IS 15499 (2004): Guidelines for Survey of Housing and Building Typology in Cyclone Prone Areas for Assessment of Vulnerability of Regions and Post Cyclone Damage Estimation [CED 57: Cyclone Resistant Structure]

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भारतीय मानक

चक्रवात संभावित क्षेत्रों में क्षेत्र की संवेदनशीलता और चक्रवात के पश्चात् क्षतिमूल्यांकन हेतु आवास और भवन टाइपोलाजी के सर्वेक्षण के मार्गदर्शी सिद्धान्त

Indian Standard

GUIDELINES FOR SURVEY OF HOUSING AND BUILDING TYPOLOGY IN CYCLONE PRONE AREAS FOR ASSESSMENT OF VULNERABILITY OF REGIONS AND POST CYCLONE DAMAGE ESTIMATION

ICS 91.120.99

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 2004

Price Group 7

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Cyclone Resistant Structures Sectional Committee had been approved by the Civil Engineering Division Council.

Cyclonic storms form far away from the sea coast and gradually reduce in speed as they approach the sea coast. Cyclonic storms generally extend up to about 60 km after striking the coast. Cyclones associated with high speed winds followed by heavy rains and accompanied by surge have been causing untold misery to the populace and wide spread devastation of properties in the coastal belts of India. The frequency of cyclonic storms is more along the East coast as compared to the West coast of India. The coastal regions of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal on the East coast and Gujarat on the West coast are cyclone prone. Damage to houses is most responsible for loss of life and thus the need to have greater emphasis on the safety of houses. Due to this, need has been felt to evolve national standard for design and construction of cyclone resistant structures so as to ensure desirable level of safety. Considering that the existing housing stock needs retrofitting to enhance its cyclonic resistance, this standard lays down the guidelines and proformae for survey of existing houses their typology and carrying out post cyclone damage evaluation in buildings. The information collected will help in compilation of database, which will be very useful for assessment of vulnerability of regions against cyclonic occurrences.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GUIDELINES FOR SURVEY OF HOUSING AND BUILDING TYPOLOGY IN CYCLONE PRONE AREAS FOR ASSESSMENT OF VULNERABILITY OF REGIONS AND POST CYCLONE DAMAGE ESTIMATION

1 SCOPE

This standard covers the guidelines for survey of housing and building typology in cyclone prone areas for assessment of vulnerability of regions and post cyclone damage estimation.

2 BASIC PRINCIPLES FOR SURVEY

2.1 The guidelines and proformae are intended to identify the preparedness and accessibility of the area, establishing building typology along with the weakness in structural schemes, inadequacies in the materials and methods of construction so that an appropriate cost effective scheme of retrofitting may be designed for improved cyclone resistance and thus decreased vulnerability to any future damage. The proformae may also be used for carrying out a post cyclone damage estimation of buildings.

2.2 Different sets of proformae as given at Annex A have been evolved keeping one village as unit. In case of district headquarters or big cities, the same may be divided in distinct zones up to a maximum of five and treating each zone as one unit. The following proformae may be got filled in stand-alone mode or in conjunction depending upon the purposes of survey:

Proforma I	To identify the preparedness of the unit for handling a cyclone disaster and the accessibility of the area for the purpose of relief. It has to be filled for each unit.
Proforma IIA	To obtain statistical information for the purpose of characterization of building typology.
Proforma IIB	To obtain information about structural system employed and various typical member size so that inadequacies of the building can be determined and suitable retrofitting measures designed.
Proforma IIC	To record the extent and nature of damage suffered to buildings only for post cyclone damage survey in a region.

NOTE — Proforma IIA may be used in stand alone mode, whereas Proforma IIA, and Proforma IIB (one for each building) may be filled when it is required to retrofit the buildings for improved cyclone resistance Proforma IIC shall always be filled in conjunction with Proforma IIB.

2.3 Sample Size

It is desired that fairly representative sample size is needed to be taken for establishing the building typology for any unit. It is therefore suggested that a minimum of 10 percent of the total houses/buildings may be surveyed with the following maximum numbers for each category.

Non-engineered	: 50
Semi-engineered	: 25
Engineered	: 10

NOTE — For the purpose of this standard, IS 15498 : 2004 'Guidelines for improving the cyclonic resistance of low rise houses and other buildings/studeses' may be referred to for non-engineered, semi-engineered and engineered construction.

2.4 Educational Background of Surveyors

Keeping in view the technical input required by the person conducting the survey, the following minimum educational background and experience is recommended for the surveyor:

Proforma I	:	Graduation.
Proforma IIA	:	Graduation/Civil engineering (Diploma).
Proforma IIB	:	Civil engineering (Diploma).
Proforma IIC	:	Civil engineering (Diploma) with at least three years of experience/Civil engineering (Degree).

3 GUIDELINES FOR FILLING UP THE PROFORMA

3.1 The aim is not to prepare a detailed plan of an entire unit but to gain information on general layout of

unit, typical building configurations evolved by the society for their housing needs and their vulnerability against cyclones. Plan, structure shapes, structural schemes, materials and methods of construction are important factors considered.

3.2 Proforma I General

For each village as a unit one general data sheet (Proforma I) has to be filled. For cities and towns, the size of the habitat may be large and therefore the delineation of zones has to be decided prior to undertaking the survey and consistent with the requirements of adequate information on building typology. Each zone thus identified shall have one general data sheet. A map of the village zone be procured from local authorities showing important land marks, inhabited area, etc, and appended with the survey record.

The information gathered in this section assesses the cyclone vulnerability of the area and its preparedness to handle the disaster, building environs and the accessibility of the area for providing quick relief.

3.3 Proforma II Building Typology and Structural Assessment

The proforma II is in three parts A, B and C. Proforma IIA covers the statistical information about buildings for the purposes of characterization of building typology. Proforma IIB covers information about structural systems, member sizes and connection details for examining the cyclone resistance of the existing buildings and to retrofit them, if needed, for improved cyclone resistance. Proforma IIC covers the damage survey of the buildings in the post disaster scenario. The questionnaire is so designed that if needed, a back analysis may be carried out to make an estimate of prevailing wind speeds at the time of damage.

The proformae are common for all building types, namely, non-engineered, semi-engineered and engineered. Buildings to be surveyed should be carefully chosen so that all important building shapes are fully covered.

3.4 Filling Up of Proformae

The proformae contains basically two types of questions. In first case, the multiple options are given and surveyors has to indicate the number of his choice in the box provided, for example

2

In the other set of questions the answer is to be provided in definite quantitative terms on the basis of actual measurement or otherwise at site like member size, spacing of connections etc, in the box provided.

4 DAMAGE SCALES

4.1 Damage to Roof of Non-engineered and Semi-engineered Construction and Walls with Thatch, AC Sheets and Other Sheets

Marginal – A few connections loosened or damaged.

Medium – Roof/Wall cladding in bad condition or blown off partially (< 50 percent), wall posts tilted, and sagging of roof.

Heavy – Roof/Wall cladding blown off with damage to runners, bracings of walls and posts.

Total – Roof/Wall totally damaged.

4.2 Damage to Walls Made of Mud, Reinforced Mud, and Brick/Stone/Cement Concrete Block Masonry

Marginal – Minor cracks in walls, plaster peeled off, moisture penetration noticed on inside wall.

Medium – Large cracks in wall, no tilt, plaster peeled off, wall material weathered at reaction locations.

Heavy – Wall tilted with or without cracks, portion of wall damaged or partial collapse.

Total – Failure of the wall.

4.3 Damage to Foundation

Minor – Few settlement cracks below plinth level.

Medium – Large settlement cracks below plinth level, posts titled with gaps noticed in soil, noticeable cracks in tie beams.

Heavy – A portion of foundation fully separated, large tilting/pull out of posts, separation between tie beam and pile, pile tilted.

Total – Failure of foundations.

4.4 Damage to Roof of Industrial Structures with AC/Metal Sheet Cladding

Marginal – A few J bolts disturbed/corroded, sheet broken over small area.

Medium – Large number of J bolts disturbed, a few sheets (< 25 percent) blown off, some elements of truss/buildings bent noticeable sagging of roof truss.

Heavy – AC sheets blown off, a few trusses bent/out of alignment, failure of a few joints.

Total – Failure of a few trusses.

4.5 Damage to Columns of Industrial Sheds

Marginal – A few bolts in built up columns are loose/corroded, bed plates between truss and column or foundation and

column not fully matched, minor cracks in reinforced concrete columns.

Medium – A few ties/braces in built up columns are corroded, a number of bolts in connection corroded, opening up of meeting surfaces at top and bottom with clearly visible separation, structural cracks in reinforced columns exceeding 0.3 mm crack width, no tilt of column.

Heavy – Column tilted inward or outward, large deformations with elongation of holes in ties/braces, failure of a few braces, excessive cracking in reinforced concrete columns, deformations of anchor bolts.

Total – Large tilt or total failure of columns.

4.6 For an overall assessment, the following recommendations are made:

Marginal – If more than 75 percent of the total number of columns have suffered marginal damage or less and maximum damage to an individual column is medium.

Medium – If more than 75 percent of columns have suffered medium damage or less, and the maximum damage to an individual column is heavy.

Heavy – If more than 50 percent of columns have suffered heavy damage and no failure.

Total – If more than 50 percent of the columns have suffered heavy damage, with one or more columns failed.

ANNEX A

(*Clause* 2.2)

PROFORMAE

PROFORMA I GENERAL

1. State

Tamil Nadu	Andhra Pradesh	Orrisa	West Bengal	Gujarat	Others
1	2	3	4	5	6

2. Name of district:

3. Name of taluk:

4. Name of village/unit:

5. Distance from district headquarters, in km

< 20	≥ 20 but < 40	≥ 40 but < 60	≥ 60
1	2	3	4

6. Area, in km^2

< 10	≥ 10 but < 20	≥ 20 but < 30	≥ 30
1	2	3	4

7. Percentage land use for housing

< 20	≥ 20 but < 40	≥ 40 but < 60	≥ 60
1	2	3	4

8. Number of inhabitants

< 100	≥ 100 but < 200	≥ 200 but < 500	≥ 500
1	2	3	4

9. Cyclone prone

Yes	No
1	2

10. Flood prone

Yes	No
1	2

11. Storm surge prone

Yes	No
1	2

12. Average distance from sea, in km

< 1	≥ 1 but < 5	≥ 5 but < 10	≥ 10 but < 20	≥ 20
1	2	3	4	5

13. Is a cyclone shelter available and accessible

Yes	No
1	2

14. Distance of cyclone shelter, in km, from unit

< 2	≥ 2 but < 4	≥ 4
1	2	3

15. Capacity of cyclone shelter

< 50	≥ 50 but < 100	≥ 100 but < 250	≥ 250
1	2	3	4

16. Other community building available (semi-engineered or better)

Yes	No
1	2

a) School building available (semi-engineered or better)

Yes	No
1	2

b) Panchayat building available (semi-engineered or better)

Yes	No
1	2

c) Primary health centre available (semi-engineered or better)

Yes	No
1	2

17. Alternative means of communications (other than telephone) available

Yes	No
1	2

18. Advanced cyclone warning system in position

Yes	No
1	2

19. Advanced warning time preceding cyclone, in h

Nil	> 0 but < 6	≥ 6 but < 12	≥ 12 but < 24	≥ 24
1	2	3	4	5

20. Storm water drainage available

Yes	No
1	2

21. Description of 3 past cyclones (*see* Note 2)

Year	Speed of Wind kmph	Approximate Duration, h	Houses Damaged	Human Lives Lost	Level of Standing Water, m	How Much Advance Cyclone Warning Issued, h

22. Approximate maximum storm surge level known to have reached in m (*see* Note 2)

23. Total number of buildings

< 100	≥ 100 but < 300	≥ 300 but < 500	≥ 500
1	2	3	4

24. Types of buildings

Total number of :

a) Non-engineered

b) Semi-engineered

c) Engineered

25. a) Approach road to the unit

i) Maximum road width, in m

< 4	≥ 4 but < 6	≥ 6 but < 10	≥ 10
1	2	3	4

ii) Type of road surface

Kutcha	WBM	Asphalt	Concrete
1	2	3	4

b) Interior roads within the unit

i) Maximum road width, in m

< 4	≥ 4 but < 6	≥ 6 but < 10	≥ 10
1	2	3	4

ii) Type of road surface

Kutcha	WBM	Asphalt	Concrete
1	2	3	4

26. Built environment

Isolated Buildings	Planned Layout	Closely Spaced
1	2	3

27. Village setting

Plain	Hilly Slope	Valley	Low Lying	Water logged
1	2	3	4	5

28. Size of trees

None	Small	Large
1	2	3

29. Any other notable tall structures, give description.

NOTES
1 A map of the village surveyed be procured from local authorities and attached with this survey report. Important land marks of the village and inhabited area be demarcated.
2 Data for this item may be obtained from concerned agencies, mentioning its source.

PROFORMA II BUILDING TYPOLOGY AND STRUCTURAL ASSESSMENT
A — TYPOLOGY

1. Name of owner/occupant:

Address:

Taluk: District: State:

2. Location of building amongst the cluster

Corner	Edge	Interior
1	2	3

3. a) Height of surge/standing water, in m

< 1	≥ 1 but < 1.5	≥ 1.5 but < 2	≥ 2 but < 4	≥ 4
1	2	3	4	5

b) Duration for which water stays, in h

< 4	≥ 4 but < 6	≥ 6 but < 8	≥ 8
1	2	4	5

4. Number of occupants

1	2	3 – 4	5 – 6	7 – 8	> 8
1	2	3	4	5	6

5. Area of plot, in m^2

< 10	≥ 10 but < 20	≥ 20 but < 40	≥ 40 but < 60	≥ 60
1	2	3	4	5

6. Area of building, in m^2

< 10	≥ 10 but < 20	≥ 20 but < 30	≥ 30
1	3	4	5

7. Building type

Non-engineered	Semi-engineered	Engineered
1	2	3

8. Estimated age of building, in years

< 1	≥ 1 but < 5	≥ 5 but < 10	≥ 10 but < 25	≥ 25
1	2	3	4	5

9. Plan shape

Square	Rectangle	L	Tee	Others
1	2	3	4	5

10. Ground slope around the building

Flat	Gentle	Steep
1	2	3

11. Height of plinth above ground level, in m

< 0.3	≥ 0.3 but < 0.6	≥ 0.6 but < 0.9	≥ 0.9 but < 1.2	≥ 1.2
1	2	3	4	5

12. Width of verandah in front, in m

Not Available	< 1	≥ 1 but < 2	≥ 2 but < 3	≥ 3
1	2	3	4	5

13. Width of verandah in rear, in m

Not Available	< 1	≥ 1 but < 2	≥ 2 but < 3	≥ 3
1	2	3	4	5

14. Width of courtyard sides, in m

Not Available	< 1	≥ 1 but < 2	≥ 2 but < 3	≥ 3
1	2	3	4	5

15. Percentage of opening in front wall

< 5	≥ 5 but < 10	≥ 10 but < 20	≥ 20
1	2	3	4

16. Percentage of opening in rear wall

< 5	≥ 5 but < 10	≥ 10 but < 20	≥ 20
1	2	3	4

17. Percentage of opening on side wall-1

< 5	≥ 5 but < 10	≥ 10 but < 20	≥ 20
1	2	3	4

18. Percentage of opening on side wall-2

< 5	≥ 5 but < 10	≥ 10 but < 20	≥ 20
1	2	3	4

19. a) Roof type

Mono slope	Gable	Hipped	Flat	Rounded
1	2	3	4	5

b) Roof materials

Jack Arch	Wooden Rafters & Bricks	MS Angle/Girder and Stone Patti	RCC	Any other
1	2	3	4	5

20. Roof slope

Flat	Small (≥ 0° but < 15°)	Medium (≥ 15° but < 30°)	Large (≥ 30°)
1	2	3	4

21. Roof cladding

Thatch	Tiles	AC Sheet	Madras Terrace	RCC	Tiles+Lime/ Cement Mortal	Others (Specify)
1	2	3	4	5	6	7

22. Height of eaves above plinth level, in m

< 2	≥ 2 but < 3	≥ 3 but < 4	≥ 4
1	2	3	4

23. Height of ridge of roof above plinth level, in m

< 2	≥ 2 but < 3	≥ 3 but < 4	≥ 4
1	2	3	4

24. Number of storey

1	2	3	4	≥ 5
1	2	3	4	5

25. Walling material

Mud	Reinforced Mud	Sun Dried Bricks	Burnt Bricks	Hollow Concrete Blocks	Stone	Others
1	2	3	4	5	6	7

26. Maintenance

Nil	Only Damage Repaired	As and when Required	Regular	Frequent
1	2	3	4	5

27. Quality of construction

Bad	Average	Good	Very Good
1	2	3	4

28. Estimated cost of buildings in thousand (Rs)

< 10	≥ 10 but < 50	≥ 50 but < 100	≥ 100 but < 200	≥ 200
1	2	3	4	5

NOTE — If there is more than one storey, relevant data of each intermediate floor slab may also be collected separately.

PROFORMA II BUILDING TYPOLOGY AND STRUCTURAL ASSESSMENT
B — STRUCTURAL AND CONNECTION DETAILS

1. Name of owner:

Address:

Village

Taluk: District: State:

2. Structure details:

a) Overall length, in m

b) Overall breadth, in m

c) Height of external walls, in m

d) Thickness of external walls, in m

e) Height of internal walls, in m

f) Thickness of internal walls, in m

g) Number of storey

3. Typical plan

4. Typical section

5. Typical member sizes — Materials used:

a) Ridge beam (m × m)

b) Rafter (m × m)

c) Purlin/Battens (m × m)

d) Beam (m × m)

6. Foundation type

Shallow	Deep
1	2

7. Depth of foundation, in m

< 0.5	≥ 0.5 but < 1	≥ 1 but < 1.5	≥ 1.5 but < 2	≥ 2
1	2	3	4	5

8. Plinth protection/apron provided or not

Yes	No
1	2

9. Foundation material

Mud Reinforced with brickbats	Mud (plain)	Stone	Bricks		Sand	RCC
			Sundried	Burnt		
1	2	3	4	5	6	7

10. Plinth beam provided

Yes	No
1	2

11. Wall plaster inside

Yes	No
1	2

12. Wall plaster outside

Yes	No
1	2

13. Type of plaster

None	Cement	Mud	Lime
1	2	3	4

14. Door/Window frames and shutters

Wood/Wood	Wood/Glass	Aluminium/Glass	Steel/Glass	Others
1	2	3	4	5

15. Ventilators permanently open or closable

Yes	No
1	2

16. Ventilator size, in m^2

Not Available	< 2	≥ 2 but < 3	≥ 3 but < 4	≥ 4
1	2	3	4	5

17. a) Roof type

Mono Slope	Gable	Hipped	Flat	Rounded
1	2	3	4	5

b) Roof materials

Jack Arch	Wooden Rafters and Bricks	MS Angle/Girder and Stone Patti	RCC	Any other
1	2	3	4	5

18. Eaves projection, in m

< 0.2	≥ 0.2 but < 0.4	≥ 0.4 but < 0.6	≥ 0.6 but < 0.8	≥ 0.8 but < 1.0	≥ 1.0
1	2	3	4	5	6

19. Eaves projection held back

Yes	No
1	2

20. Eaves edge restrained using metal straps

Yes	No
1	2

21. Mortar bands on top of roof

Not Provided	Only at Ends	Spacing < 4 m	Spacing ≥ 4 m
1	2	3	4

22. a) Does the building employ purlins or battens

Purlins	Battens
1	2

b) Spacing of purlins/battens, in m

23. Spacing of rafter/trusses, in m

24. Spacing of bolts in middle region, in m

25. Spacing of bolts in edge region, in m

26. Type of bolting for sheets

27. Size of columns (m × m)

28. Column spacing, in m

29. Connection of members

Nails	Nails and Binding Wire	Nails and Metal Strap	Binding Wire	Organic Rope	Others
1	2	3	4	5	6

30. Diameter of nails used, in m

< 2	3	4	5	> 6
1	2	3	4	5

NOTE — If there is more than one storey, relevant data of each intermediate floor slab may also be collected separately.

PROFORMA II BUILDING TYPOLOGY AND STRUCTURAL ASSESSMENT
C — DAMAGE DETAILS

1. Name of owner/occupant:

Address:

Village

Taluk: District: State:

2. Damage to roof

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

3. Damage to front walls

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

4. Damage to side wall-1

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

5. Damage to side wall-2

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

6. Damage to rear wall

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

7. Damage to compound wall

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

8. Damage to foundation

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

9. Damage to columns:

a) Total number of columns

b) Number of columns of different damage levels

None	Marginal	Medium	Heavy	Total

c) Overall assessment of damage to columns

None	Marginal	Medium	Heavy	Total
1	2	3	4	5

10. Damage to internal walls

Collapsed Most	Collapsed Few	Cracked Most	Cracked Few	None
1	2	3	4	5

11. Crack locations (please √) [*see* Note 1]

Corner	Middle of Long Wall	Middle of Short Wall	Near Top	On Top of Door/Window Opening	At Staircase	At Junction of Walls

12. Crack orientation (please √) [*see* Note 1]

Vertical	Horizontal	Inclined	Stepped	Composite

	Top of Door Opening		Top of Window Opening		Top Edge		Horizontal	Vertical
	Middle	Edge	Middle	Edges	Middle	Edges	Cracks at Bottom Edge	Cracks Around Corner Edges
Front Wall								
Rear Wall								
Left Side Wall								
Right Side Wall								

13. Damage to doors

Yes	No
1	2

14. Damage to windows/ventilators

Yes	No
1	2

15. Erosion of wall due to flooding/storm surge

Yes	No
1	2

16. Height of wall damaged due to erosion, in m

< 0.5	≥ 0.5 but < 0.75	≥ 0.75 but < 1.0	≥ 1 but < 1.5	≥ 1.5
1	2	3	4	5

17. Extent of damage, in percent of wall area

< 10	≥ 10 but < 20	≥ 20 but < 30	≥ 30 but < 40	≥ 40
1	2	3	4	5

18. Plinth protection/apron against flooding

Yes	No
1	2

19. Damage to eaves region

Yes	No
1	2

20. Damage to roof cladding, in percent

< 10	≥ 10 but < 20	≥ 20 but < 40	≥ 40 but < 60	≥ 60
1	2	3	4	5

21. Damage to truss/members (please √)

Complete	Purlins	Battens	Rafters	Tie Members	None

22. Damage to intermediate floor slab for more than one storey buildings

Yes	No
1	2

23. Damage due to falling of trees

Yes	No
1	2

24. Size of trees in immediate vicinity

None	Small	Large
1	2	3

25. Distance of trees from buildings, in m

< 1	≥ 1 but < 2	≥ 2 but < 3	≥ 3 but < 4	≥ 4
1	2	3	4	5

26. Lifting of roof/failure of roof anchorage in walls/columns

Yes	No
1	2

NOTES

1 The typical cracks observed may be marked in plan/elevations or else a separate sketch may be made.

2 If there is more than one storey, relevant data of each intermediate floor slab may also be collected separately.

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Cyclone Resistant Structures Sectional Committee, CED 57

Organization	*Representative(s)*
In personal capacity *(61, Civil Lines, Roorkee-247667)*	DR PREM KRISHNA (***Chairman***)
Adlakha & Associates, New Delhi	SHRI PRAMOD ADLAKHA
	SHRI NARENDER KAPUR (*Alternate*)
Andaman Public Works Department, Port Blair	SHRI S. P. LALLA
	SHRI B. N. NAGARAJA (*Alternate*)
Building Materials & Technology Promotion Council, New Delhi	SHRI T. N. GUPTA
	SHRI J. K. PRASAD (*Alternate*)
Central Building Research Institute, Roorkee	SHRI B. S. GUPTA
	SHRI AJAY CHAURASIA (*Alternate*)
Central Public Works Department, New Delhi	CHIEF ENGINEER (D)
	SUPERINTENDING ENGINEER (D) (*Alternate*)
College of Engineering, GITAM, Visakhapatnam	DR S. SURYA RAO
	DR K. V. G. D. BALAJI (*Alternate*)
Director of Town & Country Planning, Chennai	SHRI R. ANBHAZAJAN
	SHRI S. VENKATACHALAM (*Alternate*)
Engineer-in-Chief's Branch, New Delhi	LT-COL S. K. SHARMA
	SHRI R. DAMODARAN (*Alternate*)
Housing & Urban Development Corporation Ltd, New Delhi	CHAIRMAN-CUM-MANAGING DIRECTOR
	SHRI MALAY CHATTERJEE (*Alternate*)
Indian Institute of Science, Bangalore	PROF S. P. GOVINDA RAJU
Indian Institute of Technology, Roorkee	DR S. K. KAUSHIK
	DR N. M. BHANDARI (*Alternate*)
Indian Institute of Technology, New Delhi	PROF T. K. DATTA
	DR A. K. JAIN (*Alternate*)
Indian Institute of Technology, Chennai	PROF M. R. PRANESH
	PROF C. P. VENDHAN (*Alternate*)
Indian Meteorology Department, New Delhi	SHRI A. V. R. K. RAO
	SHRI S. C. GOYAL (*Alternate*)
Irrigation & CAD Department, Hyderabad	CHIEF ENGINEER (CDO)
	CHIEF ENGINEER (MAJ IRRIGATION) (*Alternate*)
Jadavpur University, Kolkata	DR BRATISH SENGUPTA
	DR SOMNATH GHOSH (*Alternate*)
Larsen & Toubro Limited, Chennai	SHRI P. R. VARADARAJULU
	SHRI T. V. B. S. SATYANARAYANAMURTHY (*Alternate*)
Ministry of Agriculture, New Delhi	SHRI BABU JACOB
	MS JANAK JUNEJA (*Alternate*)
Public Works Department, Bhubaneswar	ENGINEER-IN-CHIEF
Structural Engineering Research Centre, Chennai	DR N. LAKSHMANAN
	SHRI S. GOMATHINAYAGAM (*Alternate*)
Structwell Designers & Consultants Pvt Ltd, Mumbai	SHRI R. N. RAIKAR
In personal capacity *(B XI/8091 Vasant Kunj, New Delhi-110070)*	SHRI O. P. GOEL
BIS Directorate General	SHRI S. K. JAIN, Director and Head, (CED)
	[Representing Director General (*Ex-officio*)]

Member Secretary
SHRI ALOK KESARI
Deputy Director (CED), BIS

Bureau of Indian Standards

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BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 2323 0131, 2323 33 75, 2323 9402

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :		Telephone
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Eastern	: 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700 054	2337 8499, 2337 8561, 2337 8626, 2337 9120
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