भारतीय मानक

Indian Standard

IS 18153 : 2023

कच्चे घरों की चक्रवाती प्रतिरोध क्षमता में सुधार — दिशानिर्देश

Improving the Cyclonic Resistance Capacity of *Kutcha* Houses — Guidelines

ICS 91.120.99

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

August 2023 **Price Group 11**

Cyclone Resistant Structures Sectional Committee, CED 57

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.

Cyclones are the most devastating among the natural hazards when viewed in terms of their severity, frequency of occurrence and areas of destruction. The coastal regions of India, both in the east and west coasts are severely battered almost every year, causing heavy loss to both life and property. Non-engineered buildings are seen to be the most commonly affected during a cyclone. A big part of these non-engineered buildings are the *kutcha* houses, which are mainly constructed by local communities, with various local materials such as wood, stone, grass, palm leaves, branches, bushes, thatch, straws, bricks, bamboo, mud, etc, using techniques passed down through the generations. Large percentage of our low-income rural populations in the coastal region live in *kutcha* houses.

Depending on the availability of the local materials and the local economy of the region, thatch, Mangalore or country tiles and asbestos or metal GI sheets are generally used as roof cladding materials. Similarly, mud, clay, stone and bricks are generally used as wall cladding materials.

Recognizing the fact that a kutcha house is an assemblage of various elements such as walls, purlins, rafters, cladding, etc, it is essential that one has to ensure a safe load path from the roof to the foundation. This requires a proper understanding of the aerodynamics of wind flow patterns on and around the building and of the principles of anchorage, bracing and connections for the safe performance of the building.

This standard has been formulated to provide guidelines to owners, contractors, workers, and others engaged in rehabilitation of kutcha houses for improving cyclonic resistance.

In the formulation of this Indian standard, due weightage has been given to the research work done at CSIR - Central Building Research Institute, Roorkee and CSIR - Structural Engineering Research Centre, Chennai.

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

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 : 2022 'Rules for rounding off numerical values (*second revision*)'. 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

IMPROVING THE CYCLONIC RESISTANCE CAPACITY OF *KUTCHA* HOUSES — GUIDELINES

1 SCOPE

This standard lays down the guidelines for improving the cyclonic resistance of *kutcha* houses.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

IS No.	*Title*
IS 277 : 2018	Galvanized steel strips and sheets (plain and corrugated) — Specification (*seventh revision*)
IS 280 : 2006	Mild steel wire for general engineering purposes (*fourth revision*)
IS 459 : 1992	Corrugated and semi — Corrugated asbestos cement sheets — Specification (*third revision*)
IS 4826 : 1979	Specification for hot — Dipped galvanized coatings on round steel wires (*first revision*)

3 CLASSIFICATION

It is observed that kutcha houses in the cyclonic region suffer extensive damage. *Kutcha* houses which are widely used in the cyclonic region, are classified on the basis of the commonly used typologies and construction methodology as below:

a) Earth-based wall, with thatched and tiled roof construction;

b) Mud walls with thatched and tiled roof;

c) Brick masonry wall with AC/GI sheet, tiled and thatched roof construction;

d) Laterite stone wall with tiled, GI/AC sheet and thatched roof; and

e) Bamboo frame wall with thatched roof.

3.1 Earth Based Wall, with Thatched and Tiled Roof Construction

Three types of construction are mostly practiced in coastal regions of India for the construction of the earth-based wall, namely:

a) Cob construction;

b) Adobe construction; and

c) Wattle-and-daub construction.

3.1.1 *Cob Construction*

Cob is an earth-building technique based on a mixture of clay, sand, straw and water. The mixture is kneaded with hands, feet or simple tools. Subsequently lumps are made that are then compressed together and shaped by hand forming foundations and walls. Cob construction, which uses only earth, is most common in those areas that traditionally did not have other building materials and resources, but had soil suitable for construction.

FIG. 1 COB WALL HOUSE IN PANDAD VILLAGE, ANAND, GUJRAT

FIG. 2 COB WALL CONSTRUCTION

3.1.2 *Adobe Construction*

Adobe construction, which is very similar to brick or stone construction, was traditionally practiced in areas where the scarcity of construction materials was compounded with unavailability of water sources near the construction site.

FIG. 3 ADOBE HOUSES IN BHIRANDIARI, *KUTCH*

FIG. 4 ADOBE BLOCKS

3.1.3 *Wattle and Daub Construction*

Wattle and daub is a composite building method used for making walls and buildings, in which a woven lattice of wooden strips called wattle is daubed with a sticky material usually made of some combination of wet soil, clay, sand, animal dung and straw. This has been used for at least 6 000 years and is still an important construction method in many parts of the country. Many historic buildings include wattle and daub construction. Wattle and Daub construction is most commonly seen in regions where in addition to suitable soil, timber or bamboo for construction is easily available. It is one of the most practised construction methods that use earth.

FIG. 5 WATTLE AND DAUB HOUSE IN MUNKAPADA, NARMADA

FIG. 6 DAUB IS APPLIED FIRMLY OVER THE LATTICE BY WOMEN

3.2 Mud Walls with Thatched and Tiled Roof

This type of construction is mostly found in almost all coastal regions of India like Maharashtra, Kerala, Odisha, West Bengal, Karnataka, Tamil Nadu and Gujarat. In Andhra Pradesh, special conical houses called '*chutillu*' are deployed. These houses have the following features:

a) Wooden frame mud walls;
b) Thatched roof covering laid on wooden members; and
c) Roof covering having projections outside walls.

FIG. 7 *CHUTILLU* HUTS

FIG. 8 MUD WALLS WITH TILED ROOF RATNAGIRI, MAHARASHTRA

FIG. 9 MUD WALL AND THATCHED ROOF HOUSE, PURI, ODISHA

FIG. 10 MUD WALLS WITH TILED ROOF

3.3 Brick Masonry Wall with Galvanized Iron (GI) or Asbestos Cement (AC), Tiled and Thatched Roof Construction

This type of construction is mainly found in the coastal regions of Maharashtra, Tamil Nadu, Odisha and Karnataka. These houses have the following features:

a) Roof covering of corrugated asbestos cement (AC) or galvanised iron (GI) sheets secured with J and U bolts;

b) Mangalore tiles are laid with an interlocking arrangement. Profile sheets fixed to purlins with metal screws; and

c) Gable-type roof having projections of roof cover outside walls.

FIG. 11 GI ROOF DECK SUPPORTED BY PIPE PURLINS ON MASONRY WALL

FIG. 12 MASONRY EXTERNAL WALLS AND A TIMBER FRAMED UN-TRUSSED LEAN-TO-ROOF WITH AC AND GI SHEETS

FIG. 13 BRICK MASONRY WALLS WITH HIPPED THATCHED ROOF

FIG. 14 BRICK MASONRY WALLS WITH TILED AND CGI SHEET ROOF

FIG. 15 BRICK MASONRY WALLS WITH THATCHED OR CGI SHEET ROOF

FIG. 16 MANGLORE TILES HOUSING, KARNATAKA

3.4 Laterite Stone Wall with Tiled, Galvanized Iron (GI) or Asbestos Cement (AC), Sheet and Thatched Roof

This type of construction is mainly found in the coastal regions of Kerala and Odisha.

FIG. 17 LATERITE STONE MASONRY WALL WITH TILED ROOF

FIG. 18 LATERITE STONE MASONRY WALLS

FIG. 19 THATCHED AND TILED ROOF WITH STONE MASONRY WALLS

3.5 Bamboo Frame Wall with Thatched Roof

This type of construction is mainly found in the coastal regions of Tamil Nadu.

FIG. 20 WOOD AND BAMBOO WALL WITH THATCHED ROOF

3.6 Bamboo Framed Mud Walls with Bamboo Framed Roof

This type of construction is mainly found in the coastal regions of Gujarat. These houses with conical roofs are called '*bhunga'*.

FIG. 21 *BHUNGA* HUT

FIG. 22 *BHUNGA* HUT AND THEIR CONICAL ROOF INSIDE VIEW

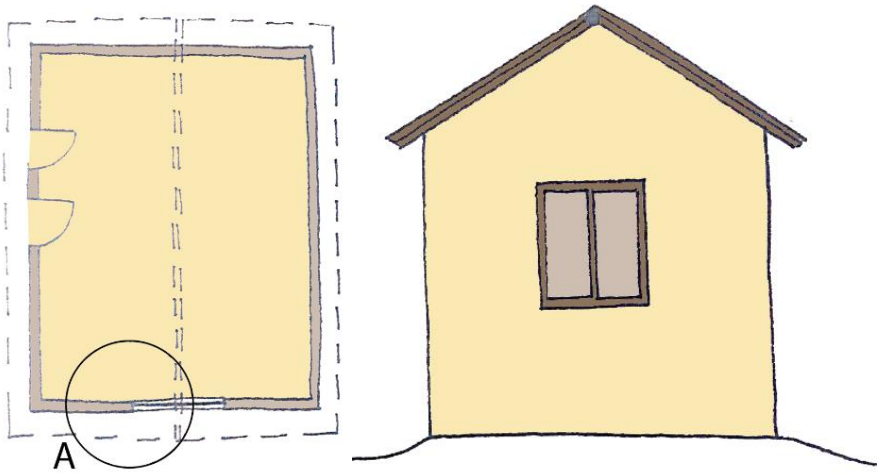
4 TYPICAL DETAIL DRAWING OF THE PREDOMINANT TYPOLOGIES

Typical details for the widely used typologies in the cyclonic region of India is given below:

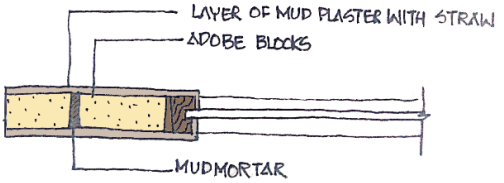
a) Mud wall and thatched roof house;
b) *Chuttilu* huts;
c) Mud walls with tiled roof;
d) Brick masonry wall with galvanized iron (GI) or asbestos cement (AC) sheet;
e) Bamboo frame wall with thatched roof; and
f) Houses with gable roof.

4.1 Mud Wall and Thatched Roof House

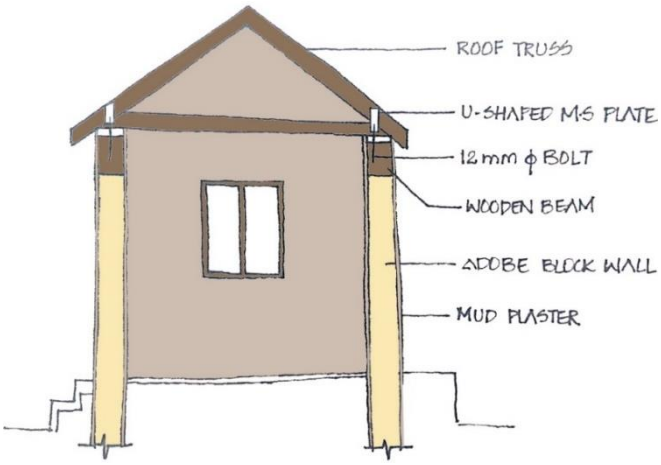
A typical detail drawing of the mud wall and thatched roof house is given in Fig. 23.



PLAN ELEVATION



DETAIL A



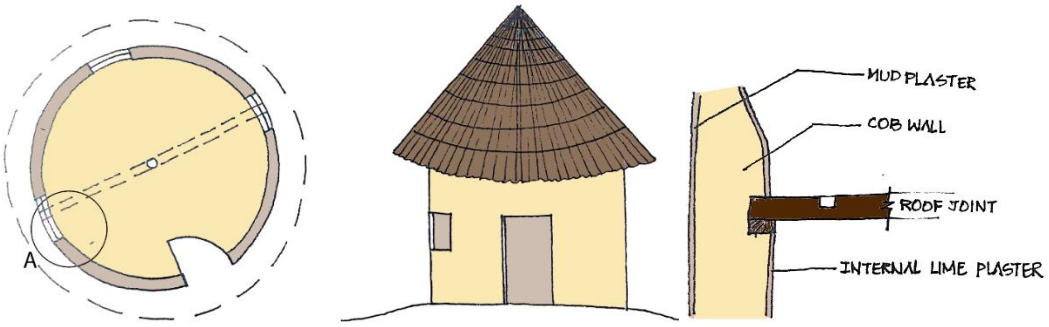
PROPOSED SECTIONAL ELEVATION

FIG. 23 MUD WALL AND THATCHED ROOF HOUSE

4.2 *CHUTILLU* Huts

The '*chuttilu'* is built with mud using the cob wall technique — mixing of mud, water and sometimes straw to create a robust putty-like material.

The leaves of the palm tree are dried and used to thatch the roof of the '*chuttilu'* house. A typical detail drawing of the '*chuttilu'* huts is given in Fig. 24.



PLAN ELEVATION DETAIL A

FIG. 24 *CHUTILLU* HUTS

4.3 Mud Walls with Tiled Roof

A typical detail drawing of the mud walls with tiled roof house is given in Fig. 25.

PLAN ELEVATION DETAIL PLAN

FIG. 25 MUD WALLS WITH TILED ROOF

4.4 Brick Masonry Wall with Galvanized Iron (GI) or Asbestos Cement (AC) Sheet

A typical detail drawing of the brick masonry wall with AC/GI sheet house is given in Fig. 26. IS 277 and IS 459 may be referred for galvanized iron (GI) sheets and asbestos cement (AC) sheets, respectively.

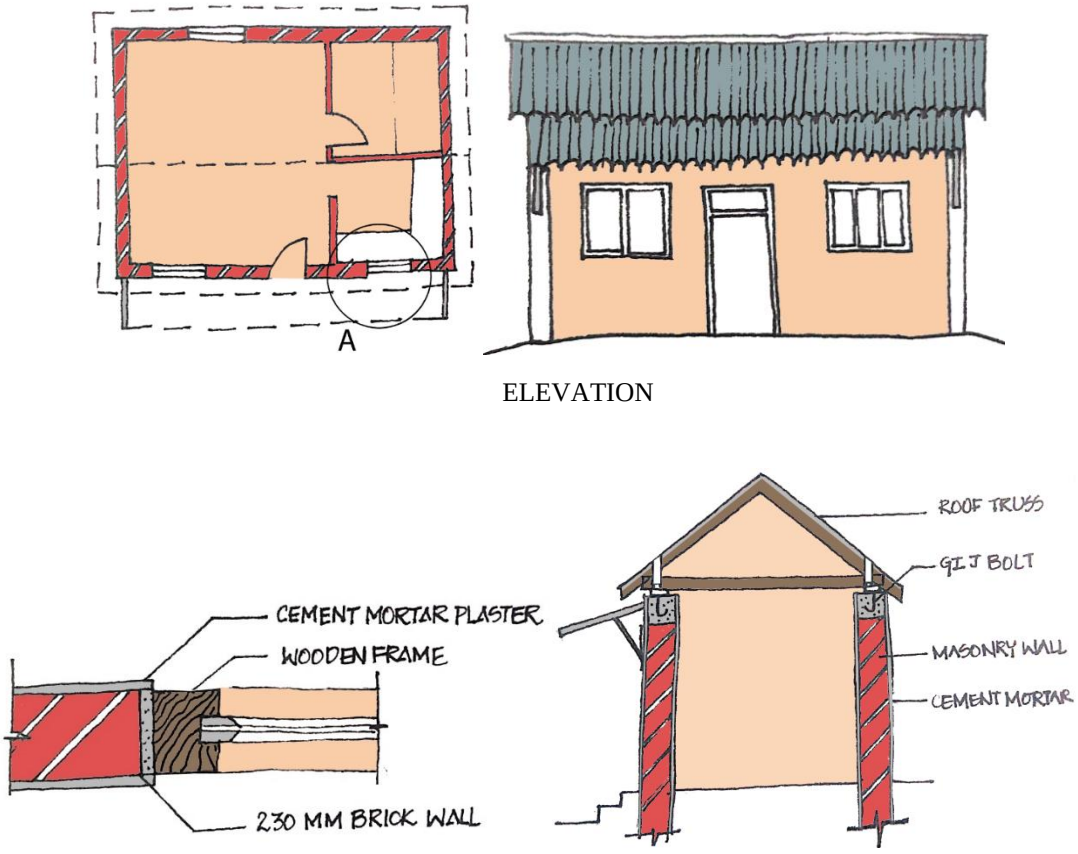


FIG. 26 BRICK MASONRY WALL WITH AC/GI SHEET

4.5 Bamboo Frame Wall with Thatched Roof

A typical detail drawing of the bamboo frame wall with thatched roof house is given in Fig. 27. The connection details for bamboo/*balli* wall frame are given in Fig. 31(A) and Fig. 31(B), and for roof truss are given in Fig. 32

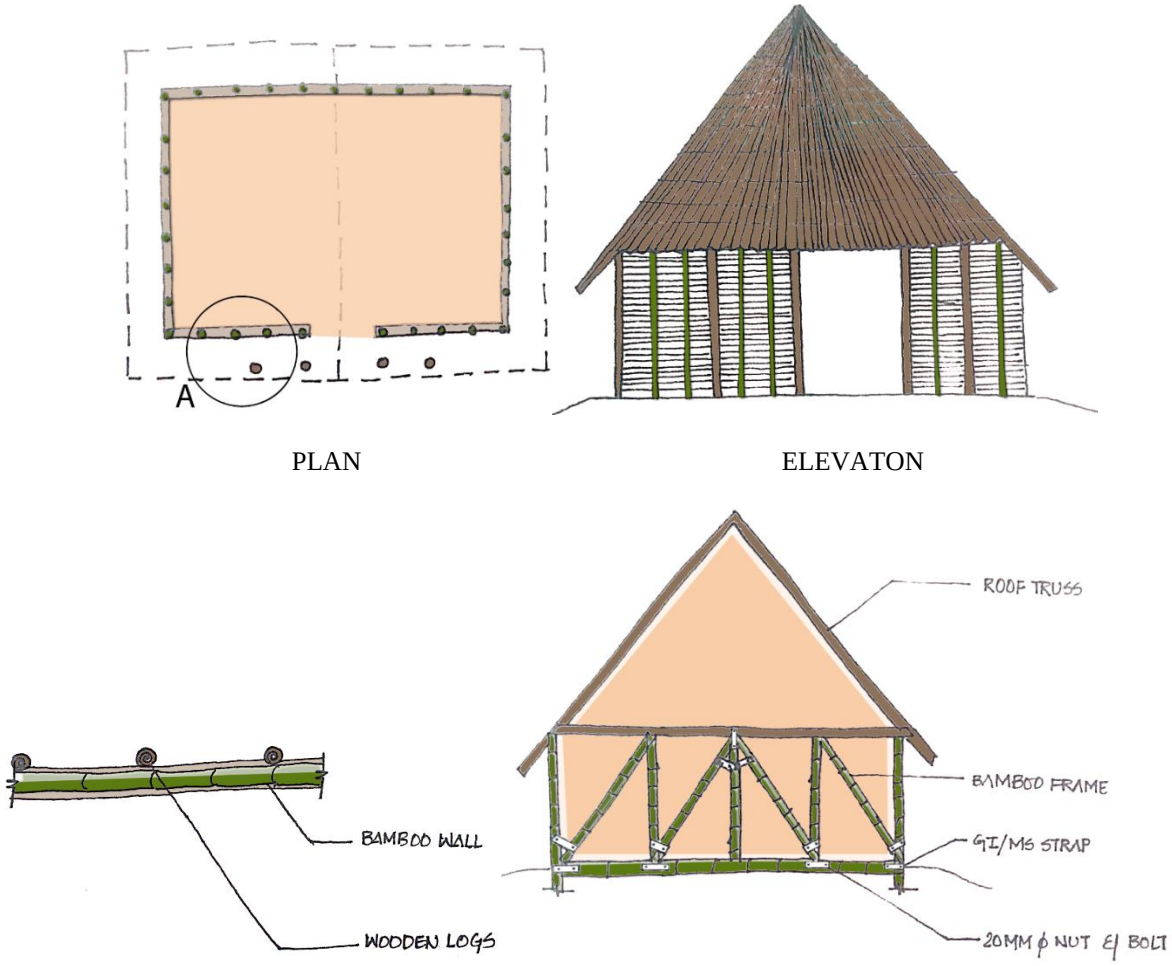


FIG. 27 BAMBOO FRAME WALL WITH THATCHED ROOF

4.6 Houses with Gable Roof

A typical detail drawing of the houses with gable roof is given in the Fig. 28(B). Fig. 28(A) gives the typical drawing without improvement measures.

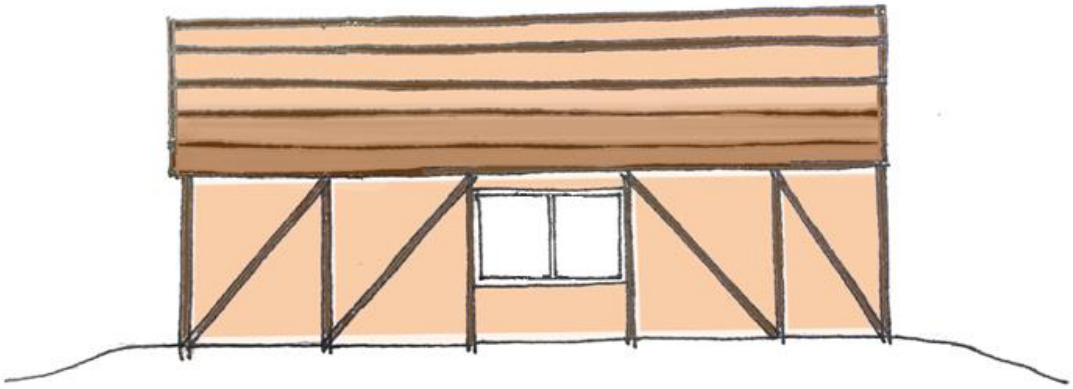


FIG. 28(A) GENERAL CONSTRUCTION PRACTICE OF HOUSES WITH GABLE ROOF

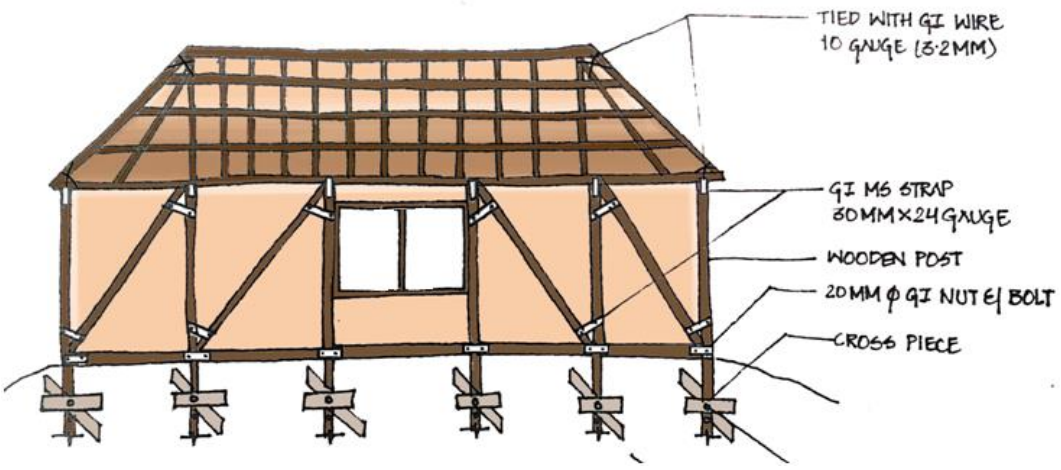


FIG. 28(B) IMPROVED CONSTRUCTION PRACTICE OF HOUSES WITH GABLE ROOF

FIG. 28 HOUSES WITH GABLE ROOF

5 GUIDELINES FOR IMPROVEMENT IN VARIOUS COMPONENTS OF KUTCHA HOUSES

The recommended aspects to be considered for building *kutcha* houses are given below:

a) Effects of roof shape on uplift;
b) Anchoring of wall post (bamboo/*balli*);
c) Bracing system in bamboo/*balli* wall frame;
d) Connection details for bamboo/*balli* truss;
e) Connection of roof truss with wooden wall frame (bamboo/*balli*);
f) Anchorage of timber wall post with foundation;
g) Different connection details of timber wall frame;
h) Bracing system of timber wall frame;
j) Connections for cladding;
k) Roof frame bracing system;
m) Doors and windows; and
n) Glass paneling.

5.1 Effects of Roof Shape on Uplift

For the purpose of reducing wind forces on the roof, a hipped or pyramidal roof is preferable to the gable type roof (*see* Fig. 29).

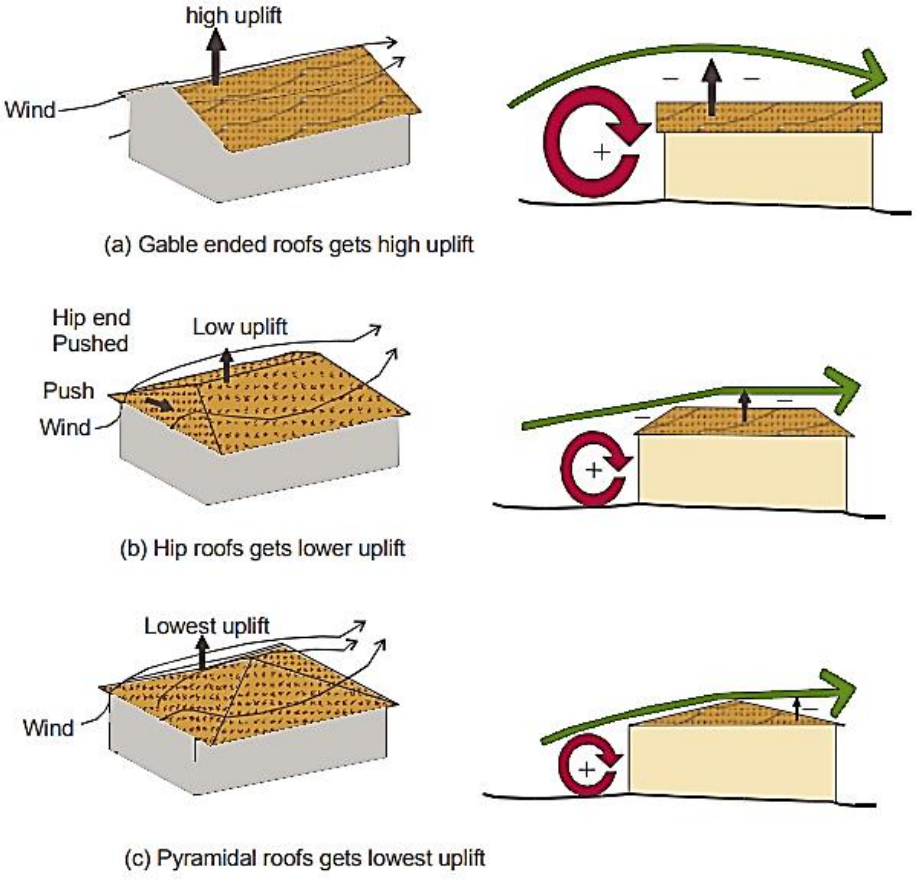


FIG. 29 EFFECTS OF ROOF SHAPE ON UPLIFT FORCES

5.2 Anchoring of Wooden Post Using Cross Pieces

For timber posts, usually cross pieces are nailed at bottom end of the post and buried into the ground to provide necessary anchorage as shown in Fig. 30. Each vertical post of wall should be buried in M 20 concrete up to 900 mm depth from ground level.

The maximum spacing between two adjacent ties should be between 8 feet to 10 feet (2.4 m to 3 m).

5.3 Bracing System in Bamboo/*Balli* Wall Frame

Diagonal bracing system and vertical support [*see* Fig. 31(A) and Fig. 31(B)] should be used to strengthen the walls. It reduces corner failures due to unequal pressures on two adjacent walls during cyclones.

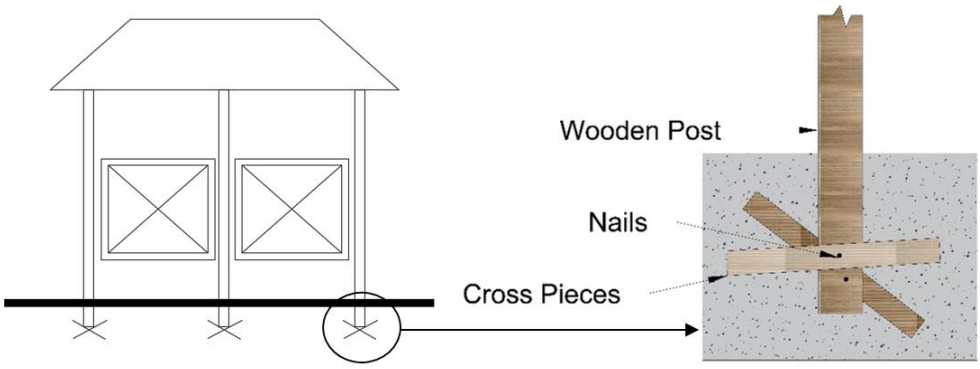


FIG. 30 ANCHORING OF WOODEN POST USING CROSS PIECES

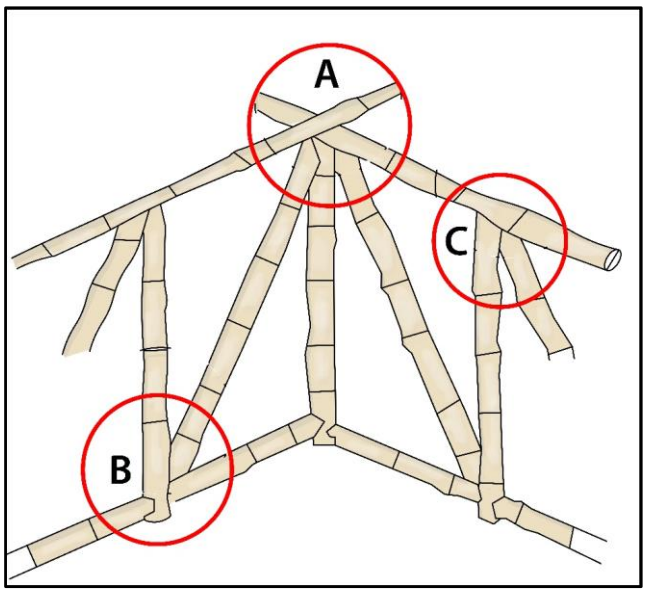


FIG. 31(A) BAMBOO/*BALLI* WALL FRAME

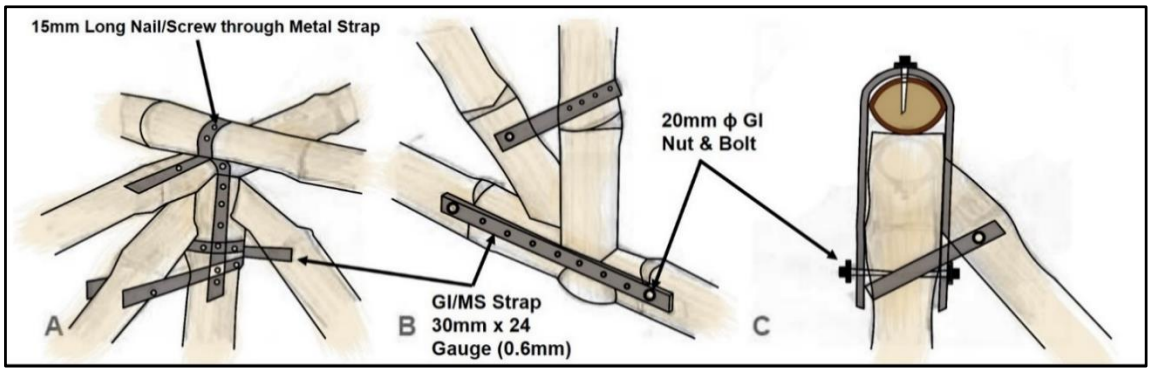


FIG. 31(B) CONNECTION DETAILS OF BAMBOO/*BALLI* WALL

FIG. 31 CONNECTION DETAILS

5.4 Connection Details for Bamboo/*Balli* Truss Suitable connections shall be ensured between various members of the roof truss. At each joint, members should be tied with GI wire of 10 Gauge (3.2 mm) to enable better integrity for the structure as a whole as shown in Fig. 32.

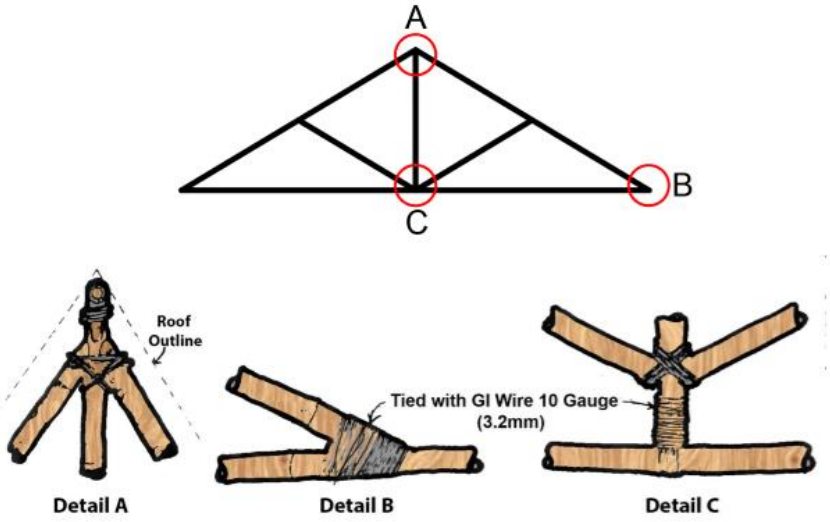


FIG. 32 CONNECTION DETAILS OF ROOF TRUSS

5.5 Connection of Roof Truss with Wooden Wall Frame (Bamboo/*Balli*)

Connection between different members of roof truss and wall frame is shown in Fig. 33. These are tied together either using steel wire of 2.5 mm to 4 mm diameter or by mild steel (MS) strip of minimum 0.6 mm thickness and minimum width of 30 mm. IS 280 and IS 4826 may be referred for wire.

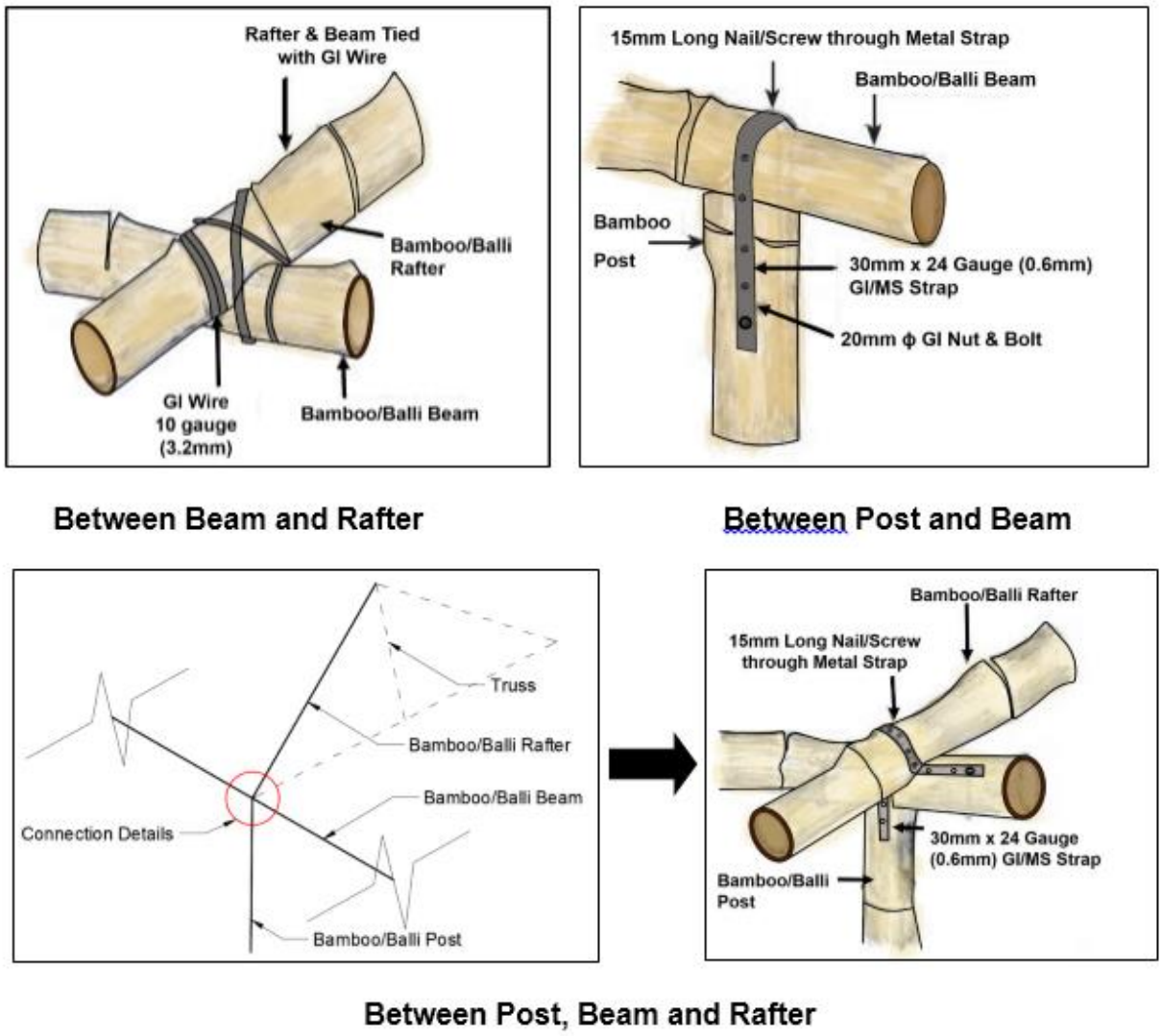


FIG. 33 CONNECTION OF ROOF FRAME WITH WOODEN WALL FRAME

5.6 Anchorage of Timber Wall Post with Foundation

J-shaped anchors should be embedded into the concrete for fixing the timber structure with foundation as shown in Fig. 34.

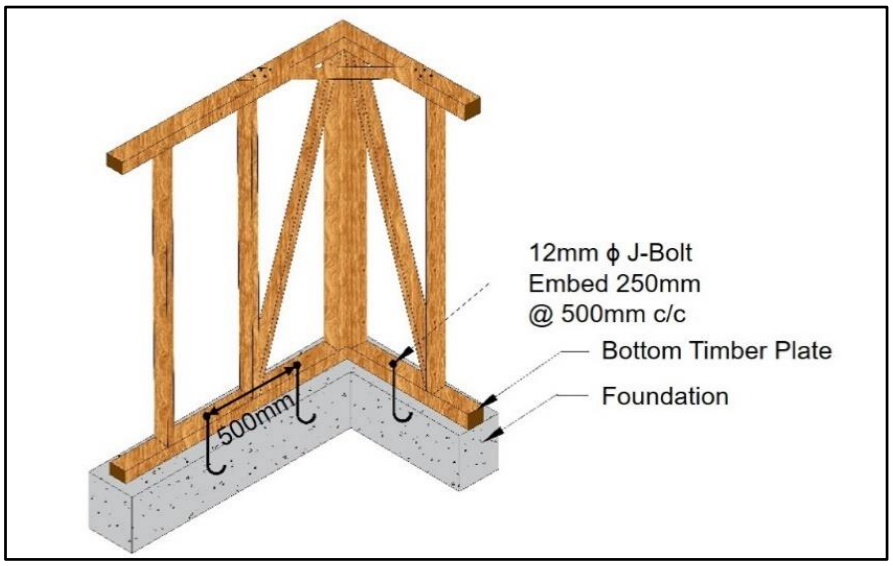


FIG. 34 ANCHORING OF BOTTOM TIMBER PLATE TO FOUNDATION

5.7 Different Connection Details of Timber Wall Frame

In places where timber frames are used for construction, the following details can be used:

a) The uprights (or posts) are fixed to the timber sill plate, which is bolted to the foundations as shown in Fig. 34;

b) ISA 50 mm × 50 mm × 3 mm or MS plate of size 3 mm × 25 mm and 15 mm long nails/screws should be used as connector for connecting the members of wall frame to improve the cyclone resistance of timber houses. The typical details of timber wall frame connections are shown in Fig. 35(A); and

c) In addition to this, some different types of connections may be used for connecting timber wall frames. Connection of timber wall frame with the help of 50 mm long screws or MS Plate tied with 15 mm nails/screws may also be used [Fig. 35(B)]. Typical view of partially threaded screws is shown in Fig. 35(C).

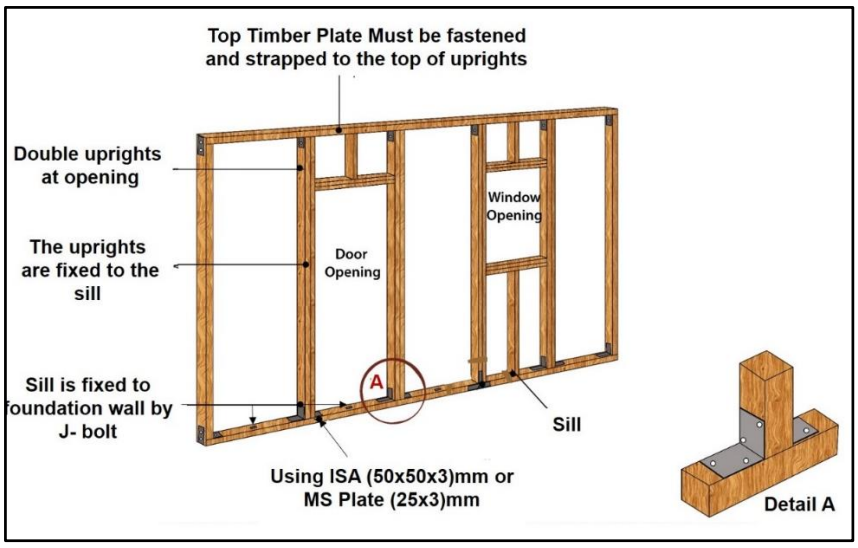


FIG. 35(A) CONNECTION DETAILS OF TIMBER WALL FRAME

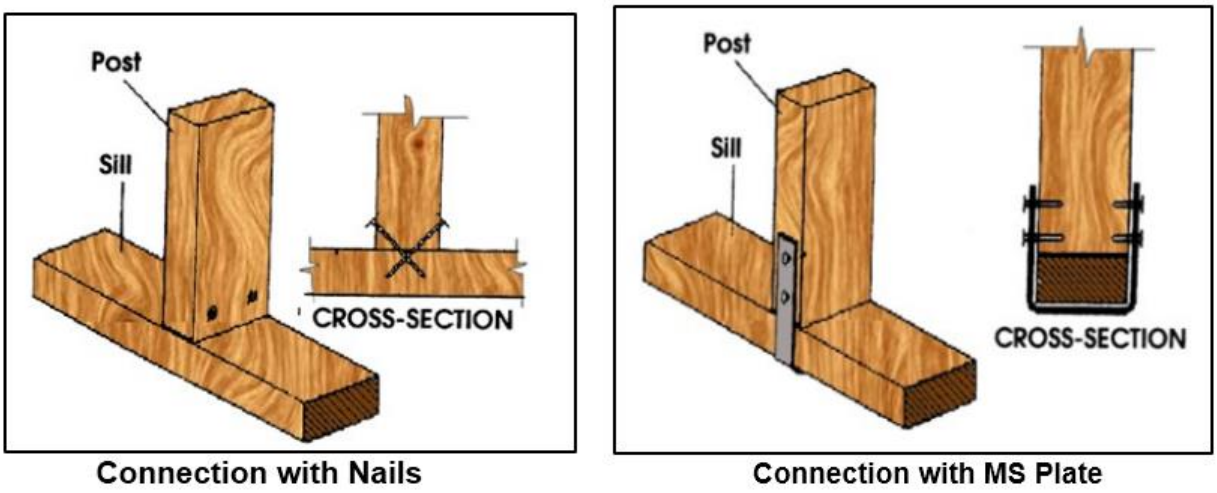


FIG. 35(B) ADDITIONAL CONNECTION DETAILS OF TIMBER WALL FRAME

FIG. 35(C) PARTIALLY THREADED SCREWS

5.8 Bracing System of Timber Wall Frame

In timber buildings, vertical posts, roofs and walls must be braced and tied with 50 mm long screws in each direction. Vertical posts are braced both ways where posts are more than 3 feet (900 mm) away. Walls should be braced across corners at top timber plate level and at both corners of each wall (Fig. 36).

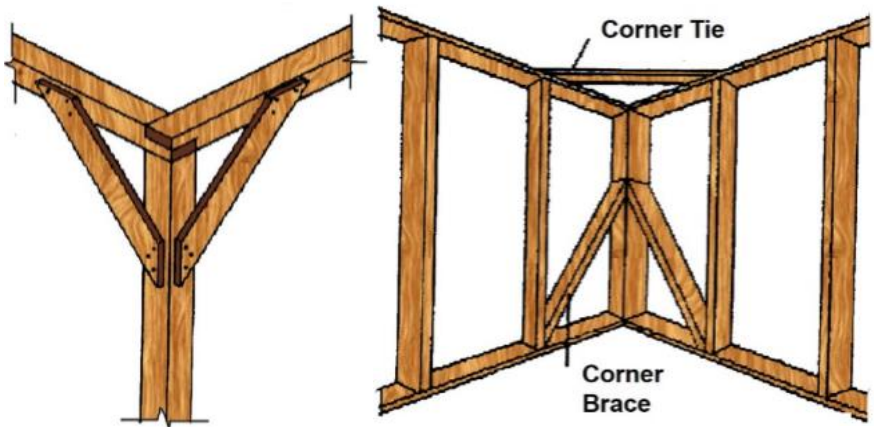


FIG. 36 BRACING SYSTEM OF TIMBER WALL FRAME

5.9 Connection of Roof Frame to Wall Frame

The proper connection of roof framing to the vertical load resisting elements that is, wall or post, is equally important for overall stability of the roof. Care is particularly required while connecting roof trusses to wall frames. Typical connection of timber roof truss framing to timber post through MS straps, twisted MS strap and timber connectors tied with nails as shown in Fig. 37(A) and Fig. 37(B).

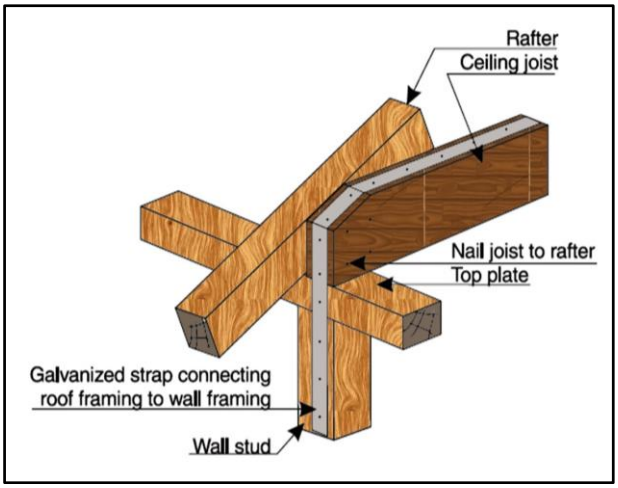


FIG. 37(A) ROOF FRAMING CONNECTION TO TIMBER WALLS BY USING MS STRAP

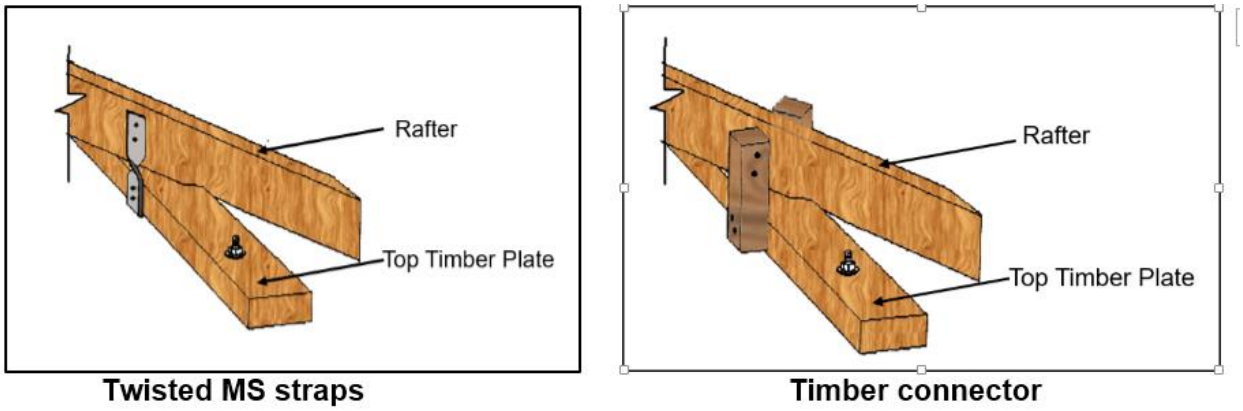


FIG. 37(B) RAFTER CONNECTION WITH TOP TIMBER PLATE

5.10 Connections for Cladding

For normal connections, J-bolts may be used, but for cyclone resistant connections U-bolts are recommended as shown in Fig. 38(A). U-bolts may be used for fixing of corrugated sheets to purlins with an MS plate to avoid punching through the sheet as shown in Fig. 38(B). Properly connected ISA 50 mm × 50 mm × 3 mm can be used to reinforce top roof joints in high suction zones, as shown in Fig. 38(C).

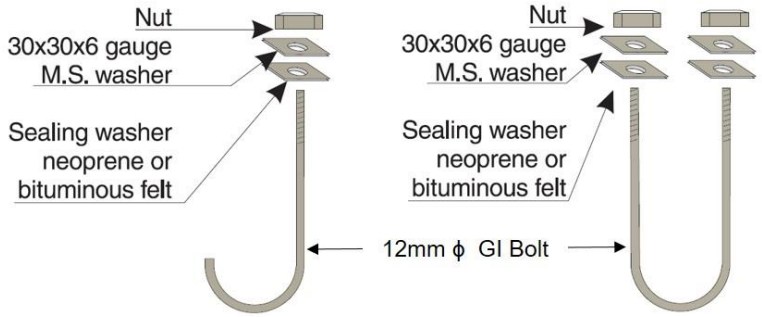


FIG. 38(A) J-BOLT AND U-BOLT

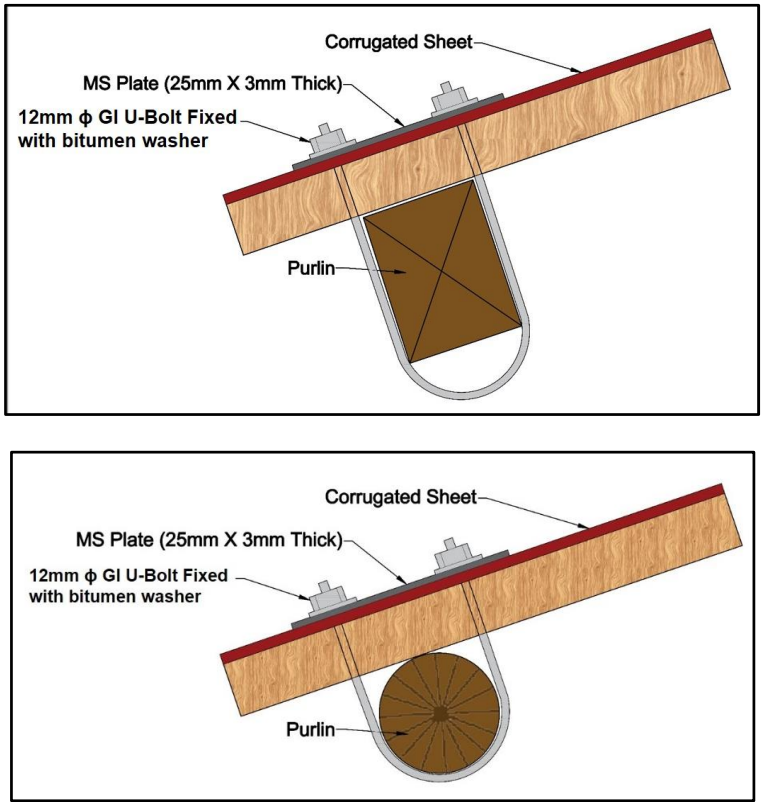


FIG. 38(B) FIXING OF CORRUGATED SHEET TO PURLIN WITH U BOLTS

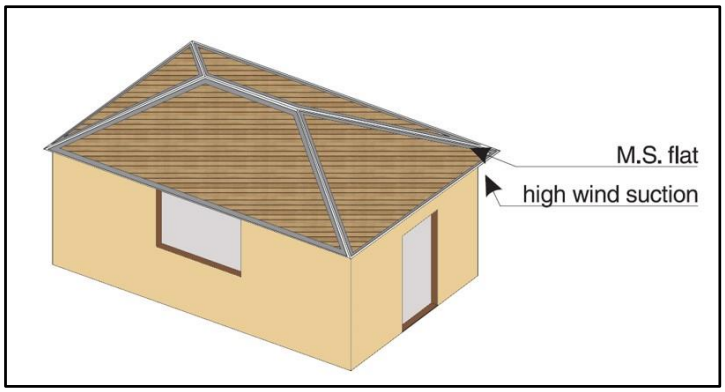


FIG. 38(C) ISA 50 mm × 50 mm × 3 mm SHOULD BE PROVIDED TO REINFORCE TOP ROOF JOINTS IN HIGH SUCTION ZONES

5.11 Roof Frame Bracing System

Eave level bracing may be provided under the roof framing and additionally diagonal 'X' bracing on roof level as shown in Fig. 39(A) and 39(B) respectively. These bracings may be made of timber planks/*ballies* and fixed with 4 strands of twisted GI wires of size 2.5 mm to 4 mm.

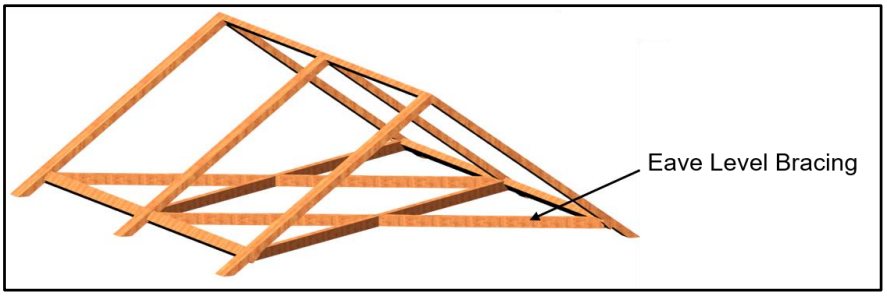


FIG. 39(A) EAVE LEVEL BRACING

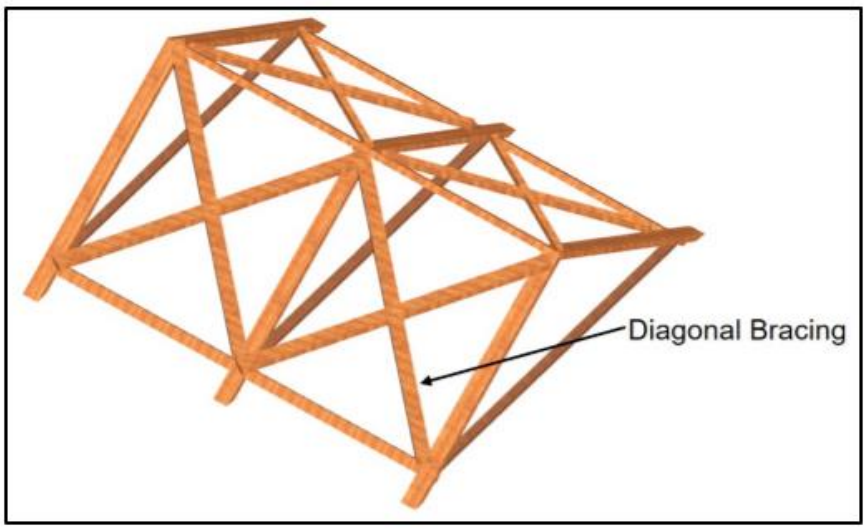
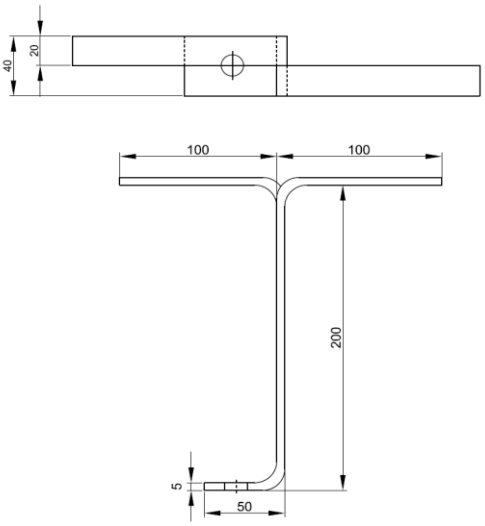


FIG. 39(B) DIAGONAL BRACING AT ROOF LEVEL

5.12 Doors and Windows

Door or window frames be securely fixed in the walls using hold fasts so as to resist the local wind pressures. Door frame should be provided with minimum 3 No. of holdfast and window frame should be provided with minimum 2 No. of holdfast on each side which should be embedded in masonry wall. The cross-section details of holdfast are shown in Fig. 40. The holdfast shall be made of mild steel flat not less than 5 mm thick.



All dimension in millimetres

FIG. 40 CROSS-SECTION OF HOLDFAST

5.13 Glass Paneling

a) Glass panels can be strengthened by pasting thin plastic film or paper strips [Fig. 41(A) and Fig. 41(B)]. This will help in holding against flying the debris of glass panel in case of breakage. It will also introduce some damping in the glass panels and reduce their vibrations; and

b) Further, to prevent damage of the glass panels from the flying wind-borne missiles, a metallic fabric/mesh should be provided outside the large panels.

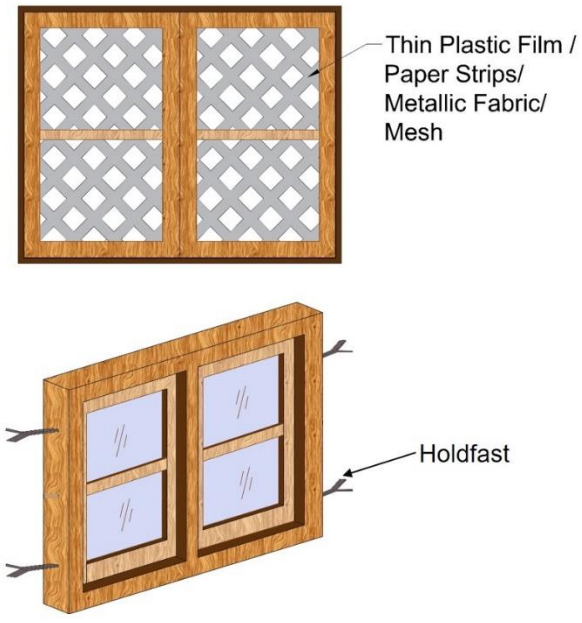


FIG. 41(A) PROTECTION OF GLASS PANELLING AND ADEQUATE ANCHORAGE OF WOODEN DOOR AND WINDOW FRAMES WITH HOLDFASTS

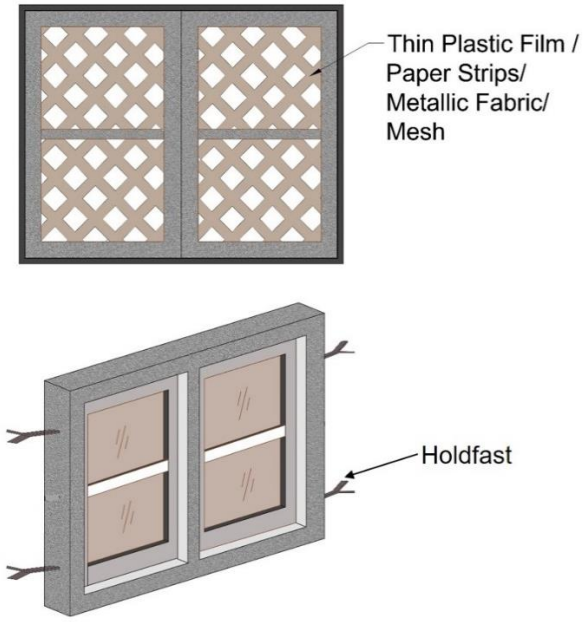


FIG. 41(B) PROTECTION OF GLASS PANELING AND ADEQUATE ANCHORAGE OF ALUMINUM/MILD STEEL SECTIONS OF DOOR AND WINDOW FRAMES WITH HOLDFASTS

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Cyclone Resistant Structures Sectional Committee, CED 57

Organization	*Representative(s)*
In Personal Capacity (*B-03-3, Raheja Atlantis, National Highway 08, Sector 31- 32A, Gurugram*)	DR PREM KRISHNA **(*Chairperson*)**
Adlakha Associates Private Limited, New Delhi	SHRI PRAMOD ADLAKHA SHRI ABHAYA ADLAKHA (*Alternate*)
BES Consultants Private Limited, Mumbai	SHRI RAJAN GOVIND SHRI VENUGOPAL S. B. (*Alternate*)
Central Public Works Department, New Delhi	SHRI A. K. RAJDEV SHRI SAUROBH KUMAR (*Alternate*)
CSIR - Central Building Research Institute, Roorkee	DR ACHAL MITTAL SHRI SIDDHARTH BEHERA (*Alternate*)
CSIR - Central Road Research Institute, New Delhi	DR R. K. GARG SHRI S. S GAHARWAR (*Alternate*)
CSIR - Structural Engineering Research Centre, Chennai	DR P HARIKRISHNA SHRI G. RAMESH BABU (*Alternate* I) DR M. KEERTHANA (*Alternate* II)
Engineers India Limited, New Delhi	DR G. G. SRINIVAS ACHARY SHRI BHASKAR PAL (*Alternate*)
Housing and Urban Development Corporation Limited, New Delhi	SHRI DEEPAK BANSAL
India Meterological Department, New Delhi	DR ANAND KUMAR DAS SHRIMATI MONICA SHARMA (*Alternate* I) DR AMIT BHARDWAJ (*Alternate* II)
Indian Institute of Technology - BHU, Varanasi	DR S. MANDAL DR A. SARKAR (*Alternate*)
Indian Institute of Technology, Delhi	PROF A. K. JAIN DR DIPTI RANJAN SAHOO (*Alternate*)
Indian Institute of Technology, Kanpur	DR RAJEEV GUPTA
Indian Institute of Technology, Madras	PROF K. MURALI PROF S. A. SANNASIRAJ (*Alternate*)
Indian Society for Wind Engineering, New Delhi	PROF MAHESH TANDON PROF AJAY GAIROLA (*Alternate*)
Jaypee University of Engineering and Technology, Guna	DR S. ARUNACHALAM
Kuraray India Private Limited, New Delhi	SHRI MALVINDER SINGH SHRI SUMIT BANERJEE (*Alternate*)

Organization	*Representative(s)*
Larsen and Toubro Limited, Mumbai	SHRIMATI BALA SARASWATHI ILANGO SHRI R. JOHN SANDEEP (*Alternate* I) SHRI PELLAKURU ANVESH (*Alternate* II)
Military Engineer Services, New Delhi	SHRI P. K. JAIN COL N. CHAKRABORTY (*Alternate*)
National Disaster Management Authority, New Delhi	SHRIMATI RANU CHAUHAN MOHAMMAND JAVED IQBAL (*Alternate*)
National Institute of Ocean Technology, Chennai	SHRI A. SATAYA KIRAN RAJU SHRI K. MULLAIVENDHAN (*Alternate*)
Nuclear Power Corporation of India Limited, Mumbai	SHRI ARVIND SHRIVASTAVA SHRI AMIT VIYAJWARGIYA (*Alternate*)
RWDI Consulting Engineers (India) Private Limited, Thiruvananthpuram	DR K. SURESH KUMAR SHRI RAHUL P. S. (*Alternate*)
STUP Consultants Private Limited, Mumbai	SHRI D. C. ATHAVALE SHRI A. D. RALKAR (*Alternate*)
Sardar Vallabhbhai National Institute of Technology, Surat	DR ATUL K. DESAI PROF ASHOK J. SHAH (*Alternate*)
Skeleton Consultants Private Limited, Noida	DR ABHAY GUPTA
Visvesvaraya National Institute of Technology, Nagpur	DR O. R. JAISWAL DR L. M. GUPTA (*Alternate*)
In Personal Capacity (*4, Jorawar Bhavan, 93, Maharishi Carve Road, Marine Lines, Mumbai*)	MS ALPA SHETH
BIS Directorate General	SHRI ARUNKUMAR S., SCIENTIST 'E'/DIRECTOR AND HEAD (CIVIL ENGINEERING) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary
DR MANOJ KUMAR RAJAK
SCIENTIST 'D'/JOINT DIRECTOR
(CIVIL ENGINEERING), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CED 57 (20533).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central : 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002 { 2323 7617

Eastern : 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091 { 2367 0012 2320 9474

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019 { 265 9930

Southern : C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113 { 2254 1442 2254 1216

Western : Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093 { 2821 8093

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. CHANDIGARH. CHENNAI. COIMBATORE. DEHRADUN. DELHI. FARIDABAD. GHAZIABAD. GUWAHATI. HIMACHAL PRADESH. HUBLI. HYDERABAD. JAIPUR. JAMMU & KASHMIR. JAMSHEDPUR. KOCHI. KOLKATA. LUCKNOW. MADURAI. MUMBAI. NAGPUR. NOIDA. PANIPAT. PATNA. PUNE. RAIPUR. RAJKOT. SURAT. VISAKHAPATNAM.

Published by BIS, New Delhi