

MINISTRY OF WORKS, PRODUCTION AND SUPPLY

R E P O R T

OF THE
COMMITTEE OF EXPERTS FOR BUILDING WORKS

APPOINTED BY THE MINISTRY OF
WORKS, PRODUCTION & SUPPLY



सत्यमेव जयते

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COMMITTEE

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Secretary—M

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COMMITTEE OF EXPERTS FOR BUILDING WORKS

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Mr. F. C. BADHWAR, Chairman, Railway Board.

Maj. Genl. H. WILLIAMS, C.B.E., Engineer-in-Chief, M.E.S.

Mr. B. S. PURI, I.S.E., Chief Engineer, C.P.W.D. (Convener).

Secretary—Mr. C. B. PATEL, Superintending Engineer.

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COMMITTEE OF EXPERTS FOR BUILDING WORKS

THE SECRETARY, GOVT. OF INDIA,
MINISTRY OF WORKS, PRODUCTION & SUPPLY,
NEW DELHI.

No. SCE/2.

New Delhi, the

April, 1952.

SIR,

We were appointed under the resolution No. AG88(123), dated the 21st September 1950. We were charged with the following responsibilities:—

- (i) to collect plans, specifications and construction costs of all types of cheap but durable buildings,
- (ii) to continuously review building costs on both the civil and the military sides of Government activity with a view to advising the Ministries of the Government of India, and, if desirable the public, of how to obtain the best value for money and
- (iii) to draw up an annual consolidation programme of construction of buildings, office, residential, etc., by the Government of India and an estimate of the materials necessary for the purpose.
- (iv) any other matter on which the advice of the Committee is sought for by Government.

We were not equipped to deal with item (iii) of our terms of reference and therefore have not been able to make any headway in respect of these consolidated programmes.

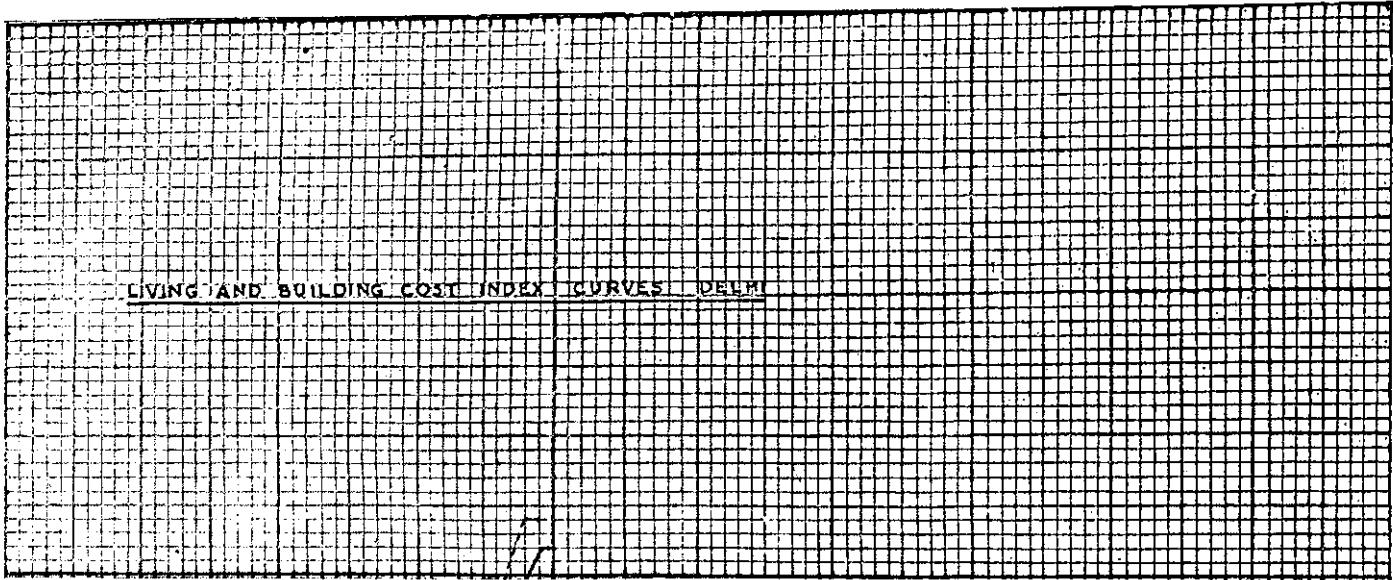
We would like to record our appreciation of the valuable services of our young and energetic Secretary, Mr. C. B. Patel. We all had our heavy full time jobs and without his assistance it would have been difficult to make country-wide investigations, collect technical data on costs, and finalize our recommendations.

Yours faithfully,

F. C. BADHWAR.

H. WILLIAMS.

B. S. PURI (Convener).



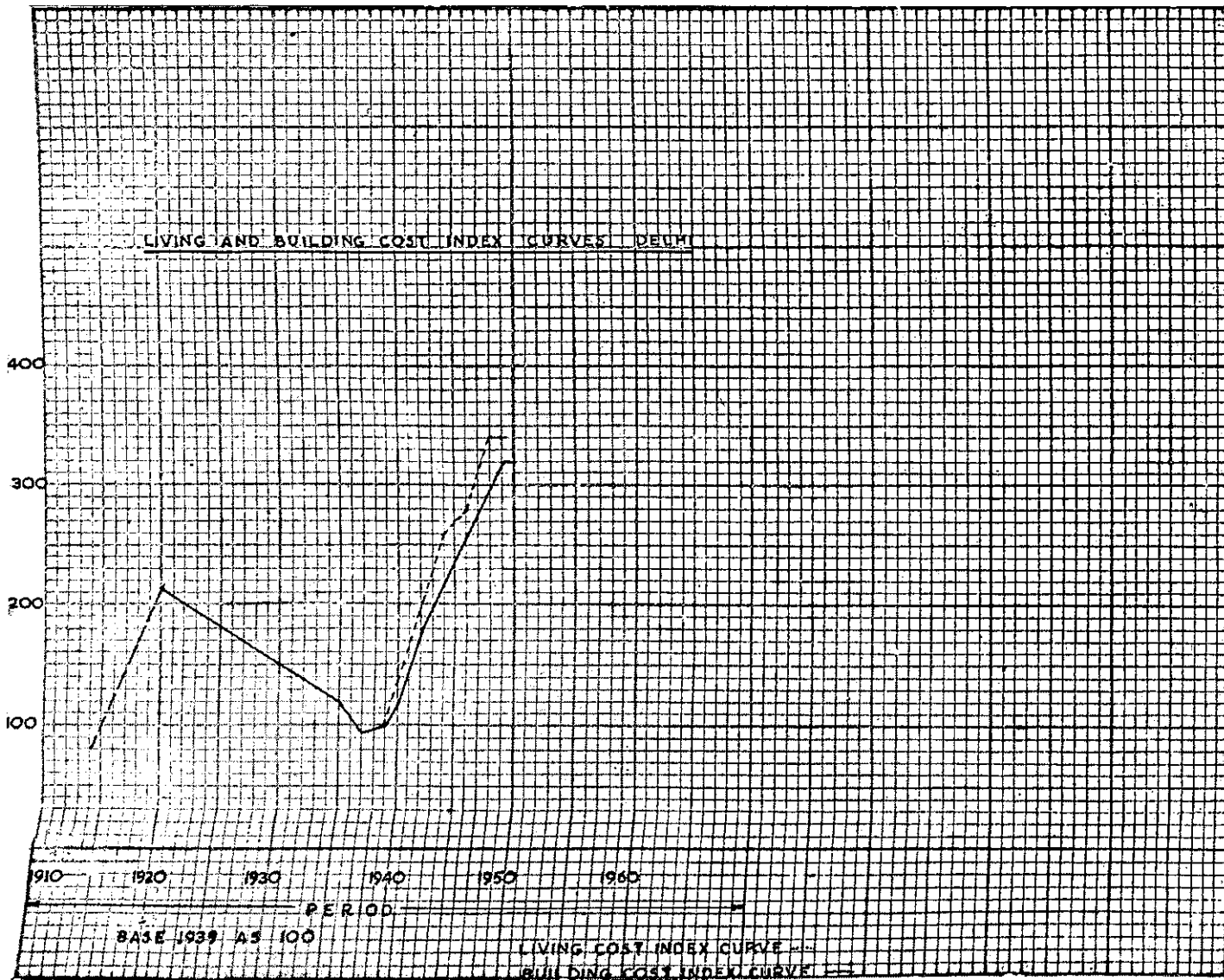


FIGURE 1

SUMMARY OF REPORT AND CONCLUSIONS

1. Building costs. (CHAPTER I)

Building costs are co-related to the cost of living. However, some degree of economy can be effected by:—

- (a) expert architectural planning and structural designing;
and
- (b) adopting utility scales of accommodation.

2. Notification of allotments of Funds two years in advance. (CHAPTER II)

Considerable time is required to progress a project through the different stages of planning. To ensure good economical planning, the practice followed in advanced countries of notifying the allotment of funds for capital projects 2 years in advance must be adopted. No major project should be included in a budget unless it has been administratively approved and technically examined in detail in the previous year.

3. National Building Organisation. (CHAPTER II)

There is a need for the establishment of an expert organisation to collect, collate and disseminate technical information available both at home and from abroad. This body should be essentially advisory in nature, and should have administrative, technical and coordinating functions.

4. Standardisation of the quality of materials and better out-turn from labour. (CHAPTER III)

The standards laid down for various locally produced materials by the I.S.I. should be enforced in order to enable the designer to allow the maximum permissible stresses.

Similarly imported materials should be subjected to strict inspections and rigid compliance to specifications.

Time honoured practice of paying labour on the basis of units of work done instead of daily or monthly basis, should continue for higher production.

5. Standards of Accommodation. (CHAPTER IV)

Seven types of residential accommodation with the appropriate pay range of the occupants shown against each have been drawn up for housing Government employees. A 10 per cent. variation

in plinth area is allowed for local conditions. In special circumstances exceptions will, however, have to be made to the application of these standards. Accommodation in the houses of upper class can be appreciably reduced.

6. Economy through Architectural design. (CHAPTER V)

Plans should be developed so as to utilize all available space to the fullest advantage.

The various components of the structure should be balanced in quality, quantity and cost and so arranged as to give a pleasing appearance.

7. Cost reduction through Structural Design. (CHAPTER VI)

Traditional materials and building methods are generally most economical in India, but traditional specifications should not be followed blindly. The functional requirement of each component of a structure should be considered and materials and methods selected to ensure a sound permanent building with minimum cost. A departure from the usual specification in many instances will result in a saving in cost. Buildings erected from public funds should be durable as temporary buildings are more expensive due to heavy maintenance and depreciation costs.

8. Ceiling costs. (CHAPTER VII)

The Committee were of the opinion that some indication of reasonable ceiling costs of various types of buildings would be a useful guide to Engineers and Architects. It would also encourage them to explore methods to bring down the costs of buildings without sacrificing essentials.

Ceiling costs for Delhi in 1950 have been calculated and coefficients for variations in building costs indices have been worked out for a number of other localities to determine the permissible ceiling costs for the latter.

9. Economy in construction through administrative and executive procedures. (CHAPTER VIII)

The tendency to design oversafe and therefore uneconomical structures must be discouraged. Engineers must be made more cost minded. Quality control of works must be instituted, and laboratories set up both in the centre and in the field to test strength of materials and structures.

Contractors should be paid promptly but not later than 90 days after satisfactory completion of works. Delay in payment means higher tender costs.

CHAPTER I

BACK GROUND

The graph at Fig. 1 shows how building costs have fluctuated during the past 30 years. The expectation that these costs would show a downward trend within a few years of the end of World War II, as was the case after World War I, was not fulfilled. The cost of labour and, to a large extent, of processed materials is directly related in this country to the cost of living and decreases in prices of building materials and labour cannot, therefore, be expected unless the cost of living comes down. Also, mechanisation and labour saving devices are in their infancy in India and building and living costs have, therefore, risen in much the same proportions. This is clearly illustrated on the graph by the superimposed red line indicating the cost of living. Some degree of reduction in building costs is, however, possible by:—

- (a) More efficient and economical utilisation of materials and space in buildings through expert architectural planning and structural designing; and
- (b) Adopting reduced and “utility” scales of accommodation which omit non-essentials.

2. Confronted with a large number of building projects and realising the complex and highly technical nature of the problems involved, the Government of India appointed a Committee of Building Experts, in their Resolution No. AG88 (123), dated the 21st September 1950, with the following terms of reference:—

- (a) To collect plans, specification and construction costs of all types of cheap but durable buildings;
- (b) To continuously review building costs on both the civil and the military sides of Government activity with a view to advising the Ministries of the Government of India, and if desirable the public, on how to obtain the best value for money; and
- (c) To draw up an annual consolidated programme of construction of buildings, office, residential, etc., by the Government of India and an estimate of the materials necessary for the purpose;
- (d) Any other matter on which the advice of the Committee is sought for by Government.

3. The Building Experts Committee was composed of the following three members:—

- (i) Shri B. S. Puri, Chief Engineer, Central Public Works Department, representing the Ministry of Works, Production and Supply; (Convener).
- (ii) Shri F. C. Badhwar, then Member, Engineering, and now Chairman, Railway Board, representing the Ministry of Railways;
- (iii) Major-General H. Williams, Engineer-in-Chief, representing the Ministry of Defence.

Shri C. B. Patel, Superintending Engineer, C.P.W.D., was placed on special duty to function as the Secretary of this Committee.

4. The Committee has interpreted the terms of reference to apply to durable buildings only, *i.e.*, structures which are planned to last for at least a generation and do not involve heavy costs of maintenance during this period. "Short-life" buildings, *viz.*, temporary structures designed for use for a few seasons only, have been excluded from these studies.

5. The investigations of the Committee mainly concern with housing projects intended for accommodating Government employees and to some extent with offices, and public buildings like hospitals, schools, colleges, hostels, etc.

6. The Committee has not been equipped to deal with term (c) and has, therefore, not been able to make any headway in respect of these consolidated programmes.

7. It was realized early that joint and vigorous efforts would have to be made by several authorities, spread all over the country, if building costs were to be effectively reduced. Much data had first to be collected and for this purpose a questionnaire, *vide* Appendix 'A', was sent to the heads of various large building organisations. Arrangements were also made for the Secretary to visit selected projects and localities to inspect works in progress and study costs, specifications, etc., first hand. The list of localities visited by him is shown in Appendix 'B'. During these investigations, details of over 300 different designs of buildings were analysed, and visits were paid to over 30 projects. An actual cross section of the building activities in the country at the time was thus obtained and the levels of costs as well as the numerous problems connected with their reduction were examined on a realistic basis.

8. It is apparent that the following features have an important and direct bearing on building costs:—

- (a) The scales and standards of accommodation provided for various purposes, *viz.*, residences, schools, colleges, hospitals, hostels, etc. These varied widely in

different projects and were sometimes influenced by considerations of prestige.

- (b) The constructional specifications in which also there were substantial variations in different projects, even in the same localities.
- (c) The degree of importance attached to durability, low maintenance and conveniences on the one hand, and the first costs of the building on the other. The differences in the policies followed have resulted in abnormally high first costs in some cases and in the adoption of sub-standard specifications in others.
- (d) The degree of awareness among engineers and architects of the importance of cost in connection with building construction.

The Government of India are reported to be spending sums of the order of Rs. 50 crores per year on the construction of various types of buildings, while the total annual expenditure of State Governments is understood to be even higher. Quasi-government authorities and private enterprises are also spending large amounts every year on buildings. The great significance to India as a whole, therefore, of the four factors mentioned above, when translated in terms of money, can be readily assessed from the enormous expenditure, which is estimated at approximately Rs. 175 crores annually.

9. To what extent these differing standards and specifications, as well as the existing wide variations in scales and practices, can affect the cost of buildings, is well illustrated in the following examples:—

- (a) Our investigations revealed that residential quarters with two main rooms could be completed by one government organisation in a particular locality at an average cost of Rs. 3,600 each, while very similar quarters in another locality, built by another department, worked out to about Rs. 8,500 per unit.
- (b) Officers' bungalows, with two bedrooms, varied in cost from under Rs. 20,000 to over Rs. 45,000 as built by different government agencies in various localities.
- (c) A primary school was projected in one place at a cost of over Rs. 1,300 per student while in another locality a primary school was being built at a cost of about Rs. 60 per student.
- (d) A general hospital in one town works out to about Rs. 10,000 per bed, while in another the cost has been kept down below Rs. 3,500 per bed.

- (e) Shedded accommodation for factories varied from Rs. 5/8/- per square foot to over Rs. 10 per square foot for similar types of structures.

There are plausible explanations for these variations which are the results of widely differing approaches to scales and standards, for which, however, there seems to be little rational basis.

10. The Committee was requested to examine a few particular projects, which had already received the administrative approval of the authorities concerned. The results of these examinations have been instructive and clearly establish how it is possible to reduce the cost of buildings substantially by inducing the engineers in charge of projects to adopt rational scales and standard specifications. In the actual cases dealt with, the Committee recommended changes in architectural and structural details which resulted in average savings in costs of over 26·1 per cent. An equally important aspect of these cases was that the Committee found it possible to carry the project engineers with it, in the desirability for making these alterations. It was not possible for the Committee, constituted as it was of three extremely busy officers, already engaged wholtime on their normal duties, to examine more than a very few projects sponsored by other Ministries, and the results of these scrutinies are shown in the statement at Appendix 'C'. Problems of high building costs must be tackled from several angles and detailed study is necessary of each factor, which directly or ultimately affects the cost of building. These factors include:—

- (a) Planning of works;
- (b) Labour and materials;
- (c) Standards of accommodation;
- (d) Architectural design;
- (e) Structural design; and
- (f) Executive and administrative procedures;

and are dealt with in the following chapters.

CHAPTER II

PLANNING OF WORKS

It is realized all the world over that a high degree of efficiency and economy cannot be achieved in any building operation of considerable size, unless it is planned in detail before the work is commenced. There are several stages of planning through which the project has to pass before it can be considered as complete.

2. In case of Government projects, the starting point is the programme of demands from the sponsoring authority. On the basis of this schedule of requirements, the Engineer incharge prepares preliminary plans and estimates. These are submitted to Government for administrative approval. If the necessity of the work is accepted and the plans and estimates are found reasonable, the work is administratively approved. It has, however, to be remembered that appreciable time may be taken for clarification of doubtful points and for preparing alternative designs and estimates to reduce the cost to the minimum, before a work is administratively approved.

3. After the administrative approval is given, the architect and the Engineer start preparing architectural and structural designs and detailed estimates, based on a schedule of quantities. This estimate is then technically sanctioned by the competent authority.

4. Tender papers are next prepared and tenders are called after giving sufficient notice to contractors. After receipt of tenders, a suitable contractor is selected and the work starts. An average double storeyed building, if the work is not unnecessarily hustled, may take from eight to twelve months to build, depending upon its size and design.

5. It will be realized that the total time taken on a project from its conception to its completion is considerable, and that the work often has to be spread over two or more financial years. To include, in a budget, projects on which insufficient preliminary investigation has been done and to expect the project to be completed economically and within the four walls of a "rough" estimate all in one financial year, is just "wishful" thinking. When the architectural and structural designs are not carefully prepared, with proper examination of alternatives, they cannot be the most economical. Also in actual execution, if sufficient time is not given to the contractor, his rates will naturally tend to be higher than if he was given adequate time to study economies.

6. In advanced countries, the allotment of funds for capital projects is usually notified at least two years before hand to the Engineers and they get sufficient time to plan the execution of projects economically. The Committee, therefore, emphasises that if Government want to get full value for money, firm allotments should be indicated at least two years in advance and no major project should normally be included in a budget unless it has been administratively approved and technically examined in detail and sanctioned in the previous year.

7. **National Buildings Organisation.**—In view of the high prices of all materials and of labour, an all-out effort is necessary to achieve economy. It is also necessary to pool all the knowledge and experience on the techniques of building construction available in the country in a compact and highly expert organisation. The main problems of building construction are common to all Engineering Departments and the establishment of a central National Buildings Organisation is the obvious step to take for advancement and economy in building construction. This is the pattern followed in Europe and America where the science of building has made rapid strides and it will be advantageous to benefit from such modern developments in these "Go-ahead" countries. The U. N. Mission on tropical housing which recently visited India stressed the necessity for the early formation of an expert unit of this kind and the Planning Commission, in their First Five Year Outline Plan, have also recommended on page 218 para. 28, the setting up of a National Buildings Organisation. The Committee previously recommended, in its second interim report, the formation of such an expert body, with certain definite functions, which should carry on the work commenced by this Committee. The new body should be essentially of an expert advisory nature but might in certain respects, follow the model of the Central Roads Organisation. Its functions and organisation may be similar to the well known international building centre in Holland after adaptation to Indian conditions. Details can, however, be decided at an inter-Ministerial meeting, to be sponsored by the Planning Commission, but a tentative list of the subjects that it could usefully deal with, if required to do so, is given below:—

Administrative

1. To activate housing programmes.
2. To make proposals for obtaining additional revenues for housing.
3. To administer such Housing Projects and funds as it is specifically requested to handle.

4. To advise on technical matters, including experiments, research, building, education and new techniques.
5. To advise on Rationalisation in building legislation, local byelaws, building codes, etc.
6. To provide an up-to-date information service regarding popular types of buildings to the public.

Technical

1. Directing research into the demands and needs of the Society.
2. Increase in functional purposefulness of buildings. Saving in management costs of factories, hospitals, schools, Saving in housewife's work. More comfort.
3. Design based on justifiable architectural, technical and economic principles. Saving in maintenance through careful choice of materials, good finish and construction methods.
4. Improvement in production and distribution of materials.
5. Standardisation.

Co-ordination

1. To promote the science of building construction.
2. To provide a channel for the expression of opinions regarding buildings, and to hold periodical meetings to discuss technical questions regarding buildings.
3. To publish technical pamphlets and to publicise the art of economical building.
4. To organize building trades.
5. To organize refresher courses for engineers and architects.
6. To provide a museum, or standing exhibition where cheap houses can be displayed and various techniques for economic building explained and demonstrated.
7. To encourage self-builders, both in the shape of co-operatives and individuals.

CHAPTER III

MATERIALS AND LABOUR

Materials required for construction can be broadly divided into three categories:—

1. Materials produced locally, such as, bricks, sand, stone chips, lime, etc., etc.
2. Materials produced by organised industries, such as, cement, steel, asbestos sheets, etc., etc.
3. Materials imported from foreign countries, such as pipes, sanitary equipments, electrical fittings, etc., etc.

2. **Materials produced locally.**—Normally the question of production of these materials should be left to private enterprise. In special circumstances, where there is a concentration of Government work, it may be advisable to organise the production and distribution of important materials to keep down cost.

3. **Materials produced by organised industries.**—The quality of materials produced by the organised industries plays a very important part in the structural design of the building. The Indian Standards for Institution is doing very useful work in laying down standards for various materials. These standards should be adopted and enforced by all Government Engineering Departments. Lately, there have been several complaints about the non-uniform quality of cement and the poor quality of steel produced by re-rolling mills. Variation in quality of such material affects building costs very adversely, because the designer is obliged to take lower working stresses in structural designs. For example, in case of R.C.C. designs, if uniform quality of materials is assured, stresses can be taken as 18,000 lbs. per sq. inch for steel and 750 lbs. per sq. inch for concrete. But if the uniform quality of the basic materials is not assured, the designer has to adopt lower stresses of say 16,000 lbs. per sq. inch for steel and perhaps 600 lbs. per sq. inch for concrete. Lowering of working stresses due to non-availability of standard materials, when translated into money may be 5 per cent. of the total building cost.

4. **Materials imported from foreign countries.**—The remarks about uniform quality of the materials produced by organised industries in India apply also to imported materials. Here strict inspections and rigid compliance with specifications are the only solutions.

5. Labour.—A large number of legislative and administrative measures have already been introduced in our country in connection with the welfare of labour. The problem is continuously receiving the attention of the Ministry of Labour and it is not, therefore, proposed to discuss it in this report.

From the point of view of economic output, however, it is recommended that the time-honoured method of paying labour by units of work produced should be continued in preference to daily, weekly or monthly wages, which are based more on attendance than on output.

6. Vocational training of skilled workers.—At present, building trades of masons, carpenters, blacksmiths, printers, handhanis, etc., etc., are handed down from father to son. A young man in these trades gets training under his elders on actual works as well as at home. This is good practice, but some theoretical knowledge and better facilities for practical training and incentive methods of payment will go a long way towards increasing the productivity of these skilled workers.

7. Government are already running many vocational training centres. A better liaison in this respect between the training institutions and managers of works is sure to improve the quality of training and make it more realistic.

8. Use of machinery.—For increasing productivity, it often becomes necessary to use modern machinery. For example, the work of breaking stones can be more conveniently and economically done by crushers. In wood work, with the help of modern machines, out-turn can be increased considerably. Earth moving machinery is being employed in a large measure on the execution of various projects. Hoists, concrete and mortar mixing machines, vibrators, and other simple machines increase the productivity of skilled and unskilled workers. It is difficult to lay down hard and fast rules but the use of modern machinery should be encouraged wherever its employment is likely to effect economies in cost and time.

CHAPTER IV

STANDARDS OF ACCOMMODATION

Factors like the high cost of construction, shortages of building materials and of skilled workmen, the necessity for providing large number of residences as quickly as possible, and the rising expenses of maintenance and upkeep of large houses and compounds, have resulted, in all countries, in the areas of living accommodation being appreciably curtailed in recent years. For example, in the U.K., even a private individual is not permitted to build for himself a residence that is more than 1,050 square feet in plinth area; while in America, the average house does not cover more than about 1,500 square feet of area. In India, there are certain peculiar climatic factors, elements of conservatism and orthodoxy, and lack of labour saving devices, which make it desirable to provide somewhat larger plinth areas for well-to-do people. But appreciable curtailment of the pre-war accommodation standards provided for the higher-income groups is both necessary and justified. The Committee is concerned mainly with residential and service buildings in the public sector, but its recommendations, with some modifications, are suitable for adoption by private organisations as well.

2. Economic rents are most desirable wherever it is possible to introduce them without hardship to the occupant as these result in making house building a business proposition and, therefore, attractive specially in the private sector. From the Governmental angle also, when priorities have to be allotted between projects of national importance, such as defence, agricultural and industrial developments, education and social programmes, etc., expenditure on housing, if it can be made productive, can be accepted more easily than if the activity is to be subsidised through uneconomical rentals. Some scaling down of the accommodation provided for occupants is justified to achieve this objective of economical rentals. Certain housing projects in Europe and America are reported to be providing average areas of between 700 to 800 square feet only for normal requirements during the housing shortage.

3. Before reaching conclusions, the Committee has endeavoured to examine all aspects of the problems involved and had made a special study of the following features:—

- (a) Requirements for health and sanitation.
- (b) Avoidance of discomforts and provision of the normal conveniences and amenities usually associated with the living standards of different income groups

(c) The fact that Government does not provide houses on purely commercial considerations and recognises an element of subsidy in providing residences, particularly for its lower paid employees.

(d) The relation between the capital cost of a building and its rent which should be economical, or nearly so in the case of senior officers.

4. It is recommended that in future, Government should adopt seven types of Residential Accommodation, shown below for housing various levels of its employees. The Committee feel that a one-roomed unit should be allotted to single workers only, as far as possible, though it is realised that with so many employees not provided with houses, and funds being very limited, many families specially in large cities will at present thankfully accept a one-roomed quarter. The pay ranges shown against each type are intended to be indicative and it is realized that in special circumstances, or if salary scales are revised, their literal adoption may present practical difficulties.

Type I		Single storey
For class IV officials with an average pay of Rs. 30 p.m.		
Room		120 sft.
Verandah		80 "
1/2 bath and 1/2 W.C.		20 "
Courtyard		200 "
Floor area		220 "
Plinth area		300 "
Type I		Double storey
Room		140 sft.
Verandah		80 "
1/2 Bath and 1/2 W.C.		20 "
Floor area		240 "
Plinth area		350 " including stair
Type II		Single storey
For officials drawing pay between Rs. 55 and Rs. 150. Average pay Rs. 100.		
2 Rooms 120 sft. each		240 sft.
Verandah		120 "
Kitchen and Store		80 "
Bath and W.C		40 "
Floor area		480 "
Courtyard		300 to 400 sft.
Plinth area		625 sft.

CHAPTER IV

STANDARDS OF ACCOMMODATION

Factors like the high cost of construction, shortages of building materials and of skilled workmen, the necessity for providing large number of residences as quickly as possible, and the rising expenses of maintenance and upkeep of large houses and compounds, have resulted, in all countries, in the areas of living accommodation being appreciably curtailed in recent years. For example, in the U.K., even a private individual is not permitted to build for himself a residence that is more than 1,050 square feet in plinth area; while in America, the average house does not cover more than about 1,500 square feet of area. In India, there are certain peculiar climatic factors, elements of conservatism and orthodoxy, and lack of labour saving devices, which make it desirable to provide somewhat larger plinth areas for well-to-do people. But appreciable curtailment of the pre-war accommodation standards provided for the higher-income groups is both necessary and justified. The Committee is concerned mainly with residential and service buildings in the public sector, but its recommendations, with some modifications, are suitable for adoption by private organisations as well.

2. Economic rents are most desirable wherever it is possible to introduce them without hardship to the occupant as these result in making house building a business proposition and, therefore, attractive specially in the private sector. From the Governmental angle also, when priorities have to be allotted between projects of national importance, such as defence, agricultural and industrial developments, education and social programmes, etc., expenditure on housing, if it can be made productive, can be accepted more easily than if the activity is to be subsidised through uneconomical rentals. Some scaling down of the accommodation provided for occupants is justified to achieve this objective of economical rentals. Certain housing projects in Europe and America are reported to be providing average areas of between 700 to 800 square feet only for normal requirements during the housing shortage.

3. Before reaching conclusions, the Committee has endeavoured to examine all aspects of the problems involved and had made a special study of the following features:—

- (a) Requirements for health and sanitation.
- (b) Avoidance of discomforts and provision of the normal conveniences and amenities usually associated with the living standards of different income groups

(c) The fact that Government does not provide houses on purely commercial considerations and recognises an element of subsidy in providing residences, particularly for its lower paid employees.

(d) The relation between the capital cost of a building and its rent which should be economical, or nearly so in the case of senior officers.

4. It is recommended that in future, Government should adopt seven types of Residential Accommodation, shown below for housing various levels of its employees. The Committee feel that a one-roomed unit should be allotted to single workers only, as far as possible, though it is realised that with so many employees not provided with houses, and funds being very limited, many families specially in large cities will at present thankfully accept a one-roomed quarter. The pay ranges shown against each type are intended to be indicative and it is realized that in special circumstances, or if salary scales are revised, their literal adoption may present practical difficulties.

Type I	Single storey
For class IV officials with an average pay of Rs. 30 p.m.	
Room	120 sft.
Verandah	80 „
1/2 bath and 1/2 W.C.	20 „
Courtyard	200 „
Floor area	220 „
Plinth area	300 „
Type I	Double storey
Room	140 sft.
Verandah	80 „
1/2 Bath and 1/2 W.C.	20 „
Floor area	240 „
Plinth area	350 „ including stair
Type II	Single storey
For officials drawing pay between Rs. 55 and Rs. 150. Average pay Rs. 100.	
2 Rooms 120 sft. each	240 sft.
Verandah	120 „
Kitchen and Store	80 „
Bath and W.C	40 „
Floor area	480 „
Courtyard	300 to 400 sft.
Plinth area	625 sft.

Type II		Double storey
1 Room		120 sft.
1 Room		150 "
Verandah		120 "
Kitchen and Store		80 "
Bath and W.C.		40 "
Floor area		510 "
Plinth area		725 "
Type III		Single storey
For officials drawing pay between Rs. 151 and Rs. 300 Average pay Rs. 250		
1 Room		150 sft.
2 Rooms 120 sft. each		240 "
Verandah		150 "
Kitchen and Store		120 "
Bath and W.C.		40 "
Courtyard		400 to 500 sft.
Floor area		700 sft.
Plinth area		900 "
Type III		Double storey
1 Room		150 sft.
2 Rooms 120 sft. each		240 "
Verandah and Corridor		200 "
Kitchen and Store		120 "
Bath and W.C.		40 "
Floor area		750 "
Plinth area		1000 "
Type IV		Single storey
For officials drawing pay between Rs. 301 and Rs. 600 Average pay Rs. 450.		
Living Room		280 sft.
2 Bed rooms 170 sft. each		340 "
Verandahs and Corridor		200 "
Kitchen and Store		120 "
Bath and W.C.		50 "
Spare room or servants' Qr.		100 "
Floor area		1090 "
Plinth area		1450 "
Type IV		Double storey
Plinth area		1550 sft.

Type V Single storey

For officials drawing pay between Rs. 601 to Rs. 1,150

Drawing room	225 sft.
Dining room	175 "
2 Bed rooms 175 sft. each	350 "
Bath Rooms and W.C. 60 sft. each	120 "
Verandahs	250 "
1 Store or Pantry and Kitchen	150 "
1 Servants' quarter	100 "
1/2 Servants' bath and W.C.	25 "
Garage	180 "
Floor area	1575 "
Plinth area	2100 "

Type V Double storey

Plinth area 2200 sft.

Type VI Single storey

For officials drawing pay between Rs. 1,151 to Rs. 1,600

Drawing room	250 sft.
Dining room	175 "
1 Bed room	200 "
2 Bed rooms 175 sft. each	350 "
2 Baths 60 sft. each	120 "
Kitchen, Store and Pantry	150 "
Verandahs and Corridors	300 "
2 Servants Qrs. 100 sft. each	200 "
Cooking verandah	80 "
Servants bath and W.C.	40 "
Garage	200 "
Floor area	2065 "
Plinth area	2750 "

Type VI Double storey

Plinth area 2,900 sft.

Type VII

For officials drawing pay above Rs. 1,600

Drawing room	275 sft.
Dining room	200 "
1 Bed room	200 "
2 Bed rooms 175 sft. each	350 "
3 Baths 60 sft. each	180 "
Study	120 "
Verandahs and Corridors	350 "
Servants Qrs. 100 sft. each	300 "
Cooking verandahs	160 "
Bath and W.C.	40 "
Garage	200 "
Kitchen, pantry and store	200 "
Floor area	2575 "
Plinth area	3450 "
	Double storey
Plinth area	3600 sft.

5. The accommodation recommended may be increased or decreased by 10 per cent. at the discretion of the controlling agency depending on the locality, *e.g.* in cities like Bombay or Calcutta, where the cost of land and construction is heavy and people are accustomed to smaller houses, accommodation can be conveniently reduced, while on the other hand, in mofussil districts with very hot climates, increase in size of verandahs may be justified.

6. Prevailing conditions and future trends indicate that units with two bed rooms should be the basic standard for gazetted staff and three bed room units might be considered for senior officers only. Four bed room units should be considered as exceptions being made in the case of the highest level officers, whose official residences are expected to provide guest rooms. Two bed roomed units should, therefore, comprise the vast bulk of officer's houses in Government's building projects.

CHAPTER V

ARCHITECTURAL DESIGN

Proper attention to the architectural design is the greatest single factor for economy in building construction. Architectural design will cover among other items the following, which have a direct bearing on cost:—

- (a) Shape of the house.
- (b) Orientation which control position and sizes of verandahs, chajjas, etc.
- (c) Room sizes.
- (d) Floor heights.
- (e) Area for circulation.
- (f) Sizes and position of doors and windows.
- (g) Plumbing.

Residential buildings

2. Skill is essential to the development of small compact plan arrangements wherein all the space may be utilized to the fullest advantage without the effect of crowding. The Committee realizes that unusual ability is also required to bring simplicity, harmony and refinement in the exterior design of small buildings and talent of competent and experienced architects is required for this.

3. In a well designed house the various elements of which it is composed are balanced in quality, quantity, and cost and so combined that they result in a satisfactory shelter unit.

4. Necessity of well balanced design is especially evident in the small house of low cost. Here the maximum amount of usable space with as much comfort, convenience and privacy, as possible, must be obtained for a minimum amount of money. To achieve this object in construction, furniture, fixtures and room arrangement must be related and considered together to avoid excesses in one or more directions at the expense of inadequacy in the others. The starting point of building design is the plan. For it is here that all essential elements of a house are brought together and are co-ordinated.

5. Experience has demonstrated that planning of well designed livable house, that can be built economically, is based upon a few fundamental principles. These principles of planning can be broadly grouped as those which affect livability and privacy, exterior and interior, appearance and construction cost. Many of

the principles overlap and are inter-dependent. To reconcile conflicting demands for space, livability, appearance and low cost compromises must be made.

6. To obtain the maximum amount of livability and privacy within the minimum area is a major problem in planning low cost houses. Livability of any house is dependent upon adequacy of room areas, relationship of rooms to afford privacy, circulation within or between rooms, room expositors and equipment that provide for convenience and comfort of the occupants. Economy in planning requires the elimination of waste space especially corridors, hall areas, communication verandahs, etc. and planning of rooms for dual purposes.

7. The position of doors and windows is most important in a small house. The living room in the small house must also serve as a passage to the kitchen, dining, bed room and bath room. Livability of the living room largely depends upon the wall space and the location of wall-openings, which permit desirable furniture arrangements. Furniture is more easily arranged for convenience and practical use when doorways are placed at one end of the room, as shown in the diagram 'A'. The other doorway location shown are less desirable.

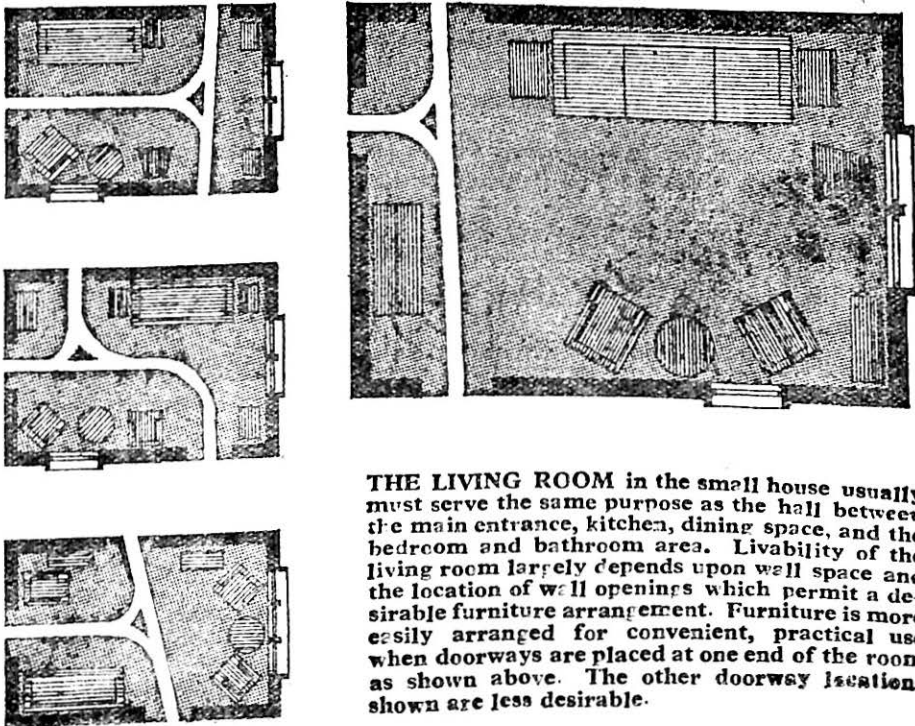


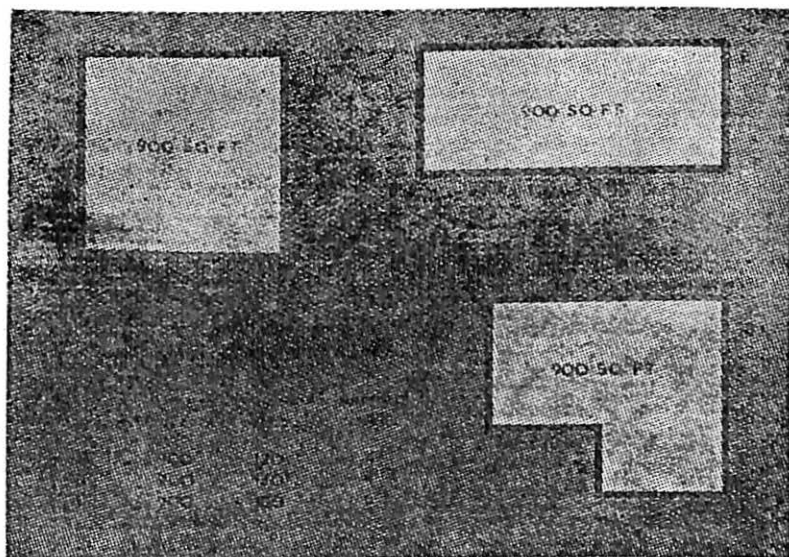
Diagram A.

(a) Shape of the house

8. Construction economies depend primarily upon the shape of the house, use of stock materials, and simplicity with which the structural shell can be constructed. The shape of the house is important due to the amount of outside wall and roof area required to enclose the given amount of space.

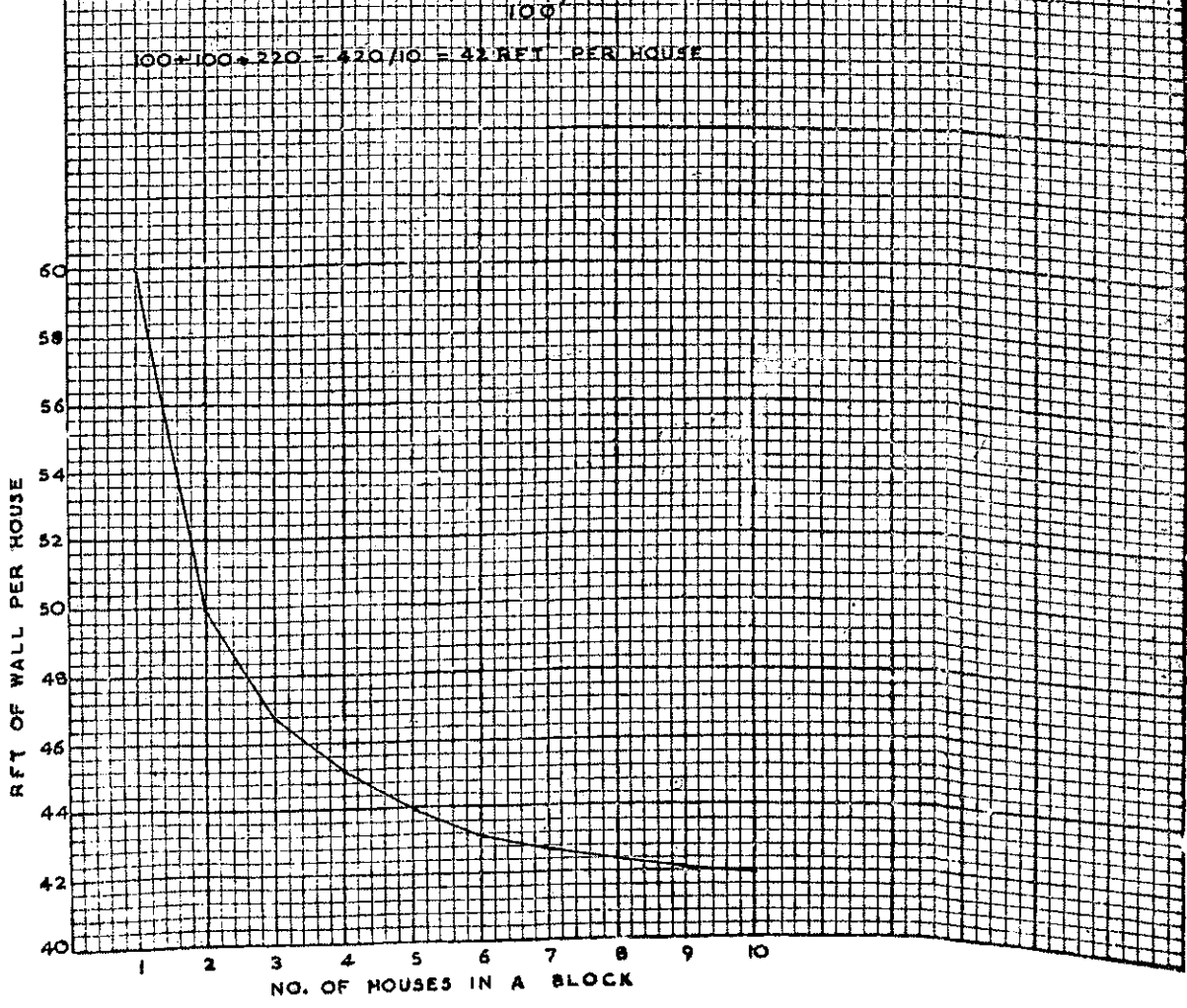
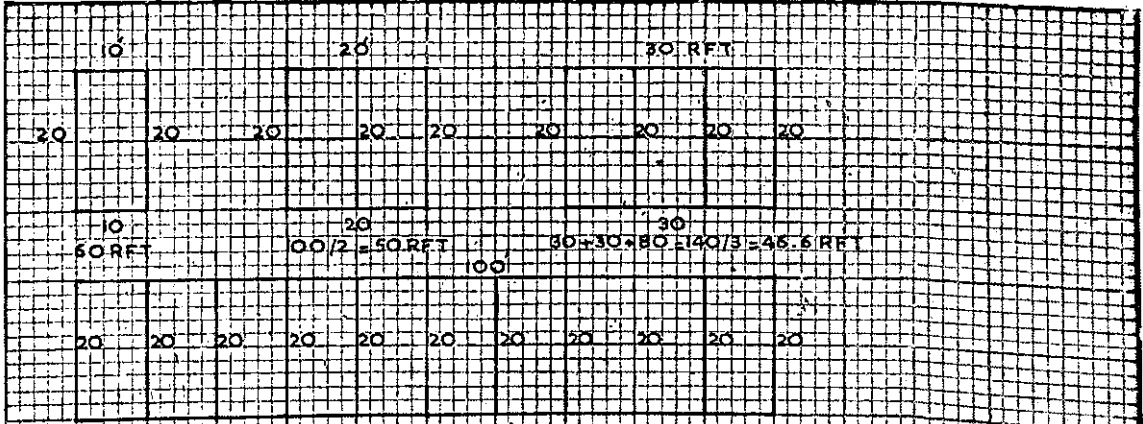
9. The square is the most economical shape since it provides the maximum amount of floor area with the least amount of wall area. Corner construction costs more than straight wall construction, due to extra expenditure in corners and increase in length of walls, with the result that the square and rectangular shaped plans are less costly than L, U or Z shapes. The square or rectangular shape also simplifies the structural framing system of roof in case of sloped roof and thus effects economies.

10. The three houses shown in the Diagram 'B' have the same floor area. The house 'A' is most economical, house 'C' will cost more than house 'B', due to the added cost of exterior corners, even though the area of walls is same in houses 'B' and 'C'.



THE THREE HOUSES ABOVE have the same floor area. House B would be more costly to build than house A due to its additional ten lineal feet of wall. If this were a one-story and basement house, it would have about 165 more square feet of foundation and exterior wall area than house A. The cost of house C, which has the same exterior wall area as house B, would be increased by the added cost of two exterior corners, and would cost much more than house A.

Diagram B.



Row and semi-detached houses

11. It is most economical and convenient to build small, one, two and three roomed houses in rows. In this type of construction there is saving in walls and the exposure to weather is limited to front and back walls.

12. If a one room or two room house is built individually then all the walls will be exposed and the house will be very hot in summer and cold in winter, moreover it will be expensive. Proper ventilation and light can always be arranged in small houses built in rows as front and back will be open. Front and back courtvards, in a single storeyed building, will give additional convenience in the tropical climate of India.

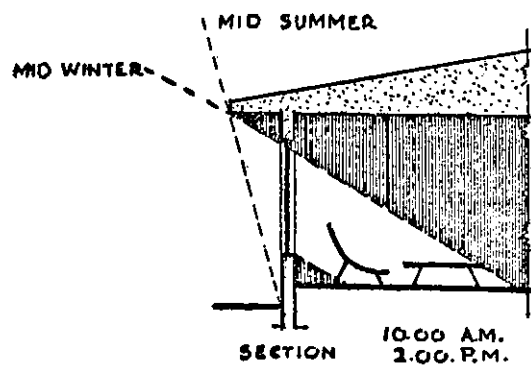
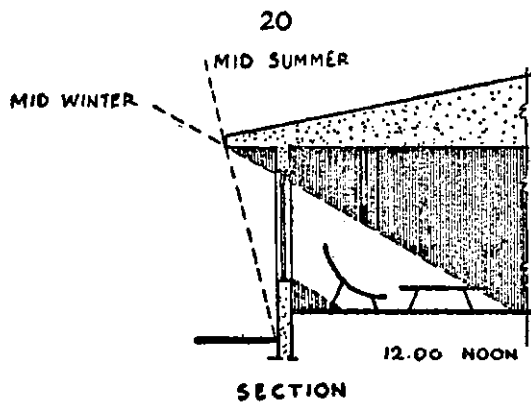
13. The economies that can be effected in row housing have been analysed. For the purpose of comparison, the house with one room and a verandah with outside dimension of 20' x 10' has been considered. If a single unit is constructed then 60 running feet of wall is required, while if it is built as a semi-detached unit, 50 running feet of wall will be necessary per house. The table showing running feet of wall per house, if it is built in blocks of more than one, is given below:—

Built in block of one 60 running feet of wall.

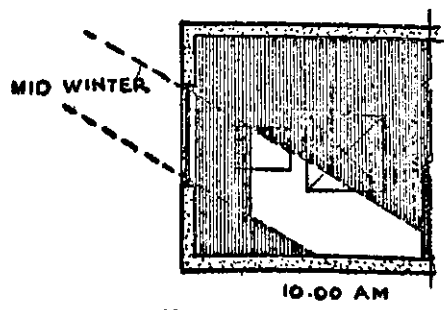
"	"	2	50	"	"
"	"	3	45.6	"	"
"	"	4	45	"	"
"	"	5	44	"	"
"	"	6	43.3	"	"
"	"	7	43	"	"
"	"	8	42.5	"	"
"	"	9	42.2	"	"
"	"	10	42	"	"

14. It will be seen from this table as well as from the graph (p. 18) that the economies achieved are quite substantial upto a block of 4 or 5. After that the saving is not very much. The saving in length of walls in a block of 5 is nearly 25 per cent. as compared to a single unit.

15. The cost of foundation, plinth and super-structure is nearly 35 to 40 per cent. of total building cost. Therefore economy, if small buildings are put in blocks of 4 and 5, will be nearly 10 per cent. of the building cost. Compared with semi-detached houses of small size the saving would be 4 to 5 per cent. in row houses.



SHADING OF SOUTH WALL
BY ROOF OVERHANG.



PENETRATION OF
SUN LIGHT IN WINTER

16. Bigger houses than these can, with advantage, be semi-detached with three sides open. Only very big houses need be built detached with all the four sides open.

17. In the seven categories recommended in chapter four, for Government officials, Types I, II and III can be in row houses. Types IV and V can be semi-detached, while only types VI and VII be detached houses. Where ground is costly even type VI can be semi-detached.

18. Such construction will save in ground and in lengths of services like roads, water supply and sewage lines, rows of trees etc., etc.,

19. Incidence of cost of development of land for houses is ultimately to come on the completion costs and rents. Therefore economy in land use and lengths of services will go a long way in reduction of housing costs.

(b) Orientation

20. In dry hot climate like Delhi, the orientation should be governed on the direction of the sun. The longer walls should be on the North-South and shorter walls on the East-West, so that the minimum wall area is exposed to the slanting rays of the sun during forenoons and afternoons. In Northern hemisphere sun is in the South during the hottest part of the day. The altitude of the sun is high in summer and low in winter. Provision of cantilever chajjas on the Southern walls will give adequate shade to the walls in the South during summer, while it will allow direct sunlight, (due to the low altitude of the sun) in winter in the rooms through the windows.

21. Verandahs can thus be eliminated from South. They will, however, be necessary in West. The afternoon sun can be very hot in summer and chajjas will not give protection from West.

22. In the wet hot climate like Bombay, Madras or Calcutta, the orientation should be governed by the direction of breeze. The sun is not very severe in such climate, but due to high humidity maximum amount of breeze is necessary for comfort

(c) Room sizes

23. Room sizes can be appreciably reduced if attention is given to the position of furniture, and fixtures, sizes and location of doors and windows, etc. Built in almirahs, wardrobes, dressing tables, etc., will also help in the reduction of room areas without effect of crowding.

24. The above remarks are based after studying the room sizes which are usually adopted for ordinary residential buildings in the other countries. It will be interesting to consider the areas

which are considered sufficient for single and double rooms in other countries. The following figures have been taken from the United Nations Social Welfare publication:—

U.K.

50 s.ft	. . . . .	½ person
70 s.ft	. . . . .	1 person
90 s.ft	. . . . .	1½ persons
119 s.ft	. . . . .	2 persons

Children below 12 is considered as ½ person.

Minimum height	. . . . .	8 feet
Window area	. . . . .	10 per cent half of which must be openable.

U.S.A.

Different standards are laid down in the different States of U.S.A. The standards vary as given below:—

60 s.ft. to 120 sft. for a bed room,

Height	. . . . .	7 1/2' to 8'
Window area	. . . . .	10 per cent.

Canada

80 s.ft. for a single room

Height	. . . . .	8'
Window area	. . . . .	10 per cent

Philippines

Single room	. . . . .	75 s.ft.
Double room	. . . . .	107 s.ft.
Height	. . . . .	9' to 10'
Window area	. . . . .	10 per cent.

Sweden

Single room	. . . . .	75 s.ft.
Double room	. . . . .	107 s.ft.
Height	. . . . .	7'-11" to 9'-6"

France

Single room	. . . . .	75 s.ft.
Double room	. . . . .	107 s.ft.
Double bed room with a child	. . . . .	129 s.ft.
Height	. . . . .	8'-2" to 8'-10"

New Zealand

Single bed room	63 s.ft.
Double bed room	100 s.ft.
Height	8' (7' allowed for old houses).
Window area	10 per cent.

Norway

Single room	65 s.ft.
Double room	100 s.ft.
Height	8'-2"

25. Except Philippines and the Southern U.S.A. the other countries have cooler climates than India. Here slightly bigger rooms may perhaps be necessary as compared to the minimum requirements laid down in other cool countries. However, we feel that considering the old size of rooms there is a definite scope of reduction in their sizes, if, as mentioned above, proper attention is given to the position of furniture, fixtures and doors and windows.

26. It is very necessary, when the room sizes are reduced, to provide adequate storage accommodation. Lack of storage space for out of season clothing, razais, mattresses, trunks, bags, equipment for games, bicycles and children's play things etc., etc. will be a serious handicap to comfortable living. Considering this and the standards allowed in other countries we feel that general storage space of 150 cubic feet plus 50 cubic feet per bed room should be provided for each living unit.

27. Over and above this for hanging clothes and keeping the requirements of daily use, minimum storage space of at least 6 s.ft. should be given to each bed room, if the sizes of the rooms are to be reduced.

28. Keeping the number of doors to minimum will increase the utility of the room. Considering it the other way by reduction in the number of doors and regulation in their sizes and position, room size can be reduced without decreasing its utility. An ideal bed room should have one door, and a living room two or at the most three doors.

(d) Floor heights

29. There has been a general feeling that the higher floor height will add to the living comfort of the occupants. This idea seems to be of rather recent origin because the old residences in India have floor heights of 8' to 8'-6" only.

30. Probably the higher floor heights came in use in British times as we find Government buildings with very high ceilings as compared to the private buildings. The basis for establishing the

ceiling heights is obscure, but it is apparent that the air contents of the room has been given considerable significance.

31. When considered from first principles high ceilings can detract from comfort indoors for a number of reasons:—

- (i) The shading of external walls by eaves is reduced. (Unless you provide verandah all round, which is an expensive affair).
- (ii) It is inconvenient to carry window heads to near ceiling level for purposes of ventilation and removal of hot air. (Unless separate expensive ventilators are provided below the ceiling).
- (iii) The winter heating and Summer cooling load is increased by the greater volume of air to be heated or cooled and by the increased heat leakage through the greater area of wall. (In extreme climates winter heating and summer cooling is necessary).

No less important is the cost of the additional materials and labour required to construct the higher walls, and this must be considered seriously with respect to national economy.

32. There appears to be three main conditions to be satisfied when fixing the height of ceilings in dwellings, *viz.*:—

- (i) There shall be adequate headroom in all rooms.
- (ii) The proportions of all rooms shall be such that they will not cause mental discomfort to occupants.
- (iii) The ceiling height selected shall not prejudice physical comfort indoors.

33. When ceiling height is considered in terms of headroom, clearance beneath an adequate lighting fitting is likely to be the limiting factor. In this regard, it is recommended that lighting fittings shall be fixed not lower than seven feet six inches above the floor. The ceiling fan, if provided, should be at least 8'-0" above the floor. This gives minimum floor height of 9'.

34. Regarding the psychological aspect of ceiling height, it does not appear that studies have been conducted to determine a generally acceptable minimum level. Further, it is doubtful that reliable tests could be conducted, since the mental reactions of subjects will be influenced by other dimensions of a room. The unfavourable impression registered by a person entering a relatively small room with a high ceiling is well known.

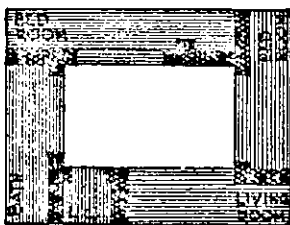
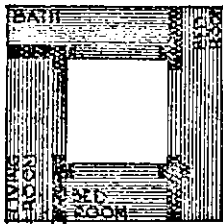
35. A person entering a room having a ceiling of 9, if he is accustomed to higher ceilings, would probably experience a short period reaction, but no permanent mental discomfort is likely to be felt. This view is based upon the normal practice in other countries where the ceilings are even lower than 9'.

36. If the ceiling temperature is higher than the room temperature then to reduce the effect of radiation, desirable distance should be 3' to 4' from the heads of the occupants. This gives the ceiling height between 9 to 10.

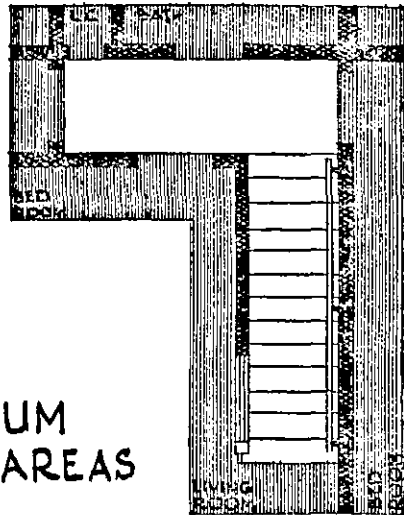
37. Regarding ventilation for healthy and comfortable living the total cubic contents are of very little consequence but the movement of air and the rate of introduction of fresh air into the room are important.

38. The question of ceiling temperature being higher than room temperature, will only arise in case of top floor in multi-storeyed structure, and it has been established that insulation of ceiling is a cheaper proposition than raising the floor heights.

39. Considering all these requirements ceiling height from 9 to 10 depending upon the type of residence and the room size, should be adequate for general requirements in India.

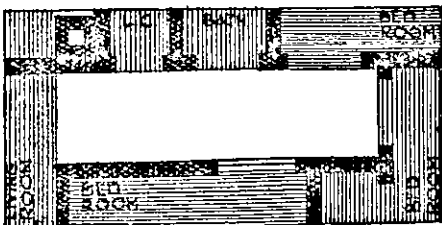


A



D

MINIMUM HALL AREAS



C

HALL SPACE in a small house should be of minimum area. The minimum hall is a square, as in A. In practice a hall for a two-bedroom house must be slightly larger, as in B. C is a minimum hall for a three-bedroom house. Two-story houses require additional space, as in D, to include the stairway. This space may include the basement stair.

(e) Area for circulation

40. Corridors or hall for circulation is necessary to afford privacy and communication between various rooms, especially between living room, bath room and bed rooms. Except for privacy and access it is not a usable space, and for all economy it should not be larger than necessary. The minimum form of a corridor should be approximately square with door openings on its four sides, permitting access to the same number of rooms. A minimum corridor can then give access to two bed rooms, bath and kitchen. The living room also has to be used for circulation in a small house.

(f) Sizes and positions of doors and windows

41. The sizes of doors and windows have to be fixed considering the functional requirements and the climate. The number of doors should be minimum in a house consistent with the requirement of circulation.

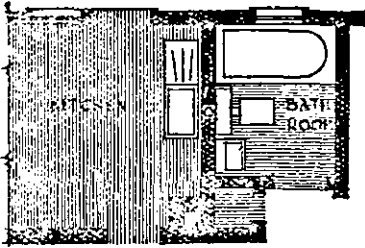
42. The window is required for ventilation and light. In dry hot climate, where sun shines brightly all the year round, small area will give adequate light. In extreme climates direct breeze from outside is not welcome and therefore in such climate smaller windows are required. Window area upto 10 per cent. of floor area is all that is required for comfortable and healthy living in such climates.

43. On the other hand in wet hot climate like that of Bombay, Calcutta or Madras, larger window openings are necessary. Window area of approximately 16 per cent. of floor would be necessary for such climates.

44. For hills, where there is likelihood of clouds and fog, even bigger windows are required, for proper light and good view from the house.

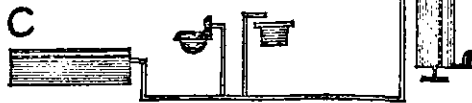
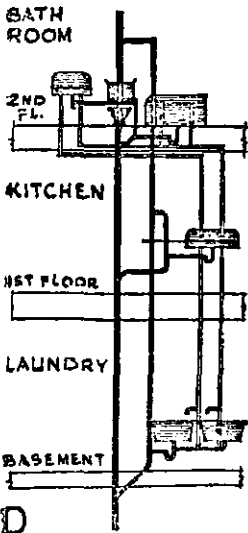
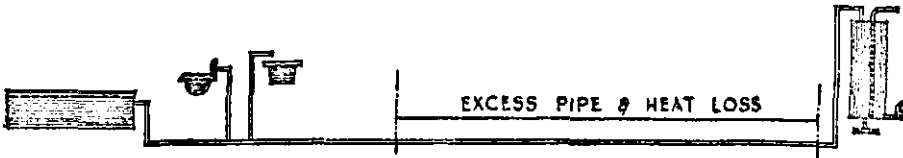
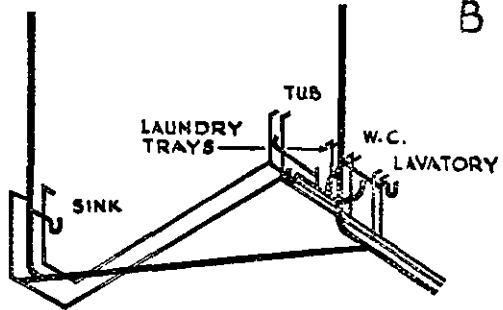
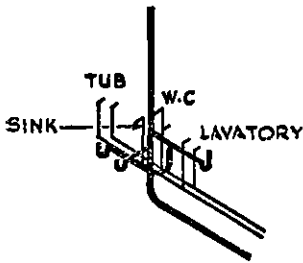
(g) Plumbing

45. Plan arrangement has an important bearing on the cost of the plumbing installation. By concentration of plumbing lines the installation can be made with a minimum amount of labour and materials. In a single storey house this can be accomplished by an arrangement of the fixtures to permit wastes, vents, and water-supply lines to be placed in a partition between the kitchen and the bath room. This requires the use of a minimum amount of pipe and but one soil stack. Where a utility room is used on the first floor, by proper grouping of rooms, concentration of the plumbing lines can be obtained with resulting economies. In two-storey houses plumbing can be concentrated vertically by placing the second storey bathroom over the kitchen and basement plumbing under the kitchen. Plumbing fixtures for economy should be selected on the basis of utility as to size, quality and design.



A

B



ECONOMY IN PLUMBING installation is obtained by locating plumbing fixtures to avoid an excessive amount of piping. A This objective can be obtained by planning the kitchen and bathroom back to back when bath rooms are on the same floor. B If the house contains a utility room which includes laundry trays, this room should be located adjacent to the kitchen and the bathroom. C Location of the hot water storage tank and heater close to fixtures requiring hot water will result in economy of piping, quantity of water used, heat loss from piping, and fuel required to heat the water. D In two-story houses, basement laundry, kitchen, and bathroom should be placed approximately over each other.

46. The sketch on p. 27 illustrates what is stated above.

(h) Other details for comfort in tropics

47. In the tropical climate of India the emphasis should be on the design for comfort. Our climate can be divided into two main categories:—

(1) Dry hot climate like Delhi, Nagpur and Ambala.

(2) Wet hot climate like Bombay, Calcutta and Madras.

48. Dry hot climate will have wide variation between the maximum temperature of the day and the minimum temperature of the night. The humidity will be low all the year round. In wet hot climate the variation between the maximum temperature of the day and the minimum temperature of the night will be small compared to dry hot climates. The humidity will be high for at least 9 months in a year.

49. For comfort in living, following factors deserve consideration:—

Dry hot climate

50. Rooms required for day use should be of heavier construction with substantial heat absorbing capacity, and that for use at night should be of light construction, so that they may not radiate heat at night. The window openings should be as small as possible consistent with the requirements of light and ventilation and may be as low as 5 to 7 per cent. but in no case should be higher than 10 per cent. of the floor area.

51. The roof may be thickened to increase its heat absorbing capacity. Use of mud phuska with brick tiles is quite suitable. It also gives a water proofing course. The floors may be of concrete, bricks or any other material with considerable heat absorbing capacity.

52. Window sills may be higher to avoid glare from the ground which is excessive in dry hot climates.

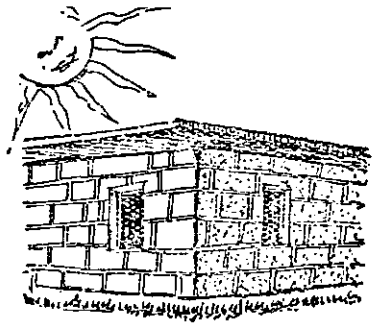
Wet hot climates

53. Heavy construction is not necessary in such climates, as there is very little variation between the day and night temperature. The area of window openings should be higher in such climates and may be round about 16 per cent. of the floor area so as to get more ventilation and breeze.

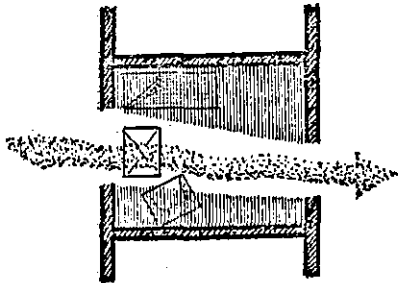
54. Window sills should be low to catch maximum breeze. There should be adequate ventilation in plan as well as section to encourage free movement of air. (See sketch).



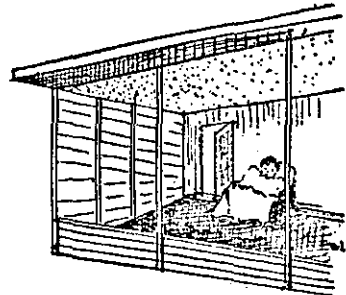
FREE AIR MOVEMENT
ALLEVIATES DISCOMFORT



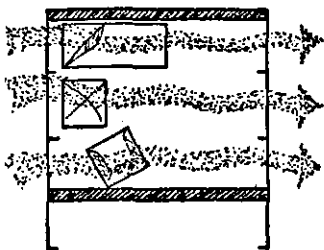
HEAVY CONSTRUCTION FOR
DAY TIME LIVING AREA



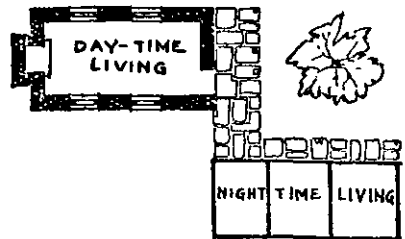
SMALL OPENINGS CREATE
LARGE DEAD-AIR SPACES



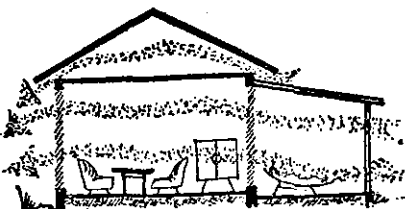
LIGHT CONSTRUCTION FOR
NIGHT TIME LIVING.



WIDE OPENINGS ALLOW
NO DEAD-AIR POCKETS,



THE COMBINED USE OF LIGHT
AND HEAVY CONSTRUCTION,



LARGE OPENINGS ALLOW FREE AIR FLOW

CHAPTER VI

STRUCTURAL DESIGN

The modern approach in the structural design of buildings is to consider the functional requirements of each structural component of a building. Each part, such as a foundation, a wall or a roof has some functions to perform.

2. Cost reduction through the approach of functional requirements can be by the use of new materials, and new methods, which may provide sound permanent buildings. Savings in the materials and labour can be effected with this approach where traditional materials and methods are used.

3. The functional idea is to set forth the requirements in such a manner that they can be fulfilled in many ways. While practised with great success in other industries, it has not been commonly adopted in the production of buildings. In this field the specification idea still prevails, with requirements so specific that they can be met only by the use of materials and construction methods actually described.

4. The functional idea encourages progress; the specification idea tends to retard progress and to perpetuate traditional—some times ancient—ways of building. The functional idea for a given piece of work cannot be expected to replace a definite specification, but it would serve the required purpose with more or less same efficiency. As for example, a smooth, washable dust and vermin proof floors and dados are required in hospitals.

5. Traditional specifications may be glazed tile dados. In the functional approach an Engineer will consider alternative specifications, such as marble chip floors and dados or dados of synthetic materials, which can be executed at a cheaper cost while it will fulfil the functional requirements with more or less the same efficiency.

6. Functional requirements can also assure uniform and intelligent appraisals of different and unfamiliar structures.

7. The idea is to put down in clear terms requirements that are not excessive, not too liberal but realistic. The main structural components in a building can be obtained by variety of structural methods, with multitude of different materials, or any

combination of these. As for example, if the requirements of residence wall are analysed, they will be:—

1. Resistance to compressive loads applied uniformly and concentrated.
2. Resistance to transverse loads uniformly applied inward and outward.
3. Resistance to concentrated loads applied inward and outward.
4. Resistance to impact loads applied inward and outward.
5. Resistance to heat transfer inward and outward.
6. Resistance to sound transfer.
7. Resistance to penetration.
8. Resistance to special lateral loads (earthquake)
9. Resistance to hurricane forces.
10. Resistance to water (rain) penetration.
11. Resistance to fire.
12. Resistance to weathering exposure under conditions of use.
13. Resistance to indentation and abrasion inside or outside.
14. Resistance to termites or other insects.
15. Resistance to fungi or other rot.
16. Reasonable architectural acceptance.
17. Ability to accommodate doors and windows.
18. Ability to accommodate mechanical lines.
19. Ability to connect to other elements
20. Low maintenance.

8. These requirements can be met with either by a brick wall, stone wall, hollow concrete wall or walls of new materials like soil cement blocks or gunite walls. Job of an Engineer will be to select an alternative which may be most economical in a particular locality, most convenient from construction point of view, regarding availability of labour, materials and other local factors.

9. Similarly the functional requirements for roof, floors, doors and windows and other structural parts, can be considered and specification chosen which may be most suitable and economical with respect to given local condition. Perhaps all the requirements may not be fulfilled by certain materials and methods. Balance

will have to be struck between the necessity of satisfying all the functional requirements and keeping the cost of the structure as low as possible.

10. With this approach to the structural design of building, substantial economies can be achieved by studying the potentialities of local materials and traditional methods, as well as considering alternative materials and new methods.

Foundations

11. In case of foundations of ordinary residential building, distinction is necessary between load bearing outer walls and other non-load bearing walls. Appreciable economy is possible in foundations of partitions.

12. It has been observed by actual analysis, that in a well designed double storeyed structure, where special attention has been given to the design of foundations, the cost of foundation and plinth comes to 7 to 8 per cent. of the total cost of the building. On the other hand where such special detailed attention is not given, the cost goes as high as 11 to 12 per cent. in a similar soil conditions.

13. In case of important structures special studies regarding bearing capacity and other properties of soil are necessary if economy is to be effected in the design of foundations.

Superstructure

14. Requirements of a good wall can be met by several alternative materials, which have stood the test of time. The choice of these alternatives will depend upon the local cost of material and the discretion of the Engineer, depending upon the actual requirements of the structure.

15. We have already stated in our second interim report that we are convinced that there is considerable scope for economy in building construction by reducing the thickness of walls. Brick and stone are the materials commonly used for walls and they are very suitable for our conditions and requirements. To avoid the use of excessive thickness of walls and for general guidance of Engineers, it is necessary to lay down thickness of walls in relation to heights and lengths of walls. The table for these thickness for brick walls is given below. These thicknesses cater for normal houses. If very big openings are provided, or there are big spans, stress on brick work should be checked and kept within safe limit. For deep basements thickness of wall may be adjusted for earth pressure.

Storeys above ground	Height above plinth	Length	Basement	Grd Flr	1st Flr	2nd Flr	3rd Flr	4th Flr	5th Flr
1	11'	Unlimited	13½"	9"					
1	16'	Unlimited upto a height of 8 feet	13½"	13½"					
		For the re- maining height		9"					
1	24'	Under 30 ft.	18"	13½"					
2	24'	Under 30 ft.	18"	13½"	9"				
2	24'	Over 30 ft.	18"	13½"	9"				
3	35'	Under 30 ft.	18"	13½"	13½"	9"			
3	35'	Over 30 ft.	18"	18"	13½"	9"			
4	46'	Under 30 ft.	18"	18"	13½"	13½"	9"		
4	46'	Over 30 ft.	22½"	18"	18"	13½"	9"		
5	57'	Under 30 ft.	22½"	18"	18"	13½"	13½"	9"	
5	57'	Over 30 ft.	22½"	22½"	18"	18"	13½"	13½"	9"

16. Notwithstanding the thickness of walls given above, walls may be constructed $4\frac{1}{2}$ " less in thickness than the thickness prescribed if such walls are built with good cement mortar with clean sharp sand and first class good quality bricks, but in no case any such walls shall be less than 9 inches thick for domestic buildings or office buildings and $13\frac{1}{2}$ inches thick for public buildings or buildings of the warehouse class. 9 inches thickness should not be adopted for more than 2 consecutive storeys.

17. This is in concurrence with the recommendations of the Committee of Engineers and Architects appointed by the Government of India, at Delhi, to go into the question of bye-laws of various municipalities and local bodies.

18. There is immediate necessity for revision of bye-laws of different municipalities and local bodies all over the country, as materials and labour are wasted on an alarming scale, by enforcement of their antiquated bye-laws. Momentum can be given to private building activity if action is taken quickly in this direction.

Doors and windows

19. As a material, timber has stood the test of time for use in doors and windows and is universally adopted. Concrete frames have been tried for cheap structures, but due to the unsatisfactory shock absorbing capacity of concrete and difficulty in fixing hinges, they have not been very successful. Their use has been very limited. However, their use cannot be completely eliminated from very cheap type of houses, for doors and window frames.

20. **Steel windows.**—The use of steel windows is increasing rapidly all over the world. Due to comparatively less area taken by frames, smaller steel windows can serve the same purpose as bigger wooden windows. Under the conditions prevailing in India at present, steel windows are not cheaper than teak windows, but when steel windows begin to be manufactured in India, it is probable that they will be able to compete with teak windows favourably. At present their use cannot be advocated for buildings on a mass scale. In special type of buildings they are particularly suitable.

21. Considering the requirements of an ordinary building, there is scope for reduction in sizes of frames and thickness of shutters. Old first class specifications provided 5" × 3" frames for doors and windows. This was reduced to 4" × 3". The sizes of door and window frames should depend upon the size of opening. Smaller frame is required for window than for a door. If the door frames are properly fixed in walls, their size can be reduced to 3" × 3" and window frames to a section of 2" × 2½". Where bars are required to be fitted in a window then section can be increased to 3" × 2". Section for small ventilators may be also 2" × 2½".

22. Regarding door shutters the old specification provides 1¾" thick doors. This was reduced to 1½" thickness. But considering the necessity for economy in ordinary type of building, shutters can be 1¼" thick and window and ventilator shutters may be 1" thick. For first class buildings 1½" for doors and 1¼" for windows may continue.

23. The cost of the door or window is nearly 4 to 5 times the cost of a brick wall. Therefore, necessity of keeping the number of doors to a minimum has already been stressed. Similarly the sizes of windows should also be governed according to the climate and the requirements of individual type of building.

24. **Roof.**—In localities where rainfall is heavy, for quick and efficient drainage, sloped roof is generally adopted. Flat ceiling is provided to these roofs for better appearance as well as for insulation from heat. In localities where rain fall is not heavy flat roofs are used.

25. In recent times, due to high prices of wood, R.C.C. and re-inforced brick work are used extensively for flat roofs.

26. In case of flat roofs rationalisation of live loads for different types of buildings will be one of the important factors towards economy in design.

27. British code of practice has always been conservative in the matter of live load allowances, but there also there has been rationalisation in the matter of live loads, as can be seen from the table given below:—

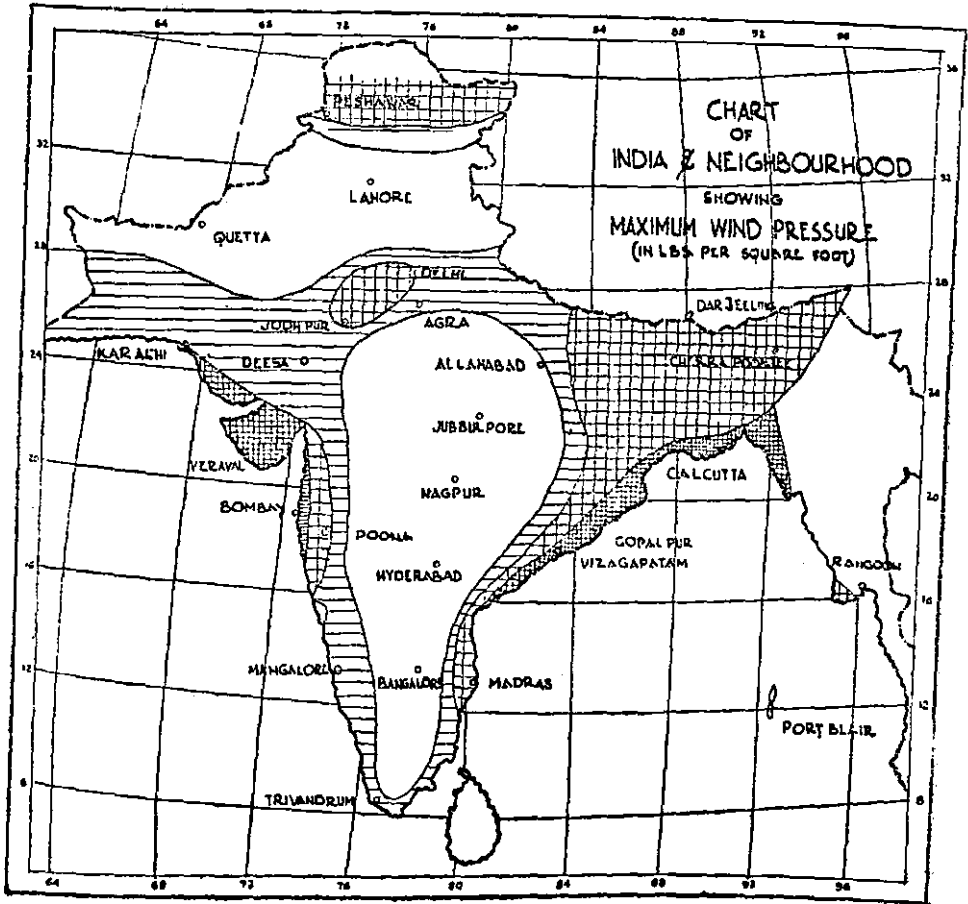
Load- ing class No.	Types of floors	Minimum imposed loads	Alternative imposed loads	
			Slabs	Beams
		lbs. per sq. ft. of floor area	lbs. (uniformly distribu- ted over span) per ft. width	lbs. uniformly distribu- ted over span
1	2	3	4	5
30	Floors in dwelling houses of not more than two storeys designed for one occupation	30	240	1,920
40	Floors (other than those of Class No. 30) for residential purposes including tenements, hospital wards, bedrooms and private sitting rooms in hotels, dormitories	40	320	2,560
50	Office floors above the entrance floor; floors of light workrooms without storage	50	400	3,200
60	Floors of banking halls; office entrance floors and office floors below entrance floor; floors of classrooms in schools	60	480	3,840
80	Shop floors used for the display and sale of merchandise; workrooms generally; garages for vehicles not exceeding 2 1/2 tons gross weight; places of assembly with fixed seating; churches and chapels; restaurants; circulation space in machinery halls; power stations, etc. where not occupied by plant or equipment	80	640	5,120

1	2	3	4	5
100	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for light-weight load; office floors for storage and filing purposes; places of assembly without fixed seating publicrooms in hotels, dance halls, etc.	100	800	6,400
150	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for medium-weight loads; floors of garages for vehicles not exceeding 4 tons gross weight	150	For garage floors only 1.5X maximum wheel load; but not less than 2,000 lb. considered to be distributed over a floor area 2 ft. 6 in. square.	
200	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for heavy weight loads, floors of book stores and stationery stores.	200		

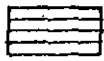
28. These allowances seem to be quite adequate even for the conditions in this country, and the old practice of allowing 50 lbs. for domestic buildings should discontinue. In case of sloped roof, most important items of live load is the wind load. This varies from locality to locality and in the interest of economy right value for the wind load should be taken for design purposes. A map of India is attached showing the wind pressures in different parts of India.

29. The standard Railway practice is to take wind pressures for design of roofs at the following rates on different surfaces:—

Slope of roof	Windward slope of pitched roof (or half of flat roof)	Leeward slope of pitched roof (or half of flat roof)
0°	-1.0	} -0.5
22½°	-0.25	
30°	0	
45°	+0.25	
70° and over	+0.5	



10 LBS PER SQ FT



15 LBS PER SQ FT



20 LBS PER SQ FT



40 LBS PER SQ FT

30. The wind pressure to be assumed on intermediate roof slopes may be interpolated linearly.

31. This seems to be reasonable and has stood the test of time. It is recommended for adoption.

32. In case of R.C.C. roofs working stresses for steel and concrete, which are adopted for the design purposes have a direct bearing on cost.

33. The old working stresses were 16,000 lbs. per square inch for steel and 600 lbs. per square inch for concrete. After considerable amount of experience and research, these working stresses have been increased to 18,000 lbs. per square inch for steel and 750 lbs. per

square inch for concrete in England. In U.S.A. even higher working stresses are adopted. In India there is a tendency to continue the use of lower working stresses. Taking lower working stresses increases the cost of a R.C.C. roof by at least 10 per cent.

34. R.C.C. roof constitutes 20 to 25 per cent. of cost of the building and increase of 10 per cent. in its cost will be a substantial amount.

35. Some concrete structures designed with 18,000 lbs. and 750 lbs. working stresses were tested to destruction and they took nearly 6 to 7 times the designed load. In the R.C.C. beams and slabs there is always some fixity or continuity; moreover, other actual assumptions regarding live loads, wind loads are always on the conservative side.

36. Considering all these factors working stresses of 18,000 and 750 for steel and concrete are recommended. They will give more than 3 for factor of safety.

37. Another important item of cost of R.C.C. roof is the centering. In Delhi the cost of centering comes to Rs. -/8/- per s. ft. Apart from this it slows down the progress of work. Considerable progress has been made in some continental countries especially France and Holland, in the technique of R.C.C. roof construction. Precast and semi-precast type of R.C.C. roofs have been evolved. In a fully precast R.C.C. roof, the roof members are precast in 1' or 1'-6" widths for the full required span. Tee, channel and 'Z' are common shapes.

38. In semi-precast type of roof, tension part of the roof is precast with stirrups sticking out. The compression part of the roof is laid *in situ* after the filler slabs or hollow blocks are laid. The stirrups bind the precast and *in situ* work properly.

39. Semi-precast type has certain advantages over the precast roof as in a precast roof the handling of the precast member becomes difficult due to heavy weight. Its casting and hoisting is also cumbersome. In semi-precast roof the sections are comparatively lighter, moreover, the *in situ* concrete binds all the precast members and the roof becomes monolithic. There are possibilities for development of this type of roof for mass work to achieve economy and speed. Appreciable work of semi-precast roof has been done in Delhi with success departmentally, but the contractors take time before they get accustomed to any new technic.

40. In double storeyed structure for an ordinary cheap type of houses, the R.C.C. slab can be finished smooth while it is laid and laying of another floor subsequently can be omitted. The R.C.C. slabs when smooth will have to be protected with 3" to 4" thick of

earth or sand. After the first floor is finished the sand protection can be removed and the R.C.C. floor would be quite satisfactory. Special attention will be necessary for slopes especially to verandahs balcony, bath rooms, W.Cs. and kitchen.

41. **Floors.**—For healthy and good residence hard floor is necessary. The actual specification of floor will depend upon the availability and the cost of materials in a locality. Hard stone slabs laid in lime and cement mortar or cement concrete floor will serve the needs of most of the residential homes. For superior type of houses marble chip floors or floors with marble slabs can be adopted. Experience has shown that in ordinary houses 1" thick 1:2:4 C.C. on a base of 3" lime concrete or lean cement concrete is quite satisfactory, if proper attention is given to mixing and curing.

CHAPTER VII

CEILING COSTS

Seven standards of accommodation for residential buildings for Government employees have been recommended and a number of suggestions have been made for economy in architectural planning and structural designing. It has also been pointed out that there is further scope for economy through a functional approach to the specifications adopted. It is, however, neither desirable nor economical to lay down a single set of specifications for different structures throughout India. Local requirements can best be catered for by resident engineers, with their intimate first-hand knowledge of the procurement position and rates for different materials and the cost and quality of the labour available. But it is felt that some indication of reasonable ceilings of costs will be helpful for guiding engineers and architects and it is also hoped that this will encourage further studies on how to bring down the costs of various types of buildings, without sacrificing essentials.

Residential Buildings

2. The ceiling costs mentioned in this Chapter have been calculated on the basis of the average rates prevailing in Delhi in 1950, and care has been taken to allow for reasonable standards of specifications for the seven types of residences recommended for Government employees. It has also been assumed that the need for detailed attention to architectural planning and structural designing will be borne prominently in mind by all builders. Coefficients for variations in building cost indices have been worked out for a number of other localities and the ceiling costs at Delhi should be multiplied by the building cost index shown for a particular locality to obtain the permissible ceiling costs for the latter. For example, the ceiling cost for a clerk's quarter (double storeyed) type II (pay range Rs. 55 to Rs. 150) at Calcutta would be $\text{Rs. } 7,250 \times 1.27 = \text{Rs. } 9,207$ or say, Rs. 9,200 in round figures. To allow for contingencies, an excess of 10 per cent. over these ceiling costs may be condoned in special circumstances, at the discretion of the competent authority. Such increase should, however, be fully justified in each individual case. The Committee's view is that generally building executives should be able to keep well within the ceilings as some Government Departments have actually completed buildings at 10 to 30 per cent. below these figures. Reduction in unit costs of single storeyed quarters can be achieved by using mud mortar and weather proof plaster instead of lime or cement mortars in

many localities. In fixing the building cost indices for various stations, weightages have been given separately for the main materials used in ordinary buildings. An idea of these weightages, including allowances for contractor's profit under each item is given below :—

1. Bricks—17 per cent.
2. Sand—7 per cent.
3. Cement—18 per cent.
4. Aggregate—8 per cent.
5. Timber—13 per cent.
6. Mild Steel—10 per cent.
7. Mason's wages—10 per cent.
8. Carpenter's wages—5 per cent.
9. Unskilled labour's wages—12 per cent.

The method used to work out a building cost index is illustrated in the attached sheet, which deals with Ahmedabad. The building cost index of a locality which does not appear in the list attached with this Chapter can be calculated on the same principles, which can also be used to revise the indices shown whenever variations in the costs of these nine items take place.

Ceiling costs for residential building

Class of building	Brief specifications	Plinth area as per recommended standards	Rate
I	2	3	4
		S. ft.	Rs. (per s. ft.)
Type I for class IV servants. Pay Rs. 30-35	Row houses in block of 10 or 12 . B.B. in cement or lime 9" thick walls, plaster both sides, soft wood doors and windows, R.C.C. roofs, concrete floors.	300	7 0 0
Type II Pay Rs. 55-150	Semi detached Specifications slightly superior to type I. Second class teak wood doors and windows and better floors. etc.	625	8 8 0
Type III Pay Rs. 151-300.	Ditto	900	8 8 0
Type IV Pay Rs. 301-600.	Semi detached or detached B.B. in cement mortar, plaster both sides, teak wood doors and windows, brass fittings, marble chips floors in main rooms, R.C.C. roofs, etc.	1,450	10 4 0
Type V Pay Rs. 601-1,150	Same as type IV	2,100	10 4 0
Type VI Pay Rs. 1,151-1,600	Ditto	2,750	10 4 0
Type VII Pay above Rs. 1,600	Ditto	3,450	10 4 0

Ground floor structures.

Cost of building	Add for internal services, water supply, electrical and sanitary fittings, etc.	Proposed ceiling cost	Rent at 1/2 per cent. per month	Average pay per month	10 per cent. of average pay	Ratio between economic rent and recoverable rent
5	6	7	8	9	10	11
Rs.	Rs.	Rs.				
2,100	at 630 per cent.	2,730	13.65	32.5	3.25	4.20
5,312.5	at 1,328.1 per cent.	6,640.6	33.20	102.5	10.25	3.24
7,650.0	at 1,912.5 per cent.	9,562.5	47.81	225.0	22.5	2.12
14,862.5	at 3,715.6 per cent.	18,578.1	92.89	450.0	45.0	2.06
21,525.0	at 5,381.2 per cent.	26,906.2	134.53	875.0	87.5	1.54
28,187.5	at 7,046.9 per cent.	35,234.4	176.17	1,375.0	137.5	1.28
35,362.5	at 8,840.6 per cent.	44,203.1	221.01	2,000.0	200.0	1.11

Ceiling costs for residential buildings

Class of building]	Brief specifications	Plinth area as per recommended standards	Rate
1	2	3	4
		s.ft.	Rs. (per s.ft.)
Type I class IV servants Pay Rs. 30—35	<i>Row houses in block of 10 or 12</i> B.B. in cement or lime mortar, plaster both sides, soft, wood doors and windows, R.C.C. roofs, concrete floors.	350	6 8 0
Type II Pay Rs. 55—150	<i>Semi detached</i> Specifications slightly superior to type I. Second class teak wood doors and windows, better floors, etc. . . .	725	8 0 0
Type III Pay Rs. 151—300	Ditto	1,000	8 0 0
Type IV Pay Rs. 301—600	<i>Semi detached or detached</i> B.B. in cement mortar, plaster both sides, teak wood doors and windows, bras fittings, marble chip floors in main rooms, R.C.C. roofs, etc.	1,550	9 12 0
Type V Pay Rs. 601—1,150	Same as type IV	2,200	9 12 0
Type VI Pay Rs. 1,151—1,600	Ditto	2,900	9 12 0
Type VII Pay above Rs. 1,600	Ditto	3,600	9 12 0

Double storeyed structures.

Cost of building	Add for internal services, water supply, electrical and sanitary fittings, etc.	Proposed ceiling cost	Rent at 1/2 per cent per month	Average pay per month	10 per cent. average pay	Ratio between economic rent and recoverable rent
5	6	7	8	9	10	11
Rs.	Rs.	Rs.				
2,275·0	682·5 at 30 per cent.	2,957·5	14·79	32·5	3·25	4·55
5,800·0	1,450·0 at 25 per cent.	7,250·0	36·25	102·5	10·25	3·54
8,000·0	2,000·0 at 25 per cent.	10,000·0	50·00	225·0	22·5	2·22
15,112·5	3,778·1 at 25 per cent.	18,890·6	94·45	450·0	45·00	2·10
21,450·0	5,362·5 at 25 per cent.	26,812·5	134·06	875·0	87·50	1·53
28,275·0	7,068·7 at 25 per cent.	35,343·7	176·71	1,375·0	137·50	1·29
35,100·0	8,775·0 at 25 per cent.	43,875·0	219·37	2,000·0	200·00	1·20

Statement showing the building cost index of various places, base Delhi 1950 Rates—

Sl. No.	Places	Building cost index
1	Agra	74
2	Ahmedabad	110
3	Ambarnath	95
4	Bagdogra	144
5	Bangalore	106
6	Bareilly	91
7	Bhavani	96
8	Bellary	79
9	Bhopal	77
10	Bhubneswar	109
11	Bina	77
12	Bombay	125
13	Calcutta	127
14	Chittaranjan	96
15	Chola	85
16	Dehra Dun	100
17	Dhubri	115
18	Dibrugarh	142
19	Digwadih	117
20	Dumka	103
21	Gauhati	143
22	Hastnapur	114
23	Hijli	107
24	Hirakud	100

Sl. No.	Places	Building cost index
25	Hyderabad Deccan	102
26	Jaipur	90
27	Jhansi	74
28	Kanpur	102
29	Karnool	85
30	Kharagpur	88
31	Kundla (Kutch)	108
32	Lucknow.	110
33	Madras	99
34	Mettur	84
35	Nagpur	108
36	Nilokheri	95
37	Poona (Khadakvasla).	127
38	Poona (Kirkee).	114
39	Rajkot	94
40	Tatanagar	100
41	Tungabhadra	74

Table showing the calculations of

Sl. No.	Materials	Delhi rates 1950 at site of works	Almudabad rates
		Rs.	Rs.
1	Bricks	33/- per 1000 Nos.	40 0 0
2	Sand 33.3 per cent Badarpur. 66.6 per cent J. Sand	24/- per 100 cft.	10 0 0
3	Cement	4/8/- per cwt.	4 12 0
4	Aggregate 3/4" 50 per cent. 1 1/2" 50 per cent.	37/- per 100 cft.	57 0 0
5	Timber	10/- per cft.	10 0 0
6	Mild steel	23/- per cwt.	22 8 0
	<i>Labour</i>		
7	Mason	4/-	5 0 0
8	Carpenter	4/8/-	5 0 0
9	Coolie	1/12/-	2 0 0

building cost index at Ahmedabad.

Percentages increase or decrease in rate	Weightage	Cost index
$40/33 \times 100 = 121\%$	17	$1.21 \times 17 = 20.6$
$10/24 \times 100 = 42\%$	7	$0.42 \times 7 = 2.9$
$\frac{4.12.0}{4.8.0} \times 100 = 106\%$	18	$1.06 \times 18 = 19.1$
$57/37 \times 100 = 154\%$	8	$1.54 \times 8 = 12.3$
$10/10 \times 100 = 100\%$	13	$1.00 \times 13 = 13.0$
$\frac{22.8.0}{23.0.0} \times 100 = 98\%$	10	$0.98 \times 10 = 9.8$
$5/4 \times 100 = 125\%$	10	$1.25 \times 10 = 12.5$
$\frac{5.0.0}{4.8.0} = 100 = 111\%$	5	$1.11 \times 5 = 5.6$
$\frac{2.0.0}{1.12.0} \times 100 = 114\%$	12	$1.14 \times 12 = 13.7$
		109.5 Say 110.0

Public (or service) Buildings**(a) HOSTELS**

3. Several plans for hostels have been examined in detail and it appears desirable to accept differing standards for post-graduate and under graduate students. Single rooms are recommended for post-graduate students, but in the case of under-graduates, two or more students might share one room in the interests of economy. It is also necessary to watch carefully that the ancillary areas, *viz.*, verandahs, corridors, halls, stairs, common rooms, lavatories, etc., etc., are kept within reasonable limits. Analyses of various hostel plans revealed that such areas vary from 190 per cent. to 350 per cent. of the actual living room areas, while the Committee's studies indicate that 200 per cent., with compact planning, is adequate. Dining room accommodation in such cases need be provided for 50 to 75 per cent. of the students only as it is general experience that meals are usually staggered. Separate reception rooms, reading rooms, recreation rooms and common rooms cannot always be accepted as inescapable and it is suggested that, except in small hostels where an increased *per capita* allowance should be approved about 6 sq. feet per student should provide not uncomfortable community facilities. Imposing halls and wide verandahs with ornate pillars should be avoided while money is tight. A hostel for post-graduate students, designed on a functional basis, would cost about Rs. 3,000 per student at the 1950 Delhi rates, while for under-graduate students, the allowance should be approximately Rs. 2,500 per student. For women's hostel a slightly higher figure is necessary, as extra visitors rooms etc., are required. If hostels are provided for single officers, a much higher cost limit would be necessary. These figures should cover water supply, electricity, modern sanitation and internal fittings, but should exclude the cost of land, levelling and gardening, boundary walls, play-grounds or special foundations, etc. In rural areas where electricity and modern sanitation would normally not be provided, it should be possible to reduce these costs by at least 25 per cent. Hostels for school children, specially in rural areas, where alfresco facilities should be used to the optimum extent, could, of course, be provided at a fraction of these costs.

(b) SCHOOLS

4. It is recommended that two standards should generally be accepted for schools, one for those situated in cities and another for those located in rural areas. Where facilities for basic education are also provided, some extra provision will be necessary. For primary schools, the area per pupil provided in urban areas should be from 10 to 12 sq. feet while in rural localities, where benches and chairs are not used, 6 to 8 sq. feet should be adequate. For nursery

classes, however, larger areas, from 18 to 20 sq. feet per pupil, are recommended. Depending upon the views of those who provide the funds, the cost of primary schools in villages should be within the range of Rs. 50 to Rs. 100 per pupil. In cities, however, this range would have to be raised to Rs. 150 to Rs. 200 per pupil to provide adequate facilities. For basic education, sheds will be needed for carpentry, weaving etc., classes and separate rooms will usually be required for needle work and embroidery etc. In villages, advantage can be taken of clear ground under shady trees, but in cities or where the monsoon is heavy, covered accommodation is necessary and these schools may cost from Rs. 300 to Rs. 350 per student altogether.

(c) COLLEGES

5. It is difficult to fix common denominators for all colleges, some of which will require laboratories and ancillary accommodation on a larger scale than others. For non-technical colleges, designed for degree courses in Arts, Commerce, History, Law, etc., it should be possible to keep the cost per student within the range of Rs. 400 to Rs. 500. For technical colleges, however, the cost would be considerably higher and a range of Rs. 2,000 to Rs. 2,500 per student should be accepted. A college for Nursing would be intermediate between these two and it is considered that a ceiling of Rs. 1,500 per probationer is reasonable. For Medical Colleges, however, additional expense will have to be faced and a range of Rs. 4,000 to Rs. 4,500 per medical student should be accepted. In each of these cases, the costs of land and its development as well as external services have been excluded.

(d) HOSPITALS

6. Depending upon the purpose for which the hospital is provided and the extent of the facilities required for out-patients, it is not considered that Rs. 7,000 per bed is excessive for a modern hospital with all amenities. In smaller cities and large villages, it might be possible to reduce this figure by 50 per cent. to 60 per cent. but much depends upon the services that the hospital is designed to provide.

CHAPTER VIII

ADMINISTRATIVE AND EXECUTIVE PROCEDURES

Factors concerned with administration and execution of works which have a direct bearing on building costs can conveniently be dealt with under four headings :—

- (i) Planning and Designing.
- (ii) Execution of works, including calling of tenders, awarding works, checking measurements, and making payments for the works.
- (iii) Contractors or Agencies, which arrange materials and labour and carry out the actual construction of buildings.
- (iv) Supplies of Building Materials.

2. Planning and Designing—The Committee has discussed in detail in Chapters V and VI the points which require special attention in architectural planning, structural designing and a functional approach to specifications. It cannot be too strongly emphasised that good and economic planning requires adequate time and cannot be hurried. The execution too should not be unduly rushed and, for all large projects, it is recommended that the provision of non-lapsing funds, which can be carried over from one financial year to another as is considered necessary in the best interests of the work, should be the rule. The fear of grants lapsing by a particular date is often responsible for economy being sacrificed and works rushed to completion, sometimes to their technical detriment.

The practice of designing over-safe structures is still common in many Government departments probably for the following reasons :—

- (a) Lack of upto-date knowledge regarding modern developments in the science of building construction.
- (b) Too liberal an allowance for poor workmanship and short-falls in quality of materials.
- (c) Margins for inadequate or incompetent supervision.
- (d) Hesitation in permitting maximum working stresses due to uncertainty about the quality or uniformity of materials.
- (e) Safeguard against unforeseen failures of completed structures due to poor facilities for testing models and prototypes.

This costly tendency to allow unduly high factors of safety can be overcome by associating imaginative and competent architects and engineers with all major building projects and arranging for reliable inspection of materials and workmanship. Sound and cost-minded inspection should be always available and it is false economy to reduce the skilled and expert supervision that should watch over a building project on behalf of the payer.

3. **Execution of works.**—Most Government departments have standard types of tender documents, work orders, etc., which are suitable for different types of work. These usually cater for lump sum contracts, percentage contracts, item rate contracts and piece work contracts and have, on the whole, worked well for many years. There is no necessity to change these procedures, where they are working satisfactorily, but executive authorities should be receptive to new ideas and should be prepared to adopt other practices which indicate scope for economy. For example, preliminary quotations might be invited from contractors of repute for important and special projects and negotiations carried out on the basis of the most favourable offers before finalising the contract. Very often a flexible procedure of this kind pays better dividends than the rigid and inelastic open tender system, under which cartels and associations sometimes “gang up” on Government departments. In the private sector of industry the largest and best run organisations often adopt this practice as standard.

On account or progress payments are usually made fairly promptly by most Government departments but there are frequently undue and quite unjustified delays in making final payments. Continuous attention at the highest level is necessary to avoid delays in payments as these must always tend to increase the total cost of the project. The Committee estimates that in some cases 10 to 15 per cent. savings can be effected by prompt payments. It is considered that a desirable target would be to fix 90 days as the time-limit, after the satisfactory completion of a work, within which the final settlement of the contractors' dues should be made, unless otherwise provided in the agreement. If delays beyond 3 months period are not condoned without a full explanation from the officer responsible, it is felt that much benefit would accrue to Government in the long run. The Committee feels strongly on this point and considers that just as promptness in execution of projects is a factor in judging an engineer's competence, similarly promptness in completing payments should be a major factor in judging the competence of paying authority and a reference to this feature might be included in the officer's annual confidential report.

Some delays in setting up final bills for works are also due to the elaborate and cumbersome procedures summarised by the popular term 'red tapism'. These vary in different Government departments and range from trivial and piece-meal objections in accounts offices to major alterations in the terms and conditions of agreements after the work has commenced by the engineer. Constant vigilance should, therefore, be exercised by superior officers in all such procedural matters if over-all economy in building projects is to be achieved.

Shortages of materials or of labour, or an imbalance between the two and the quantity of work actually undertaken, are also important factors which lead to higher costs. Foresight and good organisation before a work is commenced and the use of production planning techniques during its execution have led, in Europe, to substantial savings in unit costs of buildings as well as over 15 per cent. increases in the rate of progress of building construction.

4. Contractors.—All contractors are primarily businessmen influenced by the same factors as other industrialists in the private sector. Penalties for defaults and incentives and rewards for good and economic work can with advantage be introduced into the relationship between Government departments and their building contractors. Penalties might take the form of temporary bans, or permanent black-listing in serious cases of defaults, while rewards could include steady work and repeat orders which would benefit both contractors and Government departments by providing steady employment and uniform flow of production at economic costs.

5. Supply of materials.—Timely supply of materials in suitable quantities avoids idle time of labour and has an important bearing on building costs. During the present scarcities and controls, the practice of arranging supplies of steel, cement, asbestos sheets, etc., departmentally, is unavoidable, but this list should be kept to a minimum and contractors should be encouraged to supply all materials that are available in the open market, as this procedure eliminates the need for expense on departmental storage etc. Building materials that have to be imported generally require special steps. When such items are wanted in appreciable quantities by a number of different departments, it will usually be found advantageous to collect indents through a suitable central organisation and arrange bulk supplies for subsequent distribution to the various consumers. Where, however, items special to particular projects or peculiar to one regular consumer are concerned, it is generally more economical and quicker for the project or the consumer to make its own arrangements.

The Committee, during the course of its work, has studied many claims made on behalf of synthetic and processed materials, some of which are the by products of other industries, for achieving economy in building construction, usually through the use of such material for prefabricating houses at a central depot. Under present conditions, the Committee feels that prefabricated units manufactured from such materials have a very limited scope in India however satisfactory they may have proved to be in certain parts of other and more highly industrialised countries. Traditional building materials offer greater possibilities for economical building in this country, but there is margin for further lowering of costs through the adoption of standard precast concrete units, mass-produced under carefully controlled conditions for large housing schemes. Some "original" and uncommon building techniques have also been examined but the Committee has not been convinced that any of them are more economical, under the normal conditions prevalent in most parts of India, than the building methods in general use today. There is a tendency for "salesmen-inventors" to look upon Government organisations as happy hunting grounds for their wares whereas they generally fight shy of commercial organisations which invariably employ experts to examine such claims carefully before conceding the new technique a footing. The Committee feels that a warning against dissipation of Government's limited resources on such new and unproved techniques is necessary and recommends that the same careful scrutiny, amounting to a pre-audit by experts, should be applied in such cases as in the case of a new medicine which the inventor may claim to be a sovereign remedy. For economy in building, reliance should be placed on imaginative and expert planning, careful cost minded execution from the start to finish and prompt payment on the completion of the project.

F. C. BADHWAR.
H. WILLIAMS.
B. S. PURI (convenor).

C. B. PATEL, Secretary.

APPENDIX 'A'

Questionnaire

1. Name of Building and location:—
Constructed in the
year
for
2. Specification:—
 - (a) Foundation:—
Depth and details regarding thick-
ness and type of concrete, etc.
 - (b) Plinth:—
Height, and type of masonry, etc.
 - (c) Superstructure:—
Height of floor, thickness and type
of walls, etc., etc.
 - (d) Doors and Windows:—
Thickness and specification, type
of wood and fittings, used
 - (e) Floor:—
Thickness and the specification
adopted
 - (f) Roof:—
Type of roof used and its brief
specifications
Whether water proofing course is
used or not in case of flat roof
 - (g) External and Internal finishing:—
Details regarding plaster, pointing,
etc.
3. (a) Plinth area
(b) Carpet area
(c) Area under verandah, corridors
and passages
4. Completion cost of building portion
only without services (water supply,
electricity, etc.) excluding depart-
mental charges
5. (a) Approximate time taken for the
construction
(b) Whether usual transport facilities,
which are available in cities, were
available on the work or not.
(c) General remarks regarding quality
of work, and workmanship
(d) Any other useful information re-
garding work, which you may think
fit

6. Average rates of materials and labour
at site during construction:—

- (a) Bricks
- Size
- (b) Sand
- (c) Cement
- (d) Stone chips-gauge
- (e) Timber:—
- (i) Hard wood
- (ii) Soft wood
- (f) Mild steel

Labour—

- (a) Mason
- (b) Carpenter
- (c) Coolie

NOTE.—If any non-traditional type of construction is adopted, your opinion regarding durability and usability of such construction, as compared with the traditional type of house, will be appreciated.

APPENDIX 'B'

List of places visited by the Secretary, Committee of Experts for Building Works

1. Shakur Basti Research Station of Railway Board.
2. Bareilly (Clara Swain Hospital).
3. Bombay.
4. Poona.
5. Ullhas Nagar (Near Kalyan).
6. Bulsar.
7. Vallabh Vidya Nagar.
8. Nadiad.
9. Ahmedabad.
10. Roorkee.
11. Dehra Dun.
12. Kanpur.
13. Lucknow.
14. Calcutta.
15. Tata Nagar.
16. Kharagpur.
17. Hijli.
18. Chittaranjan.
19. Dhanbad.
20. Digwadih.
21. Sindri.
22. Ambernath.
23. Hyderabad Deccan.
24. Madras.
25. Bangalore.
26. Kolar.
27. Pawai.
28. Khadakvasla.
29. Kirkee.
30. Hirakud.

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APPENDIX 'C'

Statement giving details of projects scrutinized by the Committee with the results of scrutiny.

	Admini- tratively approved amount	Revised figure after implemen- tation of Com- mittee's sugges- tions	Saving	Percent- age reduction in cost	Remarks
	2	3	4	5	6
1. Martne Engineering College, Calcutta. (Ministry of Commerce).	Rs. 46,51,000	Rs. 33,69,900	Rs. 12,81,100	27.5%	About 15 per cent reduction was due to rationalization of the standards of accommodation, and the rest was due to change in structural details and specifications.
2. The Poor Class Qtrs. (Delhi Improvement Trust).	9,37,344	7,56,912	1,80,432	19.3%	Standard of accommodation was not reduced. Saving is due to attention to specifications and structural details.
3. Indian Institute of Technology, Hiji (Kharagpur).					
(a) 'C' type Qtrs. 45 Nos.	3,57,425	3,13,425	54,000	14.7%	Standard of accommodation was not reduced. Saving is due to rationalization of specifications.
(b) 'H' type Qtrs. 68 Nos.	3,80,800	3,12,800	68,000	17.8%	Do.
(c) Bungalows 'B' type 14 Nos.	2,74,400	2,53,400	21,000	7.7%	Do.
4. Office building for A.G. Allahabad.	3,71,000	2,72,650	98,350	26.5%	Even though saving has been nearly 1 lac by proper designing carpet area has been increased to 22,000 sft. from 17,000 sft. in original proposal.
5. Lady Hardinge Medical College and Hospital. (New Nursery, Anti-Natal and Labour Room).	1,50,000	1,02,117	47,883	31.9%	Saving effected due to rational architectural planning.
6. College of Nursing at New Delhi.	20,94,200	14,12,300	6,81,900	32.5%	Saving effected due to rational architectural planning.
7. Delhi School of Economics.	4,56,000 (Proposed)	3,36,000	1,20,000	26.3%	Do.
8. Hostel for P. & T. Training Centre, Jabbalpur, 252 students.	10,67,000 (Proposed)	8,13,000	2,54,000	23.8%	Do.
	107,49,160	79,42,504	28,06,665	26.1%	Average