80	34.2
	(d) Tungabhadra (Hyderabad)	2.2	28800	5.41	6.49	120	11.90
			15000	10.40	12.4	80	18.72
3.	<i>½ Cyds. Shovel</i>						
	(a) Tungabhadra (Andhra)	1.9	18000	10.37	2.59	25	12.95
			12000	15.50	12.4	80	27.9
	(b) Maithon	2.4	18000	10.10	10.10	100	20.20
			12000	15.00	12.0	80	27.0
4.	<i>¾ Cyds. Shovel</i>						
	(a) Harike	1.1	16000	6.68	5.63	84	12.31
			10000	10.07	8.06	80	18.13
	(b) Lower Bhawani	1.1	10000	10.88	1.06	9.75	11.94
			10000	10.88	8.70	80	19.58
	(c) Tungabhadra	1.3	10000	13.15	3.29	25	16.44
			10000	13.15	10.52	80	23.67

TABLE 16.7.1 (ii)

## Fuel &amp; Lubricants etc. and Labour of Draglines

Sl. No.	Equipment/Project	Fuel & Lubricants etc.		Labour per hour	Total (4 & 5)
		HSD oil gls./hr.	Total amount Rs.		
1	2	3	4	5	6
1.	3½ Cyds. Shovel Tungabhadra (Andhra)	—	7.81	2.92	10.74
		5.5	11.25	1.80	13.05
2.	2½ Cyds. Shovel				
	(a) Harike .. ..	7.0	14.00	6.38	20.38
	(b) Sarda Hydrl .. ..	8.0	10.50	1.80	12.30
		—	8.5	3.00	11.50
	(c) Tungabhadra (Andhra) .. ..		10.50	1.80	12.30
		2.4	4.63	1.00	5.63
	(d) Tungabhadra (Hyderabad) .. ..	5.0	10.50	1.80	12.30
			16.22	1.88	18.10
			10.50	1.80	12.30
3.	1½ Cyds. Shovel				
	Tungabhadra (Andhra) .. ..	2.5	6.16	2.44	8.60
		4.0	9.0	1.80	10.80
4.	Cyds. Shovel				
	(a) Harike .. ..	2.0	5.50	3.56	9.06
		2.0	5.25	1.80	7.05
	(b) Lower Bhawani .. ..	1.1	2.00	1.38	3.38
		2.0	5.25	1.80	7.05

*Tungabhadra (Andhra)* :—The life assumed is 60% higher for 3½ cu. yds. 20% for 2½ cu. yds., 50% for 1½ cu. yds. and is at par for ¾ cu. yds. shovel than the figures recommended by us. Provision for repairs and overhaul is very much on the low side, indirectly that the equipment has been used sparingly.

Expenditure under labour and P.O.L. is low. Productivity is above the average.

*Tungabhadra (Hyd.)* :—Life assumed is nearly double of our recommendation. Provision for repairs and overhaul is 50% higher than ours. Labour is at par, while expenditure and P.O.L. is 60% higher. Figures for productivity are not available.

## 16.8. TRACTOR DOZER

*Lower Bhawani* :—Life adopted tallies with our figures. Provision for repairs is exceedingly low and so are the figures for expenditure under labour and P.O.L. Production figures are not available.

Table 16.8.1. (i) gives figures for life depreciation, repairs and overhaul, while Table 16.8.1. (ii) gives figures for expenditure on labour and P.O.L. The following is the analysis by Projects :—

TABLE 16.8.1(i)

*Depreciation and Repairs of Tractor Dozer*

*N.B.*—The bottom figures in each line are on the basis of R.C.C. recommendations regarding life and percentage of repairs and maintenance.

Sl. No.	Equipment/Project	Cost in lakhs	Life in hours	Depreciation per hour	Repairs (major & minor)	Percentage of repairs over depreciation	Total depreciation & repairs
1. 175 H.P.							
(a)	Bhakra ..	1.4	12000	11.75	32.31	275	44.06
			12000	11.75	11.75	100	23.50
(b)	Harike ..	0.9	10000	9.41	5.52	60	14.93
			12000	11.75	11.75	100	23.50
(c)	Maithon ..	1.0	8000	13.25	13.25	100	27.5
			12000	8.83	8.83	100	17.66
(d)	Panchet Hill ..	1.28	8000	16	16	100	32
			12000	10.7	10.7	100	21.4
(e)	Gangapur ..	1.2	10000	12.09	10.3	85	22.39
			12000	10.08	10.08	100	70.16
(f)	Kakrapar ..	0.99	10000	9.9	9.9	225	30.07
			12000	8.35	8.35	100	18.50
2. 130 H.P.							
(a)	Bhakra ..	1.1	12000	9.25	20.82	225	30.07
			12000	9.25	9.25	100	18.50
(b)	Nangal ..	1.2	10000	10.0	8.0	80	18.0
			12000	10.0	10.0	100	20.0
(c)	Harike ..	1.0	10000	9.61	5.88	60	15.49
			12000	8.0	8.0	100	16.00

TABLE 16.8.1 (i)—contd.

*Depreciation and Repairs of Tractor Dozer*

*N.B.*—The bottom figures in each line are on the basis of R.C.C. recommendations regarding life, percentage of repairs & maintenance.

Sl. No.	Equipment/Project	Cost in lakhs	Life in hours	Depreciation per hour	Repairs (major & minor)	Percentage of repairs over depreciation	Total depreciation & repairs
(d)	Hirakud ..	0.8	7000	11.53	11.53	100	23.06
			12000	6.7	6.7	100	13.4
(e)	Gangapur ..	0.8	10000	7.5	10.3	137.5	17.8
			12000	6.25	6.25	100	12.5
(f)	Tungabhadra (Hyd.) ..	0.8	28800	2.86	3.44	120	6.30
			12000	6.85	6.85	100	13.70
3. 120 H.P.							
(a)	Maithon ..	0.7	8000	11.5	11.5	100	23.0
			12000	7.65	7.65	100	15.3
(b)	Hirakud ..	0.9	7000	12.85	12.85	100	25.7
			12000	7.5	7.5	100	15.0
(c)	Lower Bhawani	0.5	10000	4.44	3.44	77.5	7.82
			12000	3.70	3.70	100	7.40
4. 81 H.P.							
(a)	Bhakra ..	0.8	12000	6.4	14.63	225	21.13
			10000	7.8	7.8	100	15.6
(b)	Nangal ..	0.3	10000	3.3	2.5	75	5.8
			10000	3.3	3.3	100	6.6
(c)	Harike ..	0.4	10000	3.82	2.56	67	6.38
			10000	3.82	3.82	100	7.64
(d)	Sarda Hydrel ..	0.8	8000	10.0	10.0	100	20.0
			10000	8.0	8.0	100	16.0

TABLE 16.8.1. (i)—concl'd.

*Depreciation and Repairs of Tractor Dozer*

*N.B.*—The bottom figures in each line are on the basis of R.C.C. recommendations regarding life, percentage of repairs and maintenance.

Sl. No.	Equipment/ Project	Cost in lakhs	Life in hours	Depreciation per hour	Repairs (major & minor)	Percentage of repairs over maintenance	Total depreciation & repairs
(e)	Gangapur ..	0.8	10000	7.5	10.3	137	17.8
			10000	7.5	7.5	100	5.0
(f)	Tungabhadra .. (Andhra)	0.8	10000	7.5	7.5	100	15.0
			10000	7.5	7.5	100	15.0
(g)	Tungabhadra .. (Hyd.)	0.7	28800	2.5	3.0	120	5.5
			10000	7.2	7.2	100	14.4
(h)	Lower Bhawani	0.9	10000	9.69	1.44	15	11.13
			10000	9.69	6.69	100	19.38
5. 66 H.P.							
(a)	Bhakra ..	0.7	12000	5.63	12.69	225	18.32
			10000	6.75	6.75	100	13.50
(b)	Nangal ..	0.7	12000	5.7	4.55	80	10.25
			10000	6.85	6.85	100	13.70
(c)	Tungabhadra .. (Hyd.)	—	28800	1.88	2.25	120	4.13
			10000	5.4	5.4	100	10.8
6. 44 H.P.							
(a)	Bhakra ..	0.4	12000	3.12	8.44	270	11.56
			10000	3.74	3.74	100	7.48
(b)	Harike ..	0.2	10000	1.82	1.44	80	3.26
			10000	1.82	1.82	100	3.64
(c)	Hirakud ..	0.3	7000	2.58	2.58	100	5.16
			10000	1.80	1.80	100	3.60
(d)	Tungabhadra .. (Hyd.)	0.3	28800	1.08	1.28	118	2.36
			10000	3.12	3.12	100	6.24

TABLE 16.8.1. (ii)

*Fuel and Lubricants and Labour Charges of Tractor Dozer*

NOTE:—The bottom figures in each line are on the basis of R.C.C. recommendations regarding fuel & lubricants and labour charges.

Sl. No.	Equipment/Project	Fuel & lubricants etc.		Labour per hour	Total fuel and lubricants and labour per hour
		HSD oil gls./hr.	Total Amount (Rs.)		
1. 175 H.P.					
(a)	Bhakra	5.5	13.7	3.7	17.4
		3.9	8.6	1.8	10.4
(b)	Harike	7.0	16.13	2.35	18.48
		3.9	8.6	1.8	10.4
(c)	Maithon	6.0	12.5	1.7	14.2
		3.9	8.6	1.8	10.4
(d)	Panchet Hill	6.25	13.14	—	—
		4.00	8.6	—	—
(e)	Gangapur	—	7.32	1.67	8.99
		3.9	8.6	1.8	10.4
(f)	Kakrapar	—	11.3	2.75	14.05
		—	9.0	1.8	10.80
130 H. P.					
(a)	Bhakra	3.5	10.56	3.38	13.94
		2.89	7.5	1.8	9.3
(b)	Nangal	4.0	8.94	2.56	11.5
		2.89	7.5	1.8	9.3
(c)	Harike	4.5	10.5	3.63	14.13
		2.89	7.5	1.8	9.3
(d)	Hirakud	3.13	4.55	2.62	7.18
		2.89	7.5	1.8	9.3
(e)	Gangapur	—	7.32	1.67	8.99
		2.89	7.5	1.8	9.3
(f)	Tungabhadra (Hyd.)	—	7.86	1.88	9.74
		2.89	7.5	1.8	9.3



TABLE 16.8.1 (ii)—contd.

*Fuel and Lubricants and Labour Charges of Tractor Dozer*

NOTE:—The bottom figures in each line are on the basis of R.C.C. recommendations regarding fuel & lubricant and labour charges.

Sl. No.	Equipment/Project	Fuel & lubricants etc.		Labour per hour	Total fuel and lubricant and labour per hour
		HSD oil gls./hr.	Total amount (Rs.)		
3. 120 H.P.					
(a)	Maithon .. .. .	4.0	12.5	1.7	14.2
		2.7	6.75	1.8	8.55
(b)	Hirakud .. .. .	—	—	—	8.55
		2.7	6.75	1.8	8.55
(c)	Lower Bhawani .. .. .	2.14	3.88	1.25	5.13
		2.7	6.75	1.8	8.55
4. 81 H.P.					
(a)	Bhakra .. .. .	2.5	8.81	3.0	11.81
		1.8	5.75	1.8	7.55
(b)	Nangal .. .. .	1.0	3.5	2.38	5.88
		1.8	5.75	1.8	7.55
(c)	Harike .. .. .	1.0	3.0	1.75	4.75
		1.8	5.75	1.8	7.55
(d)	Sarda Hydel .. .. .	2.3	5.75	2.5	8.25
		1.8	5.75	1.8	7.55
(e)	Gangapur .. .. .	—	7.32	1.67	8.99
		1.8	5.75	1.8	7.55
(f)	Tungabhadra (Andhra) .. .. .	2.75	5.7	1.75	7.25
		1.8	5.75	1.8	7.55
(g)	Tungabhadra (Hyd.) .. .. .	—	7.86	1.88	9.74
		1.8	5.75	1.8	7.55

TABLE 16.8.1. (ii)—concl'd.

*Fuel & Lubricants and Labour Charges of Tractor Dozer*

NOTE:—The bottom figures in each line are on the basis of R.C.C. recommendations regarding fuel & lubricant and labour charges.

Sl. No.	Equipment/Project	Fuels & lubricants etc.		Labour per hour	Total fuel & lubricants and labour per hr.
		HSD oil gls./hr.	Total amount Rs.		
(h) Lower Bhawani	.. .. .	2.16	3.94	1.25	5.19
		1.8	5.75	1.8	7.75
5. 66 H.P.					
(a) Bhakra	.. .. .	1.75	6.25	3.85	10.13
		1.5	4.95	1.8	6.75
(b) Nangal	.. .. .	2.0	5.75	2.5	8.25
		1.5	4.95	1.8	6.75
(c) Tungabhadra (Hyd.)	.. .. .	—	6.2	1.8	8.08
		1.5	4.95	1.3	5.75
6. 44 H.P.					
(a) Bhakra	.. .. .	1.5	5.7	2.2	7.9
		1.0	4.2	1.8	6.0
(b) Harike	.. .. .	0.75	2.75	—	2.75
		1.0	4.2	1.8	6.0
(c) Tungabhadra (Hyd.)	.. .. .	—	3.9	1.82	5.78
		1.0	4.2	1.8	6.0

### 16.8.2. Comments on the Maintenance of Tractor Dozers

*Bhakra* :—Life adopted is corrected in the case of the larger machine but it is on the high side in the case of equipment below 90 h.p. Other remarks are the same as those for shovels in para 16.6.

*Nangal* :—Life adopted about correct provision for depreciation is 75% to 80% of ours. Expenditure on Labour and P.O.L. is on the high side.

*Hirakud* :—Life adopted is 60% of ours. Provision for repairs tallies with our recommendations. Labour charges are reasonable while expenditure on P.O.L. is rather low.

*Maithon* :—Life adopted is 75% of ours while the provision for repairs tallies with our recommendation. Labour charges are reasonable. Expenditure on P.O.L. is 50% higher.

*Panchet Hill* :—Life adopted is 75% of ours while the provision for repairs tallies with our recommendations. Labour charges are reasonable. Expenditure on P.O.L. is 50% higher.

*Harike* :—Figures for life of machines below 90 h.p. agree with us, while those for bigger machines are slightly less. Provision for repairs is 60% of that recommended by us. Expenditure on Labour is at par for small makes and higher for large ones, while that on P.O.L. is 50% higher.

*Sarda Hydel* :—Figures for life are 20% less than ours while those for repairs tally. Expenditure on Labour and P.O.L. is very much on the high side.

*Kakrapar* :—Life assumed is 16% less, while provision for repairs is the same as ours. Labour charges are reasonable while fuel charges are 25% higher.

*Gangapur* :—Life of machines below 90 h.p. is the same as ours, while that of larger machines 16% lower. Provision for repairs is 37% higher than that recommended by us. Labour and P.O.L. are about the same.

*Tungabhadra (Andhra)* :—Life and provision for repairs are identical with ours while the expenditure on Labour and P.O.L. is nearly the same.

*Tungabhadra (Hyd.)* :—Life assumed is very excessive  $2\frac{1}{2}$  times. Provision for repairs is 20% higher than ours. Expenditure on Labour and P.O.L. is the same as recommended by us.

*Lower Bhawani* :—The remarks about draglines (para 16.7.2.) apply to these machines also.

### 16.9. MOTORISED SCRAPPERS AND GRADERS

16.9.1. Table 16.9.1. (i) gives figures for the life, depreciation and expenditure of these machines, while 16.9.1. (ii) gives those for Labour and P.O.L.

16.9.2. The following comments will be apparent:—

*Bhakra (Motorised only)* :—Life of the larger machines is the same as recommended by us while that of the smaller machines is 16% less. Provision for repairs is  $2\frac{1}{2}$  times our figures. Expenditure on Labour is 50% higher and that on P.O.L. is 10% higher.

*Hirakud (Scrappers)* :—The life is nearly half of ours; may be, owing to the machines being second hand. Provision for repairs is the same as ours. Expenditure on labour is nearly double, while that on P.O.L. is about the same as ours.

*Sarda Hydrel* :—The life of machines is two-thirds of ours. The provision for repairs is 10% to 20% higher. Expenditure on labour tallies with our recommendations, while that on P.O.L. is 25% higher.

*Kakrapar* :—The life adopted is  $\frac{2}{3}$  that of ours while the provision for repairs is the same as recommended by us. Expenditure on Labour and P.O.L. is 60% to 70% higher.

*Gangapur* :—Figures for the life and the provision for repairs are  $\frac{2}{3}$  of those given by us. Expenditure on Labour is 20% higher while that on P.O.L. is 50% of ours.

*Tungabhadra (Hyd.) (Scrappers)* :—Figures for life tally with ours; provision for repairs is 60%. Expenditure on Labour tallies while that on P.O.L. is nearly reasonable.

*Motorised* :—Life is 20% higher. Provision for repairs is 75% of ours. Labour charges are reasonable. Expenditure on P.O.L. is rather low.

TABLE 16.9.1.(i)

*Life, Depreciation and Repairs of Motorised Scrappers and Graders*

- N.B. : 1. The bottom figures are on the basis of Rates & Costs Committee recommendations regarding life hours and percentage of repairs.  
 2. Depreciation & repairs in columns 4 & 5 are inclusive of tyres & tubes.  
 3. Separate provisions for repairs & maintenance of tyres & tubes have not been provided for in projects. Rates & Costs Committee figures are shown.

Sl. No.	Equipment/Project	Cost in lakhs	Life hours	Depreciation per hour	Repairs per hour	Percentage of repairs over depreciation	Total depreciation & repairs (5&6)
1	2	3	4	5	6	7	8
<b>I</b>							
<b>Motorised Scrappers (Rubber Tyred.)</b>							
<b>1. 12 cyds. capacity</b>							
<b>(a) Sarda Hydel</b>							
		1.56	10000	13.6	14.66	110	28.26
			15000	9.07	9.07	100.5	18.16
	<b>(b) Gangapur</b>	1.38	10000	13.75	9.13	65	22.88
			15000	10.75	8.5	100.55	19.25
	<b>(c) Tungabhadra</b>	1.28	14400	22.17	5.36	60	7.53
			15000	21.81	15.70	100.55	37.51
<b>2. 15 cyds. capacity</b>							
<b>(a) Sarda Hydel</b>							
		1.5	10000	15.0		80	27.0
			15000	10.0	12.0	100.60	20.0
	<b>(b) Hirakud</b>	1.24	8000	15.55		100	31.10
			15000	8.25	15.55	100.60	16.5
	<b>(c) Tungabhadra (Hyd.)</b>	1.14	14400	20.88	5.6	60	26.48
			15000	20.44	15.96	100.60	36.30
<b>II. Motorised Graders</b>							
<b>50 H.P. Bhakra</b>							
		0.58	10000	10.11	10.61	200	20.73
			12000	9.22	8.75	80.55	15.97
<b>115 H.P. (a) Bhakra</b>							
		0.99	12000	12.70	15.8	200	28.50
			12000	12.70	8.82	80.60	21.52
	<b>(b) Tungabhadra (Hyd.)</b>	0.56	14400	6.75	2.33	60	9.08
			12000	8.40	5.97	80.60	14.37

TABLE 16.9.1. (ii)

*Life, Depreciation and Repairs of Motorised Scrappers and Graders*

N. B: 1. The bottom figures are on the basis of Rates & Costs Committee recommendations regarding life hours and percentage of repairs.

2. Depreciation and repairs in columns 4 & 5 are inclusive of tyres & tubes.

3. Separate provisions for repairs & maintenance of tyres & tubes have not been provided for in projects. Rates & Costs Committee figures are shown.

Sl. No.	Equipment/Project	Cost in lakhs	Life hours	Depreciation per hour	Repairs per hour	Percentage of repairs over depreciation	Total depreciation & repairs (5 & 6)
1	2	3	4	5	6	7	8
<b>I. Motorised Scrappers</b>							
1. 12 cyds. capacity							
(a)	Sarda Hydrel	1.56	10000	13.6	14.66	110	28.26
			15000	9.07	9.07	100.55	18.16
(b)	Gangapur	1.38	10000	13.75	9.13	66	22.88
			15000	10.75	8.5	100.55	19.25
(c)	Tungabhadra	1.28	14400	22.17	5.36	60	27.53
			15000	21.81	15.70	100.55	37.51
2. 15 cyds. capacity							
(a)	Sarda Hydrel	1.5	10000	15.0	12.0	80	27.0
			15000	10.0		100.60	20.0
(b)	Hirakud ..	1.24	8000	15.55	15.55	100	31.10
			15000	8.25		100.60	16.5
(c)	Kakrapar	1.64	10000	12.3	12.3	100	426.
			15000	8.2	8.2	100.60	16.4
(d)	Tungabhadra (Hyd.)	1.14	14400	20.88	5.6	60	26.48
			15000	20.44	15.86	100.60	36.30
<b>II. Motorised Graders</b>							
50 H.P.							
	Bhakra .. ..	0.58	10000	10.11	10.61	200	20.73
			12000	9.22	6.75	80.55	15.97
115 H.P.							
(a)	Bhakra .. ..	0.99	12000	12.70	15.8	200	28.50
			12000	12.70	8.82	80.60	21.52
(b)	Tungabhadra (Hyd.)	0.56	14400	6.75	2.33	60	9.08
			12000	8.40	5.97	80.60	14.37

## 16.10. EARTHWORK RATES

16.10.1. The overall earthwork rates of projects made available to us were studied and the following are our comments projectwise.

## 16.10.2. Nangal

Rates for earthwork on the Nangal Project by mechanical equipment have been derived from the corresponding rates for manual labour, after converting lifts into leads and applying a premium on the sanctioned schedule of rates for the year 1942. As stated elsewhere, we do not agree with this method of derivation or comparison of rates, as leads of the range of 2000' to 6000' are not at all economic for manual work. The following table makes a comparison of rates actually obtained on the project for earthwork excavated by shovels and dumpers and those worked out by us.

TABLE 16.10.2.(i)

## (A) Earthwork by Shovels and Carrier Units

Lead in feet	Soil	Rate per CFC	
		Nangal	R. & C.C.
		Rs.	Rs.
.. .. .	Light clay mixed with gravel	3.86	3.46
3000 .. .. .	..	5.36	4.22
5000 .. .. .	..	8.36	5.80
6000 .. .. .	..	9.86	6.70

It will be seen that although the use rates of these machines are low and their outputs are the same as recorded by us [Table 16.4.2. (i.)] their final rates are on the high side. This can be ascribed to reasons given by us in para. 16.6.2. The provision of 200 as premium provided over the basic leads is high for mechanical work. We have observed that the project executives have worked with these rates despite the fact that the use rates of their machines are already low due to their adoption of abnormally high figures for life of the machines. This indicates that the work by shovels and dumpers was carried out at a higher rate than required.

*(B) Earthwork by Motorised Scrappers at Nangal*

(Premium over basic rates varies from 190% to 110% depending on lead. For leads 500 to 1100 ft. 190% is allowed and 110% for lead above 1800 ft.)

Lead in feet	Soil	Rate per CFC	
		Nangal	R.&C.C.
1000	Light clay mixed with gravel	Rs. 2.29	Rs. 2.39
1500		2.43	2.52
2000		2.75	2.67

*Comment* :—The Premium allowed on the basic rate is reasonable.

*(C) Compaction Rate per CFC*

Items	Nangal	R.C.C.
	Rs.	Rs.
Dozing	0.21	0.38
Watering	0.21	0.25
Compaction	0.86	0.21

*Comment* :—Compaction rate is high in the project.

**16.10.3. Maithon**

(a) The project has furnished cost analysis sheets 'Earthwork in the Earth Dam in Borrow (I)' area seems to be mostly done by shovels and hauled by dumpers. The unit rate obtained during Jan.' 53 to Aug.'55 is Rs. 2.19 per cu. yd. or Rs. 8.1 per CFC which included lighting, water supply charges, etc. The primary rate will be Rs. 2.03 per cu. yd. or Rs. 7.5 per CFC for excavation, hauling and compaction. The lead is not known. Assuming a maximum lead of 5000 ft., the R.&C.C. rate will be Rs. 5 for excavation and Re. 0.85 for compaction giving Rs. 5.85 as against Rs. 7.5 of the project.

(b) The earthwork for 'Earth Dam—Embankment' is mostly scrapper work done during Oct.'52 to Aug.'55. The rate exclusive of lighting and overheads is Re. 0.87 per cu. yd. or Rs. 3.22 per CFC. This rate includes compaction rate. The lead is not known. Assuming a maximum lead of 2500 ft., the rate as per R. & C.C. is Rs. 3.18 per CFC.



*Comments* :—The use rates of the machines per hour are nearly the same as those recommended by R. & C.C. The rate for compaction is high.

(a) The rate for earthwork borrow area is high indicating low output and low efficiency.

(b) The rate for embankment is adequate.

#### 16.10.4. Panchet Hill

The project has furnished 'detailed cost analysis' giving the break-up of the rates obtained during the period 1st November, '54 to 31st July '55.

(a) *Dozing and Compaction* :—The rate, without miscellaneous overheads, for dozing and compaction is Re. 0.88 per cu. yd. Rs. 3.27 per CFC. The lead is not mentioned.

Assuming an average lead of 150 ft., the rate as per R.&C.C. analysis is Rs. 3.49 per CFC.

(b) *Excavation Borrow (Semi & Impervious)* :—The work is mostly done by shovels, scrappers and beltloader dumpers, dozers and rooters. Hence the rate is composite. The rate, without lighting and miscellaneous charges is Rs. 1.4 per cu. yd. or Rs. 5.2 per CFC. Lead is not known.

Assuming an average lead of 3,000 ft, the rate, as per R.&C.C. will be about Rs. 4.84 per CFC inclusive of compaction.

(c) *Excavation Common* :—This is mostly done by shovels and hauled by dumpers. There are no shares of rates for compaction or watering units and hence it is taken that only excavation and hauling is done.

The rate is Rs. 1.7 per cu. yd. or Rs. 6.3 per CFC for maximum lead of 5000 ft. The rate as per R.&C.C. is Rs. 5.

#### 16.10.5. Hirakud

Details of the rate given below are not available.

Excavation and Transport	Rs. 9.04 per CFC
Watering, compaction and dressing	Rs. 1.20

TOTAL	Rs. 10.24
-------	-----------

The rate is inclusive of charges for electrification of borrow area, miscellaneous works, etc. Lead is not known nor are the details of the equipment used.

Assuming average lead of 5000 ft. and earthwork by shovels, the rate as per R.&C.C. is Rs. 5.84,

**16.10.6. Lower Bhawani Project***(a) Earthwork by Excavators and hauling by Dumpers  
(Lead one mile)*

Rate per CFC (loose)	Rs. 3.46
Add for compaction	Rs. 1.75
	<hr/>
Rate per CFC (compacted)	Rs. 5.21

The soil has a shrinkage of 10% and a swell of 20%. On this basis, the rate per CFC (borrow) excavated, transported and compacted is Rs 4.15 plus 2.10=Rs. 6.25.

As per R.&C.C. rates, assuming the soil as light clay, the rate is Rs. 5.8. plus 0.84=Rs. 6.64.

*(b) Earthwork by Scrappers  
(Lead 3/4 mile).*

Rate per CFC (loose)	Rs. 3.05
Add for compaction	Rs. 1.53
	<hr/>
Rate per CFC (compacted)	Rs. 4.58

On the basis of borrow measure the rate will work out to Rs. 3.66 plus 1.83=Rs. 5.49.

As per R.&C.C. rates, assuming the soil as light clay, the rate per CFC borrow measure excavated, hauled and compacted, comes to Rs. 3.41 plus 0.84=Rs. 4.25.

**16.10.7. Tungabhadra (Andhra)**

*(a) Earthwork by Shovels* :—The soil excavated is hard stiff clay and red earth.

Excavation rate	Rs. 1.28 per CFC
Hauling this a lead of 6000 ft.	Rs. 2.23
	<hr/>
	Rs. 3.51

The R.&C.C. rate for this lead is Rs. 5.

*(b) Earthwork by scrappers* :—For a lead of 1 mile, the rate for scrapping and depositing stiff clay and red earth is Rs. 3.65 per CFC. The R.&C.C. rate is Rs. 3.98 for 5000 ft.

The use rates of the machines are lower than those of R.&C.C. and hence lower rates for earthwork.

**16.10.8. Kakrapar**

Data is available from L.B.M. Canal, Kakrapar. The work is done by scrappers and bulldozers. The lead is 1000 ft. and the rate per CFC of embankment measure is Rs. 4.

The percentage of swell of the soil is not known; assuming that the compacted earth will be 10% less than borrow, the rate per CFC borrow will be Rs. 4.44.

As per R.&C.C. the rate for 1000 ft. lead by scrappers working in murum is Rs. 3.23.

*Comments* :—The hourly rate of scrapper is Rs. 50 and that of bulldozer is Rs. 37 as against Rs. 56 and Rs. 32 respectively as per R.&C.C.

The rate is reasonable considering the difficult soil conditions and average output.

**16.10.9. Gangapur**

The earthwork for hearting and casing in embankment was done by scrappers. The average lead is 3,000 ft.

The cost per CFC embankment is Rs. 6.19. The densities of borrow and bank are not stated. As per the project report the borrow pit density is 85 lbs./cu. ft. and that of fill is 105 lbs./cu. ft.

$$\text{Hence the rate per CFC borrow measure} = \frac{9 \times 105}{85} = \text{Rs. } 7.65.$$

The rate as per R.&C.C. for a lead of 3,000 ft. and scrapper work in hard murum, will be Rs. 3.35 per CFC.

*Comments* :—The rate is high, though the use rates of the machines are near about R.&C.C. rates, because the cost of rolling is 0.51 against 0.21 and dozing 0.51 against 0.38, and the output obtained is 12.4 CFC (borrow) as against about 17 CFC per R.&C.C.

**16.10.10. Sarda Hydel Project**

(a) *Earthwork by 8.1/10.5 cyds. drawn scrapper is sandy soil*:—The rate per CFC is Rs. 2.47 for excavation and hauling and Re. 0.265 for compaction giving a total of Rs. 2.74.

The rate as per R.&C.C. analysis works out to Rs. 2.24 plus 0.84 = Rs. 3.08.

(b) *Earthwork by Motorised Scrapper in sandy soil (lead 1400 ft.):* The rate per CFC is Rs. 2.63 plus Rs. 0.27 for compaction giving a total rate of Rs. 2.9.

As per R.&C.C. the rate is Rs. 2.35 plus 0.84 = Rs. 3.19.

*Comments* :—The compaction rate is Re. 0.21 for CFC bank measure or Re. 0.265 per borrow output; does not provide for dozing and watering charges; hence the unit rate is low.

### 16.11 DRILLING AND BLASTING

Comparative actual rates of rock excavation per CFC on projects are reproduced from Chapter 9. Table 9.7.1.(i). Comments are given below:

TABLE 16.11.1

*Rates of Rock Excavation per CFC on Projects*

N.B.—The Bottom figures in each line are as per Rates & Costs Committee.

Sl. No.	Projects	Type of rock	Rate per CFC of Rock in rupees		
			Drilling	Blasting	Total
1	2	3	4	5	6
1.	Bhakra .. .. .	Mixed rock	2.84	5.60	8.44
			4.20	4.50	8.70
2.	Gangapur .. .. .	Deccan trap	4.32	3.52	7.84
			4.20	4.50	8.70
3.	Gandhisagar .. .. .	Highly abrasive foliated quartzite	15.77	6.45	22.22
			12.60	6.50	19.10
4.	Kakrapar .. .. .	Deccan trap	4.75	6.0	10.75
			4.20	4.5	8.70
5.	Kotah .. .. .	Laminated quartzite	5.97	3.26	9.23
			4.20	4.50	8.70
6.	Peechi .. .. .	Granite	9.00	5.75	14.75
			6.30	5.62	11.92
7.	Vaitarna .. .. .	Basalt	3.55	7.03	10.58
			4.20	4.50	8.70

*Comments*

*Bhakra* :—The rates are as per the actual data obtained from the Register of Works of the Project. The rock excavated is of mixed type consisting of clay stone, sandstone, etc. The estimated rate for drilling and blasting using jackhammers will be about Rs. 12 as compared to the actuals Rs. 8.44. The actuals are nearly the same as that of R.&C.C.

*Gangapur, Kakrapar and Vaitarna* :—The projects being located in the Bombay State have encountered basalt or trap for excavation. The rates at which they have carried out the excavation, though slightly higher than R.&C.C. are reasonable.

*Gandhisagar Dam* :—Special mention is to be made of the high rate here which is because of the highly abrasive laminated quartzite rock of the Vindhyan range. The depth of drilling required was 18 ft. per CFC of rock and it resulted in abnormal consumption of drill bits. To arrive at a fair rate as per R.&C.C. a premium of 20% in case of laminated quartzite and 50% for granite is added to the basic R.&C.C. drilling rate for basalt. Similarly, approximate cost is added to blasting in these cases.

## 16.12. EXCAVATION IN ROCK BY SHOVELS

TABLE 16.12.1.

*Excavation in Rock by Shovels*

Sl. No.	Project & Situation	Lead in Ft.	Actual Rate per CFC (Rs.)		
			Drilling & Blasting	Shovelling Hauling	Total
1.	2	3	4	5	6
1.	<i>Bhakra</i>				
	(a) Left abutment between RL 1200-1700	—	7.9	13.7	21.6
	(b) Left abutment above RL 1700 ..	1400	6.5	6.6	13.1
	(c) Right abutment between RL 1200 to 1700	—	7.8	15.2	23
2.	<i>Maithon</i> .. .. .	—	—	9.4	—
3.	<i>Panchet Hill</i> .. .. .				
	Intermediate Rock .. .. .	—	8.64	8.8	17.44
	Hard Rock .. .. .	—	13	14	27
4.	<i>Gangapur</i> .. .. .	3 Miles Round haul	10.85	17.56	28.41

**Bnakra**

Latest estimated analysis of rate of rock excavation in Rs. 8.4 per cu yd. or Rs. 31 per CFC.

As per the actuals obtained in the Register of Works the figures are as follows :

*(i) Excavation of Left Abutment between R.L. 1200 and 1700.*

*Soils* : Common, claystone and sandstone as 1:1:5. The factual rate is Rs. 7.9 for drilling and blasting and Rs. 13.7 per CFC for excavation and hauling, giving a total of Rs. 21.6 per CFC.

*(ii) Excavation of Left Abutment above R.L. 1700*

It is mostly rock lead 1400 ft. The factual rate of drilling and blasting is Rs. 6.5 and for excavation and hauling Rs. 6.8, giving a total of Rs. 13.1 per CFC.

*(iii) Excavation of Right Abutment between R.L. 1200 and 1700.*

Mainly sandstone was quarried and transported. The rate as calculated by the project is Rs. 26.7 per CFC. The actuals are as Rs. 7.8 and Rs. 15.2 CFC for drilling and blasting and excavation and hauling respectively.

As per the R. & C.C. analysis, the rate for drilling and blasting is Rs. 8.75 and for mucking and hauling through a lead of 8,000 ft. is Rs. 12.7.

*Comments*

The cost of drilling and blasting is reasonable. In the case of mucking and hauling, between R.L. 1200-1700 for both abutments, the leads being unknown, comments cannot be given.

**Maithon***Excavation in Rock in Diversion Channel*

As per the 'cost analysis' for the period November, 1952 to June 1953, the rate for mucking and hauling is Rs. 2.54 per cu. yd. of Rs. 9.4 per CFC. The haul distance is not known.

Assuming a maximum lead of 3,000 ft., the rate for mucking and hauling as per R. & C.C. is Rs. 6.7.

**Panchet Hill**

The 'cost analysis' sheets for the period 1st November, 1954 to 31st July, 1955 record the following rates :—

*(i) Excavation intermediate rock.*

Drilling and blasting charges are Rs. 2.23 per cu. yd. or Mucking and hauling (without lighting, interest, etc.)

Rs. 8.64 per CFC

Rs. 8.8 per CFC

Rs. 17.44

The lead is not known.

(ii) *Excavation hard rock.*

Drilling and blasting Rs. 3.54 per cu. yd. Mucking and Hauling (without lighting, etc. charges).	Rs. 13 per CFC
	Rs. 14 per CFC
Total	Rs. 27 per CFC

The rate as per R. & C.C. analysis for drilling and blasting is Rs. 8.75 and Rs. 6.7 for mucking and hauling for a lead of 3,000 ft.

**Gangapur**

*Rock work at the Waste Weir.*

Drilling and blasting	Rs. 10.85 per CFC
Excavation & Hauling	Rs. 17.56 per CFC
Total	Rs. 28.41 per CFC

Average round lead is 3 miles.

As per R. & C.C., average rate for drilling and blasting is Rs. 8.75 and for a lead of 8,000 ft., the excavation and hauling rate is Rs. 12.7.

*Comments*

3/4 cu. yd. shovel is used for shovelling and hence greater cost per unit of shovelling.

3/4 hour tractor dozer is used per hour of shovel as against 1/3 of R. & C.C.

The drilling and blasting rates are high.

### 16.13. TUNNELLING

16.13.1. The data available in the country on tunnels is so meagre and the local conditions so varied that it is difficult to make any comments on these rates. A few general observations are, however, given below in Table 16.13.1. which gives comparative rates of rock excavation in tunnels.

TABLE 16.13.1.

Sl. No.	Name of Project	Nature of rock	Sectional area in sq. ft.	Length of Tunnel in ft.	Rock excavation rates per CFC			
					Primary (Rs.)	On Burden cost	Overall	
1	2	3	4	5	6	7	8	
1.	<i>Bhakra</i> *							
(a)	Right Tunnel.	Diversion	Varies from inundated clay to jointed sandstone	196	2640	72	33	105
(b)	Left Tunnel.	Diversion	Do.	Do.	Do.	118	54	172
2.	**Tungabhadra (Andhra)		Granite	168	1105	207	73	280
3.	†Bhore Ghat (Central Rly.)		Trap Shale rock	360	—	143	—	143
	†Thal Ghat (Central Rly.)		Trap Shale rock.	360	—	170	—	170
5.	††Budni Barkhera (Central Rly.)		Soft grounds needing steel support.	577	—	117	—	—
6.	§Banihal (Kashmir)		Varies from Punjab Trap, Slate Shale & Limestone	—	3819	194 to 197	—	194 to 197

\*Departmental work.

\*\*Party departmental and contract.

† Contract rate.

‡ Departmental work.

§ Burden not known.

### 16.13.2. Comments

The above table shows that the primary rates for excavating tunnels in soft rock including drilling, blasting, mucking and haulage vary from Rs. 72 to Rs. 118 while for harder rocks it ranges from Rs. 143 to Rs. 197. The rate of Rs. 209 for Ramasagram Tunnel at Tungabhadra could have been lower but for the reason of commencing work before the approach and exit flumes could be completed which was necessitated for early completion of work to allow water in the canal.

### 16.14. TRANSPORT RATES

16.14.1. Most of the projects were unable to furnish data for transport rates, their difficulty being that the rates could not be isolated. The projects given below are working against schedule rates which have been compared in Table 16.14.1. The rates derived in columns 4 and 5 are partly for rough metal roads and partly for soft roads and also allow for 3 miles lead 30% is included in R.&C.C. rates for contractors' profit and overheads.



TABLE 16.14.1  
Comparative Rates of Transport

Sl. No.	Name of Project	Project rates for 3 miles lead (Rs.)	R.&C.C. Rates		Remarks
			Petrol trucks (Rs.)	Diesel trucks (Rs.)	
1	2	3	4	5	6
<i>Rubble Stone</i>					
1.	Matatila .. .. .	12.0	11.8	10.3	
2.	Mayurakshi .. .. .	11.9	11.8	10.3	
3.	Hirakud .. .. .	12.0	11.8	10.3	
4.	Lower Bhawani .. .. .	11.9	11.8	10.3	
<i>Bricks</i>					
1.	Matatila .. .. .	12.0	9.5	8.1	
2.	Mayurakshi .. .. .	13.0	9.5	8.1	
3.	Hirakud .. .. .	12.0	9.5	8.1	
4.	Lower Bhawani .. .. .	7.3	9.5	8.1	
<i>Sand</i>					
1.	Nangal .. .. .	13.6	12.7	10.9	
2.	Matatila .. .. .	12.0	12.7	10.9	
3.	Hirakud .. .. .	12.0	12.7	10.9	
4.	Kakrapar .. .. .	11.0	12.7	10.9	
5.	Lower Bhawani .. .. .	to 15.0 9.4	12.7	10.9	
<i>Coarse Aggregate</i>					
1.	Matatila .. .. .	12.0	12.7	10.9	
2.	Mayurakshi .. .. .	12.5	12.7	10.9	
3.	Hirakud .. .. .	12.0	12.7	10.9	
4.	Kakrapar .. .. .	14.0	12.7	10.9	
5.	Bhadra .. .. .	16.6	12.7	10.9	
6.	Lower Bhawani .. .. .	11.9	12.7	10.9	

16.14.2. It appears that project rates are more or less comparable with the R.&C. C. rates for petrol trucks. Had diesel trucks been used the cost would have been less.

### 16.15. BRICKWORK

16.1.15. Brickwork like earthwork is being carried out on projects by piece-workers on the basis of the sanctioned schedule of rates and the project authorities do not have a break-up of the rates. No comments are, therefore, offered.

### 16.16. LINING OF CANALS

16.16.1. Table 16.16.1. gives the break-up of the rates into elements of costs for brick lining on three important projects. The rates per CFC hours are round Rs. 120 which is reasonable.

TABLE  
Break-up of Rates of Brick

Sl. No.	Name of Project	Mix of Mortar	Brick Tiles			Sand		
			Qty. Nos.	Rate inclusive or carriage per 1000 Nos.	Amount Rs.	Qty. in FC	Rate inclusive of carriage per CFC	Amount Rs.
1	2	3	4	5	6	7	8	9
1.	Nangal Hydrel (Rupar) 12"×6"×2" double layer tile lining in bed.	1:4 C.M.	908	51.75	47.16	36.3	16.0	5.83
2.	-do- on slopes	1:4 C.M.	908	51.75	47.16	36.3	16.0	5.83
3.	Harike 12"×6"×2" double layer tile lining in bed.	1:4 C.M.	908	47.0	42.68	36.3	6.5	2.36
4.	Sarda Sagar Hydrel. 10"×5"×2½" double layer tile lining in bed and slopes.	1:4 C.M.	1100	39.25	43.18	40.0	10.0	4.10
<i>Break-up of Rates of</i>								
5.	Tungabhadra (Hyd.) 9" thick U.C.R.S. in slopes.	1:8 CM.	100	10.29	10.29	40.0	11.14	4.46

16.16.1.

*Tile Lining per CFC*

Cement			Labour	Soaking, Tank & Water Curing Arrange- ments	T & P sundries profile for Sub- grade	Total Rate in Rs. per CFC 100 cu. ft.	Rate in Rs. per CFC 100 sq. ft.	Thick- ness of Lining (inches)	Remarks
Qty. in cwt.	Qty. in- clusive of car- riage per cwt.	Rate Rs.							
10	11	12	13	14	15	16	17	18	19
7.95	4.59	36.49	25.8	5.9	—	121.2	53.37	5	(1) excess Labour- for slope lining Rs. 4.75 per CFC.
7.95	4.59	36.49	32.4	5.9	9.13	136.94	60.33	5	(2) Rate for CFS on slope Rs. 49.2
7.95	4.77	37.95	23.25	—	—	106.25	47.12	5	
7.40	5.5	40.70	38.60	—	5.5	132.00	66.00	6	
<i>U. C. R. S. Masonry Lining (Rate per CFC)</i>									
3.98	5.57	22.17	25.12	—	—	62.00	46.5	9	

16.16.2 Table 16.16.2. gives the rates for concrete lining, which has been carried mainly by manual labour, although the normal practice in foreign countries is to go in for mechanisation on all large-scale works.

TABLE 16.16.2.  
Break-up Rates of Concrete Lining Rate per CFC

Item	Name of Project					
	Nangal Canal		Hydel	Tungabhadra (Andhra)		Tungabhadra (Hyderabad)
	5" thick in bed	6" thick in slopes	4½" thick in bed	4½" thick in slopes	4" thick in bed, blasting of agg. by Govt.	Precast
1	2	3	4	5	6	7
1. Mix of Concrete	1:3:6	1:3:6	1:6:10	1:3½:5	1:6:10	1:4:5
2. (a) Aggregates 1½" size. Quantity in FC.	46.6	47.0	77.1	77.7	100	85.7
*Rate inclusive of carriage per CFC	24.26	24.26	40.06	40.06	—	34.3
Amount (Rs.)	11.3	11.4	30.9	31.1	12.86	29.4
(b) Aggregates ¾" size. Quantity in FC	46.6	47.0	19.3	19.4	—	—
Rate inclusive of carriage per CFC	27.26	27.26	54.0	54.0	—	—
Amount (Rs.)	12.7	12.9	10.9	10.5	—	—
3. Sand						
Quantity in FC	46.6	47.0	57.8	58.2	50.0	69.0
Rate inclusive of carriage per CFC	18.06	18.06	35.0	35.0	17.16	10.3
Amount (Rs.)	8.4	8.5	20.2	20.4	8.58	7.5
4. Cement						
Quantity cwts.	12.68	12.70	7.74	13.52	6.66	13.9
Rate inclusive of carriage	4.85	4.85	5.15	5.15	5.35	5.57
Amount (Rs.)	61.5	61.6	39.9	69.6	35.67	76.5
5. Labour	15.17	19.75	10.3	31.2	26.1	*143.1
6. Plant Use	2.75	2.75	2.72	16.8	—	9.37
7. Formwork	13.7	20.0	—	33.8	—	—
8. Slurry	17.9	15.0	15.6	16.5	—	—
9. Curing	1.8	1.5	—	—	4.3	—
10. Sundries	—	—	—	—	0.73	—
11. Total Rate	145.2	159.4	130.0	229.9	88.9	265.8
Per CFC (Rs.)—AV	149.3					
12. Rate Rs.	61.0	76.75	48.75	87.75	29.6	44.12
Per CFC—AV	68.85					

\*Includes (1) Labour per concreting (2) Fixation of Blocks (3) 1:6 cu. mortar quantity of which is not given (4) Conveyance of precast slabs.  
Rates include washing of aggregates also.



TABLE 16.18.1.—(contd.)

1	2	3	4	5	6	7	8	9	
<i>R.C.M. 1:4</i>									
1. Gandhisagar ..		100	37.99		41.4	36.3	2.6	80.6	112
2. Mayurakshi ..		100	23+(14) lead=3 T		40.0	8.0	2.0	100.0	28.0
3. Kakrapar ..		110	(14+5) lead		51	12.4	2.25	119	12.25
4. Tungabhadra (And.)	5+100 +8010		20.38 14.00+ 13.06 2½-3½ miles lead		53.0	25.0	2.29	150 +9	15.14
5. Tungabhadra (Hyd.)		121	14.79+12.15		60	25.93	2.28	98.07	22.77
6 R.C.C.		100	26.9		54	17.4	2	75	15.0
Sl. No.	Item					Name of Project			
						Matatila	R.C.C.		
<i>L.R. in C.M. 1:5</i>									
1. Stone									
Qty. (cu.ft.)							90	100	
Rate per CFC							18.0+9.0	26.9	
Amount							25.2	26.9	
2. Sand									
Qty. in cu.ft.							45.0	56	
Rate per CFC							5+17	17.4	
Amount							9.90	9.75	
3. Cement									
Qty. in cwt.							7.5	9.0	
Rate							5.25	5.02	
Amount							39.40	45.18	
4. Cost of Mortar per CFC of Masonry									
Qty.							45	45	
Amount							51.9	58.23	
5. Labour									
Skilled							2.5	1.25	
Rate							3.7	4.25	
Unskilled							7.58	4.2	
Rate							—	1.5	
6. Total Labour Cost							19.6	15.0	
7. Total Primary Rate							99.20	118.33	

16.18.2. The rates for supplies of stone on the Gandhisagar, Matatila, Tungabhadra (Andhra) and Mayurakshi are considerably higher than those paid at Lower Bhawani and Malampuzha, although the methods of execution of the work are the same.

16.18.3. Barring Tungabhadra (Hyd.), Mayurakshi heads the list in labour charges per CFC of masonry against the usual rate of Rs. 15/- without lead and lift sand supplies cost Gandhisagar and Tungabhadra (Andhra) more than others because of difficult terrain out longer leads.

### 16.19 RIP-RAP

16.19.1. The rate at Konar is the highest, i.e., Rs. 37/3/- per CFC; that at Hirakud being the lowest at Rs. 20/14/- against a rate of Rs. 29 per CFC worked out by us.

TABLE 16.19.1.

Sl. No.	Name of Project	Unit (cu. ft.)	Stone	Carriage	Laying	Unit rate
1.	Hirakud*	100	8/-	9/7	3/7	20/14
2.	Gangapur**	..	8/15	9/15	3/-	23/5
3.	Malampuzhat†	..	10/-	9/12	7/8	30/-
4.	Lower Bhawani††	..	26/9	—	8/-	24/12
5.	Konar (DVC) §	..	18/-	12/10	6/9	37/3

\*Rockfilling hand packed U/S & D/S toe.

\*\*Also include Rs. 1/7 as overhead charges.

† Also include Rs. 2/12/- as miscellaneous charges.

†† Also include Re.-/3/- as incidental charges.

Original rate.

### 16.20. LIFT

16.20.1. Average rate for lift of every 5 ft., by manual labour ranges from Rs. 2 to Rs. 3 per CFC of stone masonry. This would mean Rs. 12 to Rs. 18 per CFC of stone masonry for a dam of 80 ft. height.

TABLE 16.20.1.

#### Comparative Statement of Rates for extra lift per CFC of Stone Masonry

Sl. No.	Name of Project	Extra Rates for per CFC	Remarks
1	2	3	4
1.	Matatila .. .. .	3.0	This rates is for extra lift of 5 ft. above 20 ft. (Estimate).
2.	Gandhisagar .. .. .	2.25	Average per lift charges.
3.	Mayurakshi .. .. .	12.50	10 to 30 ft. lift.
4.	Hirakud .. .. .	2.5*	For every 10' or part thereof,
		4.0**	*Contract rate for concrete dam.
			**Contract rate for power dam.
5.	Kakrapar .. .. .	4.5	Lift 10 to 20 ft.
6.	Tungabhadra (Andhra) ..	2.25	Average Lead & Lift charges
7.	Tungabhadra (Hyd.) ..	8.5	For 40 ft. height.

16.20.2. Lift charges for manual labour that are provided for in the analysis in Mayurakshi, Hirakud, Matatila, Tungabhadra (Hyd.) are on the high side. The rates could have been lowered by using crane in those projects instead of employing manual labour. The use of crane for lifting materials on dams is justified on grounds of speed, safety and economy. The rate analyses are given in para 13.7.3.

### 16.21. MASS CONCRETE

16.21.1. The rates for mass concrete have been very unsteady on the projects.

Table 16.21.1 gives latest known rates for materials and mechanical operations on the principal projects.

TABLE 16.21.1.

*Projects.*

Sl. No.	Item	Maithon	Panchet Hill	Hirakud	Vaitarna	Bhakra
1	2	3	4	5	6	7
1.	Coarse Aggregate per CFC	61.8	46.7	50.7	40.0	} 23.9 Natural shingle, crushed saw.
2.	Sand per CFC	25.0	5.9	13.1	25.0	
3.	Cement per cwt	5.3	5.2	4.2	5.0	
4.	Batching, mixing, transporting, placing, vibrating, cleaning, curing & finishing and compressed air per CFC	40.2	55.4	57.1	38.0	28

NOTE : Rates for Bhakra are estimated.

16.21.2. The rates for supplies or manufacture of crushed stone on Maithon, Panchet Hill and Hirakud Project are higher than those at Vaitarana and Bhakra. Similarly, the rate for sand on Maithon Project is higher than Panchet Hill and Hirakud.

16.21.3. The combined rate for aggregate on Bhakra is particularly low as on crushing is involved in obtaining the requisite stone and sand.

16.21.4. The rates for crushed stone are high on Maithon on account of the low efficiency of the crushing plant.

16.21.5. The rates for batching, mixing, transporting, placing, vibrating, cleaning, curing and finishing and compressed air are generally high on most of the projects. Hirakud project leads in expense with Rs. 57.1 per CFC on this account against Rs. 38.0 per CFC on Vaitarna. The fair rate should be Rs. 33.25.



16.21.6. The issue rate for cement at Bhakra is Rs. 3.8 per cent. as against Rs. 5 to Rs. 5.3 from other projects.

## 16.22. FORMWORK

16.22.1. Table 16.22.1. gives a comparative statement showing primary rates of shuttering on various projects per CFS.

TABLE 16.22.1.

1. Konar	Rs. 110
2. Tilaiya	Rs. 142
3. Vaitarna	Rs. 118
4. Maithon	Rs. 283.2

16.22.2. The rate for shuttering on the Tilaiya is high and that on the Maithon is excessive.

## 16.23. SUMMARY

(i) That proper investigations should invariably be carried out before a project is taken up. This has not been the case with many of them.

(ii) That proper planning and estimating be done by competent engineers before a project is sanctioned.

(iii) That estimates be prepared in sufficient detail to enable the project authorities to exercise proper control over cost.

(iv) That costing cells be introduced on all projects.

(v) That the existing system of classification of accounts and stores be revised and the decimal system introduced on the pattern given by us.

(vi) That a perpetual inventory of stores be taken on all large projects.

(vii) That stores be issued at a fixed schedule.

(viii) That Manuals on costing and stores be drawn up and our recommendations on the subject be codified to enable all projects to adhere to a uniform pattern of accounting.

(ix) That the life tables for equipment be standardised. Our recommendations on the subject are contained in the report.

(x) That the allowance for major repairs and overhauls be put on standard footing.

(xi) That scales be laid down for provision for fuel, stores and lubricants, and for labour required for equipment.

(xii) That the provision for contingencies for works be scaled down.

(xiii) That greater attention should be given to housing for labour.

(xiv) That the cost of acquisition of land should be excluded when making provision for overhauls.

(xv) That projects should be given greater latitude in the purchase of spares for equipment and special committee be formed for this purpose.

(xvi) That principal items of construction equipment be standardised and early steps be taken for their manufacture in the country.

(xvii) That a Central Clearing House be formed immediately for the prompt disposal of all surplus equipment and stores on projects.

(xviii) That a system of incentives in the shape of overtime bonus and recognition of merit be introduced on all projects.

(xix) That for the sake of co-ordinated development and economy in manpower and equipment, it is necessary that River Valley Projects should be made a Central Subject.

#### 16.24. ACKNOWLEDGEMENT BY THE CHAIRMAN

Thanks are due to the various project authorities which ungrudgingly placed their resources at our disposal and undertook the additional burden imposed on them and their staff during our visits and an insatiable desire for more and more data.

The Committee lays on record its deep appreciation of the purely honorary services rendered by Shri M. R. Vardarajan, General Manager Hindusthan Construction Company particularly for the final scrutiny of the Chapters on Schedules and Analyses of Rates. We also feel indebted to the Hindusthan Construction Company for lending his services.

We are grateful to Shri S. Ramier for the able contribution made by him in chacking up the report from the financial angle in spite of his multifarious duties.

The exemplary manner in which Shri B. D. Nanda has discharged his obligations as Secretary, must be mentioned. We would also like to appreciate the willing co-operation extended by the First Secretary, Shri G. G. Dhanak after relinquishing his charge.

The hard work put in by the technical and office staff is appreciated.

*Sd/- P. C. AGRAWAL, Chairman.*

*Sd/- M. R. VARDARAJAN, Member.*

*Sd/- S. RAMIER, Member.*

*Sd/- B. D. NANDA, Member-Secretary.*

**FOURTH IRRIGATION & POWER SEMINAR  
SUB-COMMITTEE'S INTERIM REPORT ON THE  
RATES & COSTS COMMITTEE'S REPORT**

The following participated in the Sub-committee meeting:-

1. Shri S.D. Khungar -Chairman
2. Shri A.L. Saxena
3. Shri Telang
4. Shri N.G.K. Murthy
5. Shri M.R. Chopra
6. Shri H.K. Niwas
7. Shri C.M. Bennett
8. Shri P.C. Agarwal
9. Shri A.L. Kohli
10. Shri B.K. Gupta -Secretary

The Sub-committee recorded with satisfaction the usefulness of large data compiled in the Committee's Report. The following are the broad recommendations, and for detailed recommendations contained in Part I and Part II of the Committee's Report, a small Sub-committee may, however, be appointed.

- (i) That investigations should be carried out properly before a project is taken up.
- (ii) That proper planning and estimating be done by competent engineers before a project is sanctioned.
- (iii) That estimates be prepared in sufficient detail to enable the project authorities to exercise proper control over cost.
- (iv) That costing cells be introduced on all projects over five crores, but details of the system to be worked out later on.
- (v) That the existing system of classification of accounts and stores be revised and the decimal system introduced on the pattern given by the Rates and Costs Committee.
- (vi) That a perpetual inventory of stores be taken on all large projects. It is also desirable to have one annual stock-taking.

- (vii) That manuals on costing and stores be drawn up to enable all projects to adhere to a uniform pattern of accounting.
- (viii) The Rates and Costs Committee have recommended life of equipment used on the projects, in table 3.7.6 (i). As the life of some of the equipment is different from that recommended by the C.P. & M.C., which have been accepted by Government recently, it is considered that no change should be recommended in the life of that equipment as an interim measure. The projects may, however, be requested to keep proper accounts of the working of machines and log books so that the question of their lives and the provision for major repairs and overhauls may be reviewed after a period of one year.

The life of the equipment for items not considered by the C.P. & M.C. and as recommended by the Sub-committee is given in the appendix attached.

- (ix) That the allowance for major repairs and overhauls be put on standard footing.
- (x) That scales be laid down for provision for fuel, stores and lubricants and for labour required for equipment depending upon the type of work.
- (xi) The provision of contingencies on project estimates put up for administrative sanction may continue to be 5 per cent.

In the case of detailed estimates, the provision for contingencies including work-charged establishment may, however, be cut down to 3 per cent.

- (xii) That greater attention be given to housing for labour.
- (xiii) That the cost of acquisition of land be excluded in making provision for overheads, since the cost of land acquisition establishment is to be shown under 'B'-Land.
- (xiv) That projects be given greater latitude in the purchase of spares for equipment, unless the item is borne on "Rate Contract" by Director General of Supplies and Disposals.

- (xv) That, since a number of items of construction equipment have been standardised, early steps be taken for their manufacture in the country. Rigorous inspection of work steps should be introduced by the Ministry concerned for important articles in use on river valley projects.
- (xvi) That a Central Clearing House be formed immediately for the prompt disposal of all surplus equipment and stores on projects.
- (xvii) That a system of incentives and recognition of merit be introduced on all projects.
- xviii) That special steps be taken by competent authority to train accounts-knowing staff to provide sufficient staff for the river valley projects.
- (xix) The recommendations in Chapter VII, Part II of the Report of Rates and Costs Committee for maintenance of stores accounts may be examined by a small sub-committee.

**APPENDIX I**

**Statement showing Recommended Life of Equipment for  
Items not Covered by the Construction Plant and  
Machinery Committee Report**

**Item I (Ref. Table 3.7.6. (i)—Report of Rates and Costs  
Committee Part I)**

Sl.No.	Equipment	Life Recommended
2	Batching Plant	5 years on three-shift working
3	Core drilling machines	6,000 hours
5	Cranes—Crawler:	
	(a) Up to 3 tons	10,000 hours
	(b) 3 to 10 tons	12,000 hours
	(c) Over 10 tons	20,000 hours
7	Crushers:	
	(a) Jaw	6 years
	(b) Gyratory	10 years
	(c) Cone	10 years
10	Loaders	15,000 hours
11	Locomotives—Diesel:	12,000 hours
12	Mixers—Concrete:	
	(a) Less than 1 cu.yd.	6,000 hours
	(b) More than 1cu.yd.	6,000 hours
13	Rollers—Road:	
	(a) Diesel	12,000 hours
	(b) Gasoline	12,000 hours
	(c) Steam	20,000 hours
16	Trucks (on road vehicle):	
	(a) Diesel:	
	Up to 3 tons	1,00,000 miles

	3 to 5 tons	1,50,000 miles
	Above 5 tons	2,00,000 miles
	(b) Gasoline	75 per cent of the figure for diesel truck.
18	Well drilling machines 5"-6'	12,000 hours
Item II	(Ref. Table 3.7.6. (ii) ibid)	
5	Cableway	100 per cent cost to be charged to the project.
Item III	As regards lives recommended for non-rated equipment in Table 3.7.6. ibid these should be charged to the project and no depreciation account is to be kept for them.	

For depreciation of the items under power plant, figures adopted in the Electricity Department may be adopted.

Table 3.12.3. ibid gives recommendation regarding "Repairs and Maintenance" of equipment as percentage of depreciation. Adopt recommendations in the Construction Plant and Machinery Committee's Report for items dealt with by them. For other items shown in the Table 3.12.3. ibid these will depend upon the load of work on each machinery.

No. 1(4)/57-Policy  
Government of India  
Ministry of Irrigation & Power

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From

Shri K.G.R. Iyer, IAS,  
Deputy Secretary to the Government of India.

To

All the State Governments.

New Delhi, the 20th July, 1959  
the 27 Asadha, 1881

Sir,

As you are perhaps aware, the Government of India set up a Committee of experts in 1954 to examine the existing rates of major items of work prevalent on the more important projects and recommend a comprehensive schedule of rates for adoption as a basic schedule by all projects and to prepare a detailed analysis of such rates. The terms of reference of this Committee were subsequently amplified, in consultation with the Comptroller and Auditor General of India, so as to include the examination of the system of maintenance and accounting of stores in force and make suitable recommendations on the stores accounting procedure and rules.

2. The Committee submitted its report in 1956 in two parts- Part I relating to the rates and costs of construction items for the consideration of the Government of India, and Part II relating to the stores and other accounting procedure for transmission to the Comptroller and Auditor General of India. The Chapters on 'Cost Control' and 'Stores' which were of interest both to the Ministry of Irrigation and Power and the Comptroller and Auditor General, have been included in both Part I and Part II.

3. The Comptroller and Auditor General will take a final decision on matters with which he is concerned under Article 150 of the Constitution of India.

4. The Rates and Costs Committee's Report was discussed at the Hirakud Seminar in January, 1957. As divergent views were expressed on some of the recommendations, it was decided



that a Sub-committee be appointed to examine the recommendations of the Committee in the light of the discussions at the Seminar. The team of officers, set up accordingly, has submitted its findings on Part I of the Report.

5. As already stated, the chapters on 'Cost Control' and 'Stores' are of interest to this Ministry as well as to the Comptroller and Auditor General of India and have therefore been included by the Committee in both the Parts of the Report. As the Comptroller and Auditor General, however, is primarily concerned with the accounting portion only, these recommendations of the Committee which relate to organisational aspects of the Cost Control may for the present be noted for guidance.

6. Subject to the considerations set out in paras 3 to 5 above, the recommendations of the Rates and Costs Committee contained in Part I of the Report, as modified by the findings of the team of officers, are brought to the notice of the State Governments for their information and guidance. Two copies of the Report and statement containing the findings of the team of officers are enclosed.

7. The receipt of the letter may please be acknowledged.

Yours faithfully,

Sd/- K.G.R. Iyer

Deputy Secretary to the Government of India.

Copy to:

1. Central Water and Power Commission.
2. Secretary to all the Control Boards.
3. Chief Engineer, Hirakud Dam Project.
4. Secretary, Tungabhadra/Damodar Valley Corporation.
5. Ministry of Finance (Shri Raneda).
6. Comptroller and Auditor General of India (Shri H.S. Mac).
7. Technical Section (Finance Officer, Shri S. Ramier).
8. All Sections in the Ministry (other than Cash, C.R., Wakf and Confidential).

Sd/- T.R. Barker

Under Secretary to the Government of India.

**STATEMENT SHOWING THE RECOMMENDATIONS OF THE RATES & COSTS COMMITTEE  
AND FINDINGS THEREON**

SL. NO.	RECOMMENDATIONS OF THE RATES & COSTS COMMITTEE	VIEWS EXPRESSED DURING THE GENERAL DISCUSSIONS AT HIRAKUD SEMINAR	FINDINGS OF THE TEAM
1	2	3	4
1.	Proper investigations should invariably be carried out before a project is taken up. This has not been the case with many of them.	It is rather difficult to insist that no project should be taken up till the investigations are complete. In this country sufficient data are not available and it will not be wise to wait on until such data is available.	We agree with the recommendation of the Rates and Costs Committee.
2.	Proper planning and estimating be done by competent engineers before a project is sanctioned.		
3.	That estimates be prepared in sufficient detail to enable project authorities to exercise proper control over cost.		

RECOMMENDATIONS AND FINDINGS

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1	2	3	4
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4. That Costing Cells be introduced on all projects.

Keeping in view that even the existing major projects have no proper cost cells, we feel that for the present, the establishment of the cost cells on all projects costing more than Rs. 5 crores is somewhat ambitious. We, therefore, feel that this limit may be raised to Rs. 15 crores. The costing cells would generally be necessary in projects where construction work is mostly carried out departmentally.

We agree with this suggestion.

Shri Ahuja suggested that not only financial terms but also quantities be indicated in cost report. The main object is to mirror performances as compared to programme schedules.

It is necessary that the costing system be based on audited accounts and not on daily reports.

Since speed is the essence of cost accounting, the cost data need not be based on audited accounts, but a reconciliation between cost and financial account should be carried out at periodical intervals.

5. That the existing system of classification of accounts and stores be revised and decimal system introduced on the pattern given by us.

Shri Guha stated that a Sub-committee of Engineers and Financial Officers may be appointed to study the various fundamentals and suggest suitable changes.

We do not feel the necessity of appointing another sub-committee to study the various fundamentals and suggest suitable changes. This work may be entrusted to the Costing Cell of the Central Water & Power Commission, who should finalise it in consultation with the Auditor General.

6. That perpetual inventory of stores be taken on all large projects.

We agree that perpetual inventory of stores should be taken as indicated in paragraph 4.8.3.2 of the Rates and Costs Committee Report, in such a way so as to complete the verification of each item at least once in a year.

Shri Khungar says, for efficient checking of stores, it would be better if security officer is present when the truck is loaded and should countersign the gate pass.

This is a matter of detail, which should be left to the discretion of the project authorities.

7. That stores be issued at fixed schedule rates.

Shri Guha says, it is not fair to issue at fixed rates, as it might involve considerable amount of profit or loss.

For the reasons given by the Rates & Costs Committee, we agree with its recommendation that there should be a standard issue rate. This should be initially based on the first purchase

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1	2	3	4
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price of the store for the project. Subsequent revisions of the standard issue rate should be made only in the following circumstances:-

(a) When a subsequent purchase price shows material variation from the previous purchase price, the standard issue rate should be refixed with reference to the latest purchase price;

(b) When the store is of a type, such as cement, that it is used in very large quantities and even a minor change in the purchase price would affect the cost of work, the standard issue rate should be refixed every time a fresh purchase is made at a different rate.

8. That manuals on costing and stores be drawn up and our recommendations on the subject be codified to enable all projects to adhere to an uniform pattern of accounting.

9. That life tables on equipment be standardised. Our recommendations on the subject are contained in the report.

Shri Khungar raised the point that depreciation for idle hours be 1/12 the working hour as it has already been accepted. It is no use taking up this point again by Rates & Costs Committee.

We agree that the table of life equipment as recommended by the Construction Plant & Machinery Committee may be adopted. For those items which were not considered by the Construction Plant & Machinery Committee, but were considered by the Hira-kud Sub-Committee at the Engineers' Seminar, the table of lives, as recommended by it may be adopted. We would, however, suggest that the matter should be reviewed, say after 5 years, in the light of actual experience gained. To enable this being done systematically, the projects should be requested to maintain sufficient data.

Presumably, Shri Khungar was referring to the recommendation of the Sub-Committee No. 1 (on the Report of the Construction Plant & Machinery Committee) held at New Delhi, on 1st October, 1954. That recommendation reads as follows:-

"In any case, a piece of equipment should be written off by at least 1/12th of its life every year, whether it is used to that extent or not".

This recommendation has already been accepted by the Co-ordination Board of Ministers. This recommendation merely provides that there should be a minimum amount of depreciation for any equipment and does not imply that depreciation for idle hours should be made on 1/12th of the working hour, as assumed by Shri Khungar. In this connection, the Rates & Costs Committee has recommended that for idle period "a quarter of the full rate of depreciation be charged to the project for idle hours". The Construction Plant & Machinery Committee had not made any recommendation, in regard to the provision of depreciation for idle period.

We also feel that, in the present context of our circumstances, when there is so much shortage of machinery at the projects and there is not much likelihood of our machinery remaining unduly idle, it does not seem to be necessary to take into account the idle time, in working out the depreciation.

We understand that this is also the practice followed in other countries.

Shri Chopra has raised the question whether plant hour as suggested by the Plant & Machinery Committee be taken. He suggested that no change be made now.

Shri Chakravarty suggested that flat rate of depreciation is not correct.

10. That the allowance for major repairs and overhauls be put on standard footing.

Shri Chopra stated that it is not possible to make any standard allowance for major overhauls. The rate of overhaul of machinery both minor and major, has to be a factor depending on type of work carried out.

We agree with the recommendation of the Rates & Costs Committee.

The principles for calculation of depreciation etc., should be the same as recommended by the Construction Plant & Machinery Committee.



11. That scales be laid down for provision of fuel, stores and lubricants and for labour required for equipment.

Shri Khungar suggests provision for spare parts for imported equipment be increased due to difficulty of importing and ready availability.

Shri Chopra stated for fuel and lubricants no definite scales can be laid down for various equipment, as these would vary depending on the condition and type of work to be done by the machine.

12. The provision of contingencies for works be scaled down.

Shri Guha suggests contingent provision should be more when unknown factors are more.

Shri Bansod says contingencies should be 3%.

13. That greater attention be given to housing for labour.

We agree with the recommendation of the Rates & Costs Committee

In view of the Government having accepted 3% for contingencies on estimates, this may be adopted, instead of the sliding scale recommended by the Rates & Costs Committee. We, however, agree that in the case of detailed estimates provision for contingencies, including workcharged establishment, may be cut down to 3%.

14. That cost for acquisition of land should be excluded when making provision for overheads.

Shri Chopra agrees to the suggestion.

We agree with the recommendation of the Rates and Costs Committee.

15. That projects should be given greater latitude in the purchase of spares for equipment and special committee be formed for these purposes.

The intent of this recommendation is not quite clear. It is not clear whether the intention is to increase the purchasing power of the project authorities, or to give power to the project authorities to depart from the normal stores purchase procedure. So far as the question of powers of purchase is concerned, it does not seem to be necessary to lay down any general rule, because the Government will have to delegate adequate powers to the project authorities, as it deems necessary, consistent with the requirements of a particular project. As regards the procedure for purchase, it would not be desirable to allow any general relaxation. The detailed recommendations made by the Rates & Costs Committee at pages 59-63 of the Report, in this connection may, however, be followed.

1	2	3	4
16. That principal items of construction equipment be standardised and early steps be taken for their manufacture in the country.	The manufacture of Heavy Earth Moving Machinery is already engaging the attention of Ministry of Commerce and Industry and proposals for their manufacture are being studied by that Ministry.	On the basis of the recommendations of Standardisation Committee, Government have already taken certain decisions. We have no further comments to make, at this stage.	
17. That a Central Clearing House be formed immediately for the prompt disposal of all surplus equipment and stores on projects.			
18. That a system of incentive in the shape of overtime, bonus and recognition of merit be introduced on all projects.	Shri Chopra wants specific suggestions.	No specific suggestions can be made in this connection; this may be left to the projects concerned.	
19. That for the sake of co-ordinated development and economy in manpower & equipment, it is necessary that River Valley Projects be made a Central Subject.	Shri Khungar says this is good only in case where there are more than one State.	This is a question of policy, which we would leave to the Irrigation & Power Ministry to consider	

RECOMMENDATIONS AND FINDINGS—Contd.

Sl. No.	RECOMMENDATIONS WHICH WERE DISCUSSED AT THE HIRAKUD SEMIKAR, BUT NOT INCLUDED IN THE SUMMARY OF THE RECOMMENDATIONS OF THE REPORT	VIEWS OF VARIOUS ENGINEERS ATTENDING HIRAKUD SEMINAR	VIEWS OF THE TEAM
1	2	3	4
1.	No quotation received after the closing of the open tender enquiry may be considered.	Shri Khungar suggests favourable quotations received even after closing dates may be considered on merits.	We have considered this matter in all its aspects and on administrative grounds we agree with the recommendation of the Rates & Costs Committee.
2.	All stores received should pass through Stock Account, as on big river valley projects all stores are held by Central Stores Organisation.	Shri Khungar is of the opinion that this suggestion is impracticable. It is necessary to have site accounts.	The intention behind the Committee's recommendation is that all stores received by a project should be accounted for in the Central Stock Account, so that, a complete picture of the stores transactions of the project, at any stage, is available. This does not, however, dispense with the necessity for the maintenance of the M.A.S. Account, wherever required, except that the M.A.S. Account will be maintained in terms of quantity only, and not in terms of value.

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It is not the intention that, in addition to being accounted for in the Central Stores Account, stores like bricks etc., should also be physically routed through the central stores. In the case of such stores, the material will be received at the site of works, as at present, by the representative of the Central Stores Organisation and simultaneously handed over to the executive authorities incharge of the work, who will then be required only to maintain a quantity account of the issue and receipts of such stores.

3. All consignments of materials received against purchase orders should be opened in the presence of an officer responsible for inspection and accounted.

Shri Chopra suggests a rigorous inspection of stores received

We agree with the recommendations.

4. Before a machine is transferred from one project to another it should be completely overhauled and put

Shri Khanna agrees with this suggestion.

The intention behind the Rates & Costs Committee's recommendation appears to be that the machines are not allowed to deteriorate on the projects and not left uncared for, and as

in perfect mechanical condition.

5. Usual formula for transfer of equipment is Book Value less depreciation.
6. Operation of equipment is affected by the availability of skilled labour.
7. Cost reports are to be worked out from daily pay rolls with output report, daily materials issued and on hand and daily equipment performance.

Shri Khungar says the practice at Bhakra is Book Value minus depreciation, minus balance outstanding on account of major repairs and overhauls.

Best utilization of equipment is obtained by appointing a good operator with assurance that he will operate the same piece of equipment for its life time — a suggestion by Shri Jatinder Singh.

such, we agree that the machines should be brought to and kept in good working order till finally disposed of.

For the transfer of machinery from one project to another, the formula of Book Value less depreciation, recommended by the Rates & Costs Committee, will generally serve the purpose.

No comments.

1

2

3

4

Shri Khungar says costing system should be based on audited accounts and the reports should be monthly.

In this connection, see our remarks on item 4 of the recommendations of the Rates & Costs Committee.

8. Referring to item at page 97 on daily reports, it is suggested that there should be no system of daily payments or what is called 'muster rolls'.

The work should be done on monthly basis on acquittance rolls.

We feel that the remarks were intended for jobs where a centralised system of time keeping is possible, and not where casual labour is employed in other places.

9. Remedial measures for clearing suspense items in the accounts which go on lying month after month and year after year should be taken.

Shri Banerji stated it is also necessary that the suspense items in the accounts which go on lying month after month and year after year and give a wrong picture of the cost, should be remedied by payment by cheque.

Payment by cheques alone will not wholly serve the purpose, but wherever possible the system of payment by cheques should be introduced.

**A N N E X U R E S**

**325-326**



## ANNEXURES

### ANNEXURE, 1

(5.3.2.)

#### *Principal Units of Measurements*

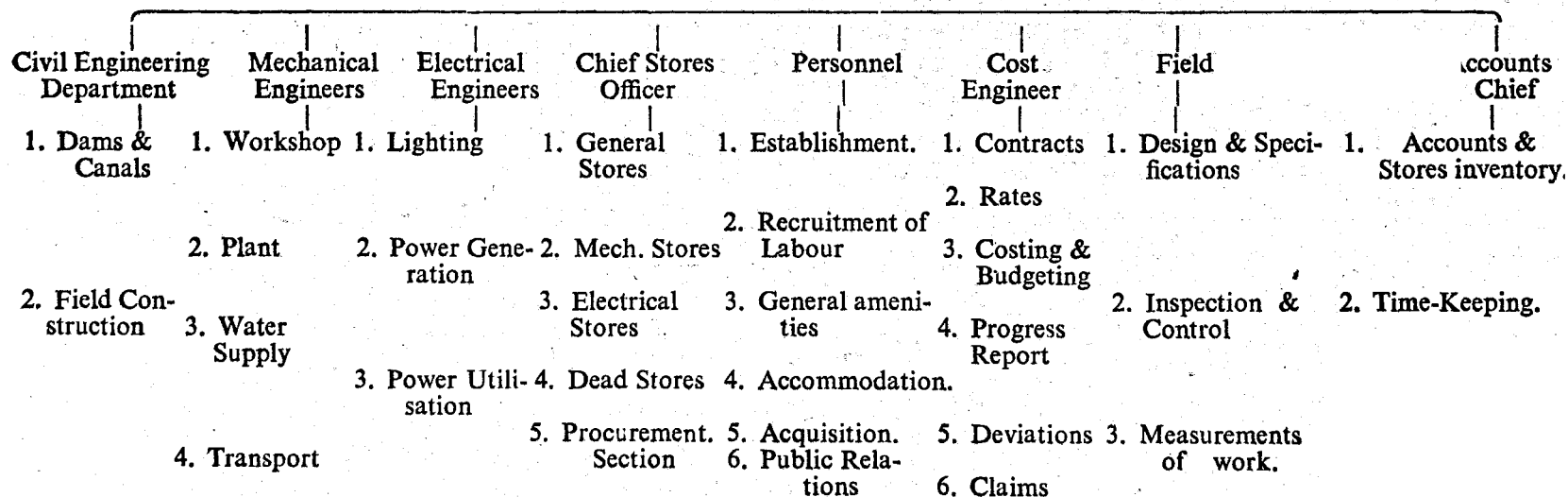
Sl. No.	Item	Unit
1.	Jungle clearance	Acre
2.	Excavation	C.F.C.
3.	Back-fill	C.F.C.
4.	Drilling and grouting holes	F.R.
5.	Boulder or quarried stone	C.F.C.
6.	Aggregate for concrete	C.F.C.
7.	Dressing of stone surface	C.F.S.
8.	Sand	C.F.C.
9.	Lime	Maund
10.	Surkhi (ordinary or fine)	C.F.C.
11.	Cement	Cwt.
12.	Steel	Cwt.
13.	P.C.C. or Lime Concrete	C.F.C.
14.	Masonry (Brick) except walls—one brick or less	C.F.C.
15.	Masonry (Stone)	C.F.C.
16.	Masonry in walls—one brick or less	C.F.C.
17.	Glass	F.S.
18.	Plastering	C.F.S.
19.	Pointing	C.F.S.
20.	Timber Boarding	F.S.
21.	Timber Scantling	F.C.
22.	Doors and Windows Shutters	F.S.
23.	Doors and Windows Frames	F.C.
24.	Formwork	C.F.S.
25.	Water Stops (Copper Strips etc.)	F.R.
26.	Pipes	F.R.
27.	Paints, stiff or ready mix.	Lbs.
28.	Varnishes and Oils	Gallons
29.	P.O.L. Group Gallons	Gallons
30.	Gates	Tons
31.	Pitching work	C.F.C.
32.	Explosives	Lbs
33.	Water	M.G.

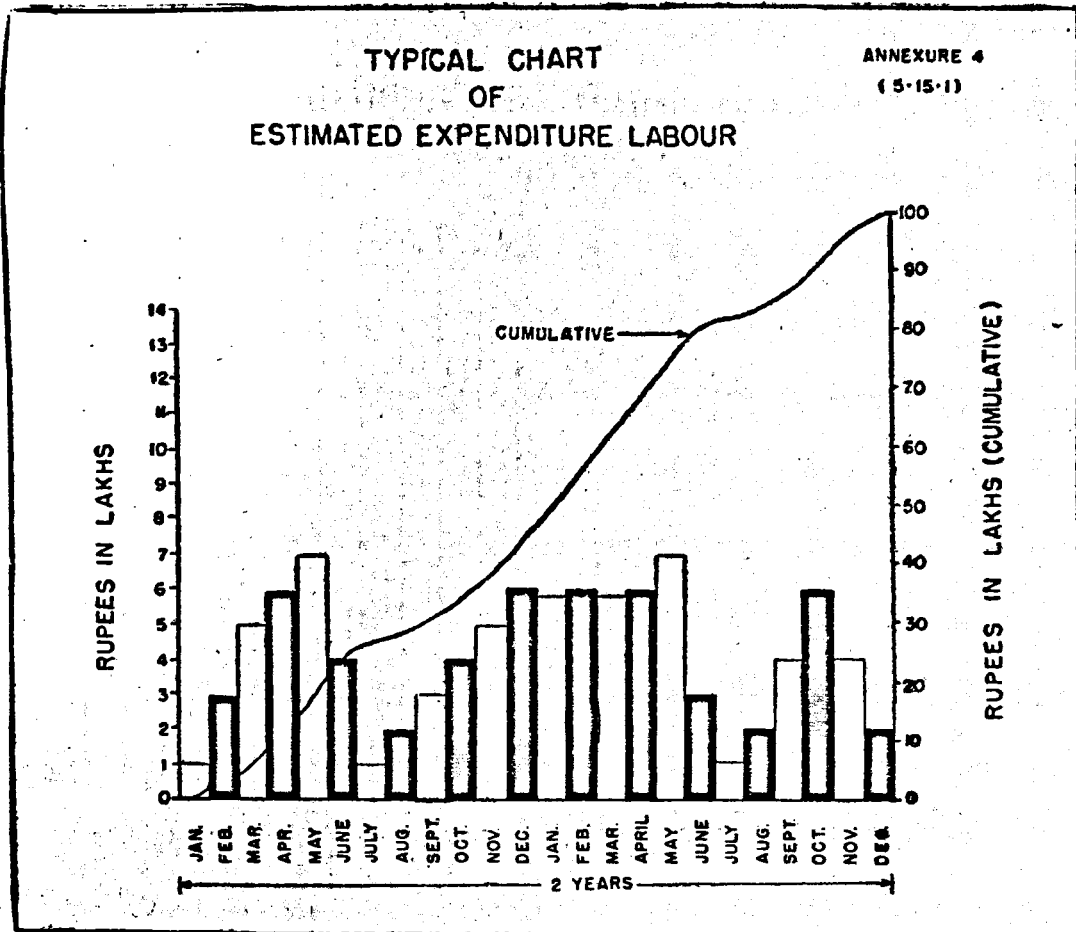
## ANNEXURE 2

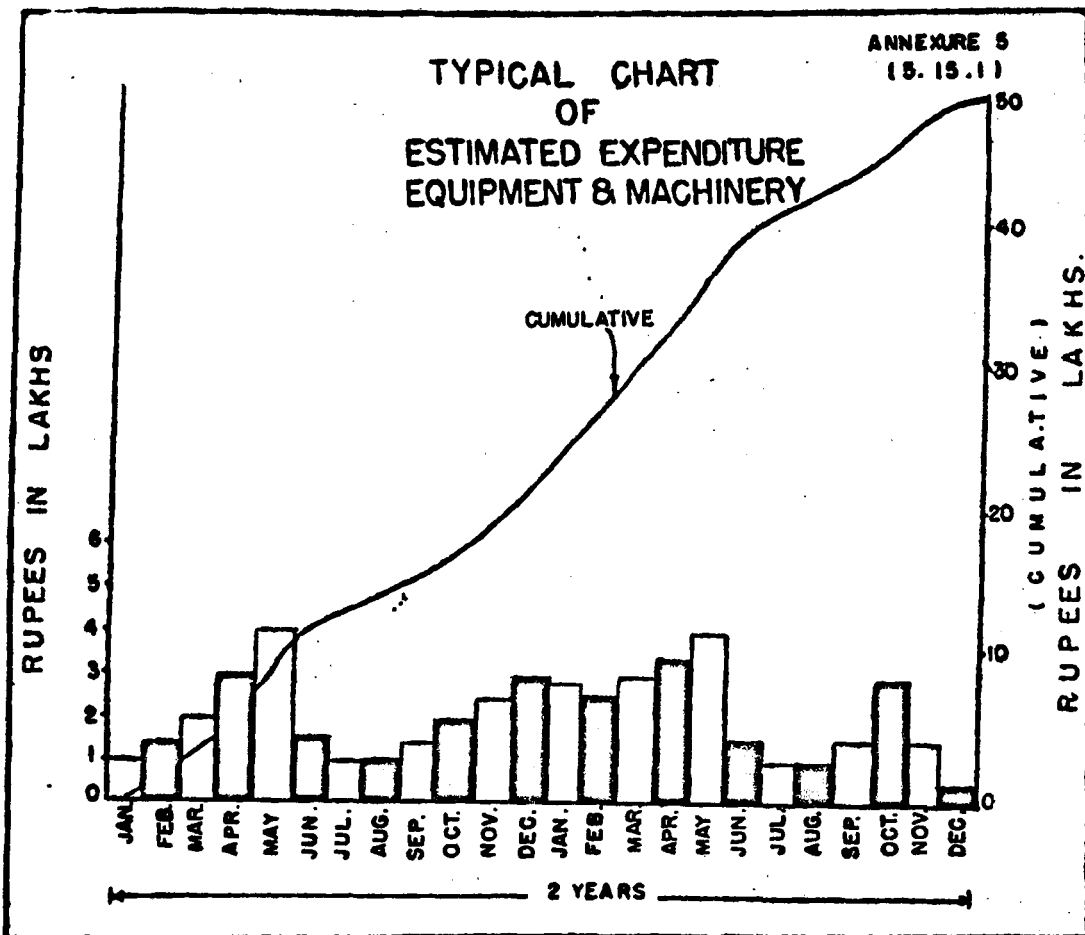
(5.12.3)

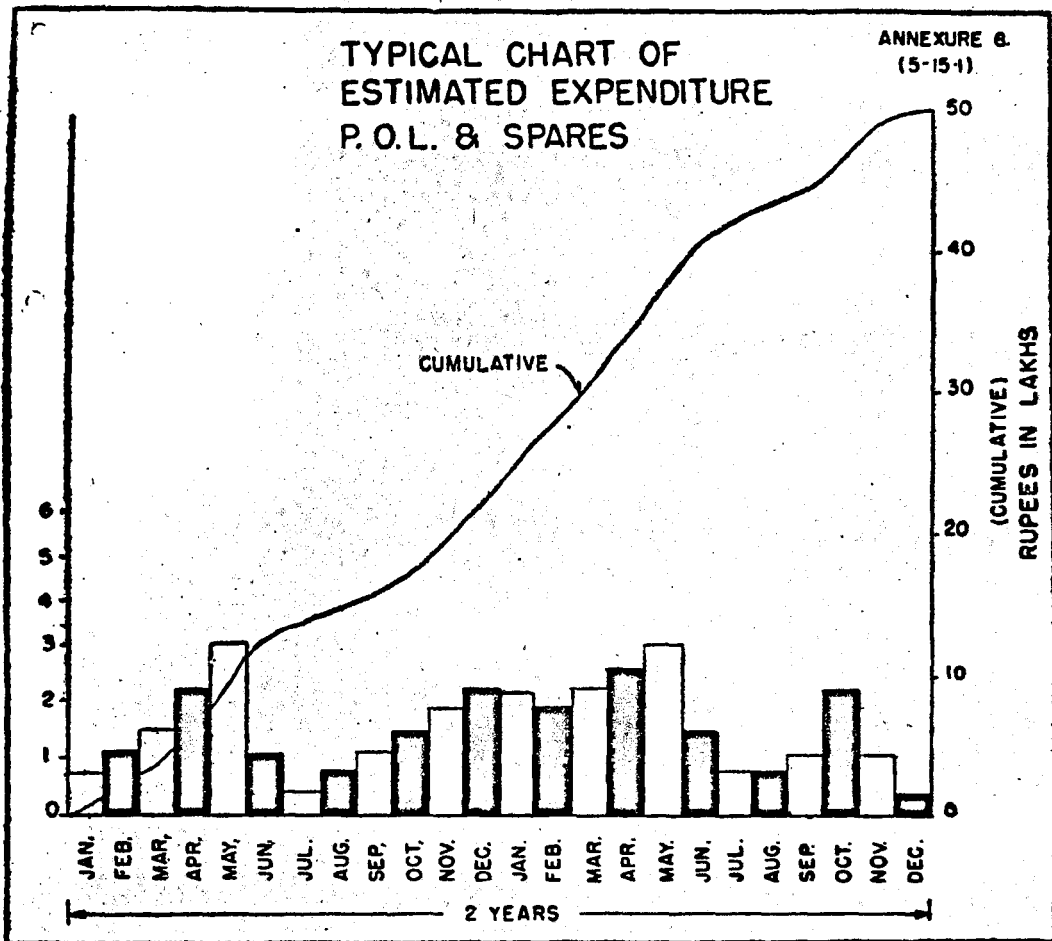
### PROJECT MANAGER OR CHIEF ENGINEER

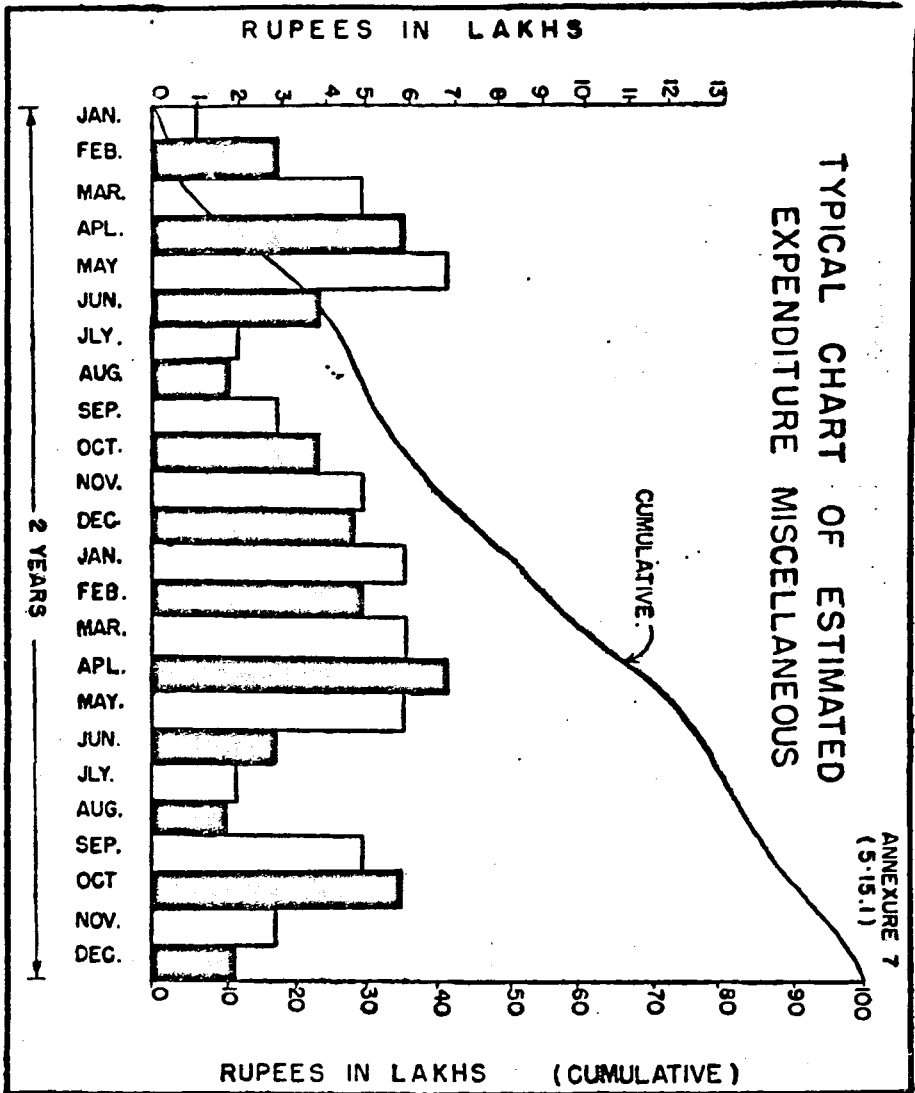
Deputy Project Manager or Superintending Engineer

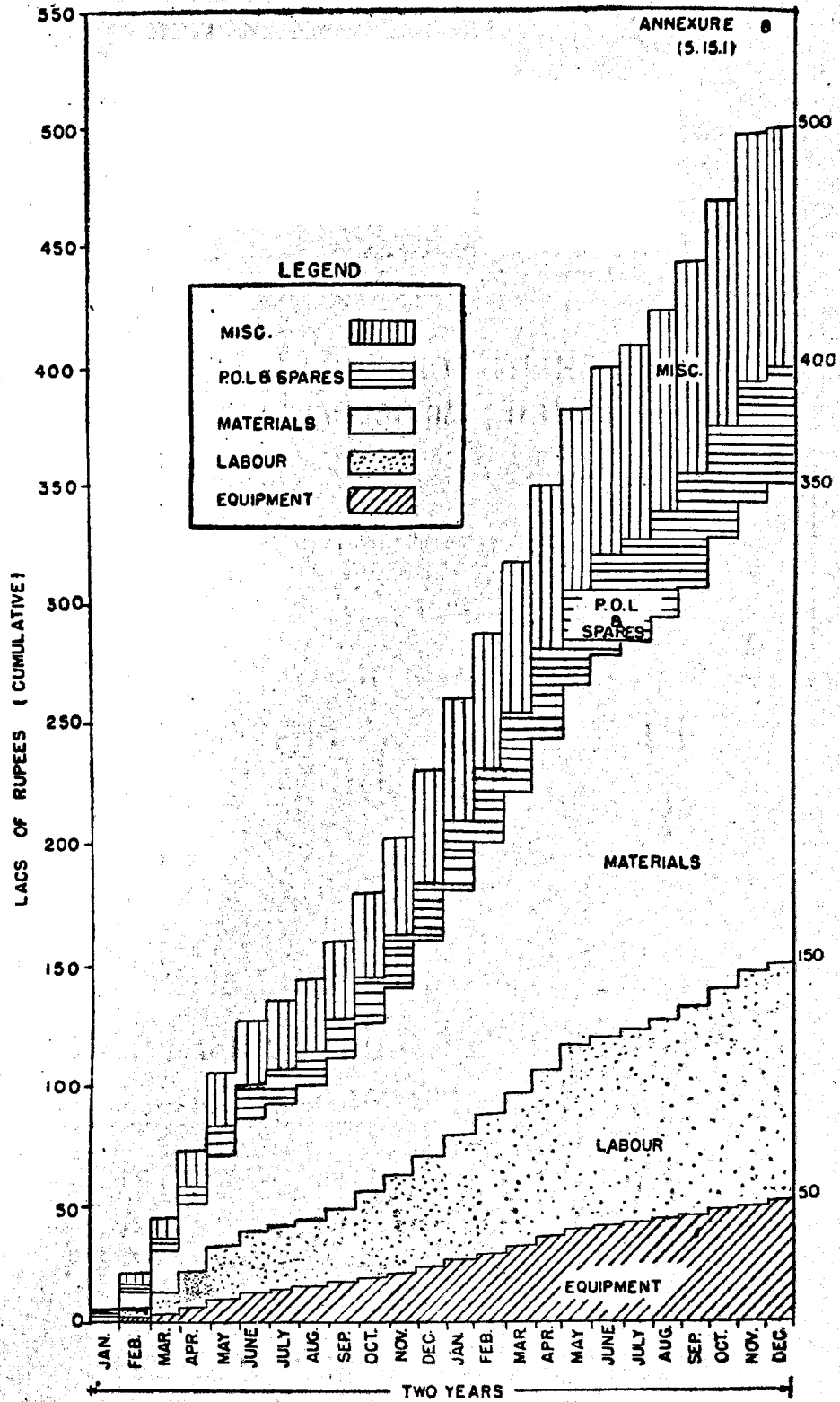












ANNEXURE  
(5-16-11)

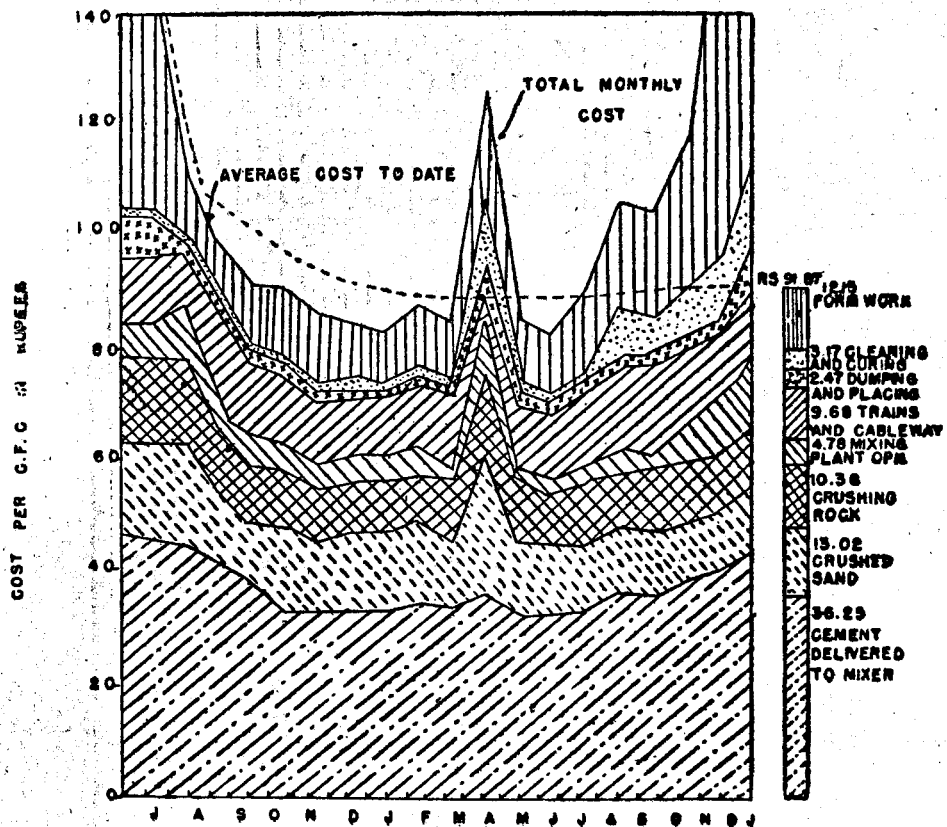
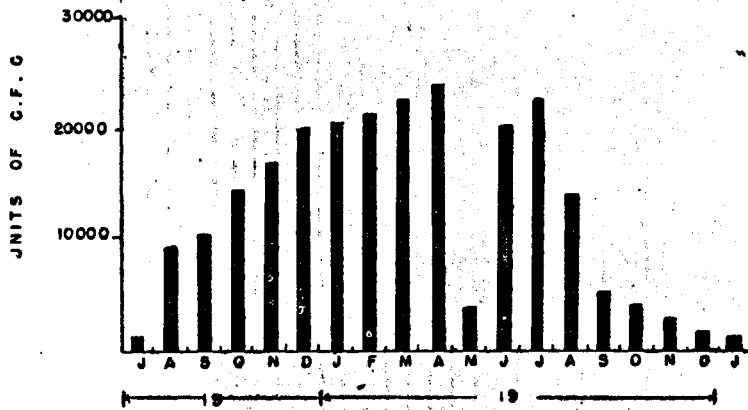
EQUIPMENT SCHEDULE

ITEM	NO	1949				1950				1951																	
		J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J		
SHOVEL 3/4 TO 3CY.	7	1	3	4	6	7	6	4	3	2	1																
TRACTOR	15	2	7	15					10	7	5	2	1														
TRUCK, DUMP	27	3	6	12	20	7			4	2	1																
TRUCK, TRAILER	14	2	6	14			2																				
TRUCK, STAKE	7	1	2	6			5		4	2																	
CARRY-ALL SCRAPER	3		3	2																							
AIR COMPRESSOR STATIONARY	1																										
AIR COMPRESSOR PORTABLE	5	1	5	3	2																						
CONCRETE MIXER	4	2	3	4	3	2				1																	
PUMP, 4"AND LESS	19	4	7	8	7	11	8	7	4					7	5							4	1				
WAGON DRILL	12	6	12			9	8	7	1																		
CORE DRILL	7	3	4	1													1	2	3								
WELL DRILL	3					3																					
ELECTRIC WELDER	3	2				3				3				1													
BUCKET LOADER	1					1																					
PATROL GRADER	1					1																					
CONCRETE GUN	3	1								3																	
GROUT PUMP	1									1																	
ROLLER, SHEEPS- FOOT	10	4	8	10	9																						

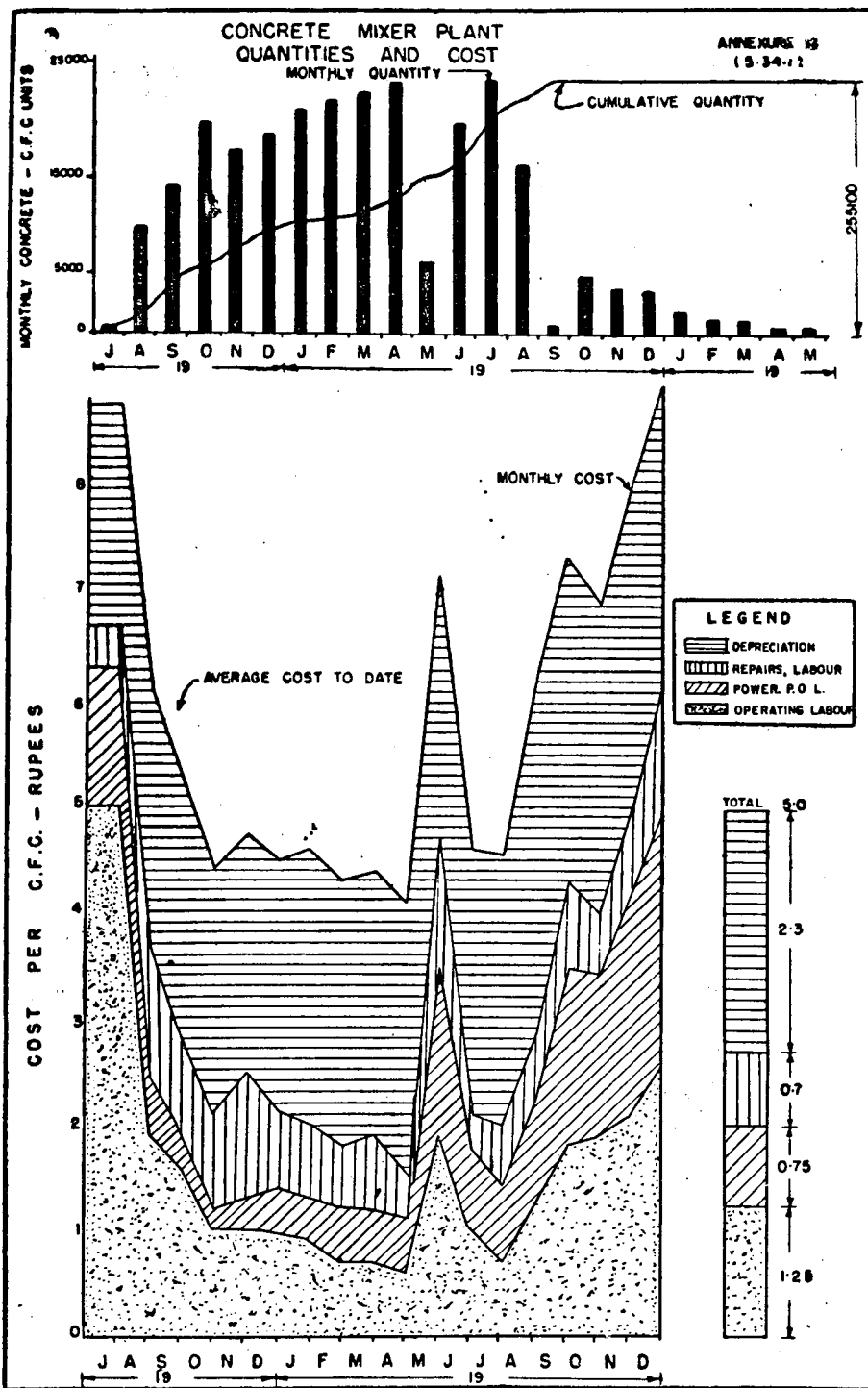


ANNEXURE II  
(5-34.1)

MASS CONCRETE  
MONTHLY QUANTITIES COSTS

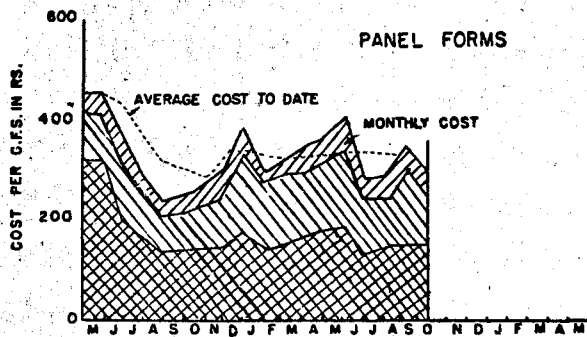
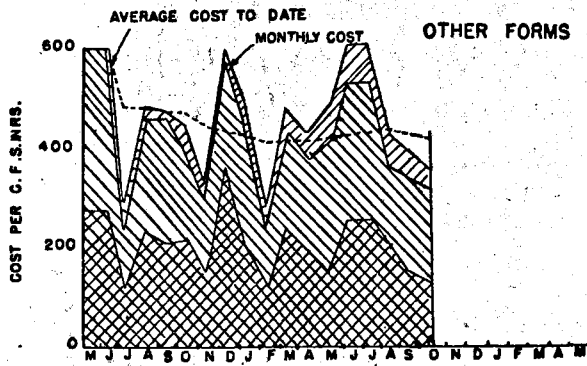
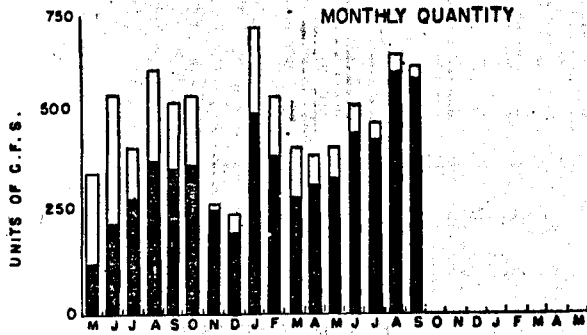


- RS 27.00 FORM WORK
- 3.17 CLEANING AND CURING
- 2.47 DUMPING AND PLACING
- 3.68 TRAMS AND CABLEWAY
- 4.78 MIXING PLANT OPM
- 10.36 CRUSHING ROCK
- 15.02 CRUSHED SAND
- 36.29 CEMENT DELIVERED TO MIXER



UNIT COST OF ALL FORMWORK  
MASS CONCRETE

ANNEXURE 13  
(15-34-11)

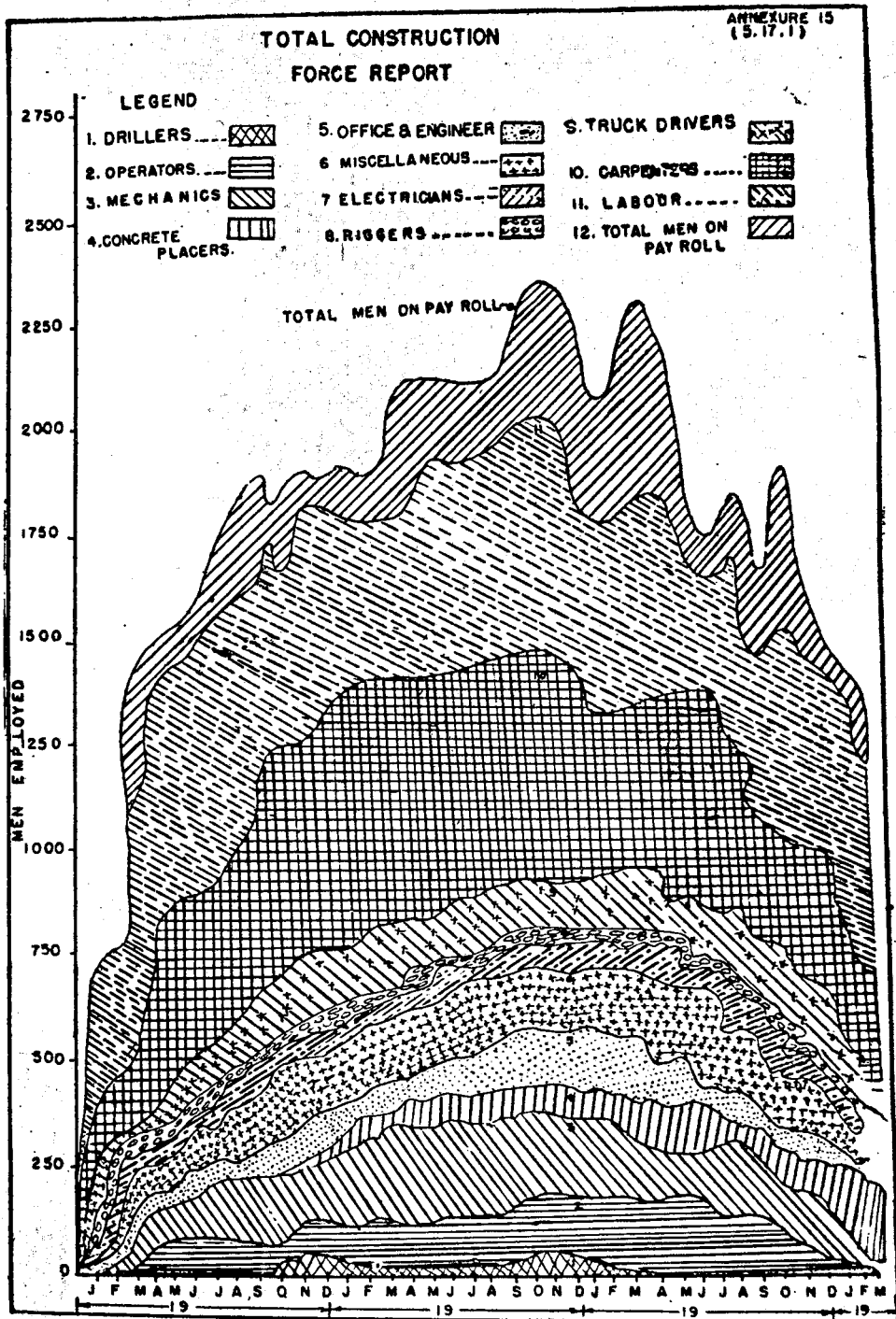


- LEGEND
- EQUIPMENT AND MISC. EXPENSE
  - MATERIALS AND SHOP WORK.
  - FIELD LABOUR
  - PANEL FORMS
  - OTHER FORMS.

— 19 — | — 19 — | — 19 —

ANNEXURE 14 (5.33.1)														
EQUIPMENT USE REPORT														
EQUIP.	MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		SUNDAY	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
TRUCK 1	Working	Stand By	Working	Stand By	Under-Repair	Under-Repair	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By
" 2	Working	Stand By	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By
" 3	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working
" 4	Working	Stand By	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working
" 5	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By
" 6	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working	Working
TRACTOR 1	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By	Working	Stand By
" 2	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By
" 3	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Under-Repair	Under-Repair
" 4	Working	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By
" 5	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By
" 6	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By
" 7	Working	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Under-Repair	Working	Working
" 8	Under-Repair	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Stand By	Under-Repair	Under-Repair	Stand By	Working
SHOVEL 1	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Working
" 2	Working	Under-Repair	Under-Repair	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Working
" 3	Working	Stand By	Stand By	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Stand By	Working	Stand By	Stand By	Working

WORKING  STAND BY  UNDER-REPAIR



ANNEXURE 16

(5.35.2)

*Monthly Progress Report*

(Quantities of Work)

Sl. No.	Item	Estimated Amount	Progress to end of previous month	Progress during the month	Total progress up-to-date	Percentage Col. 6/3	Scheduled Progress	Percentage (Col. 6/8)	Remarks
1	2	3	4	5	6	7	8	9	10

ANNEXURE 17

(5.35.3)

Monthly Progress Report

(Expenditure)

Sl No.	Item	Estimated Amount	Weighted percentage of actual	Expenditure to end of previous month	Expenditure during the month	Expenditure up-to-date	Percentage (Col. 6/3)	Scheduled Expenditure	Weighted percentage (Col. 6/8)	Weighted percentage of completion	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

## ANNEXURE 18

(5.36.2)

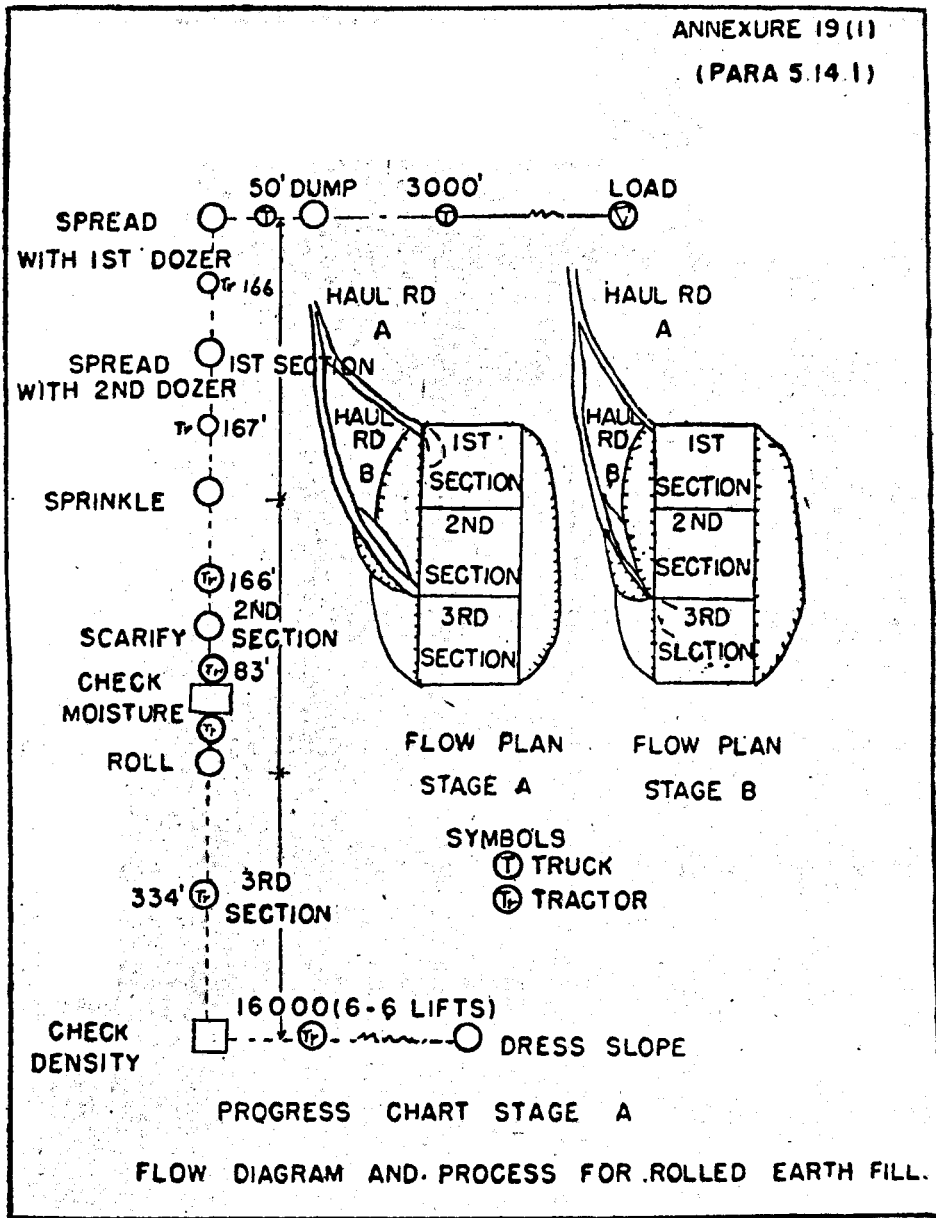
*Monthly Forecast of Variations*

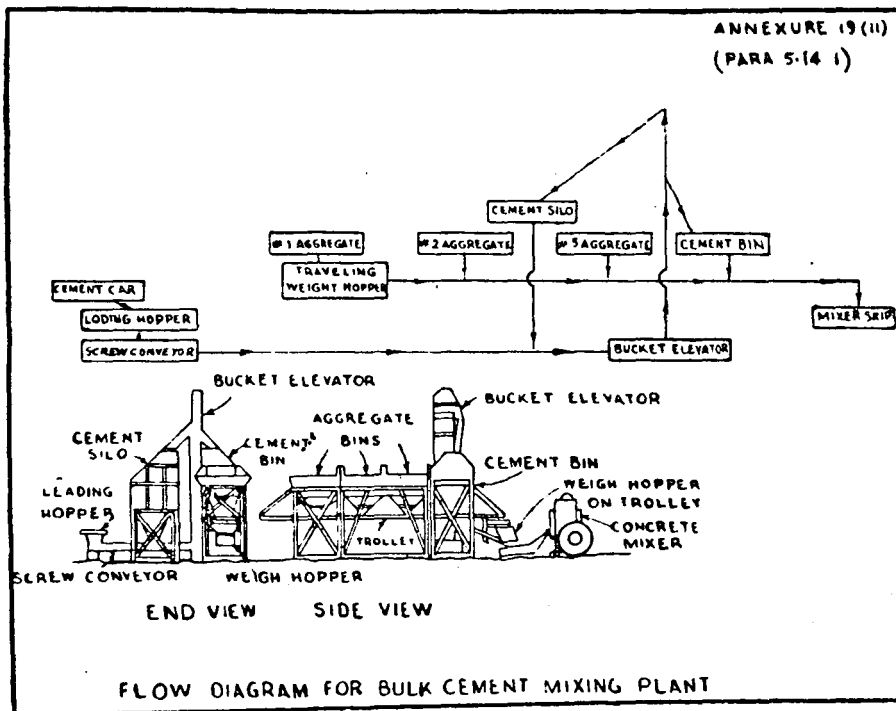
Sl. No.	Item	Estimates			Actual to end of previous month			Actual during the month			Adjust- +
		Qty.	Rate	Cost	Qty.	Rate	Cost	Qty.	Rate	Cost	
1	2	3	4	5	6	7	8	9	10	11	12

ment	Actual up-to-date			Remain- ing Qty.	Estimated Cost to Completion			Variation		Remarks
	Qty.	Rate	Cost		Qty.	Rate	Cost	+	-	
13	14	15	16	17	18	19	20	21	22	23



ANNEXURE 19 (1)  
(PARA 5.14.1)





A P P E N D I C E S

347—348.

## APPENDIX 1

(Para 2.7.2.)

*Schedule of Wages on Projects for Common Labour*

Trade	Bhakra Nangal	Maithon, Panchet, Tilaiya, Konar	Durgapur Barrage & Canal	Kakra-par	Gangapur	Vaitarna	Mayurakshi
1	2	3	4	5	6	7	8
Male Mazdoor .. ..	Rs. 2/-	Rs. 1/8	Rs. 2/-	Rs. 1/8 to 2/-	Rs. 1/12 to 2/-	Rs. 1/-12 to 2/-	Rs. 2/-
Female Mazdoor .. ..	—	1/2	1/8	1/4 to 1/10	1/4 to 1/8	1/- to 1/12	1/8
Boy Mazdoor .. ..	—	1/-	1/4	1/- to 1/4	1/4 to 1/8	—	1/8
Wadar Cooly, Male .. ..	—	—	—	—	2/8	—	—
Wadar Cooly, Female .. ..	—	—	—	—	1/8	—	—
Wadar Cooly, Boy .. ..	—	—	—	—	1/-	—	—

*Schedule of Wages on Projects for Common Labour—contd.*

Trade	Hirakud	Chambal	Bhadra	Tungabhadra	Lower Bhawani	Peechi	Perinchani
1	9	10	11	12	13	14	15
Male Mazdoor .. ..	Rs. 1/8	Rs. 1/4	Rs. 1/4 to 1/8	Rs. 1/2	Rs. 1/8	Rs. 1/8	Rs. 1/8
Female Mazdoor .. ..	1/-	1/-	-14/- to 1/8	-10/- to -12/-	-12/-	1/-	1/-
Boy Mazdoor .. ..	-12/-	1/-	-8/- to -12/-	-10/6 to -12/-	-12/-	-12/-	1/-
Stone Packer, Male .. ..	—	—	1/8 to 2/4	2/-	—	—	—
Stone Packer, Female .. ..	—	—	—	2/12	—	—	—

APPENDIX 2  
(2.18.1.)

Plinth Area Rates at Various Projects

Description of Item	C.E. Bangalow	S.E. Bangalow Type A	E.E. Bangalow Type B	S.D.O. Bangalow	Senior staff pay above Rs. 250	Pay Rs. 150 to Rs. 249	Pay Rs. 50 to Rs. 149	Peon & other class IV
1	2	3	4	5	6	7	8	9
<i>Bhakra-Nangal</i>								
(i) Plinth Area .. .. .	—	2815	1600	1367	916	689	466	260
(ii) Cost in Rs. .. .. .	52000*	17770	3283	7000	6000	4600	2900	1530
(iii) P.A. Rate per sq. ft.	—	6/5	5/2/10	5/2	6/9	6/8	6/3/5	5/15
<i>Hirakud Right</i>								
(i) Plinth Area .. .. .	5163	4555	—	3088	1403	1160	863	288
(ii) Cost in Rs. .. .. .	76010	37300	—	24800	8300	5700	4200	1700
(iii) P.A. Rate per sq. ft.	14/11	8/3	—	7/14	5/14/9	4/15	4/14	6/-
<i>Hirakud Left</i>								
(i) Plinth Area .. .. .	—	—	—	3088	1407	—	863	288
(ii) Cost in Rs. .. .. .	—	—	—	28328	8310	—	4023	1527
(iii) P.A. Rate per sq. ft.	—	—	—	9/4	5/12	—	4/4	5/4
<i>Maithon</i>								
(i) Plinth Area .. .. .	3462	2213	2741	1759	1502	899	753	738
(ii) Cost in Rs. .. .. .	86449	34190	31188	18158	10887	8094	5866	5412
(iii) P.A. Rate per sq. ft.	24/14/6	15/7/6	11/5/3	10/5	7/4	9/-	7/13/3	7/5/5
<i>Bhadra</i>								
(i) Plinth Area .. .. .	—	1900	1341	976	547	458	—	—
(ii) Cost in Rs. .. .. .	—	15200	3600	6800	4006	1600	—	—
(iii) P.A. Rate per sq. ft.	—	8/-	6/7	7/1	7/5	3/8	—	—
<i>Tungabhadra (Andhra)</i>								
(i) Plinth Area .. .. .	—	—	2018	** 1645	877	701	586	251
(ii) Cost in Rs. .. .. .	—	—	2000	9900	7600	6100	5400	1817
(iii) P.A. Rate per sq. ft.	—	—	9/4	6/-	8/11	8/11	9/3	7/5
<i>Gangapur Dam</i>								
(i) Plinth Area .. .. .	—	—	1082	1060	447	233	—	—
(ii) Cost in Rs. .. .. .	—	—	5199	4190	2149	888	—	—
(iii) P.A. Rate per sq. ft.	—	—	4/12	3/14	4/12	3/12	—	—

\*The plinth area is not available.

\*\*It is double storeyed building.

APPENDIX 2—contd.

Description of Item	C.E. Bangalow	S.E. Bangalow Type A	E.E. Bangalow Type B	S.D.O. Bangalow	Senior staff pay above Rs. 250	Pay Rs. 150 to Rs. 249	Pay Rs. 50 to Rs. 149/-	Peon & other class IV
1	2	3	4	5	6	7	8	9
<i>Gandhisagar Dam</i>								
(i) (Rates for Permanent Buildings)								
(i) Plinth Area .. .. .	2819	2263	1712	1236	676	604	357	—
(ii) Cost in Rs. .. .. .	33732	23761	19474	13751	7436	6136	3055	—
(iii) P.A. Rate per sq. ft.	1/8/11	10/8	11/6	11/-/2	11/-	10/2/6	8/8/11	—
(ii) (Rates for Temporary Buildings)								
(i) Plinth Area .. .. .	—	1738	1270	—	—	570	—	—
(ii) Cost in Rs. .. .. .	—	12184	9199	—	—	3976	—	—
(iii) P. A. Rate per sq. ft.	—	7/2	7/3/11	—	—	6/-	—	—
<i>Tungabhadra (Hyd.) (Temporary)</i>								
(i) Plinth Area .. .. .	—	—	3491 Pmt.	2192	—	929	814	375
(ii) Cost in Rs. .. .. .	—	—	31990	17331	—	7800	5871	3561
(iii) P.A. Rate per sq. ft.	—	—	9/2/6	7/14	—	8/6	7/3	9/8/2
<i>Durgapur Barrage (DVC)</i>								
(i) Permanent								
(i) Plinth Area .. .. .	—	—	1366	1355	863	—	666	363
(ii) Cost in Rs. .. .. .	—	—	18676	17720	11602	—	9293	2448
(iii) P.A. Rate per sq. ft.	—	—	13/10	13/1	13/7	—	13/14	6/12
(ii) Temporary								
(i) Plinth Area .. .. .	—	—	1289	895	—	733	720	459
(ii) Cost in Rs. .. .. .	—	—	9226	7415	—	5577	5344	2399
(iii) P.A. Rate per sq. ft.	—	—	7/2	8/4	—	7/7	7/6	5/3
<i>Lower Bhawani Project</i>								
(i) Plinth Area .. .. .	—	—	3108	1669	—	990	724	687
(ii) Cost in Rs. .. .. .	—	—	23394	10009	—	4995	4247	3220
(iii) P.A. Rate per sq. ft.	—	—	7/8/5	5/15/11	—	5/8/10	5/13/10	5/4/6
<i>Malampuzha</i>								
(i) Plinth Area .. .. .	—	—	2776	1754	—	806	666	660
(ii) Cost in Rs. .. .. .	—	—	23618	13727	—	6268	4867	3050
(iii) P.A. Rate per sq. ft.	—	—	8/8	7/13	—	7/12	7/5	4/10

## APPENDIX 3

1. *Applications*

These rules shall apply to all construction works in charge of C.P.W.D.

2. *Definition*

(a) "Work-place" means a place at which, at an average, fifty or more workers are employed in connection with construction work.

(b) "Large work-place" means a place at which, at an average, 500 or more workers are employed in connection with the construction work.

3. *First Aid*

(a) At every work-place shall be maintained in readily accessible place First Aid appliances including an adequate supply of sterilized dressings and sterilized cotton wool.

(b) At large work-place, where hospital facilities are not available within easy distance of the works, First Aid posts shall be established and be run by a trained compounder.

(c) Where large work-places are remote from regular hospitals, an indoor ward shall be provided with one bed for every 250 employees.

(d) Where large work-places are situated in cities, towns and their suburbs and no beds are considered necessary owing to the proximity of city or town hospitals, an ambulance shall be provided to facilitate removal of urgent cases to those hospitals. At other work-places some conveyance facilities, such as car, shall be kept readily available to take injured person or persons suddenly taken seriously ill, to the nearest hospital.

4. *Drinking Water*

(a) In every work-place there shall be provided and maintained at suitable places, easily accessible to labour, a sufficient supply of water.

(b) Where drinking water is obtained from an intermittent public water supply, each work-place shall be provided with storage where such drinking water shall be stored.

(c) Every water supply or storage shall be at a distance not less than 50 ft. from any latrine, drain or other source of pollution. Where water has to be drawn from an existing well, which is within such proximity of latrine, drain or any other source of pollution, the well shall be properly chlorinated before water is drawn from it for drinking. All such wells shall be entirely closed in and be provided with a trap-door which shall be dust and water-proof.

(d) A reliable pump shall be fitted to each covered well, the trap-door shall be kept locked and opened only for cleaning or inspection which shall be done at least once a month.

(e) The temperature of drinking water supplied to workers shall not exceed 90° F.

5. *Washing and Bathing Places*

(a) Adequate washing and bathing places shall be provided separately for men and women. (Showers, say, 2 per 100 persons are recommended).

(b) Such places shall be kept in clean and drained condition.

6. *Scale of Accommodation in Latrines and Urinals*

There shall be provided within the precincts of every work-place, latrines and urinals

in an accessible place, and the accommodation, separately for each, shall not be less than the following scales :—

	No. of Seats
(a) Where the number of persons employed does not exceed 50	2
(b) Where the number of persons employed exceeds 50 but does not exceed 100 (The army provide five per 100 in their camps).	3
(c) For every additional 100	3

#### 7. *Latrines and Urinals for Women*

If women are employed, separate latrines and urinals screened from those for men and marked in the vernacular in conspicuous letters 'FOR WOMEN ONLY' shall be provided on the scale laid in Rule 6. Those for men shall be similarly marked 'FOR MEN ONLY'. A poster showing the figure of a man and a woman shall also be exhibited at the entrance of latrines for each sex. There shall be adequate supply of the water close to the urinals and latrines.

#### 8. *Latrines and Urinals*

Except in work-places provided with water-flushed latrines, connected with a water-borne sewage system, all latrines shall be provided with receptacles on dry-earth system which shall be cleaned at least four times daily, twice during working hours and kept in a strict sanitary condition. The receptacles shall be tarred inside and outside at least once a year.

#### 9. *Construction of Latrines*

The inside walls shall be constructed of masonry or some suitable heat-resisting non-absorbent material and shall be cement-washed inside and outside at least once a year. The dates of cement-washing shall be kept available for inspection.

#### 10. *Disposal of Excreta*

Unless otherwise arranged for by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the work-place shall be made by means of suitable incinerator approved by the Asstt. Director of Public Health or the Municipal Medical Officer of Health, as the case may be, in whose jurisdiction the work place is situated. Alternatively, excreta may be disposed of by putting a layer of night soil at the bottom of pucca tank prepared for purpose and covering it with a 6" layer of waste or refuse and then covering it up with a layer of earth for a fortnight (when it will turn into manure).

#### 11. *Provision of Shelters during Rest*

At every work-place there shall be provided, free of cost, two suitable sheds, one for meals and other for rest, for the use of labour. The height of the shelter shall not be less than 11 ft. from the floor level to the lowest part of the roof.

#### 12. *Creches*

At every work-place, at which 500 or more women workers are ordinarily employed, shall be provided with two huts for the use of children, under the age of 6 years, belonging to such women. One hut shall be used for infants' games and play and the other as their bed room. The huts shall not be constructed on a lower standard than the following:—

- (i) Thatched roofs;
- (ii) Floors and walls; and
- (iii) Planks spread over the mud floor and covered with matting.

The huts shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two *dais* in attendance. Sanitary utensils shall be provided to the satisfaction of the Health Officer of the area concerned. The use of the huts shall be restricted to children, their attendants and mothers.

#### 13. *Canteen*

A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is an integral part of the contracts.





APPENDIX 4—contd.

Preventive Maintenance—8 Hours

Name of machine : Excavator

Unit No.....Total operating hours.....Date.....

Check and correct, if necessary, using symbol (\*) if O.K., (@) if repair or adjustment is made and (o) if repair is needed and not completed.

Work to be done	Before shift 1	Before shift 2
-----------------	-------------------	-------------------

*Engine*

- (1) Check oil level
- (2) Check radiator level
- (3) Check fuel oil level
- (4) Check water pump grease cup (1 turn)
- (5) Check water temperature
- (6) Check oil temperature
- (7) Check oil pressure
- (8) Check air cleaner and breather caps
- (9) Inspect for fuel oil and water leaks
- (10) Idle engine before starting (10 minutes)

*Excavator*

- (11) Lube all 8-hour grease points with wheel bearing grease
- (12) Lube open gears and sprockets with open gear compoind
- (13) Check controls, clutches, brakes
- (14) Check dipper teeth
- (15) Inspect loose nuts & bolts
- (16) Inspect oil leaks in Hyd. System, etc.

Operator\_\_\_\_\_

Mechanic\_\_\_\_\_

Supervisor\_\_\_\_\_

## APPENDIX 4—contd.

## Preventive Maintenance—100 Hours

Unit No. \_\_\_\_\_ Total Operating Hours \_\_\_\_\_ Date \_\_\_\_\_

Check and correct, if necessary, the following items using the symbol (\*) if O.K., (@) if repair or adjustment is made, (o) if major repair is needed and not completed. List on reverse side of sheet explanation of repairs made, or reasons why they were not completed.

1. *Lubrication*
  - Clean oil filter cap
  - Change engine oil
  - Change lube oil filter (elements)
  - Check differential lube (level)
  - Check rear axle planetaries (L.I.)
  - Check steering gear lube (level)
  - Check transmission lube (level)
  - Check hydraulic oil (level)
  - Clean and re-fill hydraulic (tank breather)
  - Grease clutch release (bearing)
  - Grease tandom units cross (shaft)
  - Grease brake anchor pins
2. *Oil Can Points*
  - Throttle linkage
  - Clutch linkage
  - Clutch air cylinder
  - Emergency brake linkage
  - Cob locks
  - Cob door hinges
  - Hood fasteners
  - Battery case fastener
  - Brake treadle valve
  - Wiper motor (air)
3. *Engine Lub. System*
  - Check—
  - All lines for locks
  - Oil filter for locks
  - Pan bolts for tightness
  - Clean breather cap
4. *Air Cleaners*
  - Tighten hose clamps
  - Clean central tube
  - Check hoses and pipes for cracks or locks
5. *Belts*
  - Check for wear frayed, or cracked spots, adjust slack
  - Fan
  - Compressor
  - Generator
  - Steering
  - Booster
  - Tighten crankshaft nut
6. *Engine Mounting*
  - Tighten engine supports
7. *Fuel System*
  - Check lines for leaks
  - Check pump for leaks
  - Check injector lines
  - Fuel filters
8. *Cooling System*
  - Check for leaks—
  - Hoses
  - Water pump
  - Oil Cooler
  - Water manifold
  - Drain Cocks
  - Check anil-freeze strength
9. (a) *Clutch Check*
  - Linkage for tightness
  - Air cylinder stop
  - Pedal clearance 1" free (travel)
- (b) *Convertor & Transmission*
  - Trans. mounting bolts for (tightness)
  - Convertor mounting bolts for (tightness)
  - Oil-liners for jacks
  - Engine synchronization
  - Convertor for locks
  - Transmission clutches
  - Gear shifts for linkage for (tightness)
  - Convertor stall speed
10. *Transmission*
  - Tighten—
  - Mounting bolts
  - Gear shifts tower bolts
  - Power take-off bolts

11. *Drive Lines*  
Tighten companion flange bolts  
Tighten universal bearing bolts  
Check for loose universals
12. *Rear Axle and Differential*  
Check and Tighten—  
Differential companion flange nut  
Carrier nuts  
Axle mounting bolts  
Clean and open differential breather
13. *Wheels & Tyres*  
Tighten lube and wheel nuts  
Tighten driving flange bolts  
Check tyre pressure  
Check for cuts, bruises & breaks  
Check tyre matting
14. *Springs and Torque Rods*  
Check and/or tighten  
Check or tighten items  
listed on (check sheet)
15. *Brakes*  
Adjust front and rear brakes
16. *Air System*  
Air lines  
Tradle valve  
Brake chamber  
Quick release valve  
Clutch air assist valve  
Air compressor
17. *Emergency Brake*  
Check brake lining for wear  
Adjust brake shoes  
Inspect the ratchet,  
pawl, and (linkage)  
Check brake airassist
18. *Steering System*  
Check for loose or bent tie rod (and drag  
link)
19. *Electrical System*
20. *Batteries*  
Check liquid level  
Check Hydrometer reading  
Check connections.
21. *Cab*  
Check, adjust or replace  
Tighten cab hold-down (bolts)
22. (a) *Instrument Panel*  
Air pressure gauge & governor  
operation  
Techometer lubricating oil pressure  
(gauge)
- (b) *Instrument panel (convertor units*  
Check
23. *Accessories*  
Check operation of the following  
accessories—  
WindshielF Wiper, Fire Extinguisher, Horn Heat & Defroster
24. *Hydraulic System*  
(Rear Dump & Scrapper Units only)  
Test Hydraulic system  
Check visually for leaks  
Check hydraulic control (linkage)
25. *Scrapper Units*  
Ejector return spring  
Cutting edges for wear  
Sheaves  
Frayed or worn cables  
Tighten
26. *Trailer Units*  
Wheel wind for adjustment  
Door stops  
Sheaves  
Frayed or worn cables
27. *Road Test*  
Engine  
Clutch  
Brakes  
Check  
Steering  
On Tractor-trailer units

## APPENDIX 4—contd.

## Preventive Maintenance—500 hours

Unit No. \_\_\_\_\_ Total Operating Hours \_\_\_\_\_ Date \_\_\_\_\_

Check and correct, if necessary, the following items using the symbol (\*) if O.K., (@) if repairs or adjustment is made, (o) if major repairs are needed and not completed. List on reverse side of sheet explanation of repairs made or reasons why they were not completed.

1. *Cleaning*  
Wash unit  
Steam clean engine
2. *Lubrication—Drain & Refill*  
Hydraulic transmission oil  
Clean transmission suction screen  
(Allison only)  
Replace fuel filter elements oil  
Generator and starter
3. *Frame*  
Examine for cracks inside and out
4. *Cab Canopy or Dash*  
Check condition of wiring
5. *Electrical System*  
Check condition of wiring
6. *Engine (Cummins)*  
Clean fuel pump screen  
Tighten cylinder head bolts  
Adjust valves  
Tighten manifold bolt  
Check blawby  
Inspect supercharger for leaks
7. *Engine (G.M.C.)*  
Adjust valves  
Time injectors  
Position injector control rock  
Tighten cylinder head nuts  
Clean air bolts
8. *Wheel Bearing—Frong and Trailor*  
Adjust Bearings
9. *Front Axle*  
Check—  
King pins and bushings  
Spindle to axle clearance (TD & FFO only)  
Toe-in
10. *Streeing System*  
Check and adjust—  
Bolts joints  
Front axle stops  
Pitman arm stops
- 10.(a) *Rear Dump Units (Body)*  
Examine and repair—  
Moles and cracks  
Broken welds  
Loose or bent canopy  
Broken welds
- 10.(b) *Trailer Units*  
Check—  
Holes and cracks  
Broken welds  
Tighten hinge bolts  
Tighten wheel wind mounting  
(bolts)
- 10.(c) *Scrapper Units*  
Check—  
Holes and cracks  
Broken welds
11. *Perform 100 Hrs. P.M.*  
Check
12. *Additions*

## APPENDIX 4—contd.

## Preventive Maintenance—1000 hours

Unit No. \_\_\_\_\_ Total Operating Hours \_\_\_\_\_ Date \_\_\_\_\_

Check and correct, if necessary, the following items using the symbol (\*) if O.K., (@) if repairs or adjustment is made, (o) if major repairs are needed and not completed. List on reverse side of sheet explanation of repairs made, or reasons why they were not completed.

1. *Lubrication—Drain & Refill*

Differential  
Rear axle planetaries  
Steering gear  
Transmission & replace oil (filter element)  
Change hydraulic oil and (filter)  
Change wheel wind oil  
Grease slack adjuster  
Refill Driver seat slack absorber  
Oil slack upper bushing

2. *Cooling System*

Drain, flush & refill  
Remove and clean oil cooler

3. *Hydraulic System*

Check relief valve adjustment  
Check steering booster relief, valve setting

4. *Air System*

Check—  
Air compressor discharge valve for carbon (& clean if necessary)  
Adjust air compressor (unloading valve)  
Clean compressor (oil supply & return lines)  
Clean Governor air strainer  
Clean safety valve pop off pressure

5. (a) *Engine (G.M.C.)*

Inspect intake parts  
Inspect Piston rings  
Inspect Blower for wear & leaks

(b) *Engine (Cummins)*

Check crankshaft end ply  
Clean injectors  
Grease water pump & fan hub

6. *Perform 500 Hour checks*7. *Additions.*

## Preventive Maintenance—2000 Hours

Unit No. \_\_\_\_\_ Total Operating Hours \_\_\_\_\_ Date \_\_\_\_\_

Check and correct, if necessary, the following items using the symbol (\*) if O.K., (@) if repairs or adjustment is made, (o) if major repairs are needed and not completed. List on reverse side of sheet explanation of repairs made, or reasons why they were not completed.

1. *Electrical System*

Check generator brushes & commutator  
Tighten generator mounting  
Check starter brushes and commutator  
Tighten starter mounting  
Tighten starter soleniod (Hold-down bolts)  
Clean and adjust regular

Re-pack wheel bearings  
Inspect planetaries  
(Unit with planetaries in wheels)

3. *Steering System*

Check steering column for alignment  
Adjust steering gear-cum-thrust (bearings)  
Adjust steering gear backlash

2. *Wheel Bearing and Brakes*

Examine all brake linings (for wear)

4. *Perform 1000, 500 and 10 Hour checks*5. *Additions*

## REPORT OF RATES &amp; COSTS COMMITTEE

## APPENDIX 4—concl'd.

## Preventive Maintenance—4000 Hours

Unit No. \_\_\_\_\_ Total Operating Hours \_\_\_\_\_ Date \_\_\_\_\_

Check and correct, if necessary, the following items using the symbol (\*) if O.K., (@) if repairs or adjustment is made, (o) if major repairs are needed and not completed. List on reverse side of sheet explanation of repairs made or reasons why they were not completed.

1. *Engine*

Re-condition engine  
Dis-assemble & inspect  
(Clutch or Converter & Transmission)

Check valve  
Treadle valve operator  
Check Air Compressor

4. *Perform 2000, 1000, 500 & 100 Hour checks*

2. *Differential & Planetaries*

Dis-assemble & inspect (differential)  
Remove and inspect (planetaries)

5. *Additions*

Time speed  
Time speed  
Time speed

3. *Air System*

Dis-assemble, clean and replace diaphragms or sects.  
Brake chambers  
Quick release valv

Mechanic  
Mechanic  
Master Mechanic

## APPENDIX 5

## (1) Maintenance Charges per day for a Sentinel Steam 1000

*N.B.* :—Monthly expenditure for loco working for 6 hours every day; working days assumed to be 25 in a month.

Sl. No.	Description of work	Rate Rs.	Amount	Total
<b>I. (a) Fuel and consumables</b>				
	Coal @ 0.4 ton per loco per day for 25 days— 10 tons .. .. .	45/- per ton	450/-	
	(b) <i>B.B. oil</i> (Mobil oil) 0.2 per loco per day for 25 days—5 gals. .. .. .	4/- per gal	20/-	
	(c) <i>Cylinder oil</i> , 600 W : 0.1 gal. per loco per day for 25 days—2.5 gals	4/- „	10/-	
	(d) <i>Kerosene oil</i> : 1 gal. for 25 days per loco ..	1/4 „	1/4/-	
	(e) <i>Cotton waste</i> for 25 days for one loco 10 lbs	1/- „	10/-	
	(f) <i>Fire wood</i> : 12 lbs. per loco per day for 25 days = $\frac{12 \times 25}{2240} = 0.13$ ton .. .. .	37/- per ton	4/13/-	
	(g) <i>Other Misc. items</i> such as grease, etc. .. .. .	L.S.	3/15/-	
			<u>500/-</u>	500/-
<b>II. Crew</b>				
	(a) Driver .. .. .	95/- per month	95/-	
	(b) Fireman .. .. .	55/-	55/-	
	(c) Cleaner .. .. .	40/-	40/-	
			<u>190/-</u>	190/-
<b>III. Labour</b>				
<b>(A) Conveyance of 10 tons of coal, breaking &amp; supplying etc.</b>				
	(i) One lorry can convey 10 tons in 5 trips ..			



## APPENDIX 5—contd.

*Maintenance Charges per day for a Sentinel Steam 100*

Sl. No.	Description of work	Rate Rs.	Amount	Total
	Milage for each trip to and fro from back-side of Genl. Stores to coal dump is 3 miles, for 5 trips (5×3)=15 miles conveyance	1/- per mile	15/-	
(ii)	Loading and unloading charges for coal—10 tons	2/- per ton	20/-	
(iii)	Breaking and supplying of coal 7 females @ 1/12/- for supplying for 9 locos at 5/4-1-per shift Total coal supplied for 9 locos— 0.4 ton (as above) × 9 = 3.6 tons	For 3.6 tons 5/4-	14/10/-	
(B)	Firewood splitting 300 lbs.	..S.	2/-	
(C)	Conveyance of oil etc.	..S.	2/-	
			53/10	53/10
<b>IV. One loco/month/shift Boiler Inspection</b>				
	Fees Rs. 30/- × 14 per year for 2 shifts	420/-	2/-	2/-
	Distributing to 9 locos	9 locos for year for 2 shifts		
<b>V. Repairs and Renewals</b>				
	One loco/month/shift	9 locos 900/- for 2 shifts	50/-	50/-
<b>VI. Petty Supervision and Contingencies</b>				
	One Mistry	94/-		
	2nd Mistry	49/-		
	Watchman	34/-		
	9 locos for 2 shift	177/-		
	One loco for one month for 1 shift	177/-	9 locos/ month/ shift	9/13
			<b>TOTAL</b>	<b>805/7/-</b>

For 25 days the total charges : 805/7/-

∴ Charges of one day =  $\frac{805/7/-}{25} = 32/3/2$ , or say Rs. 32/-

A sentinel loco can convey about 3000 cu. ft. of spoil per 8 hours with a lead of half a mile.

## APPENDIX 5—concl'd.

## (2) Maintenance Charges per day for a Diesel Loco

*N.B.* :—Monthly expenditure for one loco working for one shift of 6 hours; working days assumed to be 25 in a month.

Sl. No.	Description of work	Rate (Rs.)	Amount	Total
<i>Data for each shift of 6 hours</i>				
<b>I. Crew</b>				
	Driver .. .. .	95/- per	95/- 40/-	
			135/-	135/-
<b>II. Consumables</b>				
	(a) HSD oil 6½ gals. per day for 25 days—162½ gals.	1/4 per gal.	203/2/-	
	(b) Mobil oil, B.B. oil. 0·1 gal./day for 25 days—2·5 gals.	4/-	10/-/-	
	(c) Delvac oil 930, 0·15 gal./day for 25 days—0·15 × 25=3·75 gals.	4/-	15/-	
	(d) Cotton waste—5 lbs.	1/- per lb	5/-	
	(e) Sundries like grease, etc.	L.S.	2/-	
			235/2/-	235/2/-
<b>III. Repairs and renewals—servicing in workshop</b>				
	For 4 locos for two shifts for 25 days—Rs. 160			
	So, far 1 loco for one shift .. .. .	$\frac{160}{4 \times 2} = 20$	20/-	20/-
<b>IV. Labour for conveyance of oils, etc.</b>				
	.. .. .	L.S.	8/-	8/-
<b>V. Petty supervision charges and contingencies</b>				
	1 Mistry @ Rs. 50/- per month for 4 locos for two shifts.			
	So far one loco for one shift = $\frac{50}{4 \times 2} = 6/4/-$			6/4/-
	Total expenditure for one loco for 25 days =	404/6/-		404/6/-
	Total expenditure for one loco for day =	$\frac{404/6/-}{25} = 16·28$		
		or say Rs.		
		16/-/-		

A diesel loco can convey about 2000 cu. ft. of spoil per 8 hours with a lead of 1/2 mile.

## APPENDIX 6

*Tables of Output of Excavators as suggested by Foreign Authors*

1. *Reference* : Construction Planning and Plant by Ackermanu and Locker; McGraw-Hill Book Coy., New York.

*Maximum Output (Bank Measure) in CFC Units per hour*

Sl. No.	Soils	Capacity of the Excavator in cyds.						
		3/4	1	1½	2	2½	3	3½
1	2	3	4	5	6	7	8	9
1.	Light, moist caly or loam .. .. .	43-50	54-62	75-86	94-109	110-126	127-146	143-165
2.	Ordinary earth, loose sand and gravel .. .. .	24-45	43-55	60-77	75-97	88-113	102-131	114-149
3.	Light clay mixed with gravel .. .. .	28-32	35-40	49-56	61-70	71-82	83-95	93-107
4.	Heavy clay & boulders	22-28	27-35	38-49	47-61	55-71	64-83	72-93
5.	Blasted rock, hardpan tough rubbery clay ..	15-19	19-24	25-34	33-42	39-50	45-57	50-64

This Chart indicates the maximum outputs for favourable conditions assuming no lost operating time and 90° swing to dump. The practical output may be 85 to 50% of indicated output depending on skill and experience of operators and local conditions.

2. *Reference* : Estimating Construction Costs by Peurifoy, McGraw-Hill Book Coy., New York.

*Representative Hourly Outputs in CFC (Bank Measure)*

Soils	45°			90°			180°		
	2	3	4	5	6	7	8	9	10
	¾ cyd.			1 cyd.			2 cyds.		
<i>Shovels</i>									
Sandy loam .. .. .	45	35	25	57	45	32	97	79	55
Ordinary earth .. .. .	37	24	21	48.5	38	27	82	65	46
Hard earth .. .. .	26	20	17	40	32	22	73	58	41
Rock blasted .. .. .	21	16	14	34	27	19	64	50	36
	½ cyd.			1 cyd.			2 cyds.		
<i>Draglines</i>									
Sandy loam .. .. .	21	17.5	13.5	35	30	23	58	49	38
Ordinary earth .. .. .	16.5	14	10.9	31	26	20	51	43	33
Hard earth .. .. .	12	10	8	24	21	16	44	36	28
Wet clay .. .. .	7	6	4.5	16.5	14	10.5	32	27	21

## APPENDIX 7

*Hourly Use Rate of Mechanical Equipment*

Sl. No.	Equipment	Hourly use rate in Rs.
<b>I. Air Compressors</b>		
(a)	210 C. F. M. Diesel, Portable	10·5
(b)	315 C. F. M. Diesel, Portable	14·0
(c)	500 C. F. M. Diesel, Portable	20·0
(d)	500 C. F. M. Electrical, Stationary	16·5
<b>II. Belt Loader</b>		
	18 B. V. Belt Loaders	55·0
<b>III. Dump Truck</b>		
(a)	9·7 Cyd., 15 ton Rear Dump	34·0
(b)	14·8 Cyd., 22 ton Rear Dump	52·0
(c)	13 Cyd., Struck Bottom Dump	37·0
(d)	17 Cyd., Struck Bottom Dump	47·0
<b>IV. Excavators</b>		
(a)	(i) $\frac{3}{4}$ Cyd. Shovel	31·0
	(ii) $1\frac{1}{2}$ " "	50·0
	(iii) $2\frac{1}{2}$ " "	64·0
	(iv) $3\frac{1}{2}$ " "	89·0
(b)	(i) $\frac{3}{4}$ Cyd. Dragline	29·0
	(ii) $1\frac{1}{2}$ " "	43·0
	(iii) $2\frac{1}{2}$ " "	55·0
	(iv) $3\frac{1}{2}$ " "	74·0
<b>V. Scrappers</b>		
(a)	10/12·05 Cyd. Drawn Scrapper	14·0
(b)	15/20 " "	20·0
(c)	10/13 " Motorised	43·0
(d)	15/20 " "	56·0
<b>VI. Tractors</b>		
(a)	81 H. P. Crawler Tractor	25·0
(b)	130 H. P. " "	29·0
(c)	81 H. P. Tractor Dozer	28·0
(d)	130 H. P. " "	32·0
(e)	D-4 Tractor with Sheepsfoot Roller	15·15
<b>VII. Motor Grader</b>		
	115 Y. P.	25·0

## USE RATES OF MECHANICAL EQUIPMENT

## 1. Air Compressors—Portable

## (A) 210 C.F.M. Diesel Compressor (55 H.P.)

(a) Depreciation per working hour	Rs.
Cost of Compressor .. .. .	26,100
Life —10,000 hours	
Depreciation per hour .. .. .	2.61
(b) Repairs & maintenance cost @ 80% of depreciation .. .. .	2.09
(c) Fuels & lubricants .. .. .	
2.25 gallons Diesel Oil @ Rs. 1.5 per gal. .. .. .	3.40
Lubricants & grease .. .. .	0.75
Sundries such as cotton waste etc. .. .. .	0.75
	4.90
(d) Labour Charges	
$\frac{1}{2}$ No. Driver @ Rs. 4.5 per day per shift .. .. .	0.30
1 No. Helper @ Rs. 3.0 per day per shift .. .. .	0.40
	0.70
Add 25% for idle days & leave reserve .. .. .	0.18
	0.88
Labour rate per working hour .. .. .	0.88
<i>Abstract</i>	
Depreciation .. .. .	2.61
Repairs & Maintenance .. .. .	2.09
P.O.L. charges .. .. .	4.90
Labour charges .. .. .	0.88
	10.48
Use rate per working hour .. .. .	10.48
	Say, Rs. 10.5

## (B) 315 C.F.M. Diesel Portable Compressor (78 H.P.)

(a) Depreciation per working hour	
Cost of the Compressor .. .. .	38,300
Life —10,000 hours	
Depreciation per hour .. .. .	3.83
(b) Repairs and maintenance @ 80% of depreciation charges .. .. .	3.07
(c) Fuels, lubricants, etc.	
3 gals, Diesel oil @ Rs. 1.5 per gal. .. .. .	4.50
Lubricants and grease .. .. .	1.00
Sundries such as cotton waste etc. .. .. .	0.75
	6.25
(d) Labour charges per working hour .. .. .	0.88
<i>Abstract</i>	
Depreciation .. .. .	3.83
Repairs & Maintenance .. .. .	3.07
P.O.L. charges .. .. .	6.25
Labour .. .. .	0.88
	14.03
Use rate per working hour .. .. .	14.03
	Say, Rs. 14.00

## (C) 500 C.F.M. Diesel Portable Compressor (127 H.P.)

	Rs.
(a) <i>Depreciation per working hour</i>	
Cost of the Compressor .. .. .	58,000
Life in hours—10,000	
Depreciation per hour .. .. .	5.8
(b) <i>Repairs &amp; Maintenance @ 80% of depreciation charges</i> .. .. .	4.64
(c) <i>Fuels, lubricants etc.</i>	
4.5 gls. of Diesel oil @ Rs. 1.5 .. .. .	6.75
Lubricants & grease .. .. .	1.00
Sundries such as cotton waste .. .. .	0.75
	<hr/> 8.50
(d) <i>Labour charges</i>	
½ No. driver @ Rs. 4.5 per day per shift .. .. .	0.30
1 No. helper @ Rs. 3 per day per shift .. .. .	0.40
	<hr/> 0.70
Add 25% for idle days and leave reserve .. .. .	0.18
	<hr/> 0.88
<i>Abstract</i>	
Depreciation .. .. .	5.80
Repairs & Maintenance .. .. .	4.64
P.O.L. charges .. .. .	8.50
Labour charges .. .. .	0.88
	<hr/> 19.82
Use rate per working hour .. .. .	Say Rs. 20/-

## (D) 500 C.F.M. Stationary Electric Compressor

(a) <i>Depreciation per working hour</i>	
Cost of the Compressor .. .. .	31,200
Depreciation @ 1% per month .. .. .	312
Assuming 25 days in a month and 8 hrs. per shift per day <i>i.e.</i> 312	
200 working hrs. depreciation rate per working hour .. .. .	<hr/> = 1.56
	200
(b) <i>Repairs &amp; Maintenance @ 80% of depreciation charges</i> .. .. .	1.25
(c) <i>Power charges</i>	
Rated H.P. of the engine: 120 h.p. .. .. .	
Power consumption per hour at full load—89.5 kWh	
Power charges for 89.5 kWh @ Re. 0.125 per unit .. .. .	11.2
Lubricants and other sundries .. .. .	0.8
	<hr/> 12.0
Total power & oil charges per hour .. .. .	12.0
(d) <i>Labour charges</i>	
½ No. Operator @ Rs. 6 per day per shift .. .. .	0.38
1 No. Helper @ Rs. 3 per day per shift .. .. .	0.38
½ No. Foreman @ Rs. 12 per day per shifts .. .. .	0.40
Chowkidar @ Rs. 1.75 per day of 2 shifts .. .. .	0.12
	<hr/> 1.28
Add 25% for non-working season and leave reserve .. .. .	0.32
	<hr/> 1.60
Labour charges per hour .. .. .	<hr/> 1.60

<i>Abstract</i>	Rs.
Depreciation .. .. .	1.56
Repairs & maintenance .. .. .	1.25
Power charges .. .. .	12.00
Labour .. .. .	1.60
	16.41
Use rate per working hour .. .. .	16.41
	Say Rs. 16.50

## 2. Excavators

### (A) 3/4 Cyd. Shovels (80 H.P.)

<i>(a) Depreciation per working hour</i>	
Cost of the machine .. .. .	1,21,000
Life in hours —10,000 .. .. .	
Depreciation per hour .. .. .	12.10
<i>(b) Repairs &amp; maintenance @ 100% of depreciation .. .. .</i>	12.10
<i>(c) Fuels, lubricants, etc.</i>	
H.P. of the machine : 80	
Fuel consumption in gals. per	
60 min. hr. = $\frac{0.5 \times 80 \times 0.6}{8.26}$	2.91 gallons
For 40 min. hr. = $\frac{2.91 \times 4}{6}$	= 2 gallons
2 gals. HSD @ Rs. 1.5 .. .. .	3.00
Lubricants and grease .. .. .	0.75
Sundries such as cotton waste, petrol, filters, etc. .. .. .	1.50
	5.25
<i>(d) Labour per hour</i>	
1 No. shovel operator @ Rs. 6 per day per shift .. .. .	0.75
1 No. helper @ Rs. 3 per day per shift .. .. .	0.38
1/8 No. Foreman @ Rs.12 per day per shift .. .. .	0.20
Chowkidar, etc. .. .. .	0.12
	1.45
Add 25% for non-working season & leave reverse .. .. .	0.36
	1.81

### *Abstract*

Depreciation .. .. .	12.10
Repairs .. .. .	12.10
P.O.L. charges .. .. .	5.25
Labour .. .. .	1.80
	31.25
Use rate per hour .. .. .	31.25
	say Rs. 31/- per hour.

## (B) 1½ Cyd. Shovels (170 H.P.)

(a) Depreciation per working hour	Rs.
Cost of the machine .. .. .	2,32,100
Life in hours —12000	
Depreciation per hour .. .. .	19·4
(b) Repairs and Maintenance @ 100% of depreciation .. .. .	19·4
(c) Fuels, lubricants, etc.	
4 gals. of HSD oil @ Rs. 1·5 .. .. .	6·00
Lubricants and grease .. .. .	1·00
Sundries such as cotton waste, petrol, filters, etc. .. .. .	2·00
P.O.L. charges per working hour .. .. .	9·00
(d) Labour per working hour .. .. .	1·80

*Abstract*

Depreciation .. .. .	19·40
Repairs & maintenance .. .. .	19·40
P.O.L. charges .. .. .	9·00
Labour .. .. .	1·80
Use rate per hour .. .. .	49·60
Say	Rs. 50/-

## (C) 2½ Cyds. Diesel Shovel (200 H.P.)

(a) Depreciation per working hour	
Cost of the machine .. .. .	3,90,000
Life —15,000 hours	
Depreciation per hour .. .. .	26·0
(b) Repairs and maintenance, @ 100% of depreciation .. .. .	26·0
(c) Fuels, lubricants, etc.	
5 gals. HSD oil @ Rs. 1·5 .. .. .	7·50
Lubricants and grease .. .. .	1·00
Sundries such as cotton waste, petrol, etc. .. .. .	2·00
	10·50

*Abstract*

Depreciation per hour .. .. .	26·00
Repairs .. .. .	26·00
P.O.L. charges .. .. .	10·50
Labour .. .. .	1·80
Use rate per hour .. .. .	64·30
Say	Rs. 64/-

## (D) 3½ Cyds. Shovel (225 H.P.)

(a) Depreciation per working hour	
Cost of the machine .. .. .	5,68,700
Life—15,000 hours	
Depreciation .. .. .	37·9
Say	Rs. 38·0



	Rs.
(b) <i>Repairs &amp; Maintenance @ 100% of depreciation</i>	38.00
(c) <i>Fuels lubricants etc.</i>	
5.5 gals. of HSD oil @ Rs. 1	8.25
Lubricants & grease	1.00
Cotton waste, filters, petrol and other sundries	2.00
	11.25

(d) *Labour per working hour* 1.80

*Abstract of use rate per working hour*

(a) Depreciation	38.00
(b) Repairs & Maintenance	38.00
(c) P.O.L. charges	11.25
(d) Labour	1.80

89.05

Say Rs. 90/-

(E) *Draglines*

Sl. No.	Capacity	Cost (Rs.)	Life in working hours	Use rate per hour				Use rate (Rs.)
				Depreciation	Repairs	Fuel & Lubricants	Labour	
1	2	3	4	5	6	7	8	9
1.	$\frac{3}{4}$ Cyd.	1,21,000	10,000	12.10	9.68	5.25	1.80	29
2.	$1\frac{1}{2}$ „	2,16,700	12,000	18.00	14.40	9.00	1.80	43
3.	$2\frac{1}{2}$ „	3,54,200	15,000	23.60	18.88	10.50	1.80	55
4.	$3\frac{1}{2}$ „	5,03,800	15,000	33.60	26.88	11.25	1.80	74

3. Tractors

(A) 81 H.P. Crawler Tractor

	Rs.
(a) <i>Depreciation</i>	
Cost of tractor	88,600
Life—10000 hours	
Depreciation per hr. = $\frac{88600}{10000}$	8.86
(b) <i>Repairs &amp; Maintenance @ 100% of depreciation</i>	8.86
(c) <i>Fuels, lubricating etc.</i>	
2 gals. of H.S.D. oil @ Rs. 1.5 per gallon	3.00
Lubricants and grease	0.75
Sundries such as cotton waste, petrol etc.	2.00
	5.75

	Rs.
<i>(d) Labour per working hour</i>	
1 No. Driver @ Rs. 6 per day per shift .. .. .	0·75
1 No. helper @ Rs. 3 per day per shift .. .. .	0·38
1/8 No. Foreman @ Rs. 12 per day per shift .. .. .	0·20
Chowkidar @ Rs. 1·75 per day of 2 shifts .. .. .	0·11
	<hr/>
	1·44
Add 25% for non-working season .. .. .	0·36
	<hr/>
	1·80
	<hr/>

*Abstract of use rate per working hour*

(a) Depreciation .. .. .	8·86
(b) Repairs & Maintenance .. .. .	8·86
(c) P.O.L. charges .. .. .	5·75
(d) Labour .. .. .	1·80
	<hr/>
Use rate per hour .. .. .	25·27
	<hr/>

*(B) 130 H.P. Crawler Tractor*

<i>(a) Depreciation</i>	
Cost of the machine .. .. .	1,19,000
Life—12,000 hours .. .. .	
Depreciation per hour .. .. .	9·92
	Say Rs. 10·00
<i>(b) Repairs &amp; Maintenance @ 100% of depreciation .. .. .</i>	
	10·00
<i>(c) Fuel, lubricants etc.</i>	
3 gals. of HSD oil @ Rs. 1·5 .. .. .	4·50
Lubricants and grease .. .. .	1·00
Sundries like cotton waste, petrol, etc. .. .. .	2·00
<i>(d) Labour per working hour .. .. .</i>	
	1·8

*Abstract*

(a) Depreciation .. .. .	10·00
(b) Repairs & Maintenance .. .. .	10·00
(c) P.O.L. charges .. .. .	7·50
(d) Labour .. .. .	1·80
	<hr/>
Use rate per working hour .. .. .	29·30
	Say Rs. 30/-

**4. Scrappers***(A) Motorised Scrapper (10/13 cyds., 176 H.P.)*

<i>(a) Depreciation per working hour</i>	
(i) Cost of the scrapper less tyres and tubes (Rs. 1,69,400—16,300) .. .. .	Rs. 153,100
Life in working hours up to 10—12,000 above 10—13,000 .. .. .	
Depreciation per hour .. .. .	12·76

(ii) Depreciation of tyres and tubes	Rs.
Cost .. .. .	16,296
Life in hours—3000	
Depreciation of tyres & tubes per hour	5.44
Total depreciation per hour=(12.76+5.44)	18.20
(b) Repairs & Maintenance @100% of depr. of machine+55% of depr. of tyres = [12.76+(5.44+0.55)]	15.75
(c) Fuel, lubricants etc.	
3 gals. HSD oil @ Rs. 1.5	4.50
Lubricants and grease	1.00
Sundries such as cotton waste, petrol, etc.	2.00
	7.50
(d) Labour per hour	1.80

**Abstract**

(a) Depreciation	18.20
(b) Repairs & Maintenance	15.75
(c) P.O.L. charges	7.50
(d) Labour	1.80
	43.25
Use rate per working hour	43/-
	Say Rs.

**(B) 15/20 Cyds. Motorised Scrapper**

(a) Depreciation	
(i) Cost of the machine less 4 tyres	1,62,000
Life—15,000 hours.	
Depreciation per hours	10.8 Say 11
(ii) Cost of tyres	32,000
Life 300 hours	
Depreciation per hour	11.0
Total depreciation=Rs. (11+11)	22.0
(b) Repairs & Maintenance per hour	
(i) Of Machine @ 100% of depreciation	11.0
(ii) Of tyres @ 60% depreciation	12.6
	23.6
(c) Fuel, lubricants etc.	
4 gals. HSD. oil @ Rs. 1.5	6.00
Lubricants and grease	1.00
Sundries such as cotton waste, petrol, etc.	2.00
	9.00
(d) Labour charges	1.80

**Abstract**

(a) Depreciation	22.00
(b) Repairs & Maintenance	23.60
(c) P.O.L. charge	9.00
(d) Labour	1.80
	55.40
Use rate per working hour	56/-
	Say Rs.

5. Belt Loader

(A) 18. B.V. Belt Loader (248 H.P.)

<i>(a) Depreciation per working hour</i>	Rs.
(i) Cost of the machine .. .. .	2,90,000
Life—15,000 hours	
Depreciation .. .. .	19·3
(ii) Cost of belt .. .. .	12,000
Life—3,000 hours	
Depreciation per hour .. .. .	4·00
Total depreciation (19·3+4·0) .. .. .	23·30
 <i>(b) Repairs and Maintenance</i>	
(i) For the machine @100%of depreciation .. .. .	19·3
(ii) For belt @ 45% of depreciation .. .. .	1·7
	21·0
 <i>(c) P.O.L. Charges</i>	
4·5 gls. HSD oil @ Rs. 1·5 .. .. .	6·75
Lubricants and grease .. .. .	1·00
Sundries such as cotton waste, petrol, etc. .. .. .	2·00
	9·75
 <i>(d) Labour per working hour</i>	 1·80
 <i>Abstract</i>	
(a) Depreciation .. .. .	23·30
(b) Repairs & Maintenance .. .. .	21·00
(c) P.O.L. charges .. .. .	9·75
(d) Labour .. .. .	1·80
	55·85

Say, Rs. 56

6. 115 H.P. Motor Grader

<i>Depreciation per hour</i>	Rs.
i) Cost of the machine less tryes .. .. .	91,000
Life in hours—12,000	
Depreciation .. .. .	7·6
Cost of tyres .. .. .	6000
Life of tyres—2,500 hrs	
Depreciation of tyres = $\frac{6,000}{2,500}$ .. .. .	2·4
Total Depreciation = (7·6+2·4) .. .. .	10

(b) <i>Repairs and Maintenance</i>		Rs.
(i) Of the machine @ 80% of depr.	.. .. .	6.0
(ii) Of the tyres @ 55% of depr.	.. .. .	1.3
		<hr/>
		7.3
(c) <i>Fuels, lubricants, etc.</i>		
H.S.D. oil per 60 min. working hour	$= \frac{0.5 \times 115 \times 0.4}{8.26} = 2.78$ gals.	
Per 40 minute working hr.	$= \frac{2.78 \times 4}{6} = 1.79$	
2 gls. HSD oil @ Rs. 1.5	.. .. .	3.00
Lubricants and grease	.. .. .	0.75
Sundries like cotton waste, petrol, etc.	.. .. .	2.00
		<hr/>
		5.75
(d) <i>Labour per hour</i>	.. .. .	1.80
<i>Abstract</i>		
(a) Depreciation	.. .. .	10.00
(b) Repairs and maintenance	.. .. .	7.30
(c) P.O.L. charges	.. .. .	5.75
(d) Labour	.. .. .	1.80
		<hr/>
Use rate per working hour	.. .. .	24.85
		Say, Rs. 25

### 7. Dumpers (150—165 H.P.)

(A) 9.7 Cyd., 15 Ton Rear Dumper

(a) <i>Depreciation per working hour</i>		Rs.
(i) Cost of the dumper less tyres	.. .. .	1,40,320
Life in working hours—12,000		
$\therefore$ Depreciation per hr.	$= \frac{140,300}{12,000}$	11.7
(ii) Cost of tyres and tubes		
Front : 2 Nos. of 12.00 × 24-16 ply @ Rs. 1,099		2,198
Rear : 4 Nos. of 14.00 × 24-20 ply @ Rs. 1,529		6,080
		<hr/>
		8,278
Life in Hours—3,000		
Depreciation per Hour	$= \frac{8,280}{3,000}$	= 2.76
$\therefore$ Total depreciation per hour	$= (11.70 + 2.76)$	14.46
(b) <i>Repairs and Maintenance @ 80% of Depr. of the machine + 60% of Depr. of tyres.</i>	$(11.7 \times 0.8 + 2.76 \times 0.6)$	11.01
(c) <i>Fuels, lubricants, etc.</i>		
2.5 gls. of HSD @ Rs. 1.5	.. .. .	3.75
Lubricants and grease	.. .. .	1.00
Sundries such as cotton waste, petrol, etc.	.. .. .	2.00
		<hr/>
P.O.L. per working hour	.. .. .	6.75

(d) Labour per working hour	Rs.
1 No. Driver @ Rs. 5 per day per shift .. .. .	0.63
1 No. Helper @ Rs. 3 per day per shift .. .. .	0.38
1/8 No. Foreman @ Rs. 12 per day per shift .. .. .	0.20
Chowkidar, etc. .. .. .	0.12
Add 25 % for non-working season and leave reserve ..	0.33
	<hr/>
	1.66

*Abstract*

(a) Depreciation .. .. .	14.46
(b) Repairs & maintenance .. .. .	11.01
(c) P.O.L. charges .. .. .	6.75
(d) Labour .. .. .	1.70
	<hr/>
Use Rate per working hour ..	33.92
	Say, Rs. 34

*(B) 14.8 Cyds., 22 Ton Rear Dumper (250 H.P.)*

(a) Depreciation per working hour	Rs.
(i) Cost of dumper less tyres .. .. .	2,02,735
Life—12,000 hours	
	$\frac{202,735}{12,000}$
∴ Depreciation per hour	= 16.9
Life of tyres—3,000 hours	
	$\frac{21,660}{3,000}$
Depreciation of tyres and tubes per hour	= 7.2
∴ Total depreciation per hour (16.9+7.2) .. .. .	24.1
	Say, Rs. 24
(b) Repairs and maintenance @ 80% of depr. of the machine +60% of depr. of tyres = (16.9×0.8+7.2×0.6) .. .. .	17.84
(c) Fuels, lubricants, etc.	
3.5 gals. of HSD @ Rs. 1.5 .. .. .	5.25
Lubricants and grease .. .. .	1.00
Sundries such as cotton waste, petrol etc. .. .. .	2.00
	<hr/>
	8.25
(d) Labour per working hour .. .. .	1.70

*Abstract of use rate*

(a) Depreciation .. .. .	24.00
(b) Repairs and Maintenance .. .. .	17.84
(c) P.O.L. charges .. .. .	8.25
(d) Labour .. .. .	1.70
	<hr/>
Use rate per working hour .. .. .	51.79
	Say, Rs. 52/-

*(C) Bottom Dump, 13 Cyds. Payload (200 H.P.)*

	Rs.
<i>(a) Depreciation</i>	
(i) Cost of the dumper less the tyres	1,38,330
Life hours—15000	
Depreciation per hour	9.22
(ii) Tyres and Tubes	
Cost of tyres & tubes	26,100
Life of tyres—3500 hours	
Depreciation of tyres & tubes per hour	7.5
Total depreciation per hour (9.22+7.50)	16.72
<i>(b) Repairs and maintenance @ 80% of depreciation of the machine +50% of depreciation of tyres = (9.22 × 0.8 + 7.5 × 0.5)</i>	11.13
<i>(c) Fuels and lubricants</i>	
3 gls. of HSD oil @ Rs. 1.5	4.50
Lubricants & grease	1.00
Sundries such as cotton waste, petrol & others	2.00
	7.50
<i>(d) Labour per working hour</i>	1.70
<i>Abstract</i>	
(a) Depreciation	16.72
(b) Repairs & maintenance	11.13
(c) P.O.L. charges	7.50
(d) Labour	1.70
	37.05
Use rate per working hour	37.05
Say, Rs.	37/-

*(D) Bottom Dump, 17 Cyds. Struck (260 H.P.)*

	Rs.
<i>(a) Depreciation</i>	
(i) Cost of the dumper less tyres and tubes	1,85,500
Life in working hours—15000	
∴ Depreciation per hour	12.37
(ii) Cost of tyres & tubes	31,940
Life of tyres—3500 hours	
∴ Depreciation of tyres and tubes per hour = $\frac{31900}{3500}$	9.13
Total depreciation per hour = (12.37 + 9.13)	21.50
<i>(b) Repairs and maintenance @80% of depreciation of the machine +50% of depreciation of tyres (12.37 × 0.8 + 9.13 × 0.5)</i>	14.5
<i>(c) Fuels and lubricants etc.</i>	
4 gls. HSD oil @ Rs. 1.5	6.00
Lubricants & grease	1.00
Sundries such as cotton waste, petrol and others	2.00
	9.00

(d) Labour per hour .. .. .	Rs. 1.70
<i>Abstract</i>	
(a) Depreciation .. .. .	21.50
(b) Repairs & maintenance .. .. .	14.59
(c) P.O.L. charges .. .. .	9.00
(d) Labour .. .. .	1.70
	<hr/>
Use rate per working hour .. .. .	46.70
	Say, Rs. 47/- per hour

### 8. D-4 Tractor with Turindrum Sheepsfoot Roller

#### Use Rate of D-4 Tractor

(i) Depreciation	Rs.
Cost of D-4 Tractor .. .. .	45,000
Life Hours—10,000	
Depreciation per hr .. .. .	4.5
(ii) Repairs and maintenance @ 100% of depreciation .. .. .	4.5
(iii) Fuels and lubricants etc.	
1.5 gls. HSD Oil @ Rs. 1.5 .. .. .	2.25
Lubricants & grease .. .. .	0.75
Sundries like cotton waste, etc. .. .. .	0.75
	<hr/>
(iv) Labour per hour .. .. .	3.75
	1.50

#### Use Rate of Sheepsfoot Roller

(i) Depreciation	
Cost .. .. .	6,800
Depreciation @ 1.5% per month .. .. .	102
Assuming 200 hours working per month	
Depreciation per working hour .. .. .	0.5
(ii) Repairs and maintenance @ 40% of depreciation .. .. .	0.2
(iii) Lubricants, etc. .. .. .	0.2
	<hr/>
	0.9

#### Abstract (D-4 Tractor with Sheepsfoot Roller)

(a) Depreciation .. .. .	5.0
(b) Repairs .. .. .	4.7
(c) P.O.L. charges .. .. .	3.95
(d) Labour .. .. .	1.50
	<hr/>
	15.15
	Say, Rs. 15/-



## APPENDIX 8 (i)

## Statement of Sluice Gates and Equipment Manufactured

Sl. No	Name of Project	Type of Gate	Purpose ved	ser- No.	Width	Depth	Lift	Max. Head
1	2	3	4	5	6	7	8	9
1.	Tilaiya(DVC)	Radial	Spillway	14	30'-0"	10'-0"	14'-0"	10'-0"
2.	Bokaro(DVC)	Free Roller	Spillway Emergency	19 1	30'-0" 36'-0"	13'-0" 15'-6"	33'-0" 33'-10"	15'-0" 15'-10"
3.	Durgapur(DVC)	Free Roller	Wier U'Sluice	24 5 5	60'-0" 60'-0" 60'-0"	16'-0" 18'-0" 19'-0"	24'-0" 26'-0" 27'-0"	16'-6" 18'-6" 19'-6"
4.	(i) Kopai (Mayurakshi Project)	Free Roller " Wheel	Wier U'Sluice Regulator	4 2 2	30'-0" 30'-0" 24'-0"	10'-0" 13'-0" 5'-0"	15'-10" 18'-10" 5'-6"	10'-6" 13'-6" 10'-0"
	(ii) Dwarka (Mayurakshi Project)	Free Roller " Wheel	Wier U'Sluice Regulator	6 2 2	30'-0" 30'-0" 18'-0"	12'-0" 15'-0" 5'-0"	14'-0" 17'-0" 5'-6"	12'-5" 15'-6" 8'-6"
	(iii) Bakreswar Mayurakshi Project)	Automatic " Wheel	Crest " U'Sluice U'Sluice Regulator	16 2 2 1 4	12'-0" 13'-2" 24'-0" 17'-0" 24'-0"	2'-6" 2'-6" 7'-0" 9'-0" 3'-9"	— — 17'-0" 18'-0" 4'-0"	3'-0" 3'-0" 8'-0" 10'-0" 15'-0"
	(iv) Brahmani (Mayurakshi Project)	Free Roller " Wheel	Wier U'Sluice Regulator	10 2 2	30'-0" 30'-0" 12'-0"	10'-0" 13'-8" 4'-0"	12'-6-" 15'-6" 4'-6"	10'-6" 13'-6" 9'-6"
5.	Hirkud Main Dam	Radial	Spillway	4	51'-0"	20'-0"	16'-0"	20'-0"
6.	Thambrapani	Free Roller	Spillway	6	52'-0"	18'-0"	20'-0"	20'-0"

## APPENDIX 8 (i)

for River Valley Projects in India

Type of water seal (each)	Weight of gate leaves (each)	Weight of counter balance (each)	wieght of embed- ded parts (each)	Price ex- works of gate em- bedded parts & hoisting gear	Type of hoisting gear	Erection charges	Year of manu- facture
10	11	12	13	14	15	16	17
1. Rubber Flats ..	5.7 T	—	2 T	4,56,000	Electric	85,000	1952
2. Music Note .. Rubber Flats	8.3 T 14 T	— —	7.5 T —	8,20,000	Electric Electric Travelling	1,45,000	1952
3. Rubber Flats	27 T 34 T 35 T	54 T 68 T 70 T	13.0 T 13.5 T 14.0 T	30,50,000	Electric	7,20,000	1953
4. (i) Rubber Flats & M.S.Flats .. M.S. Rods & Flats	5 T 8 T 3.2 T	10 T 16 T 6.4 T	5.5 T 9 T 3.6 T	2,94,000	Hand	44,000	1950
(ii) Rubber Flats & M.S. Flats M.S. Rods & Flats	7.5 T 9.5 T 2 T	15 T 19 T 4 T	7 T 9 T 2 T	3,77,000	Hand	53,000	1951
(iii) — — Rubber Flats .. & M.S. Flats .. Rods & Flats ..	0.3 T 0.4 T 3.5 T 3.0 T 3.0 T	— — 7 T 6 T 6 T	— — 3 T 3 T 2.5 T	1,85,000	Hand	40,000	1951
(iv) Rubber Flats & M.S. Flats .. Rods & Flats ..	5.5 T 8.0 T 1.0 T	11 T 16 T 2 T	6.0 T 9.0 T 1.0 T	6,42,000	Hand	1,43,000	1953
5. Rubber Flats	28 T (approx.)	—	9 T (approx.)	25,37,360	Electric	—	1955
6. M.S. Rods, M.S. Flats	39 T	39 T	19 T	3,40,000	Electric	—	1946

## APPENDIX 8 (ii)

*Statements of Tungabhadra Workshops*

Sl. No.	Name of project	Type of gate	Purpose served	No.	Width	Depth	Max. head	Type of water seal	Weight of counter-balance (each)
1	2	3	4	5	6	7	8	9	10
1.	Kotah Barrage	Guide Roller	Radial		40'-0"	41'-6"	44'-0"	Rubber Flats	75
2.	Hirakud Dam, Bargarh Canal	Fixed Wheel	Regulator	8	8'-6"	9'-6"	49'-5"	Rubber Flats	
3.	(i) Tungabhadra	Fixed Wheel	Spill-way	33	60'-0"	20'-0"	20'-0"	Rubber Music Note Flats	38
	(ii) Tungabhadra	Fixed Wheel	Sluice		6'-0"	12'-0"	83'-0"	Rubber Music Note Flats	
	(iii) Tungabhadra	Fixed Wheel	Pen-stock		10'-9"	17'-4"	88'-5"	Rubber Music Note	
4.	Bhadra	Fixed Wheel	Under Sluice		6'-0"	15'-0"	141'-0"	Rubber Flats	
5.	Jawai	Fixed Wheel	Spill-way	13	50'-0"	15'-0"	15'-0"	Rubber Flats	17
6.	Umtru	Fixed Wheel	Pen-stock		9'-9"	9'-9"	53'-0"	Rubber Flats	—

## APPENDIX 8 (ii)

*Details of Equipment Fabrication*

Weight of gate leaves (each)	Weight of embedded parts (each)	Price ex-works of gate embedded parts & hoisting gear	Type of hoisting gear	Capacity of hoisting gear	Year of manufacture	Cost per Ton of gate leaves	Cost per Ton of embedded parts	Cost of hoisting gear
11	12	13	14	15	16	17	18	19
72	24	190,400	Rope Drum & Chain Hoist, electric & hand.	25	—	1550	1200	50,000
3½	3	31,625	Chain Hoist, electric & hand.	12	1955	2900	1400	18,000
49	6.5	116,840	Chain Hoist, motor & hand.	25	1952-54	1360	800	45,000
6.5	21	119,000	Rope Drum, electric & hand.	30	1952-53	4600	1500	57,600
14	12	151,140	Chain Hoist electric	43	1953-54	4800	1620	64,500
11	6	79,500	Rope Drum, electric & hand	35	To be manufactured	2750	1500	40,250
19	3	46,550	Chain Hoist, electric & hand	10	1954-55	1450	1000	16,000
4½	3	43,800	Chain Hoist, elect. & hand	15	To be manufactured	3300	1650	24,000

## APPENDIX 9 (i)

## Comparative Statement of Primary and Overall Rates

Sl. No.	Name of Project	Mix	Stone	
			Quality	Density
1	2	3	4	5
1.	Matatila .. .. .	CM 1:5 CM 1:4	Granite	165
2.	Gandhisagar .. .. .	RCM 1:2.75 RCM 1:4	Quartzite	140 "
3.	Mayurakshi .. .. .	RCM 1:4		
4.	Hirakud .. .. .	CM	Granite	165
5.	Kakrapar .. .. .	RCM 1:3 RCM 1:4 CM 1:5	— Rubble	— — —
6.	Tungabhadra (Andhra) .. .. .	RCM 1:2.75 RCM 1:4 RCM 1:5	Granite , ,	165 " "
7.	—do— (Hyd.) .. .. .	RCM 1:2.75 RCM 1:4	, "	165 "
8.	Lower Bhawani			
	R.R. Masonry .. .. .	CM 1:6	"	"
	" .. .. .	CM 1:2	"	"
	" .. .. .	CM 1:5	"	"
	" .. .. .	CM 1:5	"	"
	" .. .. .	CM 1:4	"	"
	" .. .. .	CM 1:4	"	"
	" .. .. .	RCM 1:2.75	"	"
	" .. .. .	CM 1:2.75	"	"
9.	Malampuzha			
	R.R. Masonry .. .. .	CM 1:4	"	"
	" .. .. .	CM 1:2.75	"	"
	" .. .. .	CM 1:5	"	"
	" .. .. .	RCM 1:2.75	"	"
	" .. .. .	RCM 1:5	"	"
	" .. .. .	CM 1:8	"	"
10.	Peechi			
	R.R. Masonry .. .. .	CM 1:5	"	"
11.	Perinchani			
	R.R. Masonry .. .. .	CM 1:2	"	"
	" .. .. .	CM 1:3	"	"
	" .. .. .	CM 1:4	"	"
	" .. .. .	CM 1:5	"	"
	" .. .. .	CM 1:6	"	"

## APPENDIX 9 (i)

of U.C.R. Hearting Masonry at River Valley Projects

Quantity of stone per CFC			Cement Cwt.	Sand FC	Surkhi FC	Lime	Total	Remarks
Stone FC	Spall FC	Total FC						
6	7	8	9	10	11	12	13	14
90	—	90	7.5	45	—	—	—	
—	—	—	—	—	—	—	—	
100	—	—	10.0	43.1	4.7	—	42.5	
100	—	—	6.8	41.4	2.6	—	40.8	
100	—	100	7.5	40	2.0	—	40.0	
110	—	—	8.5	—	—	—	—	
—	—	—	—	—	2.3	—	—	
110	—	110	7.2	51	—	—	45	
120	—	120	6.8	43	—	—	45	
100	10	110	9.6	53	3.4	—	42	
100	10	110	6.6	53	2.3	—	42	
100	10	110	5.3	53	1.8	—	42	
121	—	121	11.5	60	3.3	—	45	
121	—	121	8.0	60	2.3	—	46	
100	—	100	5.3	40	—	—	40	
100	—	100	16.0	40	—	—	40	
100	—	100	5.8	40	—	—	40	
100	—	100	6.4	40	—	—	40	
100	—	100	7.2	40	1.0	—	40	
100	—	100	8.0	40	—	—	40	
100	—	100	10.5	40	1.5	—	40	
100	—	100	11.7	40	—	—	40	
110	—	110	8.0	40	—	—	40	
110	—	110	11.7	40	—	—	40	
110	—	110	6.4	40	—	—	40	
110	—	110	9.3	40	2.9	—	40	
110	—	110	5.1	40	1.6	—	40	
110	—	110	4.0	40	—	—	40	
100	—	100	5.6	35	—	—	35	
100	—	100	12.9	40	—	—	40	
100	—	100	10.3	40	—	—	40	
100	—	100	8.0	40	—	—	40	
100	—	100	6.4	40	—	—	40	
100	—	100	5.3	40	—	—	40	

## APPENDIX 9 (ii)

## Comparative Statement of Primary and Overall Rates

Sl. No.	Name of Project	Mix	Nature of work	Maximum height above river bed in feet	Quantity of UCR Masonry in CFC	Cost in Rs. (lakhs)
1	2	3	4	5	6	7
2.	Matatila	CM 1:5 CM 1:4	Dam		102310 12840	112.5 14.8
2.	Gandhisagar	RCM 1:2.75 RCM 1:4			48961 169992	68.6 190.4
3.	Mayurakshi	RCM			88100	107.7
4.	Hirakud	CM			147020	224.6
	Kakrapar	RCM 1:4	Weir		14323	18.0
	Tungabhadra (Hyd.)	RCM 1:2.75 RCM 1:4	Dam		13133 22262	15.9 31.2
7.	Tungabhadra (And.)	RCM 1:2.75 RCM 1:4 RCM 1:5	Dam		— — —	— — —
8.	Bhadra	L.S. 1:4	Dam		231900	347.9
9.	Lower Bhawani	CM 1:6 CM 1:2 RCM 1:5 CM 1:5 RCM 1:4 CM 1:4 RCM 1:2.75 CM 1:2.75	Dam		466 1030 9960 4388 1291 86022 4299 23175	0.4 1.3 8.8 4.2 1.3 86.0 4.5 26.2
10.	Malampuzha	CM 1:2.75 CM 1:4 CM 1:5 RCM 1:2.75 RCM 1:5 CM 1:8	Dam		26813 35837 9503 4257 2731 —	29.5 33.7 8.4 4.4 2.4 —
11.	Pecchi	CM 1:2.75 CM 1:4 CM 1:5	Dam		4161 10822 4475	7.7 18.5 6.6
12.	Perinchani	CM 1:2.5 CM 1:4 CCM 1:55	Dam		1930 1700 15020	3.0 2.4 1.57

## APPENDIX 9(ii)

of U.C.R. Hearing Masonry on River Valley Projects

Primary rate per CFC (Rs.)			On Costs					Overall Rate per CFC 10+15
Depart- mental supply	Contract piece- work	Total	Percen- tage rate of depart- mental	Amount (Rs.)	Percentage rate of contract work	Amount (Rs.)	Total 12+14	
8	9	10	11	12	13	14	15	16
54	45	99	15	8	8	4	12	111
—	—	—	—	—	—	—	—	—
78	53	131	22	17	11	6	23	154
59	53	112	22	13	11	6	19	131
—	121	121	—	—	11+9 =20	24	24	145
47	92	139	30	14	11	10	24	163
56	37	93	45	25	21	8	33	126
165	—	165	35	58	—	—	58	223
148	—	148	35	52	—	—	52	200
134	—	134	35	47	—	—	47	181
116	—	116	35	41	—	—	41	157
108	—	108	35	38	—	—	38	146
34	90	124	35	12	17	15	27	151
31	48	79	19	6	6	3	9	88
78	50	128	19	15	6	3	18	146
32	58	90	19	6	6	3	9	99
37	58	95	19	7	6	3	10	105
39	61	100	19	7	6	3	11	111
42	58	100	19	8	6	3	11	111
54	50	104	19	10	6	3	13	117
58	55	113	19	11	6	3	14	127
48	62	110	33	16	8	5	21	131
36	58	94	33	12	8	5	17	111
30	58	88	33	10	8	5	15	103
45	59	104	33	15	8	5	20	124
28	58	86	33	9	8	5	14	100
27	54	81	33	9	8	4	13	94
85	100	185	12	10	7	7	19	204
58	112	170	12	7	7	8	15	185
47	100	147	12	6	7	7	13	160
71	43	114	44	31	22	9	40	154
59	43	102	44	26	22	9	35	137
44	43	87	44	19	22	9	28	115
35	43	78	44	15	22	9	24	102



## APPENDIX 10

## STATEMENT A

*Analysis of Cost per CFC of Cement Concrete*

Basic Weight of Cement per CFC : Brief Specifications

Sl. No.	Item	Unit	Qty.	Rate	Amount	Remarks
1	2	3	4	5	6	7

1. *Coarse Aggregates*

- 1.1 Quarrying
- 1.2 Transport to crushers
- 1.3 Crushing, processing & conveyance to stockpiles
- 1.4 Transport from stockpiles to batching plant
- 1.5 Washing of gravel

2. *Sand*

- 2.1 Quarrying
- 2.2 Transport to site
- 2.3 Crushing & processing, if any
- 2.4 Transport from stockpiles to batching plant

3. *Cement*

- 3.1 Cost ex-factory
- 3.2 Rail or road transport and handling to site of work
- 3.3 Storage & handling up to batching plant

STATEMENT A—*contd.*

1	2	3	4	5	6	7
---	---	---	---	---	---	---

4. *Water*5. *Admixture*

- 5.1 Cost of purchase or manufacture
- 5.2 Cost of transport
- 5.3 Storage and handling up to batching plant

6. *Batching, Mixing and Laying*

- 6.1 Batching & mixing
- 6.2 Placing including transport from batching plant and vibrating
- 6.3 Cleaning, slurry, curing and finishing.
  - (a) Cleaning
  - (b) Cement for slurry mortar
  - (c) Curing & finishing
- 6.4 Construction joints
- 6.5 Scaffolding, if any

7. *Other Items*

- 7.1 Precooling plant & expenses
- 7.2 Embedded system and operation cost

## TOTAL Primary Rate

NOTES :— 1. Separate analysis should be given for every operation in support of the figures given above such as crushing, cement storage and handling, batching and mixing, pre-cooling, etc.

2. In case of transport, means of transport should be mentioned and analysis given for unit cost of transport.

3. Mention name and brand of admixture.

## STATEMENT A (i)

*Sand Washing Operation*

1. Average use rate of the sand -washing plant per-CFC
2. Total quantity of sand to be washed.
3. (a) Cost of supporting structure for the plant inclusive of foundations.  
(b) Rate per CFC (3a)/(2).
4. Total cost per CFC of sand : (1)+3 (b).

NOTES :—1. Use rate per CFC of the sand-washing plant is obtained from Proforma M (iv.)  
2. Cost of supporting structure is total cost of material used, foundation, erection and dismantling charges less the salvage value, if any. Its details, if available, should be furnished.

## STATEMENT A (ii)

*Crushing and Screening Operation*

1. Use rate per CFC output of : (a) Crushers  
(b) Screens & belts.
2. Total quantity of aggregate to be handled in CFC units.
3. (a) Cost of supporting structure and foundations etc.  
(b) Rate per CFC: (3a)/(2).
4. Total Rate per CFC: (1)—(3b)

NOTES :—1. Use rates of crushers, belts and screens are obtained from Proforma M (iv.)  
2. Cost of structure is the total cost of materials used, foundations, erecting and dismantling charges, less the salvage value. If break-up is available it should be furnished.

## STATEMENT A (iii)

*Reclaiming Tunnel Operation*

- 
1. Brief particulars of
    - (i) Discharge gate
    - (ii) Belt conveyors
  
  2. Total quantity of aggregate to be handled
  
  3. (a) Cost of
    - (i) Reclaiming tunnel
    - (ii) Supporting structure for conveyor belts
 Total cost :  
 (b) Cost per CFC: 3(a)/(2).
  
  4. (a) Ownership charge
 

	Discharge gates	Belt conveyors
(i) Total Cost		
(ii) Repairs		
(iii) Salvage value		
Net total cost		
(b) Cost per CFC		
  
  5. (a) Operation cost per hour
 

	Discharge gates
(i) Power	
(ii) P.O.L.	
(iii) Other materials	
(iv) Labour	

  
 (b) Cost per hour
  
  6. (a) Total output of conveyor belts per hour  
 (b) Rate per CFC: (5b)/(6a)
  
  7. Cost of dozing per CFC (share only)
  
  8. Total rate per CFC
- 

- NOTES :—1. Cost of items under (3) includes the cost of foundations, erection and dismantling charges less salvage value if any. Details should be furnished.
2. In case the hours for which operation cost is given are not clock hours, precise definition of the hour should be given.
3. For all items of operation cost in item 5 details should be given.
4. Details of cost of dozing should be given.

## STATEMENT A (iv)

*Operation of Cement Pump and Silos*

- 
1. Use rate per CFC output of cement pump.
  2. Cost of silos.
  3. Quantity to be handled.
  4. Cost of silos per CFC of cement
  5. Rate per CFC : (1) + (4)

---

NOTES :—1. The number of silos and their brief particulars should be furnished.  
2. The cost of silos should be inclusive of the cost of foundation, erection and dismantling of the structure, less the salvage value, if any.

## STATEMENT A (v)

*Conveying, Lifting and Placing and Vibrating Concrete*

- 
1. Output of the batching and mixing plant per hour
  2. (a) Use rate per hour of
    - (i) Diesel locomotive
    - (ii) Crane
    - (iii) Vibrators

Total :

- (b) Rate per CFC
3. (a) Ownership charge

	Flat wagons	Concrete buckets
(i) Cost		
(ii) Repair charges		
(iii) Salvage value		
Total		
Net cost		

4. (a) Quantity of concrete to be handled
  - (b) Rate per CFC of flat wagons and concrete buckets
  5. (a) Cost of supporting structure
  - (b) Rate per CFC:  $(5a)/(4a)$
  6. (a) Labour per hour
  - (b) Labour cost per CFC
  7. Total rate per CFC
- 

- NOTES :—1. Use rate per hour is taken from Performa M (iv).  
 2. Brief details and number flat wagons and concrete buckets used should be given.  
 3. Cost of supporting structure includes cost of foundations, erecting and dismantling charges less the salvage value if any. Details should be furnished.  
 4. Under item (6) details of labour should be given. It would be that required for general purposes not included in the use rate of machines in item (2).

## STATEMENT A (vi)

*Curing and Finishing per CFC of concrete*

- 
1. Cost of equipment, if any.
  2. Cost of materials.
  3. Cost of water.
  4. Cost labour.
  5. Miscellaneous, if any.
  6. Total cost per CFC.
- 

Note : 1. Details for item: 1 & 2 should be given.  
2. Under item 4 details of labour should be given.

## STATEMENT B (i)

*Analysis per CFC of stone Masonry*

Brief Specifications :

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7

1. *Rubble*

- 1.1 Quarrying
- 1.2 Dressing Masons
- 1.3 Transport to the site of work.

2. *Sand*

- 2.1 Quarrying or manufacturing
- 2.2 Transport to site of work
- 2.3 Storage and handling up to mills

STATEMENT B (i)—*contd.*

1	2	3	4	5	6	7
3.	<i>Cement or lime</i>					
	3.1 Cost at source of supply					
	3.2 Transport to the site of work					
	3.3 Storage and handling up to mills					
4.	<i>Water</i>					
5.	<i>Admixtures</i>					
	5.1 Purchase or manufacturing cost					
	5.2 Transport to the site of work					
	5.3 Storage and handling up to mills					
6.	<i>Mixing of Mortar</i>					
	(a) By Manual labour					
	Male Mazdoor					
	Female Mazdoor					
	Bhishti or Water-carrier					
	OR					
	(b) By mixture and manual labour					
	Depreciation					
	Repairs					
	sumable materials					
	Operation labour					
	Other labour					
	(i) Male Mazdoor					
	(ii) Female Mazdoor					
	(iii) Bhishti or Water-carrier					
7.	<i>Lead and Lift</i>					
	7.1 Scaffolding					
	7.2 Lead and Lift of stone					
	7.3 Lead and lift of mortar					
8.	<i>Laying and Curing</i>					
	8.1 Cleaning and slurry					
	(a) Cement for slurry mortar					
	(b) Cleaning					
	Male Mazdoor					
	8.2 Cost of laying including handling					
	Mason I Class					
	Mason II Class					
	Male Mazdoor					
	Bhishti or Water-carrier					
	8.3 Wetting					
9.	<i>Petty Supervision</i>					
10.	<i>Miscellaneous</i>					

NOTES :—1. In case of transport, means of transport should be mentioned and detailed analysis be given for unit work of transport.

2. Where necessary separate analysis should be given in support of figures in the above proforma.

3. For wetting details must be given.

4. Name and brand of admixture may be given.



## STATEMENT B (ii)

*Analysis of Cost per CFC of Brick Masonry*

1. Size of Bricks.
2. Brief specifications.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Brick I Class</i>					
	1.1 Cost ex-kiln.					
	1.2 Transport to the site of work					
2.	<i>Sand</i>					
	2.1 Cost of quarrying or manufacture					
	2.2 Transport to the site of work					
	2.3 Storage and handling up to mills					
3	<i>Cement or Lime</i>					
	3.1 Cost ex-project godown					
	3.2 Transport to the site of work					
	3.3 Storage and handling up to mills					
4.	<i>Water</i>					
5.	<i>Admixtures</i>					
	5.1 Purchase or manufacturing cost					
	5.2 Transport to the site of work					
	5.3 Storage and handling up to mills					
6.	<i>Mixing of Mortar</i>					
	Male Mazdoor					
	Female Madzdoor					
7.	<i>Lead and Lift</i>					
	7.1 Scaffolding					
	7.2 Lead and lift of bricks					
	7.3 Lead and lift of mortar					
8.	<i>Laying and Curing including</i>					
	<i>Soaking</i>					
	8.1 Cleaning and raking, Male Mazdoor					
	8.2 Soaking					
	8.3 Cost of laying including handling					
	Mason I Class					
	Mason II Class					
	Male Mazdoor					
	Female Mazdoor					
	Bhishti or Water-carrier					
	8.4 Wetting					
	Bhishti or Water-carrier					
<b>Total Primary Rate</b>						

- NOTES :
1. In case of transport, means of transport should be mentioned and supporting analysis for unit cost of transport be given.
  2. Name and brand of admixture may be given.
  3. For soaking under 8.2 details may be given.

## STATEMENT C (i)

*Excavation in Earth by Manual Labour*  
Unit=100 cu. ft.

1. Brief description of soil and tools used for excavation and the method of transport.
2. Initial lead and lift.
3. Extra for lead and lift.

Sl. No.	Description	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	Labour					
	1.1 Male Mazdoor					
	1.2 Female Mazdoor					
	1.3 Boy Mazdoor					
2.	Ordinary T. & P.					
3.	Sundries such as rope, flags and staves etc.					
4.	Petty Supervision					

## STATEMENT C (ii)

*Analysis of Rate for Earthwork per CFC by Mechanical Equipment*

1. Machines used.
2. Material handled with brief characteristics.
3. Average weighted lead.
4. Gradient and condition of haul roads.
5. Output of the combined equipment during the period.
6. The cost of excavating and transporting the material.

Equipment	Size or Capacity	Number of Machines used	Number of Hours worked during the period	Use rate per hour of each machine	Amount
Total Rs.					

## 7. Rate per unit of excavation and transporting

- NOTES :
1. Particulars of excavation and transporting the material, only should be given.
  2. The machines should be those for which use-rate details are given in Proforma M (i).
  3. The units of output should be given in CFC units and whether they are borrow-pit or compacted measurements should be stated.
  4. In case of hours worked, if the hours are not clock hours, precise definition of the 'hour' mentioned should be given.

## STATEMENT C (iii)

*Analysis of Rate of Earthwork Compaction by Machines.*

1. Zone of operation : pervious/semipervious/impervious.
2. Type of soil compacted and its characteristics
3. Machines used.
4. Output of the machines over the period.
5. Cost of compaction.

Machine Numbers	Machines	Size or capacity etc.	No. of machines used	No. of hours worked during the period	Use rate per hour of each machine	Amount	Remarks if any
1	2	3	4	5	6	7	8

Total Rs

(a)

(b) Watering charges during the period =

∴ Total cost of (a) and (b)

6. ∴ Cost of compaction of earthwork per unit =

- NOTES :—1. The machines should be those for which use-rate details are given in Proforma M (i).  
 2. The units of output should be given in CFC units and whether they are borrow-pit or compacted measurements should be clearly stated.  
 3. In case the hours worked are not clock hours, precise definition of the 'hour' mentioned should be given.  
 4. Details of watering charges, if available, should be furnished.

## STATEMENT D (i)

*Analysis of Cost per CFC of Quarrying Rubble or Rock Excavation by Mechanical Means*

1. Brief description of rock.
2. Percentage of recovery in case of quarrying.
3. Lift in case of rock excavation.
4. No. and depth of hole required per CFC.
5. Percentage of voids per CFC.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Preliminary</i>					
2.	<i>Drilling</i>					
	2.1 Bits					
	2.2 Loss of bits					
	2.3 Sharpening					
	2.4 Depreciation of machine					
	2.5 Repairs					
	2.6 Cost of air					
	2.7 Cost of water					
3.	<i>Pipe, pipe fittings and other equipment</i>					
4.	<i>Explosives</i>					
	4.1 Dynamite etc.					
	4.2 Detonators					
	4.3 Fuse coils					
5.	<i>Carriage of materials</i>					
6.	<i>Labour</i>					
7.	<i>Mucking, transport and stacking</i>					
	6.1 Shovel operation					
	6.2 Dumper					
	6.3 Labour for stacking					
	Male Mazdoor					
	Female Mazdoor					

Total Primary Rate

- NOTES :-1. Under 1 expenditure on royalty and removal of over-burden etc. may be given.  
 2. Under 6 all labour engaged with their particulars may be given.  
 3. Under 5 carriages of materials pertains to explosives etc. from stores to the site of work.

## STATEMENT D (ii)

*Analysis of Cost per CFC of Quarrying Rubble by Manual Labour*

1. Brief description of rock.
2. Percentage of recovery.
3. No. and depth of hole required per CFC.
4. Percentage of voids per CFC.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7

1. *Preliminary*2. *Labour*

- 2.1 Drillers
- 2.2 Male Mazdoors
- 2.3 Blaster
- 2.4 Helper
- 2.5 Mending & Sharpening tools
- 2.6 Other work-charged establishment

3. *Material*

- 3.1 Gelignite etc
- 3.2 Detonators
- 3.3 Fuse coil
- 3.4 Gun powder
- 3.5 Coal

4. *Carriage of Materials*5. *Pro-rata cost of hammers, crowbars & jumper rods etc.*6. *Mucking, handling and stacking*

- 6.1 Male Mazdoors
- 6.2 Female Mazdoors

7. *Carriage from quarry stacks to worksite.*


---

Total Primary Rate

- NOTES :—1. Under 7 mention means of transport and give supporting analysis of unit cost.  
2. Under 1 expenditure on royalty & removal of over-burden etc. may be given.

## STATEMENT E

*Analysis of Gates and Regulators*

1. Name of Project.
2. Type of gate and purpose served.
3. Number and size.
4. Maximum head for which designed.
5. Type of water seals.
6. Whether rollers provided, if so, what type—fixed or moving type.
7. Whether counter weights are provided; if so, what is the weight.
8. Weight of the gate leaves.
9. Weight of the embedded parts.
10. Cost per ton of the gate leaves.
11. Cost per ton of the embedded parts.
12. Type of hoisting gear provided and the method of operating the same.
13. Capacity of the hoisting gear/gears.
14. Cost of the hoisting gear per ton of weight and per ton of capacity.
15. Type of operating bridge, giving span, width, design and live loads.
16. Weight of the operating bridge and cost per ton.

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NOTES :—(a) Whether the costs are inclusive of erections or for workshop.

(b) The prices of raw materials taken into account.

(c) Specifications of the structural work e.g. welded, rivetted, one shop paint included etc.

(d) Year of manufacture. Information for jobs executed prior to 1950 is not required.

(e) The figures for cost should be split up in the following heads and original estimated costs and actual costs separately with explanatory remarks regarding excess, if any :—

(i) Cost of materials.

(ii) Cost of labour.

(iii) Charges for the use of machine and their overhauls.

(iv) The over-heads—general.

## STATEMENT F

*Analysis of Cost per cwt. of Reinforcement*

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7
1.	<i>Materials</i>					
	1.1 M.S. Bars					
	1.2 Wastage					
	1.3 Binding Wire					
2.	<i>Labour for handling from stores, binding and placing, in position.</i>					
	2.1 Blacksmith.					
	2.2 Male Mazdoors					
3.	<i>Carriage from stores to the worksite, e.g., on canals.</i>					
4.	<i>Sundries, etc.</i>					
<b>Total Primary Rate</b>						

## STATEMENT G-1

*Analysis for Manufacture of Steel Shuttering per CFC*

1. Brief specifications and design.
2. Life in terms of number of uses.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	<i>Steel</i>					
	1.1 M.S. Plate of sizes					
	1.2 Structural sections					
	1.3 Other materials					
	1.4 Bolts, nuts & wedges, etc.					
2.	<i>Fabrication</i>					
Total						
3.	<i>Depreciation</i>					
				$\frac{\text{Total amount}}{\text{Number of uses}} =$		

- NOTES :-1. In case of other materials under 1.3 details may be given.  
2. Analysis for fabrication charges should be given separately.

## STATEMENT G-2

*Analysis for Steel Formwork per CFS of Concrete Surfaces*

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1	2	3	4	5	6	7

1. *Depreciation of steel shuttering*
2. *Fixing and removing*
  - 2.1 Cost of materials for anchorage
  - 2.2 Crane charges
  - 2.3 Labour
  - 2.4 Linseed oil, etc.
3. *Miscellaneous*
  - 3.1 Petty repairs
  - 3.2 Transportation of materials from workshop to worksite
  - 3.3 Cleaning

Total Primary Rate \_\_\_\_\_

- NOTES :—
1. Under 2.1 details of materials for anchorage may be given.
  2. Under 2.3 details of labour required for fixing and stripping such as carpenters, mazdoors, etc. may be given.
  3. Any charges for job electricity should be incorporated under Miscellaneous.
  4. If any painting is done that may be included under 2.4 and its details should also be supplied.



## STATEMENT H

*Analysis of Cost per FC of Drilling*

1. Brief description of the work and particulars of rock
2. Particulars of drilling machine used.
3. Size and depths of holes.
4. Average time taken per f

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
		L. S.				
1.	<i>Preliminary</i>					
2.	<i>Materials</i>					
2.1	Drilling Rod					
2.2	Drilling bits including allowance for losses and sharpening etc.					
2.3	Pipes and pipe fittings					
2.4	Other materials					
3.	<i>Charge of machines</i>					
3.1	Depreciation per hour					
3.2	Repairs per hour					
3.3	Fuel/Power/Air					
3.4	Lubricants					
3.5	Water charges					
3.6	Labour					
4.	<i>Miscellaneous such as</i>					
4.1	Shifting charges					
4.2	Cradle platform					

Total Primary Rate

- NOTES :—
1. Brief description of the work should also be specified if the hole is required for exploration, grouting, weep-holes or drainage.
  2. Preliminary includes expenditure on site clearance, etc., if any.
  3. Ownership charges of machines per hour should tally with the detailed proforma on use rate of the machine. In case more than one machine is used, depreciation, etc. should be separately shown.
  4. Any charge for lighting power should be incorporated under Miscellaneous.

## STATEMENT J

*Analysis of Cost per FC of Cement Grouting*

1. Brief description of the work and particulars of strata.
2. Particulars of the machine used.
3. Average time taken for pumping one FC of grout.
4. Specification of grout.

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	<i>Cleaning and washing</i>	L. S.				
2.	<i>Materials</i>					
	2.1 Cement					
	2.2 Water					
	2.3 Nipples, pipes & pipe fittings, etc.					
	2.4 Other materials					
3.	<i>Charge of machines</i>					
	3.1 Depreciation					
	3.2 Repairs					
	3.3 Fuel/Power/Air					
	3.4 Lubricants					
	3.5 Labour					
4.	<i>Miscellaneous</i>					
	4.1 Shifting of machine					
	4.2 Platform, etc.					

Total Primary Rate

- REMARKS :—1. Brief description of the work should also be specified if the work is required for dam foundations or power plant.
2. Charges of machines per hour should tally with the detailed proforma on use-rate of the machine. In case more than one machine is used, depreciation should be separately shown.
3. Any charge for lighting power should be incorporated under Miscellaneous.

## STATEMENT K

*Analysis of Cost per CFC of Stone Rip-Rap or Pitching*

Brief specifications :—

Sl. No.	Item	Unit	Quantity	Rate	Amount	Remarks
1.	<i>Rubble stone at quarry including spalls.</i>					
2.	<i>Labour</i>					
	2.1 Mason					
	2.2 Male Mazdoor					
	2.3 Female Mazdoor					
	2.4 Other work-charged establishment					
3.	<i>Carriage of Rubble stone and spalls from quarry to worksite</i>					
4.	<i>Sundries and T. &amp; P.</i>					

Total Primary Rate

**PROFORMA L**  
*Swell and Shrinkage Factors of Soils*

Sl. No.	Type of soil	Natural moisture content of the soil	Borrowpit density	Borrowpit volume before excavation	Volume after excavation	Compaction			Remarks
						Optimum moisture content descend	No. of passes of the rollers & the pressure lbs./sq. in. required	Volume after compaction	
1	2	3	4	5	6	7	8	9	10

NOTE:—In case of rock, the type of rock, its specific gravity, its volume before and after excavation need only be mentioned.

PROFORMA M (i)  
PROJECT (EARTHWORK MACHINERY)

PART I

- |   |                                 |
|---|---------------------------------|
| 1. Name of machine.   | 2. Number.                      |
| 3. Make and Model.  | 4. Size, rated capacity.        |
| 5. Year of manufacture.   | 6. Date of commencement of use. |
| 7. Rated h.p. of engine.  |                                 |
| 8. Rated fuel consumption at Full load.<br>Half load.<br>No load. | 9. Name of supplier.            |
10. (a) Cost of machine at the Rail Head, exclusive of tyres, tubes and belts:  
Transport  
Assembly  
Test  
Dismantling  
(b) Cost of tyres, tubes and belts, etc.
11. (a) Life assumed for machine.  
(b) Life assumed for tyres, tubes and belts, etc.
12. Number of working shifts each day and duration of each shift
13. Assumed salvage value.
14. Proposals for disposal of machine after completion of the work.
15. Characteristics of soil—  
(i) Classification  
(ii) Density, Natural/Compacted.  
(iii) Swell.
16. Condition of haul road.

PART II

17. No. of hours used by years.
18. No. of hours lost by years due to  
(i) No Work.  
(ii) Major repairs and overhauls.  
(iii) Bad weather.  
(iv) Strikes.  
(v) Other causes, if any.
19. Expenditure each year on—  
(i) Major repairs and overhauls.  
(ii) Minor repairs and servicing.
20. Expenditure each year showing also quantities of issues and rates—  
(i) Fuel oil/Electricity energy. (ii) Lubricants.  
(iii) Air (share). (iv) Water (share).
21. Expenditure each year on operating staff—  
(i) Foreman (share only).  
(ii) Operators.  
(iii) Helpers.
- |                               |                                      |
|-------------------------------|--------------------------------------|
| 22. Output of work each year. | 23. Lead (Average)<br>Lift (Average) |
| 24. Angle of swing.           | 25. Depth of cut.                    |
| 26. Bucket efficiency.        | 27. Other details, if any.           |

- NOTES :—1. In Part II of the proforma information should be given in respect of each successive financial year separately.
2. Where necessary average figures may be filled in.
3. In case of life assumed and hours worked, if hours are not clock hours, precise definition of the "hour" should be given.
4. In case of output it should be mentioned if the figures given are on borrow measurements or compacted.
5. Units should be mentioned for all the quantities. In case of volumetric, cu. ft. should be used.
6. Under major and minor repairs, if break-up is available for labour and spares, it should be given.

## PROFORMA M (ii)

*Air Compressors*

## PART I

1. No. of the machine.
2. (a) Make and model.  
(b) Whether portable or stationary.
3. Year of manufacture.
4. Date of commencement of use.
5. Rated capacity and pressure of air in lbs./sq. in.
6. Rated h.p. of the engine.
7. Rated fuel/power consumption per hour at
 

Full load.
Half load.
No Load.
8. Name of supplier.
9. (a) Cost of the machine at the Rail Head.  
(b) Cost of Transport.
 

Assembly.
Foundation
Test
Dismantling.
10. No. of working shifts each day and duration of each shift.
11. Assumed life of the machine.
12. Assumed salvage value.
13. Proposals for disposal of the machine after the completion of the work.

## PART II

14. No. of hours used, in consecutive years.
15. No. of hours lost during the years due to—
  - (i) No work.
  - (ii) Major repairs and overhauls.
  - (iii) Bad weather.
  - (iv) Strikes.
  - (v) Other causes, if any.
16. Expenditure, each year, on
  - (i) Major repairs and overhauls.
  - (ii) Minor repairs and servicing.
17. Expenditure, each year, showing also quantities of issues and rates of—
  - (i) Fuel oil/Power.
  - (ii) Lubricants.
  - (iii) Water (share only)
18. Expenditure, each year, on operating staff—
  - (i) Foreman (share only)
  - (ii) Operators.
  - (iii) Helpers.
  - (iv) Other W.C. Establishment like Chowkidar, Time-keeper, etc. (share only).

- 
- NOTES :—1. In Part II, information should be given in respect of each successive financial year separately.  
 2. Where necessary, average figures may be filled in.  
 3. In case of life and hours worked, if hours are not clock hours, precise definition of the "hour" should be given.  
 4. Under Major and Minor repairs if break up is available, of labour, material and spaces it should be given.

## PROFORMA M (iii)

*Drilling and Grouting*

## PART I

1. Name of machine.
2. No. of machine.
3. Make & model.
4. Size and rated capacity.
5. Year of manufacture.
6. Date of commencement of use.
7. Rated h.p. of the engine.
8. Rated fuel/power/air consumption per hour.
9. Name of supplier.
10. (a) Cost of equipment at the Rail Head.  
(b) Cost of : Transport  
Assembly.  
Test.  
Dis-assembling.
11. (a) Assumed life of the machine.  
(b) Life of drill bits.
12. Assumed salvage value.
13. Proposals for disposal of the plant after completion of work
14. No. of working shifts each day and duration of each shift.
15. Type of rock, its specific gravity and other characteristics.
16. Other particulars, if any.

## PART II

17. No. of hours used, by years.
18. No. of hours lost, by years, due to—
  - (i) No work.
  - (ii) Major repairs and overhauls.
  - (iii) Bad weather.
  - (iv) Strikes.
  - (v) Other causes, if any.
19. Expenditure, each year, on—
  - (i) Major repairs and overhauls
  - (ii) Minor repairs and servicing.
20. Expenditure, each year, showing also quantities of issues and rates of—
  - (a) (i) Fuel.  
(ii) Lubricants.  
(iii) Air.  
(iv) Water (share only).
  - (b) Other materials like drill bits, cement for grout mix, etc.
21. Expenditure, each year, on operating staff—
  - (i) Foreman (share only).
  - (ii) Drillers/pump operator.
  - (iii) Helpers.
  - (iv) Other W.C. Establishment like Chowkidars, etc. (share only).
22. (a) Depth of hole in ft.  
(b) Diameter of hole in inches.
23. Average output per working hour.

- NOTES :—1. In Part II, information should be given in respect of each successive financial year separately.  
2. Where necessary, average figures may be filled in.  
3. In case of life and hours worked, if hours are not clock hours, precise definition of "hour" should be given.  
4. Under major and minor repairs, if break-up is available for labour, material and spares it should be given.

## PROFORMA M (iv)

Details should be given separately for each type of machine viz., sand-washing plant, crushers, conveyors, belts and screens, batching and mixing plants, diesel locomotives, cranes and vibrators.

## PART I

1. No. of the equipment.
2. Make and model.
3. Size and rated capacity.
4. Year of manufacture.
5. Date of commencement of use.
6. Rated h.p. of the engine.
7. Rated fuel/power consumption per hour.
8. Name of supplier.
9. (a) Cost of equipment at Rail Head.  
(b) Cost of : Transport.  
                  Assembly and erection.  
                  Foundation.  
                  Test.  
                  Dismantling.
10. Assumed life of the plant.
11. Assumed salvage value.
12. Proposal for disposal of the plant after completion of the work.
13. No. of working shifts each day and duration of each shift.

## PART II

14. No. of hours used, by consecutive years.
15. No. of hours lost, by years, due to—
  - (i) No work.
  - (ii) Major repairs and overhauls.
  - (iii) Bad weather.
  - (iv) Strikes.
  - (v) Other causes, if any.
16. Expenditure, each year, on—
  - (i) Major repairs and overhauls.
  - (ii) Minor repairs and servicing.
17. Expenditure, each year, showing also quantities of issues and rates of—
  - (i) Fuel oil/power
  - (ii) Lubricants.
  - (iii) Air (share)
  - (iv) Water (share)
18. Expenditure, each year, on operating staff—
  - (i) Foreman (share only).
  - (ii) Operators.
  - (iii) Helpers.
  - (iv) Other W.C. Establishment like Time-keeper, Khalasis, etc. (share only).
19. Output of each year in CFC units.
20. Any other details.

- NOTES :—1. In part II, information should be given in respect of each consecutive financial year separately.  
2. Where necessary, average figures may be filled in.  
3. In case of life and hours worked, if hours are not clock hours, definition of the 'hour' should be given.  
4. In case of crushers, percentage of voids of the crushed stone should be given.  
5. Under major and minor repairs if break-up is available for labour, material and spares, it should be given.



## APPENDIX 11

*Decimal system of classification of Detailed heads and their Sub-heads.*

- 10.10.00 Preliminary Expenses.
  - 11.00 Dam and Spillway.
  - 12.00 Power houses and allied works
  - 15.00 Weirs and Barrages.
  - 16.00 River training and Diversion Works.
  - 17.00 Main Canal and Branches.
  - 18.00 Distributaries and Minors.
  - 19.00 Flood Control and Drainage Works.
  - 20.00 Navigation.
  - 21.00 Relocation of Highways and Railways.
  - 22.00 Communications.
  - 23.00 Power Generation.
  - 24.00 Power Transformation, Transmission.
  - 25.00 Power Distribution and Supply.
  - 26.00 Ground Water.
  - 27.00 Soil Conservation and Land Reclamation.
  - 28.00 Fish and Games, Reservoir, Navigation, Recreation.
  - 29.00 Gates, Allied Fixture and Equipment.
  - 30.00 Township.
  - 31.00 Construction Plant and Equipmen
  - 32.00 Construction Plant and Equipment Operation.
  - 33.00 Bandhs and Tanks.
  - 34.00 Suspense.
  - 35.00 .....
  - 36.00 .....
  - 98.00 .....
  - 99.00 General Services-operation and Maintenance, Police, Posts and Telegraphs, Fire Protection, Watch and Ward, Health and Sanitation, Medical Facility and Water Supply & Sewage, Camp Operation Maintenance.
  
- 11.10.00 Preliminary Expenses.
  - 11.00 Reconnaissance.
  - 12.00 Topographical Surveys and Mapping.
  - 13.00 Geological Surveys.
  - 14.00 Hydrological and Meteorological Surveys.
  - 15.00 Economic Surveys.
  - 16.00 Laboratory Tests.
  - 17.00 Consultant's Fees.
  - 18.00 Preparation of Preliminary Projects.
  - 19.00 .....
  - 20.00 .....

**APPENDIX 11—contd.**

- 12.10.00 Masonry Dam (Concrete-Stone Masonry) & Spillway.  
 11.00 Site Clearance.  
 12.00 Roads etc.  
 13.00 Electric Distribution System.  
 14.00 Fire Alarm System.  
 15.00 Drainage.  
 16.00 Landscaping.  
 17.00 Photography.  
 18.00 Land.  
 19.00 Excavation of Foundation.  
 20.00 Building.  
 21.00 Plantation.  
 22.00 Gates, Sluices, Water Conduits and Intake Structure.  
 23.00 Mechanical Fittings.  
 24.00 Bridges.  
 25.00 Buckets, Baffles.  
 26.00 Spillway Peirs.  
 27.00 Cofferdams.  
 28.00 Tunnels.  
 29.00 Fitters.  
 30.00 Joints.  
 31.00 Instrumental Fittings.  
 32.00 Miscellaneous Works.  
 33.00 .....  
 34.00 .....
- 13.10.00 Earthen or Rockfill Dam.  
 11.00 Site Clearance.  
 12.00 Roads etc.  
 13.00 Electric Distribution System.  
 14.00 Fire Alarm System.  
 15.00 Drainage.  
 16.00 Landscaping.  
 17.00 Photography.  
 18.00 Land.  
 19.00 Excavation of Foudnation.  
 20.00 Building.  
 21.00 Plantation.  
 22.00 Gates, Sluices, Water Conduits and Intake Structure.  
 23.00 Mechanical Fittings.  
 24.00 Bridges.  
 25.00 Buckets, Baffles.  
 26.00 Spillway Peirs.  
 27.00 Cofferdams.  
 28.00 Tunnels.  
 29.00 Fitters.  
 30.00 Joints.  
 31.00 Instrumental Fittings.  
 32.00 Miscellaneous Works.  
 33.00 .....  
 34.00 .....
- 14.10.00 Power House and Allied Works.  
 11.00 Land.  
 12.00 Excavation and Treatment of Foundations.  
 13.00 Power House Building.  
 14.00 Crane and Hoisting Equipment.  
 15.00 Gates.  
 16.00 Draft Tubes.

## APPENDIX 11—contd.

- 17.00 Tail Race.
- 18.00 Upstream and Downstream Regulators.
- 19.00 Penstocks, Surge Towers etc.
- 20.00 Spiral Casing.
- 21.00 Joints and Water Stops.
- 22.00 Electric Fittings.
- 23.00 Fire Extinguishers.
- 24.00 Tanks.
- 25.00 .....
- 26.00 .....
- 15.10.00 Weirs and Barrages (Headworks).
  - 11.00 Site Clearance.
  - 12.00 Foundation Excavation and Treatment.
  - 13.00 Superstructure.
  - 14.00 Gates, Quantities.
  - 15.00 Bridge and Gangway.
  - 16.00 Aerial Ropeways, Telephones, Cabins.
  - 17.00 Head.
  - 18.00 Downstream Protection Works.
  - 19.00 Buildings including Lighting, Water Supply.
  - 20.00 Miscellaneous Works
  - 21.00 Land.
  - 22.00 .....
  - 23.00 .....
- 16.10.00 River training and Diversion Works.
  - 11.00 Bunds.
  - 12.00 Groynes and Spurs.
  - 13.00 Cuts.
  - 14.00 Coffor Dams.
  - 15.00 Tunnels.
  - 16.00 Levees and the size Embankments.
  - 17.00 Land.
  - 18.00 .....
  - 19.00 .....
- 17.10.00 Main Canal and Branches
  - 11.00 Head.
  - 12.00 Channels Excavation and Embankments Liner, Service Road.
  - 13.00 Regulators, Bridges and Falls.
  - 14.00 Gauging.
  - 15.00 Drainage Crossing and Inlets.
  - 16.00 Other Work
  - 17.00 Escapes.
  - 18.00 Buildings.
  - 19.00 Plantations.
  - 20.00 Mills (Water & Wing.)
  - 21.00 Land.
  - 22.00 .....
  - 23.00 .....
- 18.10.00 Distributaries and Minors.
  - 11.00 Minors.
  - 12.00 Channel Excavation Embankment Lining, Service Road.
  - 13.00 Regulators, Bridges and Falls.
  - 14.00 Other Works.
  - 15.00 Drainage Crossings.

## APPENDIX 11—contd.

- 16.00 Escapes.
- 17.00 Buildings.
- 18.00 Water Courses, Culverts, Outlets, Metres.
- 19.00 Plantations.
- 20.00 Land.
- 21.00 .....
- 22.00 .....
- 19.11.00 Diversion.
- 12.00 Spreading of Flood Waters.
- 13.00 Channel Rectification.
- 14.00 Channel Enlargement.
- 15.00 Channel Cleaning.
- 16.00 Embankment.
- 17.00 Reservoirs.
- 18.00 .....
- 19.00 .....
- 20.10.00 Navigation.
- 11.00 Dredging Operations.
- 12.00 Wharfs, Quays, Jetties etc.
- 13.00 Borat, Tugs, Barges, Steamer.
- 14.00 Gauging and Control.
- 15.00 Buildings.
- 16.00 Land.
- 17.00 .....
- 18.00 .....
- 21.10.00 Relocation of Highway and Railway.
- 11.00 Clearance.
- 12.00 Deforestation.
- 13.00 Rim Treatment.
- 14.00 Road Bridges.
- 15.00 Embankments.
- 16.00 Buildings.
- 17.00 Gauging.
- 18.00 Recreation.
- 19.00 Fishing.
- 20.00 Parks. etc.
- 21.00 Land.
- 22.00 .....
- 23.00 .....
- 22.10.00 Communication.
- 11.00 Roads.
- 12.00 Railways.
- 13.00 Tramways.
- 14.00 Rolling Stock and Locomotives.
- 15.00 Buildings.
- 16.00 Plantations.
- 17.00 Land.
- 18.00 .....
- 19.00 .....
- 23.10.00 Power Generation.
- 11.00 Feed Pumps.
- 12.00 Boilers.
- 13.00 Turbines, Steam, Water.
- 14.00 Diesel Engines.

## APPENDIX II—contd.

- 15.00 Generators.
  - 16.00 Governors.
  - 17.00 Control Equipment.
  - 18.00 Switch Gear.
  - 19.00 Insulators.
  - 20.00 Spray Tanks or an alternative Cooling Arrangement.
  - 21.00 Elevators.
  - 22.00 Conduits.
  - 23.00 Wiring and Cables.
  - 24.00 Flutures.
  - 25.00 Protective Equipment.
  - 26.00 Compressed Air.
  - 27.00 Fire Protection.
  - 28.00 Forced Draught.
  - 29.00 Induced Draught.
  - 30.00 Feed Water Heaters or Economisers.
  - 31.00 Chimney.
  - 32.00 Coal Handling Equipment or Conveyors.
  - 33.00 Sootblowers.
  - 34.00 Automatic Feed Check Values.
  - 35.00 Feed-water arrangement (tubewell etc.) and water for other pumps.
  - 36.00 Condensers.
  - 37.00 Circulating Water Pumps and Mortars.
  - 38.00 Spray Pipe Line.
  - 40.00 Coal Buckets.
  - 41.00 Ash Handling Equipment.
  - 43.00 Boiler Foundation with Enloins.
  - 44.00 Boiler House Building.
  - 45.00 Turbine room Building.
  - 46.00 Oil storage tanks and Arrangement.
  - 47.00 Storage tank of water if and where necessary.
  - 51.00 Other recording instruments like Carbon dioxide recorder,  
Carbon Monoxide recorder or Steam recorder etc.
  - 52.00 Special tools and plant for Maintenance and Construction.
  - 53.00 .....
  - 54.00 .....
- 24.10.00 Power Transformation, Transmission.
- 11.00 Foundations, Platforms, Support etc.
  - 12.00 Transformers.
  - 13.00 Protective Gear.
  - 14.00 Transmission Lines.
  - 15.00 Step down Transformers.
  - 16.00 Compressed Air.
  - 17.00 Fire Protection.
  - 18.00 .....
  - 19.00 .....
- 25.10.00 Power Distribution and Supply.
- 11.00 L.T.Lines.
  - 12.00 H.P. Meters.
  - 13.00 Switch Gear.
  - 14.00 Transformers.
  - 15.00 Service Lines.
  - 16.00 Domestic Meters.
  - 17.00 Land.
  - 18.00 .....
  - 19.00 .....

## APPENDIX 11—contd

- 26.10.00 Ground Water.
  - 11.00 .....
  - 12.00 .....
- 27.10.00 Soil Conservation and Land Reclamation.
  - 11.00 Check Dams.
  - 12.00 Cantour Bunding.
  - 13.00 Terracing.
  - 14.00 Ridging.
  - 15.00 Planting trees, shrubs etc.
  - 16.00 Gully Plugging.
  - 17.00 Land.
  - 18.00 .....
  - 19.00 .....
- 28.10.00 Fish and Games, Reservoir Navigation, Recreation
  - 11.00 Dam development and management of Fisheries and Fish Life.
  - 12.00 Development and management of games, including Kenels and Mammals.
  - 13.00 Navigation on the Reservoir.
  - 14.00 Recreation.
  - 15.00 Land.
  - 16.00 .....
  - 17.00 .....
- 29.10.00 Gates, Allied Fixture and Equipment.
  - 11.00 Spillway Gates.
  - 12.00 Intake Gates.
  - 13.00 Sluice and outlet Gates and Valves.
  - 14.00 Draft tube Gates.
  - 15.00 Garrage Gates.
  - 16.00 Regulator Gates.
  - 17.00 .....
  - 18.00 .....
- 30.10.00 Township.
  - 11.00 Site Clearance.
  - 12.00 Roads etc.
  - 13.00 Electric Distribution.
  - 14.00 Drainage System.
  - 15.00 Sewerage System.
  - 16.00 Water Supply.
  - 17.00 Residential Buildings—Permanent.
  - 18.00 Residential Buildings—Temporary.
  - 19.00 Streets, Parks, Pavements.
  - 20.00 Recreation Grounds.
  - 21.00 Fire Alarm.
  - 22.00 .....
  - 23.00 Godowns.
  - 24.00 Hospitals.
  - 25.00 Police Station.
  - 26.00 Workshop Buildings.
  - 27.00 Cafeteria.
  - 28.00 School.
  - 29.00 Garrages.
  - 30.00 Land.
  - 31.00 Fire Station.
  - 32.00 P. & T. Affairs and Wireless Station.
  - 33.00 Maternity Centres, Clubs, Swimming Pools.
  - 34.00 Pumping Stations.
  - 35.00 .....
  - 36.00 .....

## APPENDIX 11—contd.

- 31.10.00 Construction Plant and Equipment.
  - 11.00 Site preparation.
  - 12.00 Time office.
  - 13.00 Warehouse, Tool House.
  - 14.00 Carpenters Shop.
  - 15.00 Machine Shop.
  - 16.00 Blacksmith Shop.
  - 17.00 Sheet Metal Shop.
  - 18.00 Drilling, Sharpening Shop.
  - 19.00 Servicing Station.
  - 20.00 Railway Siding.
  - 21.00 Compressed Air.
  - 22.00 Raw Water System.
  - 31.00 Hauling Equipment.
  - 32.00 Excavation and Grading Equipment.
  - 33.00 Hoisting Equipment.
  - 34.00 Tractors.
  - 35.00 Wagon Drills.
  - 41.00 Primary Crushing Plant.
  - 42.00 Secondary Crushing and Screening Plant.
  - 43.00 Sand Plant.
  - 44.00 Conveyor System.
  - 45.00 Aggregate Storing and Reclaiming Plant.
  - 46.00 Cement handling and storage Plant.
  - 47.00 Concreting, Batching and Mixing Plant.
  - 48.00 Cableway Plant.
  - 49.00 Jackhammers.
  - 50.00 Concrete Vibrators.
  - 51.00 Concrete Boggies and Buckets.
  - 52.00 Portable Concrete Mixers.
  - 53.00 Portable Air Compressors.
  - 54.00 Portable Welders.
  - 55.00 .....
  - 56.00 Dredgers.
  - 57.00 Tractors and Dozers.
  - 58.00 Scrappers.
  - 59.00 Rakes.
  - 60.00 Cranes, Winches and Cables.
  - 61.00 Draglines.
  - 62.00 Root Cutters.
  - 63.00 Chain Saws.
  - 64.00 Drills.
  - 65.00 Pile Drivers.
  - 66.00 Tow Boats.
  - 71.00 Barges.
  - 72.00 Drill Boats.
  - 73.00 .....
  - 81.00 Office Furniture.
  - 82.00 Office Equipment.
  - 83.00 Engineering Equipment.
  - 84.00 .....
- 32.10.00 Construction Plant and Equipment Operation.
  - 11.00 Carpenters Shop Operation.
  - 12.00 Blacksmith Shop Operation.
  - 13.00 Electric Shop Operation.
  - 14.00 Compressor Air Operation.
  - 15.00 Reinforcing Yard Operator.

## APPENDIX 11—concl'd.

- 16.00 Excavation and Grading Equipment Operation.
- 17.00 Hoisting Operation.
- 18.00 Tractor Operation.
- 19.00 Wagon Drill Operation.
- 20.00 Primary Crushers.
- 21.00 Secondary Crushing and Screwing Plant.
- 22.00 Sand Plant Operation.
- 23.00 Conveyor Plant Operation.
- 24.00 Aggregate Storage and Reclamation
- 25.00 Concrete Mixer Plant Operation.
- 26.00 Job Rail Road Operation.
- 27.00 Cableway Operation.
- 28.00 Tow Boat Operation.
- 29.00 .....
- 30.00 .....
  
- 33.10.00 Bunds and Tanks.
  - 11.00 Site Clearance.
  - 12.00 Rooting.
  - 13.00 Embankment.
  - 14.00 Gates Regulators.
  - 15.00 Rip-Rap.
  - 16.00 Miscellaneous.
  - 17.00 Land.
  - 18.00 .....
  - 19.00 .....
  
- 34.00.00 Suspense.
  
- 34.10.00 Stock.
  - 11.00 Purchases.
  - 12.00 Miscellaneous Advances.
  - 13.00 Workshop Suspense.
  - 14.00 General Plant.
  - 15.00 Mobile Equipments
  - 16.00 Concrete Plant.
  - 17.00 .....
  - 18.00 .....
  
- 99.00.00 General Services—Operation & Maintenance.
  - 11.00 Police.
  - 12.00 Posts & Telegraphs.
  - 13.00 Wireless Station.
  - 14.00 Watch and Ward.
  - 15.00 Fire Protection.
  - 16.00 Medical, Health & Sanitation.
  - 17.00 Social Service.
  - 18.00 Education.
  - 19.00 Accidents.
  - 20.00 Recreation, Entertainments, Public Functions.
  - 21.00 Training Centres.
  - 22.00 Water Supply.
  - 23.00 Lighting.
  - 24.00 .....
  - 25.00 .....



## E R R A T A

<i>Page</i>	<i>Line No.</i>	<i>for</i>	<i>Read</i>
2	13	all	large
5	35	Purchase Committee.	Purchase Committee—Ministry of Works, Housing and Supply.
7	6	and two	and no two
	8	local materials,	the materials used,
8	17	The Coordination Committee of Engineers was	The committee was
16	16	The financial provision	The provision
17	1 and 2 from bottom	no salvage value.	as little salvage value as possible.
22	last line	cost of works.	cost of works, excluding land.
38	2	Statement of Depreciation Rate per Month of Non-Rated Equipment	Statement of Depreciation Rate per Month of Non-Rated Equipment as a Percentage of the Capital Cost
69	15 and 16	will remain constant till such an occasion crops up again.	should remain in force until a similar contingency crops up again.
73	7	Cardools,	the tools,
	8	with	card
	9	tool	with
	10	ther	tool
	32	further	have also
85	5	and be responsible	and is largely responsible
	28	skill, the	skill, in
93	3	executives	the authorities
94	27	recognition	appreciation
96	1	Engineer's Office if it be	Engineer if he be
110	13	Capacity in CFC	Capacity in CFC per Huor
184	21 column 6	1½	2½
294	22	4. Cyds.	4. ¾ Cyds.
358		Streeing	Steering
359	42	10	100
362	11	5/4-1	5/4/-
363	17	0.15 gal.	.15 gal.
365	last line	115 Y.P.	115 H.P.
368	30	reverse	reserve
389	18	Discharge gates	Discharge gates Belt Conveyors
413	21	Borat,	Boat,

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