



REPORT
ON
RESIDENTIAL BUILDINGS

COMMITTEE ON PLAN PROJECTS
(Buildings Projects Team)
NEW DELHI
July 1961

Composition of the Team for Selected Buildings Projects.

Leader

Shri S. K. Patil, Minister for Food and Agriculture.

Members

Shri Sarup Singh, I.S.E., (Retd.), formerly Director, National Buildings Organisation.

Shri N. G. Dewan, I.S.E., Chief Engineer, Central Public Works Department.

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Dr. Eng. A. Carbone, Consulting Engineer, Calcutta.

Shri C. P. Malik, Director, National Buildings Organisation (*ex-officio*).

Member Secretary

Shri T. S. Vedagiri, Superintending Engineer.

**MINISTER FOR
FOOD AND AGRICULTURE,
New Delhi, January 10, 1961.**

My dear Chairman,

I have great pleasure in forwarding the report of the Selected Buildings Projects Team on Residential Buildings. You will recall that this was one of the major items of study taken up by the Team. Since the outlay on Residential Buildings is substantial, the Team considered it worth while to evaluate certain building projects with a view to minimise the cost of construction commensurate with reasonable living standards so that many more could be given the benefit of accommodation within the limited resources available. The Team set up a Panel of Engineers and Architects for the purpose, under the Chairmanship of Sardar Sarup Singh, I.S.E., (Rtd.), Member-Chief Engineer of the Team. The Panel studied in detail a few selected housing projects put up both in private and public sectors in Madras, Bhopal, Bombay and Bhilai. Many other plans relating to housing colonies were also reviewed.

On the basis of this study, the recommendations contained in this report have been evolved. The Panel observed that there have been wide variations in standards. It has, therefore, laid down certain norms for effective space utilisation and standards and specifications for economical construction. The report includes recommendations on every aspect of building technique such as lay-out, orientation, space utilisation, use of materials, methods of reducing cost of construction, amenities and fittings, organisation, foundation in different soils and construction in different regions including earth-quake regions, etc.

One of the important recommendations, is regarding standards of accommodation for different categories of Staff. The recommendation envisages a saving of 44 per cent. in the element of subsidy and 11 per cent. in the capital costs over standards obtaining at present for Government Construction in Delhi.

With these recommendations given by the Team regarding all essential aspects of residential buildings, I am confident that the Government will be able to realise greater benefit for the money spent on this sector in this and the future Plans. The Team is glad to endorse the views of the Panel and is grateful to them for their valuable recommendations contained in the report.

I take this opportunity of thanking the authorities of the Public and Private Sectors for their co-operation in supplying information required by the Team and for the facilities that they have afforded for site studies and discussions.

Yours sincerely,
S. K. PATIL.

**Chairman,
Committee on Plan Projects,
Government of India,
New Delhi.**

REPORT ON RESIDENTIAL BUILDINGS

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INTRODUCTION

0.1. In the Second Five Year Plan about Rs. 200 crores was provided to be spent on residential buildings alone—a very substantial outlay. In the Third Five Year Plan the outlay is expected to be still larger. Wide variations have been observed in the lay-outs, scales of accommodation and specifications. Even after making due allowance for local conditions, the cost variation from project to project and from department to department is much too much. It is obvious, therefore, that rationalisation in design and uniformity in specifications will result in sizeable saving in the cost of residential buildings.

0.2. With a view to achieving economy in building construction on rational lines, the Committee on Plan Projects constituted the Buildings Projects Team to carry out evaluation of selected building projects and lay down norms and standards. The Buildings Projects Team in turn set up a Panel of experts for the study of the problem. Its composition is given below:

(i) Sardar Sarup Singh, ISE (Retd.), Member-Chief Engineer, Buildings Projects Team	<i>Chairman</i>
(ii) Shri E. A. Nadirshah, Concrete Association of India, Bombay	<i>Member</i>
(iii) Colonel H. C. Vijh, Chief Engineer, Balmer Laurie & Co. Ltd., Calcutta	<i>Member</i>
(iv) Shri R. W. Wilson, Director (Standardisation), Railway Board, New Delhi	<i>Member</i>
(v) Shri K. N. Subbaraman, General Manager (Construction), Hindustan Steel Ltd., New Delhi	<i>Member</i>
(vi) Shri R. L. Gehlote, Senior Architect, C.P.W.D., New Delhi	<i>Member</i>
(vii) Shri M. S. Bhatia, (formerly Housing Adviser, Min. of W.H.&S) Additional Chief Engineer, C.P.W.D., New Delhi	<i>Member</i>
(viii) Prof. G. S. Ramaswamy, Assistant Director, Central Buildings Research Institute, Roorkee.	<i>Member</i>
(ix) Shri N. B. Shroff, Architect to Ministry of Railways, New Delhi	<i>Member</i>
(x) Shri Fayazuddin, Chief Town Planner, Government of Andhra Pradesh, Hyderabad.	<i>Member</i>
(xi) Shri T. S. Vedagiri, Superintending Engineer and Secretary, Buildings Projects Team.	<i>Member Secretary</i>

0.3. When the Panel's work was in progress, Shri Wilson and Shri Gehlote retired from service and in their places Shri D. N. Chopra, Director, Standards (Civil) Railway Board and Shri S. R. Yardi, Senior Architect C.P.W.D. took over as Members.

0.4. We have devoted considerable time to on-the-spot study of the housing colonies put up by various agencies, both public and private. The Projects that have been visited are listed below:—

- | | | |
|--------|----------------------------------|--|
| Madras | (a) Lower Bhavani Sagar Project. | |
| | (b) Neiveli Lignite Project. | |

- (ii) Bhopal (a) Tantia Topi Nagar.
(b) Heavy Electricals Project.
- (iii) Bombay (a) Air India International Colony, Santa Cruz, Bombay.
(b) M.E.S. Flats at Colaba.
(c) Railway Flats at Bhadwar Park.
(d) Income Tax Officers Flats at Peddar Road.
(e) Flats for Reserve Bank Officials.
- (iv) Bilai Residential Buildings of Bilai Steel Project.

0.5. During their visits, the Panel held discussions with the local officers on the merits of the types adopted. The report is the result of the case studies, observations and discussions.

APPENDIX I (Para 2.1.2)

Statement showing monthly subsidy for the different types of quarters in the various projects

Scale of Pay	Below Rs. 60	Rs. 61 to Rs. 250	Rs. 251 to Rs. 600	Rs. 601 to Rs. 1200	Rs. 1201 to Rs. 1800	Above Rs. 1800	Total subsidy per month for 100 Qrs.
1	2	3	4	5	6	7	8.
Average percentage of the various types of Quarters.	26·1	52·2	15·2	5·9	0·4	0·2	—
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1. Heavy Electrical Project, Bhopal	333	802	266	—	—	—	1401
2. Integral Coach Factory, Madras	228	640	473	119	24	—	1484
3. Hindustan Steel Project, Bhilai	800	1588	510	76	—	—	2974
4. Hindustan Steel Project, Rourkela	377	774	422	110	35	—	1718
5. Nangal Fertilizers, Nangal	333	1044	174	122	2	—	1675
6. Central P. W. D., New Delhi	253	988	601	264	8	—	2114
7. According to Standards laid down by Railways	153	1142	304	121	—	—	1720

Note : The subsidy has been worked out on the basis of average pay of different categories.

APPENDIX II

1. Statement of subsidy as per existing accommodation in Delhi

Sl. No.	Description and Pay range	Percentage of Quarters	Subsidy per month Rs.
1	2	3	4
1.	H-Type — up to Rs. 110/-	26.1	215
2.	G-Type — Rs. 110/- to 209/-	26.1	480
3.	F-Type — Rs. 210/- to 319/-	26.1	497
4.	E-Type — Rs. 320/- to 589/-	14.5	284
5.	DII-Type — Rs. 590/- to 839/-	6.2	296
6.	DI-Type — Rs. 840/- to 1099/-	0.4	21
7.	CII-Type with Servant Quarters and Garage. — Rs. 1100/- to 1499/-	0.3	16
8.	CI-Type with Servant Quarters and Garage — Rs. 500/- 1999/-	0.2	8
9.	A & B Type with Servants Quarters and Garage — Above Rs. 2000/-	0.1	2
TOTAL			1,819

2. Statement of subsidy as per accommodation recommended by the panel-

1.	Type I — Below Rs. 110/-	26.1	248
2.	Type II — Rs. 110/- to 250/-	26.1	427
3.	Type III — Rs. 251/- to 400/-	28.0	211
4.	Type IV — Rs. 401/- to 800/-	18.8	127
5.	Type V — Rs. 801/- to 1600/-	0.7	6
6.	Type VI — Rs. 1601/- to 2,250/-	0.2	—
7.	Type VII — Above Rs. 2500/-	0.1	—
TOTAL			1,019

APPENDIX III

An extract from the Report of Committee of National Buildings Organisation on Foundation in Black Cotton Soil'

While the Committee feels that in its present stage of investigations it is not in a position to give firm recommendations regarding construction of buildings in black cotton soil, the following general principles of design can be enunciated on the basis of the studies so far made of the methods adopted in this country and elsewhere.

The soil in the locality should be investigated completely and a report prepared.

Where the depth of the black cotton soil is shallow, it might be necessary to carry foundations to the inert-soil below the black cotton stratum. While judging the inert nature of soil for founding the structure, mere colour should not be taken for guidance as it is found that even yellow soils met at that depth below B.C. Soil layers exhibit swelling and shrinking properties. The footings may be either continuous footings or of pier on pillar and beam or arch construction. Where the black cotton soil is deep, the footing depth should, wherever practicable, be below the zone of seasonal moisture change (which may extend up to about 12 ft. in some parts of the country) especially for buildings that cannot tolerate any movements. It is cautioned that even this depth may not be sufficient since clays are sometimes desiccated by average climatic conditions to depths far greater than those reached by seasonal variations. In such cases a structure which changes moisture equilibrium over a large area adjacent to it, may cause slow swelling of deep layers with consequent heaving of footing.

In many cases it is impractical or uneconomical to take footings down to soil that will not expand. Under such circumstances the footings may be placed at a higher level, say 5 to 6 ft. below ground level, but the footing pressures may be kept high enough to impede expansion. While it is impractical to design the footing to counteract entirely the expansion pressure the latter is very much reduced if slight expansion is permitted. Thus, if the building superstructure is of a relatively flexible nature and if small movements can be tolerated, a smaller depth than 12 ft. can be considered. Traditional practices of providing rubble filling under foundations and floors and constructing superstructure in coursed rubble in mud or lime mortar provides a certain measure of flexibility.

The Foundation pressure for Dead Load only should not be less than the swelling pressure of the soil where saturated, which is to be determined experimentally. Simultaneously there should be an adequate factor of safety against plastic failure.

The interior footings can be put at shallower depths than the exterior, or can have lighter unit loads if at the same depth. If construction is done where the soils are dry, interior depth and loading conditions should be the same as for the exterior.

It is not practicable always to transmit high pressures by means of continuous strips. The load from the building is then transmitted through masonry pillars or through bored piles which may be under-reamed where necessary. Such piles or pillars may be insulated from the surrounding soil by surrounding them with granular non-cohesive material.

Where the load is transmitted through columns or piers, the superstructure is carried on grade beams resting on these columns. The beam is necessarily placed close to the surface of the ground. It is a good practice to avoid contact of these grade beams with the soil to prevent action of swelling soil on the beam. It is best to have the space between the grade beams and the ground surface empty with a dwarf wall protection on the two faces to prevent entry of materials. This is only a palliative and does not always prevent development of stresses in beams due to swelling of the soil. These beams are designed taking the composite action of the masonry wall coming over it. Design of these beams will be indicated in a subsequent report.

When continuous strip foundation is used, it is sometimes usual to provide reinforced cement concrete bands at plinth level and at lintel level. Design of these bands is empirical and at best they serve only as crack control measures. These beams may be reinforced both at top and bottom. Empirically, the total reinforcement may be kept at $1\frac{1}{2}\%$ of the area of the section for both the layers together.

Raft foundations require careful calculation and have proved successful.

Considering the high cost of foundation of buildings, in black cotton soil, it is uneconomical to construct single storeyed buildings in such areas. Double storeyed buildings not only distribute the cost of foundation over twice the floor area, but also assist in increasing the foundation pressure, to contract the swelling pressure. It was observed that in several areas with identical designs of foundations, the single storeyed buildings suffered greater damage than the double storeyed structures.

The excavations for footings of foundations should not be allowed to become excessively dry, or excessively wet, so as to lose its shear strength. On the other hand undertaking construction during the dry season and completing it before the on set of monsoon has proved successful.

The effects of moisture changes in active soils below the floors can be vertical movements of the order of several inches and such movements are also non-uniform over a large floor area. Design and construction measures to eliminate or minimise such effects should include:—

- (a) removal of as much active soil as practicable.
- (b) replacement by fill of inactive soil properly compacted.
- (c) completion of fill to floor level with properly compacted inactive soil.
- (d) separation of floor slabs from contact with walls, footings, etc.
- (e) support of floor slabs on flexible base such as boulder filling etc. which can provide relief against upward expansion pressures.

- (f) floors suspended from the grade beams in the pile or pier and beam construction are the ideal method of construction, but these are expensive.

Sometimes ponding the area under the floor to an optimum condition before or after the foundations have been constructed is practised. In such cases the soil is allowed to get wet and to swell before the fill is placed. A good judgment is, however, necessary to see that the soil does not swell excessively and soften to such an extent as on reconsolidation will lead to its settlement under the weight of the floor and the fill.

A commonly used specification to interrupt the capillary rise into the fill is by making the bottom one or two feet of fill of clean granular material, continuing upward with cheaper local material and finally topping off with cheaper local material a course of sand at least 8" in thickness just below the floor. In such cases the local soil should be compacted to at least 90% of the optimum density and at 2 or 3% higher than the optimum moisture content. While compacting these fills special precaution must be taken to avoid failure of external walls which might act as retaining walls for this purpose.

The dessicating action of fast growing trees in the vicinity of buildings should be taken into account while planting of trees is done near a newly constructed or existing building on active soils. Similarly removal of trees from the vicinity of buildings and covering up large areas near the building with pavements or starting extensive gardening operations near the building, should be done after careful consideration of their effects on the moisture movement towards and from the building area.

In the case of boiler rooms, hot process units, etc. measures should be taken to prevent the heat from furnaces, including use of insulating materials, provision of air space, forced or natural ventilation, use of cooling water and even carefully regulated irrigation of the surface clay to prevent its drying out.

The racking consequent upon the movement of soil can sometimes be very wide and there is often a tendency to insist on immediate repairs which involves filling the cracks with mortar. This is often a mistake. Cracks of this nature are seasonal and they tend to close in the wet season. The immediate filling of cracks with dense mortar will therefore result in building up of high compressive stresses when the reverse movements take place. It is therefore essential that in such cases before any repairs are attempted the matter should be investigated by a soil engineer. Repair measure may include under-pinning and removal of contact between soils and grade beams in the case of pillar and beam construction, correction of drainage conditions, location and repair of water leaks, establishment of evaporation barriers; alteration of thermal gradient by increasing the paved areas round the building or decreasing it as necessary; and a variety of other operations followed finally by structural repairs.

APPENDIX IV (Para 4.6.2.)

An extract from article in the Journal of National Building Organisation dated October, 1958 by Dr. M. L. Puri & N. R. Srinivasan of Central Road Research Institute, New Delhi.

Mostly Surkhi is prepared by powdering bricks. There has been a great confusion about the degree of burning bricks to get reactive Surkhi. Some laboratories reported that under-burnt bricks gave better results, some recommended use of over-burnt bricks, while some others advocated the use of normally burnt bricks. No one studied the fundamentals of the problem to know the reasons for such variations in the results. The Central Road Research Institute, New Delhi has been engaged upon this problem and their findings can be summarised as below:—

(1) The degree of burning is a function of the mineralogical composition of the clay. Generally mentmerilonite type of clays show their maximum reactivity after being burnt at a temperature between 600° and 800° C. The kaolin and illite types may require higher temperatures of about 800° C and 1000° C respectively.

(2) Impurities like free iron oxide have profound influence, both on the pozzolanic activity and the optimum temperature of burning.

(3) There seems to be a close relationship between the maximum pozzolanic activity and the temperature at which collapse of the clay's lattice structure takes place. Heating either above or below this temperature does not bring out the maximum activity of the pozzolana.

(4) Materials, even though in a fine powder, if found to consist of well developed crystalline structure, will not behave as good pozzolanas.

(5) Pozzolanic activity seems to depend upon the presence of partially decomposed and highly disordered clay structure or a large percentage of the oxides of silicon, aluminium and iron in a very fine state and poor crystallinity as got from clays after the collapse of their structure. Further heating beyond this decomposition point will result both in the improvement in crystallinity and size and also in the disappearance of internal strain in the lattice, thus affecting the growth of stable crystals with poor pozzolanic activity.

(6) The practice of making surkhi from bricks cannot yield surkhi of a high quality since bricks are generally made from loamy soils that contain a high percentage of inert material. The soil for making surkhi should be more clayey and rich in clay minerals which give out the active components on heating. But all clays cannot yield good surkhis. Much depends upon the exact mineral composition and the structural aspects of the clay and the burnt product.

This work has provided the Indian Standards Institution with a good basis for drafting the specification for surkhi which is expected to be finalized shortly.

The exact mechanism of the pozzolanic reaction is still not definitely known. While further research is required to know answers to so many questions, the work already carried out is sufficient to form a basis for the proper selection and burning of the material to produce high grade pozzolanas.

APPENDIX V (Para 4.9.1.)

An extract from the National Buildings Organization, Technical Information Series-14 on Termite and Termite Proofing.

Damage to structures of buildings by termites, specially in the tropics, is considerable. Termites can be divided into two types on the basis of their habitat, viz. (1) the ground inhabiting or subterranean termites and (2) the drywood termites.

A termite colony consists of a pair of reproductives, the so-called king and queen and a large number of sterile workers and soldiers. If, however, the queen is lost or destroyed, her place is taken by a number of supplementary reproductives, thus even by removing the queen, the colony will not be destroyed.

Once termites find a suitable foothold in or near a building, they start spreading slowly from a central nest through underground and over-ground galleries in the case of subterranean termites and galleries within the structural member, once they get direct access to them, in the case of drywood termites. The food of the termite is cellulosic material like timber, grass, stumps of dead trees, droppings of herbivorous animals, paper, etc. In their search for food they bypass any obstacle like concrete or resistant timber to get at suitable food several feet away.

The following conditions are favourable to the growth and spreading of termites:-

- (i) Moist warm soil containing abundant food in the form of wood or other cellulosic material.
- (ii) Timber members of a building in direct contact with the ground.
- (iii) Use of non-resistant and or untreated wood. (A large portion of timber now sold in the market has a high percentage of sapwood and therefore is attractive to termites).
- (iv) Cracks and voids in foundations and floors which make it easy for termites to reach wood that is not otherwise in contact with the soil. Apparently termites sometimes do penetrate concrete. This is more due to the fact that termites in their search for wood are able to find weak spots like cracks and effect their passage through them.

There is no permanently effective and economical method of dealing with termites once the building is affected. Hence the best time to provide protection against termites is during the planning and construction of buildings.

The essential features of termites proofing construction can be summarised under the following general principles:

- (a) Use of resistant wood and/or wood rendered poisonous to termites.

- (b) Creating conditions unfavourable to termite growth in and around buildings.
- (c) Use of soil poisons.
- (d) Use of termite barriers between the likely source of infestation and the susceptible material in buildings.

The use of termite-resistant timbers for structures isolated from the ground and preservative treatment for all timbers coming in contact with the ground are to be strongly recommended. In areas where dry-wood termite exists, no amount of isolation from ground will keep wooden structures from being attacked. Structural timber in such cases is to be made termite-proof by adequate preservative treatment. This will also be a second line of defence against subterranean termites.

The service life of timber will depend on the nature of wood, its position in use, the preservative treatment given to it and the type of termite. It is obvious that highly resistant timber, placed out of contact with earth in localities where the termite attack is mild, will require little or no preservative treatment whereas non-durable timbers in highly termite-infested areas will require preservative treatments to give a high absorption and deep penetration of the preservative in the structural member.

For rough outside work where decorative value is not expected, creosote is the best preservative to combat termites. Impregnation with D.D.T. gives good protection against termites (D.D.T. also leaves wood in a condition that does not interfere with subsequent painting and polishing. Most of the chemicals indicated in the preservatives toxic to termites for use as soil poisons can be used for treating wood to resist termite attack.) In planning and executing a building, it is possible to eliminate conditions that will be favourable for subsequent termite attack. Site clearance is necessary preliminary to all buildings in all cases and specially where the subterranean termites are prevalent. All dead-wood, old tree stumps and other cellulosic materials must be removed. Removal of top 3" of soil which is rich in decaying matter will be a good practice. If there are living termites in the soil they must be destroyed with poisonous chemicals as indicated later.

All underground constructions should be made of materials impervious to termites so as to prevent concealed termite attack. It may consist of brick, stone or concrete or made of timber as in the case of timber piling. The timber should be adequately treated against termite attack by one or other of the recognized processes.

Brick floors are seldom proof against termites. Concrete, especially if it is a good mixture like 1 : 1½ : 3 poured or cast slabs with a plastic pitch or bitumen seals at joints, will be impervious to termites.

Concrete floors are best constructed on gravel base, or clean coarse sand at least 6" thick. Dampness and cracking should be avoided.

The most important aspect of protection against termites in the construction of new buildings is the use of chemical soil poisons to combat termites. Some of the best known preservatives are sodium arsenite and other arsenicals, coal tar creosote, arthodichlorobenzene and Trichlorobenzene.

In the case of the subterranean termites, it has been found that construction techniques which provide a continuous layer of materials like concrete capping over brick work foundation, piers, etc., prevent the access of termites from ground level to any untreated timber above such capping. A bent-over sheet of metal also prevents termites at ground above such shields. This layer is to be of such a nature that it will not be bypassed by termites. Experience in the use of termite shields has shown that they give excellent results when properly made and fitted. Metal turned down at an angle of 45° requires termites to construct a downward gallery and negotiate the edge in order to pass. For some reason the termites are not able to do this.

APPENDIX VI (Para 4.16.2.)

Madras terraced roofing with brick on edge, 3 inches concrete, three courses of flat tiles on the casts of lime, plaster to top and bottom

CLAUSES ADDITIONAL TO "GENERAL" PRECEDING

1. The terrace shall consist of a course of thoroughly burnt approved terrace bricks in standard specification lime mortar, of 1 lime: $1\frac{1}{2}$ sand, the bricks laid on edge diagonally across the joists, and extending for at least 6 inches over the wall. Joints are not to exceed $\frac{3}{8}$ inches thickness. The bricks are to have a slight rise between joists. The terrace bricks shall be immersed in water for 24 hours in advance of the work to ensure that the bricks are well burnt and the skin allowed to dry before use.

After ten days, or when this brick-on-edge course has set, a layer of brick-concrete 4 inches in thickness made of 32 cubic feet broken brick $\frac{3}{4}$ inch gauge and $12\frac{1}{2}$ cubic feet slaked lime (no sand) shall be laid over and well beaten to 3 inches thickness with wooden hand-beaters. The beating shall continue until the concrete is well consolidated and the beater makes no impression, and readily rebounds from the surface when struck on it; the whole shall be constantly wetted by sprinkling lime water. Should this surface, during the process of beating, become so uneven that water lodges, it shall be picked up and fresh concrete added as may be necessary.

2. After six days or after the concrete laid has hardened, three courses of flat tiles shall be laid in standard specification lime mortar 1: $1\frac{1}{2}$, diagonally and breaking joint. The side joints of tiles and the beds shall not be more than $\frac{1}{4}$ inch thick, set full in mortar.

The flat tiles shall be immersed in water for two hours before being used. The joints of the top layer shall be left open to afford a key for the plaster. The top surface and ceiling shall then be plastered three coats of lime mortar, in accordance with the standard specification for same and rubbed to a polished surface.

3. The roof shall ordinarily be laid with a slope of $\frac{1}{4}$ inch to a foot to preclude the possibility of standing water.

In very rainy parts such as Malabar, this slope may be increased—vide Chief Engineer's Memo. No. 2315-Wks./28-C.P., dated 25th July, 1929.

This slope shall be given in the joists themselves and not by increasing the thickness of terracing.

4. Care shall be taken to support the joists from below by wedged uprights while the terrace is being laid. Neglect of this precaution produces sagging at centre of joists and consequent tilting at their ends which disturbs the terrace-work above them and produces cracks in it.

5. The brick jelly for concrete shall be from well burnt broken bricks or clinker bricks and no underburnt ones shall be allowed. The brick jelly shall be soaked in water for a sufficiently long period before mixing with the lime.

6. As the work proceeds, it shall be kept thoroughly wetted until the mortar has set firm and hard. Watering shall be continued for three weeks after construction.

7. Should the mortar perish through neglect of watering the work shall be pulled down and rebuilt at the contractor's expense, or should the contractor fail to water the work to the satisfaction of the officer-in-charge of the work, the latter may supply the requisite men to water the work properly, and charge the cost to the contractor.

8. Special attention is to be paid to drainage openings in parapet and binding walls to ensure that the rain runs off quickly.

N.B.—In the case where shell or fat lime is used, the above specification will be modified to replace one part in three of sand by surkhi in the mortar, or such other proportions as the Executive Engineer may specify.

Madras Terraced Roofing with brick on edge 3 inches concrete, Three courses of Flat Tiles, Three Coats of Lime Plaster to Top and One Coat of Cement Plaster 1 : 3 to Bottom

NOTE.—This roofing will generally be preferable to the preceding specification.

The work shall be executed similar to the standard specification for the same class of work with lime plaster ceiling except that one coat of standard specification "Plastering with cement mortar 1 : 3, $\frac{1}{2}$ inch thick" to bottom, will replace the three coats of lime plaster to bottom.

Terraced Roofing with Brick on Edge, 3 Inches Concrete, Two Courses of Flat Tiles to Top and One Coat of Cement Plaster 1 : 3 to Bottom.

CLAUSES ADDITIONAL TO "GENERAL" PRECEDING.

1. The brick on edge and 3 inches concrete shall be laid in conformity with clause 1, S.S. No. 46-G.

2. After six days or after the concrete laid has hardened, two courses of flat tiles shall be laid in cement mortar 1 : 3 mixed with crude oil. The mortar shall be prepared as instructed in S.S. 47 except that the crude oil is to be in the proportion of 10 percent of the weight of the cement. The tiles shall be laid first course diagonally and second course square to the parapet thus breaking joint. The side joints of tiles shall not be more than $\frac{1}{2}$ inch thick, set full in mortar. The mortar layer bed over the roof slab shall be not less than $\frac{3}{8}$ inch finished thickness after receiving the first layer of tiles and $\frac{3}{8}$ inch thick mortar bed between the two layers of tiles. The flat tiles shall be immersed in water for two hours before being used. The tiles shall be carried through roof parapet walls and finished off as instructed in clause 7, S.S. No.46-J. . Where the roof

abuts against the wall of a higher storey, the tiles shall be carried so as to overlap the extremity of the terrace bearing on the wall.

3. Before the work dries up completely, the tile joints shall be raked out and pointed over with cement mortar 1:3 mixed with crude oil prepared as instructed in clause 2 *supra*. The joints shall be well rubbed over with thin bar trowels and the excess of mortar scraped off, until the surface of the pointing attains a black polish and becomes hard.

4. The ceiling shall be plastered with one coat of standard specification "Plastering with cement mortar 1:3, $\frac{1}{2}$ inch thick" (S.S. No. 61).

5. Clauses 3, 4, 5, 6, 7 and 8 of S.S. No. 46-G shall apply to this specification as also the method of measurement for payment described in clause 7, S.S. No. 46-J.

STATEMENT SHOWING BUILT-IN FURNITURE AND AMENITIES

Types of Residential Buildings	Kitchen or Cooking space	Bath and Washing	W. C.'s	Living Room	Bed Rooms	Back Verandah & stores	Servant Quarters
1	2	3	4	5	6	7	8
I	(1) Tiers of shelves (2) Loft (3) One tap (4) Sunk in floor	(1) One tap (2) One small Shelf (3) Pegs 2 or 3 nos.	(1) Indian type W. C. with flushing cistern (2) One tap desirable	(1) Built-in-Shelf without shutters (2) Pegs 3 or 4 (3) Ledge	..	..	..
II	(1) Tiers of Shelves (2) Loft (3) One tap (4) Sunk in floor (5) Fly proof shutters for door & window	(1) One tap (2) One shower (3) One small Shelf (4) Pegs 2 or 3 nos.	(1) Indian type W. C. with flushing cistern (2) One tap	(1) Built-in-Shelf without shutters (2) Pegs 3 or 4	(1) Cupboard or Ward-robe having seasonal storage space above	Pegs or some arrangement for drying clothes where considered necessary	..
III	(1) Tiers of Shelves (2) Loft (3) One tap (4) Sunk in floor (5) Fly proof shutters for door & window	(1) One tap (2) One Shower (3) One small Shelf (4) Pegs 2 or 3 nos.	(1) Indian type W. C. with flushing cistern (2) One tap	(1) Built-in-Shelf with shutters	(1) Ward-robe half hanging & half shelving	R.C.C. Shelves in stores	..

Contd.

APPENDIX VII (Para 5.1)

1	2	3	4	5	6	7	8.
IV	(1) Tiers of Shelves, partly open & partly having fly proof shutters (2) Loft (3) One tap (4) Sunk in floor (5) Fly proof shutters for doors & windows (6) Sink & draining board	(1) Wash basin mirror & towel rail (2) One shower (3) One tap (4) One small shelf (5) Pegs 2 or 3 nos. Two bath-rooms each having:	(1) Indian type W.C. with flushing cistern (2) One tap	Drawing-cum-dining <i>Drawing portion</i> (1) Display shelf recess in wall 6" deep and 3" projecting, Size 3'-6" x 7'-0" <i>Dining Portion</i> (1) Built-in-Shelf with shutters Drawing-cum-dining.	Ward-robe half hanging & half shelving	R.C.C. Shelves in stores	(1) Shelf with 2 or 3 tiers (2) Ledge (3) Indian type W.C. with flushing cistern. (4) One tap
V	(1) Tiers of Shelves, partly open & partly having fly proof shutters (2) Loft (3) One tap (4) Sunk in floor (5) Fly proof Shutters for doors & windows (6) Sink & draining board. (7) Plate rack (8) Cupboard	(1) Wash basin, mirror & towel rail (2) One shower (3) One tap (4) Glass shelf with chromium plated brackets & rails (5) Pegs 3 or 4 nos.	(1) W.C. with flushing cistern (2) One tap	<i>Drawing Portion</i> (1) Display Shelf recess in wall 6" deep & 3" Projecting. Size 3'-6" x 7'-0" having tiers with fully glazed shutters. <i>Dining Portion.</i> (1) Built-in Shelf with shutters (2) Pelmet & curtain rods (3) Fly-proof shutters for doors & windows	Ward robe half hanging and half shelving.	One wash basin with single tap in verandah where considered, suitable and necessary R.C.C. shelves in Stores	(1) Shelf with 2 or 3 tiers. (2) Ledge (3) Indian type W.C. with flushing cistern (4) One tap

1	2	3	4	5	6	7	8
<p>VI (1) Tiers of Shelves partly open & partly having fly proof shutters. (2) Loft (3) One tap (4) Sunk in floor (5) Fly proof shutters for doors & windows. (6) Sink & draining board. (7) Plate rack (8) Cupboard</p>	<p>Two bath rooms each having (1) Wash hand basin with one tap & Mirror. (2) One shower. (3) Minto plate. (4) Glass shelf with chromium plated brackets & rail. (5) Towel rails. (6) One of the bath rooms to contain:— (a) European type W. C. preferably with low type chinaware cistern. (b) Toilet paper holder. (c) Liquid soap bowl.</p>	<p>(1) W. C. with flushing cistern (2) One tap</p>	<p><i>Drawing-cum-dining portions</i> <i>Drawing Portion</i> (1) Display Shelf recess in wall 6" deep & 3" projecting. Size 3'-6" x 7'-0" having tiers with fully glazed shutters. <i>Dining Portion.</i> (1) Built in shelf with shutters or Boardside. (2) Pelmet & Curtain rods. (3) Fly-proof shutters to doors & windows.</p>	<p>Ward robe, half hanging & half shelving.</p>	<p>One wash basin in verandah with single tap & mirror where considered suitable and necessary. Chromium plated towel rail. Liquid soap bowl, R. C. C. shelves in Stores.</p>	<p>(1) Shelf with 2 or 3 tiers. (2) Ledge (3) Indian type W. C. with flushing cistern. (4) One tap.</p>	
<p>VII Kitchen and Pantry (1) Tiers of Shelves partly open & partly having fly proof shutters. (2) Loft</p>	<p>Three bath rooms each having (1) Wash hand basin with one tap & mirror. (2) Minto plate</p>	<p>(1) W. C. with flushing cistern. (2) One tap.</p>	<p><i>Drawing-cum-dining portions.</i> <i>Drawing Portion</i> (1) Display Shelf, recess in wall 6" deep & 3"</p>	<p>Ward robe, half hanging & half shelving.</p>	<p>One wash basin with double tap & mirror where considered suitable and necessary. Chromium</p>	<p>(1) Shelf with 2 or 3 tiers. (2) Ledge (3) Indian type W. C. with flushing</p>	

contd.

APPENDIX VII (Para 5-1)

1	2	3	4	5	6	7	8												
(3) Low tap with sunk in floor in Kitchen.	(4) Sink with dining board in pantry.	(5) Fly proof shutters for doors & windows.	(6) Plate racks	(7) Cupboard	(8) Meat Safe.	(3) One Shower	(4) Glass shelf with chromium plated brackets & rail.	(5) Towel rails	(6) One of the bath rooms to contain:—	(a) European type W. C. preferably with low type chinaware cistern	(b) Toilet paper holder	(c) Liquid Soap bowl.	projecting, size 3'-6" x 7'-0" having tiers with fully glazed shutters in the Drawing room.	<i>Dining Portion.</i>	(1) Built-in shelf with shutters or Side Board.	(2) Pelmet & Curtain rods.	(3) Fly-proof shutters to doors & windows.	plated towel rail. Liquid soap bowl R. C. C. Shelves in stores.	cistern. (4) One tap.

ELECTRICAL INSTALLATIONS

Type of Residential Building	Type of Wiring	Light points Nos.	Plug points Nos.	Fan points Nos.	Ceiling fans Nos.	Call bell Nos.	Power plugs Nos.
I	2	3	4	5	6	7	8
Type I	V. I. R. wiring in casing and capping in Hot and Arid regions and C.T.S. or T.R.S. wiring in other regions.	3	1	1	..	..	..
Type II	Do.	5	2	2	1	..	..
Type III	Do.	8	3	2	2	..	..
Type IV	L.S. wiring for hot and arid Regions and LS/C.T.S. wiring in other regions	12	4	3	3	1	1
Type V	<i>Drawing & Dining</i> : Recessed conduit wiring. <i>In other Rooms</i> : L. S. in Hot & Arid & LS/C. T.S. in other Regions.	16	7	6	5	1	2
Type VI	<i>Drawing & Dining</i> : Recessed conduit wiring <i>In other Rooms</i> : L. S. in Hot & Arid Regions. & LS/C.T.S. in other Regions. <i>Servant Qrts</i> : No electrification. <i>Fittings</i> : In drawing and dining superior Type Decorative fittings.	22	8	7	6	2	4

contd.

APPENDIX VII (Para 5.6)

1	2	3	4	5	6	7	8
Type VII	<i>Drawing & Dining: Recessed conduit wirings.</i>	30	8	8	7	2	5
	<i>In other Rooms: L. S. in Hot & Arid Regions and LS/C.T.S. in other Regions.</i>						
	<i>Servant Qris: No electrification.</i>						
	<i>Fittings: In drawing, Dining, Study, & Bed Rooms superior Type Decorative fittings.</i>						

NOTE:—In Types VI & VII one of the two calling bells may be fixed at the entrance door for the visitors and the other at a convenient place in the house for calling the servants.

(2) The number of L.P., and plug points and Fan points may be varied by 10% either way depending upon nature of plan and local considerations.

(3) Also in places with cold climate, number of ceiling fans may be reduced or omitted and number of power plugs increased to suit local requirements.

APPENDIX VIII

(Para 6·6·2)

COMPARISON OF MAN-HOURS BETWEEN CONVENTIONAL AND ADVANCED BUILDING METHODS IN THE CONSTRUCTION OF MASONRY WALL DWELLING*

Item	Man-hours by Building Method	
	Conventional	Advanced
Degree of Skill		
Skilled	140·3	118·4
Unskilled	131·4	80·1
Work Elements :		
Tools	13·3	11·3
Materials	62·9	45·3
Supervise	11·4	6·8
Measure, level, plumb	15·3	10·7
Cut and Chip	2·2	—
Assist	3·4	0·5
Error	0·1	0·5
Idle personnel	7·4	3·8
Idle avoidable	17·2	5·4
Idle unavoidable	23·6	8·2
Temporary construction	11·7	7·1
Lay block and brick	57·5	68·3
Plaster and tool joint	13·7	7·0
Mix and temper	18·0	16·1
Set ties or clips	3·2	1·2
Miscellaneous	10·8	6·2
Total time	271·7	198·5
Productive time	113·6	97·0
Preparation time	109·8	83·6
Non-productive time	48·3	17·9

*The house is of masonry wall construction, with a total area of 811 square feet consisting of 5 rooms and a full basement. The data are adopted from University of Illinois, Small Homes Council, Research Report on a Study of Nonmodular Masonry Construction, Urbana, Ill., 1949, Appendix No. 13.

From Building Industry
Report by the
United States Department of Labour.

APPENDIX IX (Para 6.6.2)

*Savings through use of Modular Co-ordination as compared with conventional construction methods in the construction of 6. Homes., U.S.A. 1947**

Operation	Items included	Man-hours			Percent of		
		By conventional methods	By Modular Co-ordination**	Number saved	Man-Hours savings	Savings in total Labour on job.	Savings in Total Cost***
Foundation and Floor	Excavation, footings, foundation floor, floor Joist and subfloor.	257	231	26	10	1.2	0.6
Exterior wall	Structural framing and sheeting.	262	218	44	18	2.1	1.0
Roof	Roof trusses, gable ends, roof boards, and roofing and cornice	375	277	98	26	4.7	2.2
Interior	Flooring, wall and ceiling material, interior partitions.	412	251	161	38	7.8	3.6
Millwork	Trin, cabinets, windows, painting.	534	440	94	18	4.5	2.1
Mechanical	Plumbing	80	55	25	32	1.2	0.7
	Heating	43	48	—5	—12	—0.2	—0.1
	Wiring.	40	53	—13	—31	—0.6	—0.3
Miscellaneous	Not included in any of the above groups.	75	67	8	10	0.3	0.2
Total for entire house.		2079	1640	439	21	21.0	10.0

79

* The house with total floor area of 811 squares feet, consists of 3 rooms and a full basement. The data are adapted from University of Illinois, Small Homes Council, Construction Methods, Circular Series.

** An average of the houses built by application of modular coordination.

*** Material and labour ; no allowance for contractor's overhead or profit.

From Building Industry
Report by the
United States Department of Labour.

APPENDIX X: (Para 6.8.1)

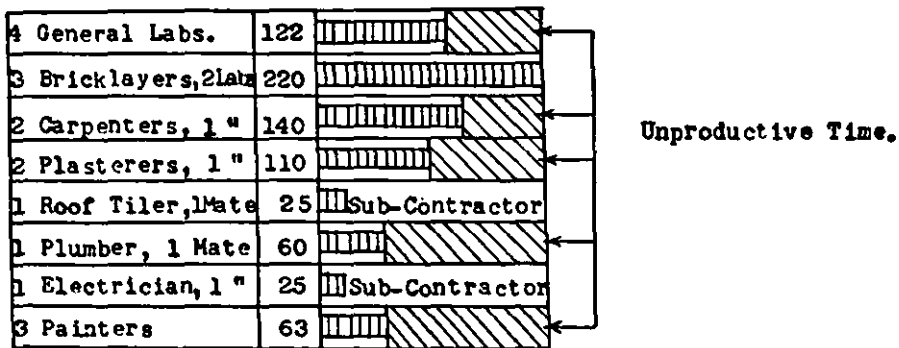
NUMBER OF MANHOURS REQUIRED IN EACH MAIN TRADE FOR ONE PAIR OF SEMI - DETACHED HOUSES

MAN HOURS

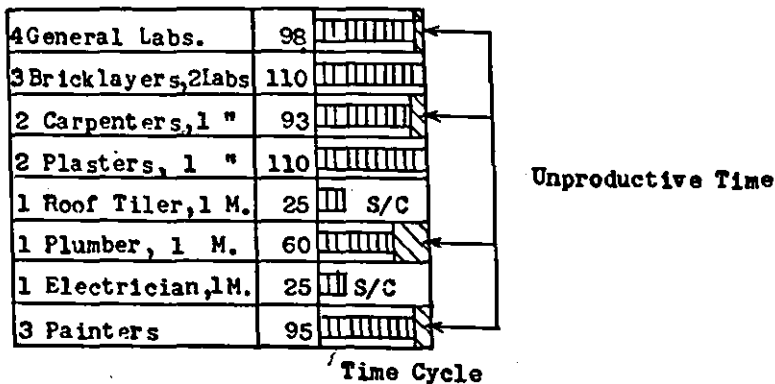
General Labourers	490	
Bricklayers & Labs	1100	
Carpenters	280	
Plasters, & Labs.	330	
Roof Tiler & Mate	50	
Plumber & Mate	120	
Electrician & Mate	50	
Painters	190	

RESULT OF HAPHAZARD SELECTION OF TRADE GANG CONSTRUCTION UNBALANCED WORKING TIMES.

HOURS



RESULT OF PLANNED & PHASED PRODUCTION BALANCED TRADE GANGS BALANCED WORKING TIMES TIME-CYCLE & UNPRODUCTIVE TIME REDUCED.



FLOW CHART (ADMINISTRATIVE)

Sl. No.	Particulars	M.E.S. Qrs. at Bombay 'E' type	M.E.S. Qrs. at Bombay 'E' I type	Western Rly. Qrs. at Bombay Junior Officer's flat	Income Tax Officers flat at Bombay. (Built by C.P.W.D.) Type III flat	Income Tax Officers flat at Bombay (Built by C.P.W.D.) Type-IV flat	C.P.W.D. Qrs. at New Delhi (E) Type	C.P.W.D. Qrs. at New Delhi 'G' Type
1	2	3	4	5	6	7	8	9
1.	Date and amount of Administrative approval.	5-2-54 Rs. 9,55,000	5-2-54 Rs. 8,84,000	Final works programme for 1956-57 Rs. 5,54,000	3-7-54 Rs. 13,87,800 (For the entire project).	3-7-54 Rs. 13,87,800 (For the entire project).	11-6-55	11-2-54
2.	Date of Technical sanction	31-3-54	5-8-54	17-4-56	21-3-55	21-3-55	3-9-55	8-6-54
3.	Date of call of tenders :							
	(i) Pile foundation	4-6-54	20-9-54	24-3-56	} 30-12-55	} 30-12-55	} 29-7-55	} 20-10-54
	(ii) Super structure	3-2-55	1-3-55	23-6-56				
4.	Date of start of work							
	(i) Pile foundation	21-10-54	4-1-55	1-8-56	} 22-2-56	} 15-2-56	} 16-10-55	} 31-12-54
	(ii) Superstructure	2-4-55	2-4-55	1-10-56				
5.	Stipulated time							
	(i) Pile foundation	2 months	2 months	3 months	} 16 months	} 16 months	} 8 months	} 8 months
	(ii) Superstructure	12 months	12 months	10 months				
6.	Time required as per circular of C.E., C.P.W.D., New Delhi.	25 months	25 months	26 months	26 months	28 months	15 months	11 months
7.	Actual time taken :							
	(i) Pile foundation	3 months and 3 weeks	2 months and 22 days	3 months	} 20 months & 27 days.	} 20 months & 3 days.	} 16 months & 16 days.	} 15 months
	(ii) Super structure	19 months and 20 days.	20 months	11 1/2 months				

1	2	3	4	5	6	7	8	9
8. Percentage of extra time taken to the stipulated time.								
(i) Pile foundation.	88%	38%	Nil	31%	26%	104%	88%	
(ii) Superstructure	64%	67%	15%					
9. Reasons for delay in execution if any :								
(i) Pile foundation.	(a) Labour strike.	(a) Labour Strike			(a) Supply of materials.	(a) Supply of materials.	(a) Supply of materials.	(a) Supply of materials.
(ii) Superstructure	(a) Late supply of steel. (b) Change in siting of garages. (c) Delay in laying cables. (d) Sub soil water in lift wells. (e) Water proofing of lift wells. (f) Late approval of samples of tiles.	(a) Shortage of stores. (b) Late approval of fittings. (c) Delay in laying cables, by B.E..S.T. (d) Sub soil water in lift wells.	(a) Due to Flu-epidemic at Bombay.		(b) Finalising lift room details.	(b) Finalising machine room details.	(b) Delay in completion of work of other trades engaged in the Building work.	(b) Delay in deciding plinth work (c) Delay in completion of work of other trades engaged in building work.

APPENDIX XI (ii)

1	2	3	4	5	6	7	8	9
10. Amount of contract :								
(i) Pile foundation	Rs. 55,296	Rs. 49,506	Rs. 30,450	} Rs. 3,09,927	} Rs. 5,14,339	} Rs. 12,07,969	} Rs. 3,85,892	
(ii) Superstructure	Rs. 6,74,657	Rs. 6,12,000	Rs. 3,07,300 (Excluding cost of steel and cement.)					
11. No. of items in the contract :								
(i) Pile foundation	Lumpsum contract	Lumpsum contract	1	} 43	} 44	} 60	} 42	
(ii) Superstructure			94					
12. No. and amount of extra items and their percentage to the tendered amount.								
(i) Pile foundation	(i) Rs. 23,121 42%	Rs. 20,060 40%	Nil	} 24 items for Rs. 13,303 4.3%	} 19 items for Rs. 68,096 13.2%	} 30 items for Rs. 25,378 2.1%	} 25 items for Rs. 23,592 6.3%	
(ii) Superstructure	(ii) 21 items for Rs. 43,809 6.5%	23 items for Rs. 48,382 7.9%	14 items for Rs. 4,133 1.2%					
13. Reasons for extra items :								
(i) Pile foundation	(i) (a) deeper foundation	(i) Site conditions.		(a) Due to rocky soil.	(a) Due to rocky soil.	(a) Change in specification.	(a) Change in specification.	
(ii) Superstructure	(ii) (a) Issue of different sections of steel. (b) Structural & architectural changes. (c) Site conditions.	(ii) (a) Non-availability of stores. (b) Site conditions.	(ii) (a) Omission in the schedule of quantities.	(b) Architectural changes. (c) Non-provision of items in the original estimate.	(b) Architectural changes. (c) Change in specification.	(b) Structural & architectural changes.	(b) Structural & architectural changes.	
14. Time taken for final payment after completion of work,								
	4 months and 10 days.	4 months	Final bill not paid.	Final bill not paid,	Final bill not paid,	14 months	12 months.	

APPENDIX XII (Para 7.10.3.)

WESTERN RAILWAY

No. W. 113/14.Vol.II.
DSS-BCT.BRC. RTM.KTT.AII.JP. RJT. BVP.
DAOs— -do-

GENERAL OFFICE
CHURCHGATE—BOMBAY.
Dated 7th February, 1958.

Joint Accounts & Engineering Circular

Sub:—Contracts—Engineering—Outstanding dues of Contractors.

Ref:—This office Confidential Circular letter Nos. W.118/14 dated 18th January 1957 & 7th May, 1957.

At the time of Divisional Engineers' Conference held on 5th, 6th & 7th December, 1957 in the Headquarters Office, Churchgate, Bombay, the F.A. & C.A.O. and C.E. had pointed out that the Divisional Engineers were taking an unduly long time to finalise the Running and Final Bills. The Divisional Engineers, however, expressed their difficulty in working to the schedule of time laid down in Circular No. W. 118/14 dated 18th January, 1957. The views expressed by the Divisional Engineers have been considered and the following revised procedure in passing 'On account' and 'Final' bills is laid down in supersession of the Circulars quoted above. It must be emphasised that the revised time limit is the maximum allowed and that every effort should be made to pass the bills earlier:—

(i) *Running Bills*

Time allowed for PWI or IOW—	3 days +
	2 days in transit =5
Time allowed for AEN	7 days +2 days
	in transit=9 days.
Time allowed for XEN/DEN	3 days + 1
	day in transit=4 days
Time allowed for Accounts	2 days 2 days
Total No. of days from taking measurements to Passing the bill by DAO	20 days

(ii) *Final Bills*

(a) Maximum time for preparation of Final bills from date of physical completion of work will be as under :—

Time allowed for PWI or IOW and his office for

(i) SMALL WORKS	15 days maximum.
(ii) LARGE WORKS	30 days maximum.
Period of transit to AEN's office	2 days.

Time allowed for AEN and his office
for checks and preparation of

bills for (i) SMALL WORKS—10 days maximum.
(ii) LARGE WORKS—20 days maximum.

Period of transit to DEN's office.—2 days.

Period in Divisional Office for arithmetic check by Accounts and technical
check by Computer and DEN's own site check etc.

10 days for small works.

20 days for large works.

Period of transit to DAO 1 day.

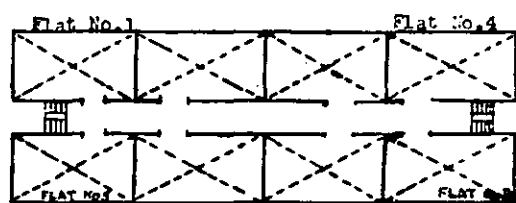
(b) Period of check by DAOs including disposal of all queries etc for
SMALL WORKS—8 days. LARGE WORKS—15 days.

Thus, in case of final bills for Small Works, the total period that
should not be exceeded will be $(15 + 2 + 10 + 2 + 10 + 1 + 8) = 48$ days, while
for Large Works, the total period allowed will be $(30 + 2 + 20 + 2 + 20 + 1 + 15) = 90$ days.

APPENDIX XIII (Para 1.7)

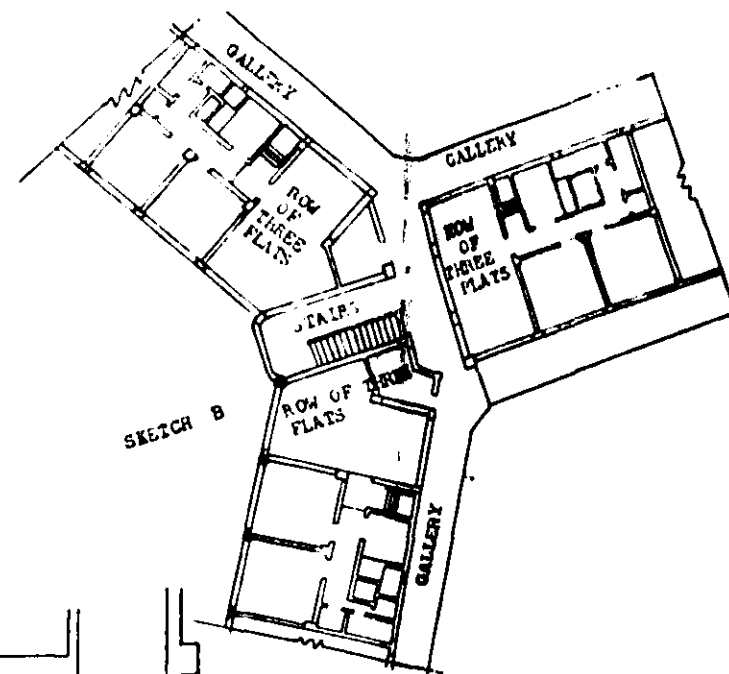
List of Selected Reference Books

- 1) Indian Railway Standard Code of Practice for Design and construction of Earthquake Resistant Building and Structures (Adopted 1951).
- (2) Bulletin of the Central Building Research Institute (April 1953).
- (3) Proceedings of the World Conference of Earthquake Engineering—Berkeley, California (June 1956).
- (4) Earthquake Engineering Problems in India by Jai Krishna, California Institute of Technology (April 1957).
- (5) Journal of the Structural Division—Volume 84 No. ST4—(July 1958) Part I.
- (6) Earthquake Engineering Seminar held at the University of Roorkee (From 10th to 12th February, 1959).
- (7) Journal of the Structural Division—Volume 85 No. ST2—(February 1959).
(Proceedings of the American Society of Civil Engineers).
- (8) Engineering (13th March, 1959).
- (9) Indian Railway Technical Bulletin (May 1959).

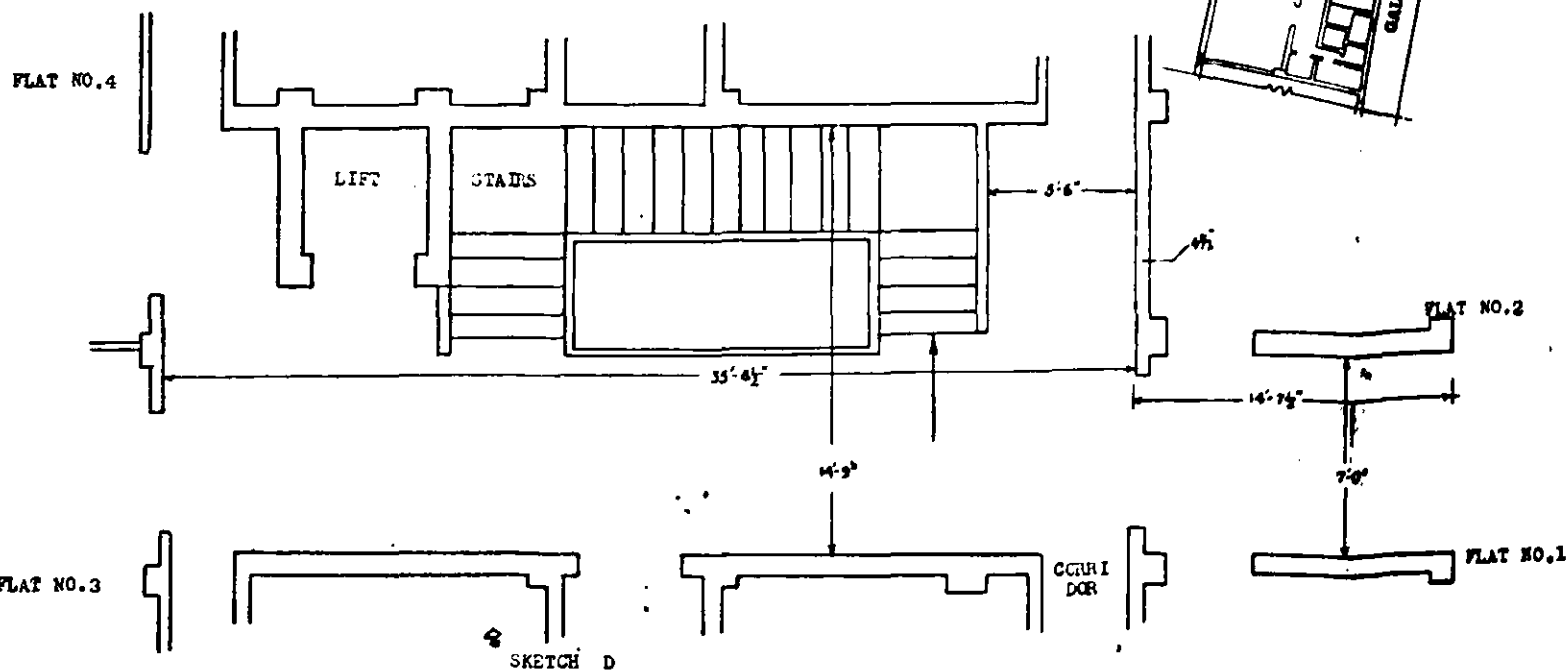


PLAN SHOWING STAIRCASE ACCESS WITH INTERNAL CORRIDORS

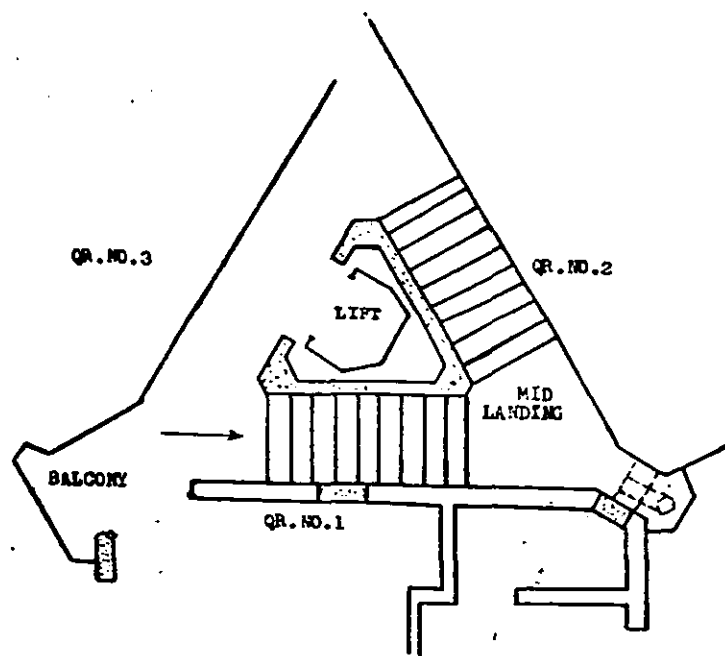
SKETCH A



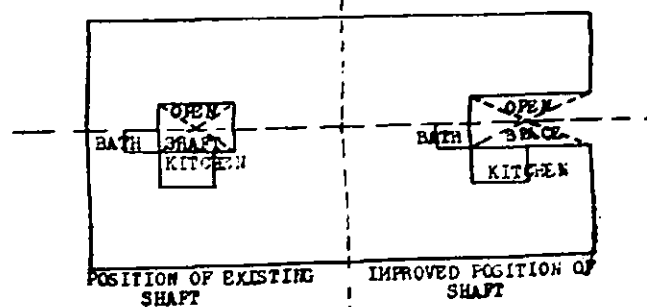
SKETCH B



SKETCH D



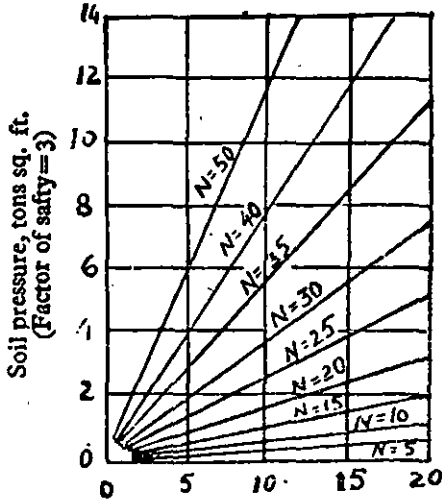
SKETCH C



SKETCH E

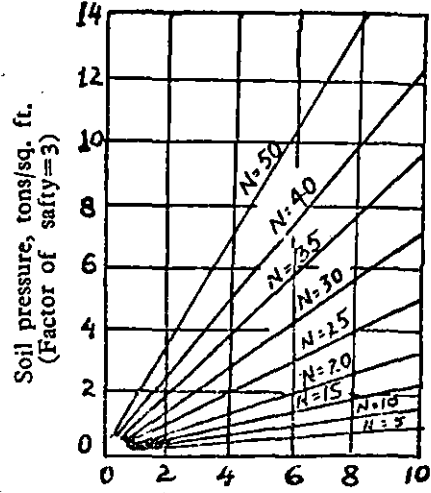
PLATE I
SKETCHES SHOWING BALCONY
AND CORRIDOR ACCESS

Fig. (a)
Para (4.2.3)



Footing Width, B, Ft. Fig. (a) Safe Soil pressure without Surcharge $D_f=0$

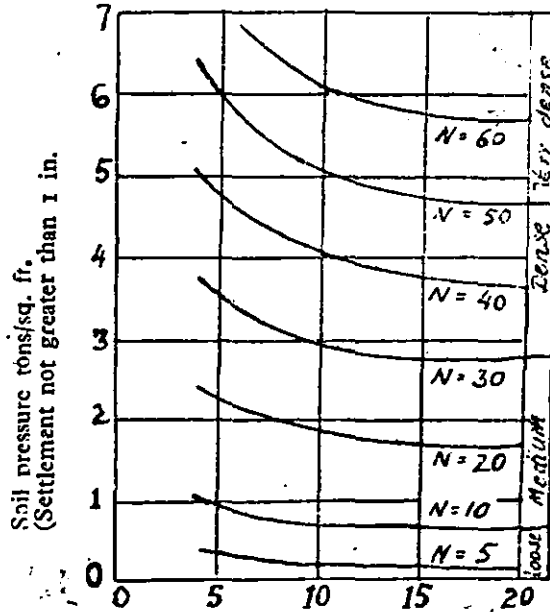
Fig. (b)
Para (4.2.3)



Depth of surcharge, D_f , ft. Fig. (b) Additional safe soil pressure due to surcharge

Charts based on water table not closer than B below base of footing.
Safe soil pressures beneath footings on sand, as determined by bearing capacity.

Fig. (c)
Para (4.2.7)

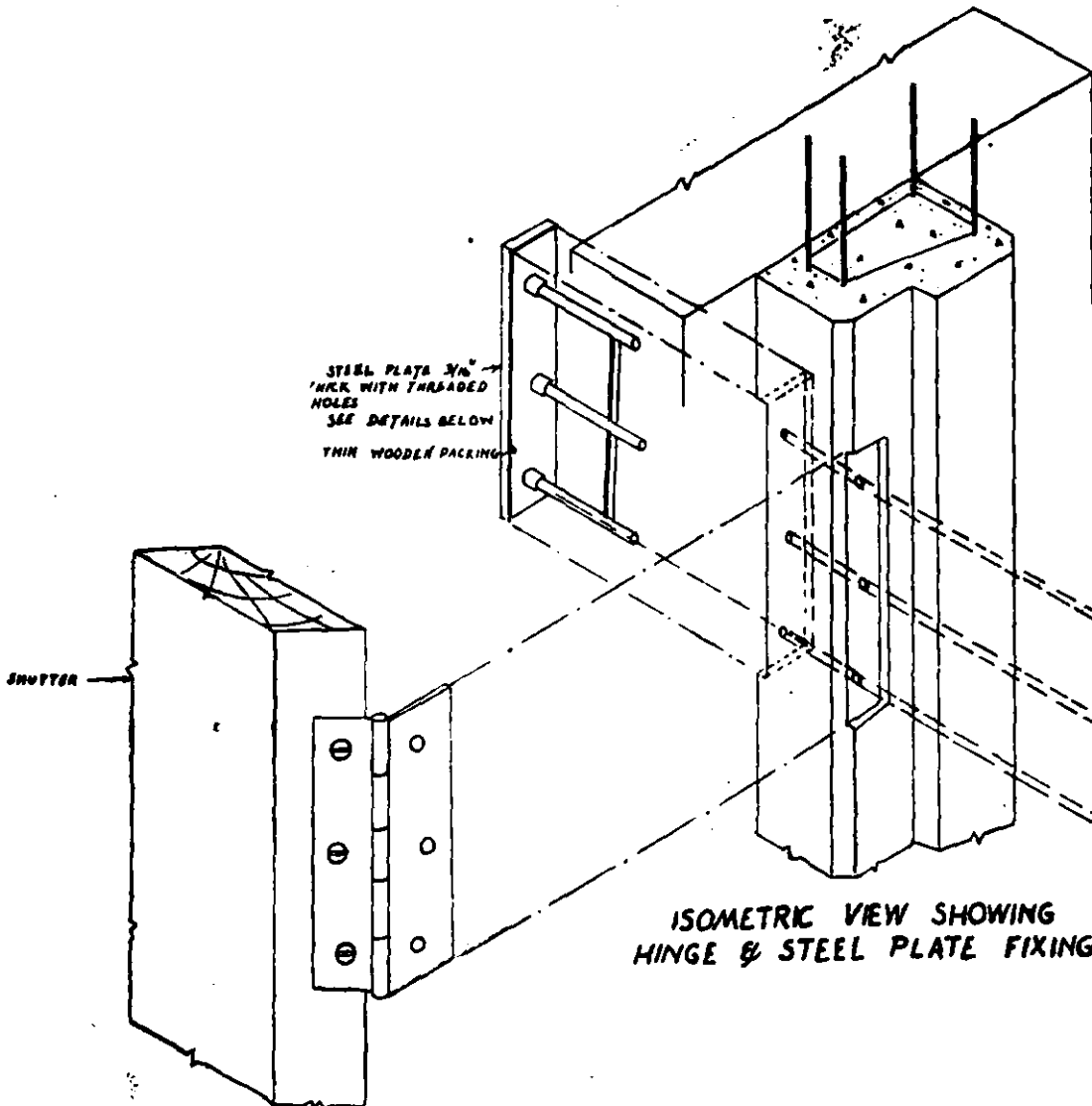


Width of footing, B, ft.

Chart based on water table not closer than B below base of footing.

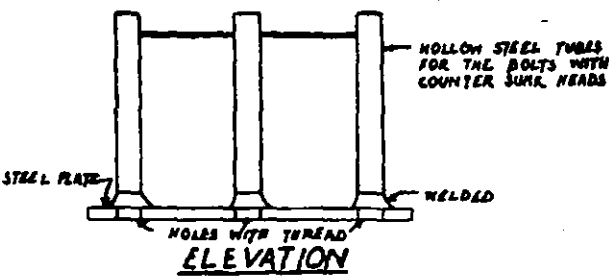
Fig. (c) Soil pressure corresponding to 1. inch settlement of footings on sand.

PLATE NO. III (Rev. 4.10.65)
METHOD OF SECURING THE SHUTTERS WITH PRECAST R.C. FRAMES.

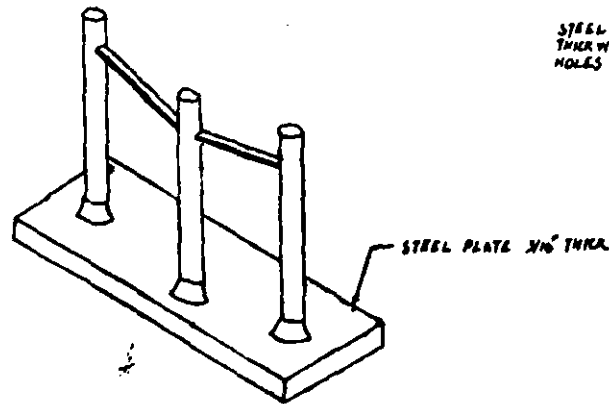


ISOMETRIC VIEW SHOWING HINGE & STEEL PLATE FIXING

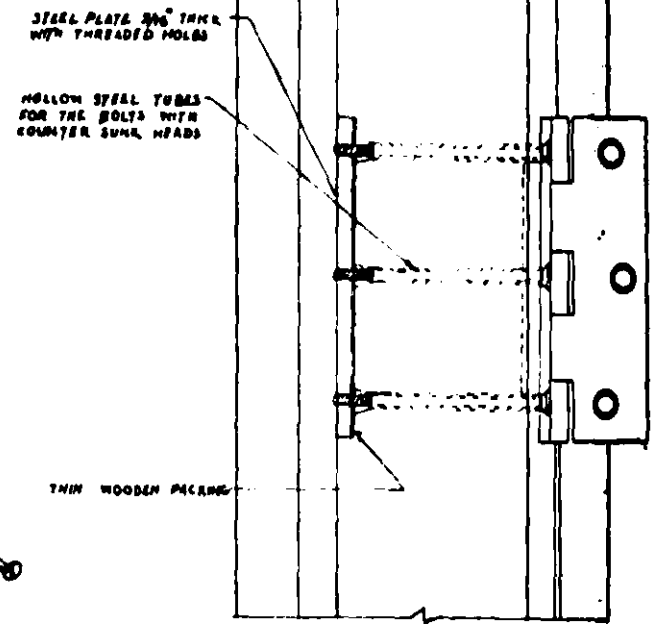
READY MADE FIXTURE TO BE INTRODUCED IN THE R.C. FRAME MOULD BEFORE CONCRETING



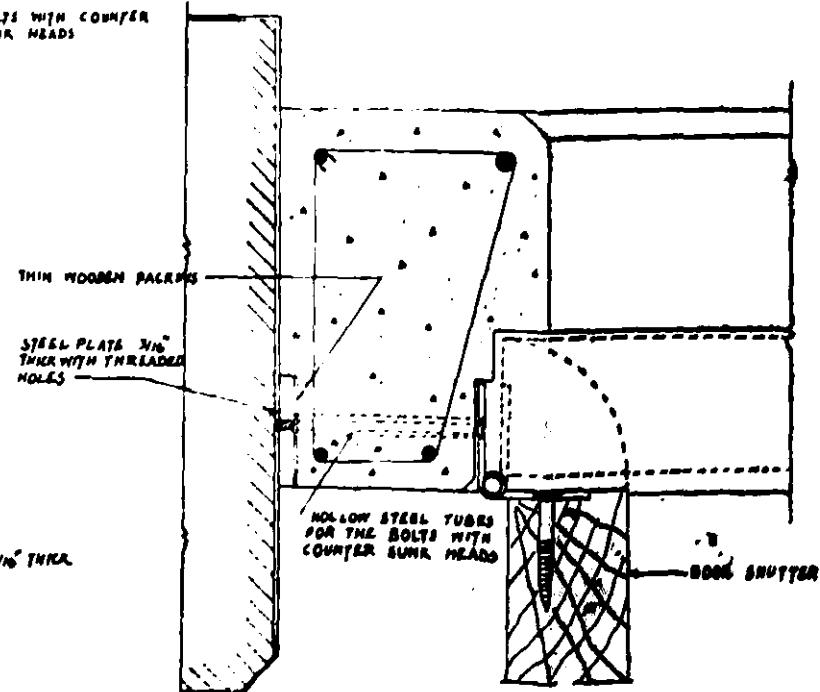
ELEVATION



ISOMETRIC VIEW



ELEVATION



PLAN AT HINGE LEVEL SCALE: FULL SIZE