



**GOVERNMENT OF INDIA
MINISTRY OF WORKS & HOUSING**

**REPORT
OF THE
TECHNICAL COMMITTEE ON ECONOMY
IN THE USE OF CEMENT AND STEEL
IN
BUILDING CONSTRUCTION**

NOVEMBER, 1974

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PREFACE

0.1 The country has been facing shortage of essential construction materials like cement and steel for the past few years and the position has been gradually deteriorating. In a meeting held under the aegis of the Planning Commission in May, 1974, it was decided that a Technical Committee be set up by the Ministry of Works & Housing to go into the matter and suggest measures that should be adopted for bringing about economy in the use of essential construction materials like cement and steel in building industry. In pursuance to that decision, a Technical Committee was set up by the Ministry of Works & Housing vide their No. N-16012/1/73-PS dated 8-7-1974. Some more members were added to this Committee by the Ministry of Works & Housing vide their No. N-16012/1/73-PS dated 24-8-1974. Copies of these orders are enclosed as Appendices A1 and A2.

0.2 Terms of reference of this Committee were as follows :

- (i) To study and recommend changes required in architectural concept, structural designs and space standards for ordinary buildings to allow for greater use of local materials like lime, surkhi, stone, tiles, timber etc. to ensure economy in the use of cement and steel and measures for getting these changes accepted and implemented ;
- (ii) To recommend operational measures which would allow for immediate use of fly ash in Civil works of PWDs, Public Sector Undertakings and other Government Works ;
- (iii) To recommend amendments to PWD and departmental specifications, rules and procedures to

(iii)

(iv)

allow for greater use of local materials referred to in (i) above ;

- (iv) To examine and suggest measures for implementation of the recommendations of the Committee on economy in consumption of steel in the country in so far as they concern building construction ;
- (v) To study the technical feasibility and suggest use of precast building components like channel units, cored units, battens and hollow blocks and cellular units, with a view to reducing consumption of cement and steel *vis-a-vis* conventional RCC construction ;
- (vi) To recommend amendments to National Building Code so as to include provisions for greater use of local materials and simplification of the relevant parts of the Code to facilitate their adoption by local authorities.

0.3 The Committee held meetings in New Delhi on 30th and 31st August, 26th, 27th, 28th September and 11th November, 1974. The Committee was required to submit an interim report within three months and final report within six months. In view of the urgency and importance of the matter, however, the Committee thought it proper to send the final report itself within a period of about four months so that measures for effecting economy in the use of cement and steel could be brought into force with the least possible delay.

0.4 The Committee, during its deliberations, reviewed the recommendations contained in the Reports of some earlier committees which had some bearing on the subject matter of this Committee and has in its Report referred to some of the recommendations of the earlier Committees.

0.5 Recommendations contained in this Report apply only to ordinary buildings like residences, offices, schools, dispensaries etc. and do not apply to industrial complexes, hospitals and other buildings having special requirements.

(v)

0.6 Since, apart from other factors, cost of building materials depends on relation between demand and supply, it is likely that construction of buildings based on greater use of local materials which are not at present being manufactured/produced in the country in sufficient quantity may cost more in the initial stages. It is, however, expected that with the gradual stepping up of production/manufacture of these materials, and improvement in quality, cost of construction will come down.

0.7 In Section 3 of the Report the Committee has recommended adoption of certain alternative specifications based on the use of materials like lime, surkhi, stone slabs, roofing tiles etc. in the context of present shortage in cement and steel. Buildings based on these specifications, however, may not be as per the prevailing concepts and trends, and will have to be of comparatively simple and austere standards. These recommendations will therefore hold good only till shortages in availability of cement and steel continue.

0.8 The Committee places on record its appreciation of the preparatory work done by Shri R. G. Gokhale, Convenor and Shri B. V. Kulkarni, Member, as a result of which it became possible for the Committee to complete its task in a short time. The Committee also acknowledges valuable assistance rendered by Shri P. Padmanabhan, Executive Engineer of the Central P.W.D. in collecting and analysing the technical material that was required by the Committee and in the drafting of Report.

APPENDIX A1

GOVERNMENT OF INDIA MINISTRY OF WORKS AND HOUSING

No. N-16012/1/73-PS

New Delhi, the 8th July, 1974

ORDER

SUBJECT : *Appointment of technical committee to draw up guidelines for economy in the use of cement and steel.*

The Government of India are considering actively measures aimed at reducing the cost of construction and economising in the use of cement and steel. As a step in that direction, the Government of India have decided to set up a Technical Committee to draw guidelines regarding the changes required in architectural concepts, structural designs and space standards of ordinary buildings to allow for greater use of local materials.

2. The composition of the Committee is as follows:—

- | | | |
|--|-------------------------|------------------------|
| (i) Engineer-in-Chief, C.P.W.D. | Chairman | (Shri M.S. Bhatia) |
| (ii) Adviser (Constn.), Bureau of Public Enterprises. | Member | (Shri V.R. Vaish) |
| (iii) A representative of Engineer-in-Chief, Army Headquarters. | Do. | (Birg. Harish Chandra) |
| (iv) Chief Architect, C.P.W.D. | Do. | (Shri J.M. Benjamin) |
| (v) Shri Kulbir Singh, Chief Engineer, Chandigarh. | Do. | |
| (vi) Shri K.R. Ramaswamy, Retired Chief Engineer, Slum Clearance Board, Tamil Nadu. | Do. | |
| (vii) Director, National Bldg. Organisation. | Do. | (Shri Rabinder Singh) |
| (viii) A representative from Indian Standards Institution. | Do. | (Shri D. Ajitha Simha) |
| (ix) Shri R.G. Gokhale, Chief Engineer, C.P.W.D. (Now Chief Engineer, Delhi Administration). | Convener | |
| (x) Chief (UD), Planning Commission | Member and Jt. Convener | (Shri P. C. Khanna) |

3. The terms of reference of the Committee are as follows:—

- (i) To study and recommend changes required in architectural concept, structural design and space standards for ordinary buildings to allow for greater use of local materials like lime, surkhi, stone, tiles, timber etc. to ensure economy in the use of cement and steel and measures for getting these changes accepted and implemented.
- (ii) To recommend operational measures which would allow for immediate use of flyash in civil works of P.W.Ds., Public Sector Undertakings and other Govt. works.
- (iii) To recommend amendments to P.W.D. and departmental specifications, rules and procedures to allow for greater use of local materials referred to in (i) above.
- (iv) To examine and suggest measures for implementation of the recommendations of the Committee on economy in consumption of steel in the country in so far as they concern building construction.
- (v) To study the technical feasibility and suggest use of pre-cast building components like channel units, cored units, battens and hollow blocks and cellular units with a view to reducing consumption of cement and steel *vis-a-vis* conventional RCC construction.
- (vi) To recommend amendments to National Building Code so as to include provisions for greater use of local materials and simplification of the relevant parts of the Code to facilitate their adoption by local authorities.

4. The Committee should submit an interim report to Government within a period of three months from the date of issue of this order and final report within six months.

5. The Committee will be free to lay down the methods of its working and other procedural matters.

The Committee will work under the auspices of the C.P.W.D. which will also meet the costs of the Committee on travel, stationery etc. from within the sanctioned budget grant. The expenditure involved should be debited to the Head "Other Charges of the C.P.W.D.—Major Head 259, Demand No. 89".

Sd/- R. GOPALASWAMY,
Joint Secretary to the Govt. of India

APPENDIX-A2

GOVERNMENT OF INDIA
MINISTRY OF WORKS AND HOUSING

No. N-16012/1/73-PS.

New Delhi, the 24th August, 1974.

ORDER

SUBJECT : *Inclusion of additional members in the technical committee to draw up guidelines for economy in the use of cement and steel.*

The Government of India have decided that the under-mentioned officers should be included in the technical committee set up in this Ministry's Order No. N-16012/1/73-PS, dated 8-7-1974 and that their names should be added to the existing list in para 2 of the said order as indicated below:—

- (xi) Shri B.G. Baljekar, Managing Member
Director, Hindustan Steel Works
Construction Ltd., Calcutta.
- (xii) Shri K.G. Salvi, Managing Director, Hindustan Housing Factory Ltd. Member
- (xiii) A representative of Civil Engineering Wing of the P & T Member (Shri K. Rama Ver-
man)
- (xiv) A representative of the Railway Board. Member (Shri T.M. Thomas)
- (xv) *Shri B.V. Kulkarni, Chief Engineer (Central Designs Organisation, C.P.W.D. Member

Sd/ R. GOPALASWAMY,
Joint Secretary

*Shri V. Narayanan took over charge as Chief Engineer (C.D.O.) from 26th September, 1974.

APPENDIX B

PROPOSED SPECIFICATIONS TO MINIMISE USE OF CEMENT, STEEL AND OTHER CRITICAL MATERIALS IN BUILDINGS

<i>Items :</i>	<i>Specifications :</i>
1. Foundation Concrete	Lime concrete using surkhi, sand, cinder or suitable mixture of these depending on availability and quality of the materials, coarse aggregate to be brick or stone ballast according to availability and local costs. (Please see Notes 1, 2 and 3 below)
2. Mortar for Masonry in Foundation, Plinth and Superstructure.	Mud Mortar (For single storey construction where suitable soil is available). Lime : Sand 1 : 3 to 1 : 2 Lime : Flyash : Sand 1 : 1 : 2 to 1 : 1 : 1 Lime : Surkhi : Sand 1 : 1 : 2 to 1 : 1 : 1 Cement : Lime : Sand 1 : 3 12 to 1 : 1 : 6 Please see Notes 2, 4, 5 and 6)
3. Lintels	(i) Flat or segmental arches in brick work upto 1 metre span. (ii) Precast RCC Lintels designed on the principle of composite action between lintel and brick work (15). (iii) RCC lintels based on conventional design to be used where (i) and (ii) above are not feasible.

NOTES:—

1. In areas where soil is poor (e.g. black cotton soil) plain or reinforced cement concrete may be used in foundation if it is unavoidable on structural considerations.
2. Lime mortars are subject to attack by sulphate action which may arise if bricks contain soluble sulphates, or if soil contains soluble sulphates which would find way into the masonry/concrete, in foundation and plinth in localities of high water table. (14).
3. Mix proportions of lime concrete for foundation may be decided to suit local conditions after conducting tests.

4. Floors/Roofs .

- (i) Stone slabs on timber or precast RCC joists (16)
- (ii) Brick Tiles on RCC or timber joists (17)
- (iii) Timber Floors
- (iv) Jack arches with RCC joists (18)
- (v) Brick-cum-Concrete composite (Madras Terrace) floor or roof (19)
- (vi) Reinforced brick or reinforced brick concrete, slabs (20).
- (vii) Various types of precast units such as channel units, cored units, cellular units with RCC joists, hollow concrete/clay blocks with precast RCC/pre-stressed joists, doubly curved shells and waffle units for span more than 6 m.
- (viii) Sloping roofs using Mangalore tiles, Allahabad tiles, slates or shingles over wooden trusses.
- (ix) CGI/AC sheet roofs over wooden trusses.
(Please see Notes 7, 8 and 9).

NOTES :-

4. Proportion of mix for lime mortar should be decided after taking into consideration quality of lime and fine aggregate and design strength of mortar/masonry.
5. Generally lime mortar without any cement should be used in all masonry walls of buildings upto two storeys and also in non load-bearing walls like partitions, or filler walls. For load-bearing walls of buildings of more than two storeys, composite cement-lime mortar may be used, the proportion being determined according to the strength required.
6. When for structural reasons, brick walls are reinforced, the mortar used may be composite cement-lime mortar.
7. For floors and roofs, stone slabs or Tiles on timber/RCC joists, Jack arches, Madras terrace or other specification which require only small quantity of cement and steel should be preferred where suitable materials are available. Sloping roofs with tiles, slates or shingles should be adopted in regions where these materials are economically available and where their use is suitable for local climatic conditions.
8. Where precast RCC units are functionally and structurally suitable and where their use will result in economy of cement/steel, they should be preferred to cast in situ R.C.C. constructions.
9. Where local materials mentioned above are not economically available, and do not meet the functional requirement of any particular building R.C.C. construction may be adopted.

5. Flooring

- (a) Base for Ground floor . Lime concrete as in item 1.
- (b) Wearing Course . . . (i) Flat brick tiles laid with 12 mm thick joints grouted with mortar and finished with 12 mm thick plaster of cement mortar (1:4) in ground floor of low cost housing (Not suitable in areas like W.C. bath and Kitchen).
- (ii) Burnt clay flooring tiles (IS : 1478-1969).
- (iii) Stone slabs as locally available.
- (iv) Timber flooring.
- (v) Cement concrete/mosaic/terrazo tiles flooring to be provided when it is not possible to adopt any of the above alternative specifications on functional and cost considerations.

6. Plaster

- (a) External Cement lime mortar 1 : 2 : 9 to 1:1:6 depending on intensity of rainfall and quality of bricks.
- (Please see Notes 10 and 11 below).
- (b) Internal (i) Lime : Sand 1:3 to 1:2
- (ii) Lime : Surkhi : Sand 1:1:2 to 1:1:1
- (iii) Lime : Flyash : Sand : 1:1:2: to 1:1:1
- (iv) Lime : Surkhi 1:2
- (v) Where good lime is not available and where functionally needed, cement lime mortar 1:1:6 to 1:2:9 may be used.
- (Please see Note 10 below).

NOTES :-

10. External plastering need not normally be provided on stone work and only pointing shall be provided with lime or cement lime mortar.
11. In regions of low rainfall, if the bricks are of reasonably good quality, only pointing may be done externally with lime or cement lime mortar.
12. In areas subjected to continuous wetting such as bathrooms and kitchens, mortar for plaster used should be of comparatively greater strength.

7. Doors and Windows :
- (a) Frames and shutters To be made of recognised secondary species of timber, seasoned and treated.
(Please see Note 13 below).
- (b) Fittings For purpose of economy, costly fittings such as Brass/Aluminium should be avoided.
8. Drive-ways and Courtyards Any specification based on the use of stones, bricks lime etc., avoiding use of cement.
9. Plumbing (i) Plastic pipes may be used for low cost Housing Schemes.
(ii) Single stack system of plumbing, where Building By-laws permit.
10. Electrical Installations (i) Surface wiring on wooden battens shall be provided as far as possible.
(ii) When conduit wiring is essential PVC conduits may be used.

NOTE :—

13. Where soil is infested with termites, soil and timber should be subjected to Anti-termite treatment.

APPENDIX C
LIST OF SOME OF THE INDIAN STANDARDS ON BUILDING
MATERIALS

S. No.	I.S. No.	Title
(1)	(2)	(3)
<i>Pozzolanas</i>		
1.	IS : 1344—1968	Specification for burnt clay pozzolanas.
2.	IS : 3812 (Part I) 1966	Specification for fly ash. For use as pozzolana.
3.	IS : 3812 (Part II) 1966	Specification for fly ash. For use as admixture for concrete.
4.	IS : 3812 (Part III) 1966	Specification for fly ash. For use as fine aggregate for mortar.
<i>Building Limes</i>		
5.	IS : 712—1973	Specification for building limes.
6.	IS : 1624—1960	Code of practice for field testing of bulding lime and lime mortar.
7.	IS : 2686—1964	Specification for cinder aggregate. For use in lime concrete.
8.	IS : 3068—1965	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
9.	IS : 3115—1965	Specification for lime-cement-cinder solid blocks.
10.	IS : 4098—1967	Specification for lime-pozzolana mixture.
11.	IS : 3182—1967	Specification for broken brick (burnt clay) fine aggregates for use in lime mortar.
<i>Stones</i>		
12.	IS : 1124—1957	Method of test for water absorption of natural building stones.

(1)	(2)	(3)
13. IS : 1125—1957		Method of test for weathering of natural building stones.
14. IS : 1126—1957		Method of test for durability of natural building stones.
15. IS : 1128—1957		Specification for lime-stone slabs.
16. IS : 1706—1972		Method for determination of resistance to wear by abrasion of natural building stones.
17. IS : 3620—1966		Specification for laterite stone block for masonry.
18. IS : 3622—1966		Specification for sand-stone slabs for use in flooring.
<i>Clay Products for Building</i>		
Blocks :—		
19. IS : 3952—1967		Specification for burnt clay hollow blocks for walls and partitions.
Tiles :—		
20. IS : 654—1972		Specification for clay roofing tiles, Mangalore pattern.
21. IS : 1478—1969		Specification for clay flooring tiles.
22. IS : 2690—1964		Specification for burnt clay flat terracing tile.
23. IS : 3951—1967		Specification for structural hollow clay floor tiles.
<i>Gypsum Building Materials</i>		
24. IS : 2095—1964		Specification for gypsum plaster boards.
25. IS : 2547—1963		Specification for gypsum building plaster.
26. IS : 2849—1964		Specification for non-load bearing gypsum partition blocks (solid and hollow types).
<i>Timber</i>		
27. IS : 399—1963		Classification of commercial timbers and their zonal distribution.
28. IS : 4970—1968		Key for identification of commercial timber.
<i>Floor Coverings and Other Finishes</i>		
29. IS : 777—1970		Specification for glazed earthenware tiles.
30. IS : 4456—1967		Methods of test for chemical resistant mortars.

APPENDIX D

IMPORTANT RECOMMENDATIONS OF THE "COMMITTEE ON ECONOMY IN CONSUMPTION OF STEEL IN THE COUNTRY" WITH REFERENCE TO BUILDING CONSTRUCTION

Residential and Office Buildings

1. Where good bricks are available load bearing masonry structures without reinforced concrete columns and beams may be provided in low rise buildings, say upto 4 storeys, depending upon the strength of bricks. In the case of office building where larger rooms are required, a combination of reinforced concrete frames and load bearing walls may be adopted, if necessary (5.1.1).

2. Where adoption of framed structures for multi-storeyed buildings is unavoidable, this may be of reinforced concrete construction generally. Where buildings have a large service core to serve as a stiff shear wall, combination of RC frames and shear walls may be used. In other cases "framed tube", "tube-in-tube" and "Bundled tube" system may be suitable depending upon the height of the building. (5.1.2).

3. Jack arches with RC supporting beams are recommended for adoption in floors and roofs of bldgs., with load bearing walls, in lieu of RC beam and slab construction, as far as possible (5.1.7).

Industrial Structures, storage sheds and other similar structures

4. At present a majority of industrial structures storage sheds and similar structures are of conventional designs with steel columns treated as propped or free vertical cantilevers and simply supported roof trusses. This type of construction may be avoided. Instead they can be planned either as completely RC structures or partly RC and partly steel constructions. Even in industrial structures with cranes of upto medium capacity RC columns may be used, instead of steel, leading to economy in consumption of steel. (5.2 and 5.2.5).

5. All structures may be constructed, as far as possible, only as RC rigid frames with deformed bars as main reinforcement. Till such time deformed bars become available in requisite quantity, mild steel plain round bars may be used. (5.2.1).

6. Shell and folded plate structures consume minimum amount of cement and steel compared to any form of RC construction. These will be suitable only if a large number of identical units are to be constructed. Large workshop structures where this condition is fulfilled may be constructed as doubly curved shells, such as hyperbolic paraboloid, conoid and hyperboloid shapes which can be cast on forms composed of straight planks, being ruled surfaces (5.2.2).

7. Precast and prestressed corrugated shells, funicular shells and hyperboloid shells and PC trusses may be used for storage sheds replacing steel structures. Prestressed shell elements may be prestressed in the longitudinal direction as well for connecting them. A saving of steel upto 50 percent can be expected with these systems. These may be standardised by ISI in consultation with SERC and suitable design aids furnished to the users. Standardisation will help the industry to manufacture the precast products and make available as ready made units in the country (5.2.3).

8. Funicular shells with bricks are suitable for use in storage sheds and industrial buildings without crane loading. National Building Organisation may, in consultation with SERC, publish literature on the subject for its large-scale adoption (5.2.4).

9. Only in those cases where the methods mentioned above are not feasible, structures made of new steel may be resorted to. In all such cases welded construction instead of revetting should be the normal practice and the structures designed as rigid frames by plastic theory where possible. In industrial buildings with overhead cranes, where designs cannot be based on plastic theory, it is recommended that welded rigid frames structures designed on elastic theory may be adopted. In these cases also use of tubular/hollow sections has to be preferred to that of plates and structurals. If used for heavy construction, the field connections could be welded or with friction grip fasteners. Use of light gauge structural in preference to rolled structural sections is recommended only where the use of tubular sections is not feasible.

Open web structures of either tubes or angles and bars, open web joist with concrete flange and castellated beams can be used as long span purlins, roof trusses in medium span storage buildings and in lightly loaded locations. ISI may standardise these systems in consultation with SERC (5.2.7 to 5.2.10).

Water Supply Installation

10. PVC and AC pipes may be used substituting steel pipes upto a dia of 315 mm. It is necessary to develop an efficient and effective method of joining PVC pipes. The ISI may take urgent action to finalise the codes for PVC pipe fittings and their laying and joining. Rate contracts may be concluded by the DGS & D and suitable instructions issued by Govt. Organisations for their adoption. (5.5.1 and 5.5.2).

11. PC and RC pipes may be used replacing large diameter pipes. ISI can standardise these products, in consultation with the Ministry of Works and Housing and C.P.H.E.R.I. Nagpur (5.5.2).

12. Water tanks and stagings may, as far as possible, be constructed of RC with high strength deformed bars as main reinforcement. Use of RC tanks may not, however, be practicable in railway yards, where these tank might have to be dismantled and shifted to provide for any future yard re-modelling required. (5.5.3).

APPENDIX—E

TABLE—1

Quantities of Cement and Steel required for different designs of RCC slabs per Sq. M. of slab area

Span 3.5 to 3.6 M.

S. No.	Type of slab and design method	Cement* Kg/m ²	Mild Steel Kg/m ²	Remarks
1.	One way slab (Elastic Theory)			
	(a) Simply supported	45.27	7.90	
	(b) Continuous	42.07	6.95	
2.	One way slab (Ultimate Strength Design)			
	(a) Simply supported	42.07	7.35	
	(b) Continuous	35.67	7.55	
3.	Two way slab (Working Stress Design)			
	(a) Simply supported	38.87	6.80	
	(b) Continuous	35.67	6.40	$\frac{L_y}{L_x} = 1.33$
4.	Two way slab (Ultimate Strength Design)			
	(a) Simply supported	38.87	5.95	—do—
	(b) Continuous	35.67	4.98	—do—
5.	Two way slab (Yield Line Theory)			
	(a) Simply supported	38.87	5.23	
	(b) Continuous	35.67	4.17	

*The quantities indicated include cement required for rendering the soffit.

APPENDIX E—contd.
TABLE—2.

Quantities of Steel and Cement required for different types of Precast Floor construction per Sq. M. of floor area
Span 3.5 to 3.6 M.

S. No.	Type of construction	Cement Kg/m ²	Steel (Kg/m ²)			Remarks/Source
			M.S.	H.T.Wire	Total	
1.	Cored units (RCC) 0.30 Metre wide	28.50	7.70	—	7.70	CBRI data sheet 3
2.	Cellular units 1.2 m × 0.6 m × 7.5 cm. on precast RCC joists	35.50	6.28	—	6.28	CBRI data sheet 4 RCC joist designed in CDO
3.	Channel Units :					
	(a) 0.30 metre wide	22.20	6.03	—	6.03	CBRI data sheet 5
	(b) 1.00 metre wide	22.60	5.34	—	5.34	Designed in CDO
4.	Waffle shells (size of shell 1.1' m × 1.1' m)	31.20	5.32	—	5.32	G.S. Ramaswamy's lecture note on economy in the use of steel in Building construction N.B.O., Sept., 1973
5.	Cored Units (Prestressed)					
	(a) 0.30 metre wide	55.00	2.60	1.70	4.30	Hindustan Housing Factory
	(b) 0.60 metre wide	51.00	3.00	1.40	4.40	
6.	Hollow block and Prestressed battens	46.00	3.00	1.00	4.00	Hindustan Housing Factory. Cement includes requirement for 40 mm. topping and 12 mm. ceiling plaster.
7.	Channel units (Prestressed)					
	(a) 0.30 metre wide	34.00	2.20	1.70	3.90	Hindustan Housing Factory.
	(b) 0.60 metre wide	30.00	2.30	1.40	3.70	

APPENDIX F

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