DESIGN CATALOGUE FOR RECONSTRUCTION OF EARTHQUAKE RESISTANT HOUSES

VOLUME II

MARCH, 2017 (CHAITRA,2073)

GOVERNMENT OF NEPAL
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
BABARMAHAL, KATHMANDU
DESIGN CATALOGUE FOR RECONSTRUCTION OF EARTHQUAKE RESISTANT HOUSES

Approved by Nepal Government, Ministry of Urban Development (Minister Level)
2073/12/16

VOLUME-II

GOVERNMENT OF NEPAL
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
BABARMAHAL, KATHMANDU
FOREWORD

It is my immense pleasure that Design Catalogue Volume II comprising of alternative construction materials and technologies is published. The devastating Earthquake of 25th April 2015 and its aftershocks not only resulted in massive loss of life and properties but also raised awareness among development practitioners the need to improve our physical infrastructures to make our communities resilient against these kind of disasters. I see this post-earthquake reconstruction as an opportunity to improve our housing construction technology and practice at grass root level.

The objective of this document is to pave way for use of alternate materials and technologies in the reconstruction process. As per the principles set by Post Disaster Needs Assessment (PDNA) for housing and human settlements recovery and reconstruction, the proposed cost efficient, environment friendly and green technologies are expected to be helpful for sustainable reconstruction of both urban and rural houses.

I would like to sincerely thank Mr. Deependra Nath Sharma, respected Secretary of Ministry of Urban Development for his valuable support and suggestion during the process. I am also thankful to Mr. Ravi Shah, former Deputy Director General, Mr. Ram Chandra Dangal, Deputy Director General (Housing Division) and Mr. Raju Neupane, Senior Divisional Engineer and all the staffs of Housing Division for their continuous involvement during the preparation of this document. I also express my thanks to the team of Central Level Project Implementation Unit (CLPIU) for their support in bringing out this publication. My thanks also goes to all the personnel and agencies for their hard work and concerned efforts on preparation of this important document.

Er. Shiva Hari Sharma
Director General,
Department of Urban Development and Building Construction (DUDBC)
I would like to congratulate all the personnel and agencies involved in the development of Design Catalogue Volume II for reconstruction of Earthquake Resistant Houses. This publication has been developed by the Department of Urban Development and Building Construction to support urban and rural households in the reconstruction of their houses.

The second volume of Design Catalogue consists of seventeen model designs based on twelve alternative materials and technologies not covered by Nepal National Building Code. A wide variety in terms of materials, technology, cost, size and layout are provided to cater the diverse need of both urban and rural households. The proposed designs are ready to use designs and technical details are provided accordingly.

I again express my sincere thanks to members of Technical Working Group, Task Force, Structural experts, UNDP and all personnel of DUDBC and Central Level Project Implementation Unit (CLPIU) involved directly or indirectly in preparation of this publication.

Er. Ram Chandra Dangal
Deputy Director General,
Department of Urban Development and Building Construction (DUDBC)
BACKGROUND

The devastating earthquake of April 25th, 2015 and its aftershocks caused widespread damage to both life and properties. Housing and Human settlement sector was one of the most affected sector. The Government of Nepal figures indicate that around 602,257 houses were fully damaged, 285,099 houses were partially damaged and loss of life was about 9000.

The Post Disaster Needs Assessment (PDNA) report of Government of Nepal, sets out principles for housing and human settlements recovery and reconstruction as follows:

• Encourage the participation of communities by empowering them to take control of reconstruction of their houses and ensuring facilitation of Owner Driven reconstruction
• A comprehensive view of housing reconstruction should indicate holistic habitat development, with basic services and community infrastructure. The principles of Build Back Better (BBB) should translate into a concept of safer settlements.
• Reconstruction should be seen as a vehicle to build long-term community resilience by reducing vulnerabilities and strengthening community capacities to mitigate future disasters through improved construction practices for the majority of building stock in the country.
• Strengthen the local economy through reconstruction and processes that work to the benefit of the poor and marginalised sections who are mostly in the informal sector. Reconstruction should provide an opportunity for the poor to upgrade their living conditions.
• Ensure sustainable and environment-friendly reconstruction processes, taking note of climate change, natural resource management and scientific risk assessments.
• Ensure that rehabilitation is equitable and inclusive.
INTRODUCTION

DUDBC has prepared second volume of Design Catalogue and named it as “Catalogue for Reconstruction of Earthquake Resistant Houses Volume II”. The Catalogue includes architectural design, structural detailing and material estimate. The main objective is to support urban and rural households in reconstruction of their houses.

The model designs of seventeen houses provided in the catalogue are placed under the following twelve technologies:

- Interlocking Brick Masonry
- Confined Hollow Concrete Block Masonry
- Hollow Concrete Block Masonry
- Compressed Stabilized Earth Block Masonry
- Random Rubble Masonry with GI Wire Containment
- Bamboo and Stone Masonry Hybrid Structure
- Rat Trap Bond Masonry
- Earth Bag Masonry
- Light Gauge Steel Structure
- Steel Structure
- Timber Structure
- Debris block Masonry

The designs provided in this catalogue are based on calculations, model test and analytical tests as these technologies are not covered by Nepal National Building Code, 2060. These designs are approved by Ministry of Urban Development. For each design included in the catalogue, the following information is provided:

- 3D view of the design
- Floor plans
- Elevations
- Section
- Structural Details
- Quantity estimate of major materials

Designs included in this catalogue can be selected and used as they are, for reconstruction of urban and rural housing. For designs, other than those included in this catalogue, detailed engineering design and approval from concerned authorities shall be done.
<table>
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<th>MODEL NO.</th>
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</table>
INTERLOCKING BRICK MASONRY
I.B.-1.1
I.B.-1.2
I.B.-1.3
Interlock Brick Technology consists of specially designed unburnt bricks with tongue and groove features that allows bricks to interlock each other in masonry and thereby reduces mortar usage. Construction with interlocking brick is economical, quick and environment friendly. Special design of interlocking bricks allows for vertical reinforcement bars in strategic locations of buildings. Three designs are featured under this category. Model I.B 1.1 and I.B 1.3 are single storied one bedroom units. Load bearing walls are of Interlocking Bricks with corrugated galvanised iron sheet roofing. Model I.B. 1.2 is a two storied 3 bedroom housing units. Interlocking bricks are used for wall and precast joist and pan are used for floors. Both vertical and horizontal reinforcement are used and grouted respectively in different part of building

**MATERIAL PROPERTIES**

Block Size: 30cm X 15cm X 10cm of Full Size
15cm X 15cm X 10cm of Half Size
Min Compressive Strength of Block : 3.5 MPa
Nominal Mix Ratio: 1:1.5:3 (C:S:A)
Min Yield Strength of Reinforcing Steel :415 MPa
### MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

#### ONE STOREY

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone</th>
<th>Interlocking Bricks</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>CGI sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
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<tr>
<td></td>
<td>Cu.m</td>
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<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
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<td>Bundle</td>
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<td>Cu.m.</td>
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<td>-</td>
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<td>3.5</td>
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<td>TOTAL</td>
<td>8.4</td>
<td>4,912</td>
<td>57</td>
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<td>279.4</td>
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<td>6.5</td>
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</table>
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

GROUND FLOOR PLAN
FLOOR AREA: 20.16 SQ.M.

- BEDROOM: 2850 X 1950
- LIVING ROOM: 2250 X 2400
- KITCHEN: 1500 X 2850

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

MINISTRY OF URBAN DEVELOPMENT

HOUSING TYPE: I.B.-1.1
DRAWING TITLE: GROUND FLOOR PLAN
SCALE: NONE
DATE: 2/5
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

ONE STOREY

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: I.B.-1.1
DRAWING TITLE: SECTION

SCALE: NONE
DATE: 4/5

ONE STOREY

SECTION AT A-A

REFER ROOFING AND BAND DETAILS

REFER FOUNDATION DETAILS

150MM D.P.C BAND

10Φ VERTICAL REINFORCEMENT ANCHORED AT FOUNDATION WITH 1:4 CEMENT MORTAR WITH MIN. CLEAR COVER 25MM

MORTAR LAYER UNDER 1ST LAYER OF BRICK TO MAKE IT PERFECTLY HORIZONTAL

6 NOS. 10Φ REINFORCEMENT

26 GAUGE CGI ROOFING MATERIALS

26MM X 26MM BATTENS @ 300MM C/C

180MM X 90MM RAFTERS @ 600MM C/C

1 LAYERS U-BLOCK WITH 10Φ HORIZONTAL REINFORCEMENT @ ROOF TIE LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS 10Φ HORIZONTAL REINFORCEMENT @ LINTEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS U-BLOCK WITH 10Φ HORIZONTAL REINFORCEMENT @ SILL LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

150MM INTERLOCKING BRICK WALL GROUTED WITH MICRO-CONCRETE OF CEMENT, SAND AND CHIPS (1:2:3).

REFER ROOFING AND BAND DETAILS

75MM X 75MM BATTENS @ 300MM C/C

1 LAYERS U-BLOCK WITH 10Φ HORIZONTAL REINFORCEMENT @ ROOF TIE LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS 10Φ HORIZONTAL REINFORCEMENT @ LINTEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS U-BLOCK WITH 10Φ HORIZONTAL REINFORCEMENT @ SILL LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

150MM INTERLOCKING BRICK WALL GROUTED WITH MICRO-CONCRETE OF CEMENT, SAND AND CHIPS (1:2:3).

REFER ROOFING AND BAND DETAILS

75MM X 75MM BATTENS @ 300MM C/C

1 LAYERS U-BLOCK WITH 10Φ HORIZONTAL REINFORCEMENT @ ROOF TIE LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

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150MM INTERLOCKING BRICK WALL GROUTED WITH MICRO-CONCRETE OF CEMENT, SAND AND CHIPS (1:2:3).
### TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Reinforced Stabilized Interlocking Brick Masonry Structure with horizontal and vertical reinforcing bars in strategic locations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of Stone Masonry in 1:6 cement sand mortar. Foundation size shall be of width 800mm and depth 800 mm (refer drawing).</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>R.C.C (1:1:5:3) band of size 450mm x 150 mm. 6 nos. of 10 mm Ø reinforcement with 8 mm Ø stirrups at 150 mm C/C.</td>
</tr>
<tr>
<td>Wall</td>
<td>Load bearing walls of Interlocking bricks. Interlocking bricks shall be made of cement and soil mixed in 1:8 ratio. Two types of Interlocking blocks; normal and U shaped shall be used in full size (300 x 150 x 100 mm) and half size (150 x 150 x 100 mm). These blocks shall be air cured for 1 day and water cured for 21 days. Minimum Compressive strength of the block shall be 3.5 Mpa. 12 mm Ø vertical bars shall be provided at corners and joints and grouted with Micro concrete 1:2:3 (Cement, Sand &amp; Chips) ratio. Horizontal reinforcement requirement is stated in sill and lintel details below.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>2 layers of special U shaped Interlocking bricks shall be used in Sill level. In the grove of U shaped Bricks, 12 mm Ø reinforcements shall be provided in each layer and grouted with Micro concrete 1:2:3 (Cement, Sand and Chips) ratio.</td>
</tr>
<tr>
<td>Lintel Band</td>
<td>2 layers of special U shaped Interlocking bricks shall be used in Lintel level. In the grove of U shaped Bricks, 12 mm Ø reinforcements shall be provided in each layer and grouted with Micro concrete 1:2:3 (Cement, Sand and Chips) ratio.</td>
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<tr>
<td>Roof</td>
<td>Lightweight roof of corrugated Iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
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**MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY**

**TWO STOREY**

![3D View of Two-Storey Building](image)

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Housing Type: I.B.-1.2

Drawing Title: Estimate and 3D View

Scale: None

Date: 1/5
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY  TWO STOREY

HOUSING TYPE: I.B.-1.2
DRAWING TITLE: FLOOR PLANS
SCALE: NONE
DATE: 2/5

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

GROUND FLOOR PLAN
AREA: 40.36 SQ.M.

FIRST FLOOR PLAN
AREA: 40.36 SQ.M.
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

SIDE ELEVATION

FRONT ELEVATION

SIDE ELEVATION

BACK ELEVATION

HOUSING TYPE: I.B.-1.2
DRAWING TITLE: ELEVATIONS

DATE: 3/5

SCALE: NONE
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

Housing Type: I.B.-1.2

Drawing Title: Section

Scale: None

Date: 4/5

Two Storey

- **Foundation Details**:
  - 6 Nos. 10Φ Reinforcement
  - 150 mm D.P.C Band
  - 12Φ Vertical Reinforcement Anchored at Foundation

- **Wall Details**:
  - 2 Layers U-Block with 12Φ Horizontal Reinforcement @ Roof Tie Level
  - 2 Layers 12Φ Horizontal Reinforcement @ Lintel (with 1:2:3 Cement: Sand: Chips)
  - 2 Layers U-Block with 12Φ Horizontal Reinforcement @ Sill Level (with 1:2:3 Cement: Sand: Chips)
  - 2 Layers U-Block with 12Φ Horizontal Reinforcement @ Bottom Wall Level (with 1:2:3 Cement: Sand: Chips)

- **Floor Details**:
  - Wooden or RCC Concrete Floor

- **Roofing Details**:
  - 26 Gauge CGI Roofing Materials
  - 75 mm x 75 mm Battens @ 300 mm C/C
  - 180 mm x 90 mm Rafters @ 600 mm C/C

- **Other Details**:
  - 150 mm Interlocking Brick Wall Grouted with Micro-Concrete of Cement, Sand and Chips (1:2:3)
  - Refer Roofing and Band Details
  - Refer Foundation Details

- **Section at A-A**
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Reinforced Stabilized Interlocking Brick Masonry Structure with horizontal and vertical reinforcing bars in strategic locations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of Stone/Brick Masonry in 1:6 cement sand mortar. Foundation size shall be width 800 mm and depth 800 mm (refer drawing).</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>R.C.C (1:1.5:3) band of size 450mm x 150 mm. 6 nos. of 10 mm Ø reinforcement with 8 mm Ø stirrups at 150 mm C/C.</td>
</tr>
<tr>
<td>Wall</td>
<td>Load bearing walls of Interlocking bricks. Interlocking bricks shall be of cement and soil mixed in 1:8 ratio. Two types of Interlocking blocks; normal and U shaped shall be used in full size (300 x 150x 100 mm) and half size (150 x 150 x 100 mm). These blocks shall be air cured for 1 day and water cured for 21 days. Minimum Compressive strength of the block shall be 3.5 Mpa. 12 mm Ø vertical bars shall be provided at corners and joints and grouted with Micro concrete 1:2:3 (Cement, Sand &amp; Chips) ratio. Horizontal reinforcement requirement is stated in sill and lintel details below.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>2 layers of special U shaped Interlocking bricks shall be used in Sill level. In the groove of U shaped Bricks, 12 mm Ø reinforcements shall be provided in each layer and grouted with Micro concrete 1:2:3 (Cement, sand and chips) ratio.</td>
</tr>
<tr>
<td>Lintel Band:</td>
<td>2 layers of special U shaped Interlocking bricks shall be used in Lintel level. In the groove of U shaped Bricks, 12 mm Ø reinforcements shall be provided in each layer and grouted with Micro concrete 1:2:3 (Cement, sand and chips) ratio.</td>
</tr>
<tr>
<td>Floor:</td>
<td>50 mm thick cast in Situ Micro concrete over precast pans and precast concrete joists of 50mm x 200 mm.</td>
</tr>
<tr>
<td>Roof:</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
</tr>
</tbody>
</table>
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

HOUSING TYPE: I.B.1.1 AND I.B. 1.2

FOUNDATION OF STONE MASONRY IN CEMENT MORTAR

150MM STONE SOLING
COMPACTED EARTH

U-BLOCK WITH 12Φ HORIZONTAL REINFORCEMENT @ ROOF TIE LEVEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS 12Φ HORIZONTAL REINFORCEMENT @ LINTEL (WITH 1:2:3 CEMENT: SAND: CHIPS)

2 LAYERS 12Φ HORIZONTAL REINFORCEMENT @ SILL (WITH 1:2:3 CEMENT: SAND: CHIPS)

3" P.C.C
FLAT BRICK SOLING
COMPACTED EARTH

MORTAR LAYER UNDER 1ST LAYER OF BRICK TO MAKE IT PERFECTLY HORIZONTAL

6 NOS.10 OR12Φ REINFORCEMENT

150MM D.P.C BAND

12MM Φ VERTICAL REINFORCEMENT ANCHORED AT FOUNDATION COVERED IN 1:4 CEMENT MORTAR WITH MIN. 25MM COVER

3" P.C.C

120MM STONE SOLING
COMPACTED EARTH

ROOF, LINTEL AND SILL LEVEL

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

DRAWING TITLE: STRUCTURAL DETAILS

SCALE: NONE

I.B.-1.1/1.2

DATE:
1/8
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

TYPICAL ELEVATION (REBAR DETAIL IN WALL)

- 2 nos. 12 Ø vertical rebar at both sides of opening
- 2 nos. 12 Ø horizontal rebar at lintel level through out wall section
- 2 nos. 12 Ø horizontal rebar at sill level through out wall section

- Regular full brick
- Regular half brick
- Lateral full lock brick
- U full brick
- U half brick
- Lateral U full lock brick

Housing Type: I.B.1.1 and I.B. 1.2
Drawing Title: Structural Details
Date: 2/8
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

2 NO.S OF 12 ø VERTICAL REBAR AT EACH SIDE OF WINDOW

2 NO.S OF 12 ø VERTICAL REBAR AT EACH SIDE OF DOOR

4 NO.S OF 12 ø VERTICAL REBAR AT T-JUNCTION

MIN 3 NO.S OF 12 ø VERTICAL REBAR AT L-CORNER

2 NO.S OF 12 ø VERTICAL REBAR AT EACH SIDE OF DOOR

NOTE:
GROUTING FOR THE HOLE IS DONE WITH MORTAR

HOUSING TYPE: I.B.1.1
DRAWING TITLE: STRUCTURAL DETAILS
SCALE: NONE
DATE: 3/8
NOTE:
GROUTING FOR THE HOLE IS DONE WITH MORTAR
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

TYPICAL DETAIL OF WALL

DETAIL A
(TYPICAL DETAIL OF L-CORNER)

DETAIL B
(TYPICAL DETAIL OF T-CORNER)

1 NO.S OF 12MM Ø VERTICAL REBAR AT 1.2M C/C
2 NO.S OF 12MM Ø HORIZONTAL REBAR AT LINTEL AND SILL
3 NO.S OF 12MM Ø VERTICAL REBAR AT L-CORNER
4 NO.S OF 12MM Ø VERTICAL REBAR AT T-CORNER
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

TYPICAL DETAIL @ WINDOW OPENING

TYPICAL DETAIL @ DOOR OPENING

2 NO.S OF 12MM Ø VERTICAL REBAR AT EACH SIDE OF WINDOW

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT LINTEL LVL

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT SILL LVL

2 NO.S OF 12MM Ø VERTICAL REBAR AT EACH SIDE OF DOOR

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT LINTEL LVL

MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

TYPICAL DETAIL @ WINDOW OPENING

TYPICAL DETAIL @ DOOR OPENING

2 NO.S OF 12MM Ø VERTICAL REBAR AT EACH SIDE OF WINDOW

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT LINTEL LVL

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT SILL LVL

2 NO.S OF 12MM Ø VERTICAL REBAR AT EACH SIDE OF DOOR

2 NO.S OF 12MM Ø HORIZONTAL REBAR AT LINTEL LVL
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

INTERIOR VIEW OF THE FINISHED JOIST AND PAN CAST IN SITU

REINFORCEMENT DETAILS IN CONCRETE JOISTS SPAN UPTO 5M

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: 1.B. 1.2
DRAWING TITLE: STRUCTURAL DETAILS

SCALE: NONE
I.B.-1.3
DATE: 8/8
### MATERIALS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone No.</th>
<th>Interlocking Bricks No.</th>
<th>Cement Bags</th>
<th>Sand Cu.m.</th>
<th>Aggregate Cu.m.</th>
<th>Reinforcing Bar Kg.</th>
<th>Clay Tile Nos</th>
<th>Clay Tile Ridge Sq.m.</th>
<th>Wood Cu.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>33.5</td>
<td>2,406.0</td>
<td>129</td>
<td>18.3</td>
<td>7.7</td>
<td>832.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>3,350.0</td>
<td>14</td>
<td>0.9</td>
<td>1.3</td>
<td>188.8</td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1580</td>
<td>282.0</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>33.5</td>
<td>5,756.0</td>
<td>143</td>
<td>19.2</td>
<td>9.0</td>
<td>1,021.3</td>
<td>1580</td>
<td>282.0</td>
<td>3.1</td>
</tr>
</tbody>
</table>
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

ONE STOREY

GROUND FLOOR PLAN
AREA: 54.26 SQ.M.

BEDROOM
3500X3500

KITCHEN
3380X3500

LIVING ROOM
3500X3380

DECK

12MM Ø VERTICAL BARS AT CORNERS AND JOINTS

SCALE: NONE

DATE:

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: FLOOR PLAN

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DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

I.B.-1.3
2/6
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: ELEVATIONS
DATE: 3/6
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

HOUSING TYPE: I.B.-1.3

SCALE: NONE

DATE:

ONE STOREY

26 GAUGE CGI ROOFING MATERIALS
75MM X 75MM BATTENS @ 300MM C/C
180MM X 90MM RAFTERS @ 600MM C/C

SECTION AT A-A

150MM INTERLOCKING BRICK WALL GROUTED WITH MICRO-CONCRETE OF CEMENT, SAND AND CHIPS (1:2:3).

REFER ROOFING DETAILS

REFER FOUNDATION DETAILS
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

FOUNDATION DETAIL

PLINTH LEVEL

G.L.

PLINTH BAND (450MMX150MM)

STONE MASONRY IN CEMENT MORTAR (1:4)

8Ø LINKS @ 150C/C

3- 10Ø Hz.

8Ø LINKS @ 6"C/C

150

100

2- 10Ø Hz.

SILL/LINTEL/ROOF BAND SECTION

GABLE BAND

ROOF BAND

MASONRY WALL

GABLE BAND DETAIL AT-X

WOODEN NAIL

WOODEN KEY

RAFTER

75X100 MM WALL PLATE

100X75 MM WALL PLATE

180X90MM RAFTER @600MM C/C

75X75MM PURLIN @300MM C/C

CGI SHEET

100X90MM RAFTER @600MM C/C

J-HOOK

EAVES BOARD

ROOFING DETAILS

PLINTH BAND SECTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: DETAILS
SCALE: NONE
DATE:

I.B.-1.3
5/6
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Reinforced Stabilized Interlocking Brick Masonry Structure with horizontal and vertical reinforcing bars in strategic locations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of Stone Masonry in 1:4 cement sand mortar. Foundation size is width 900mm and depth 900 mm (refer drawing).</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>R.C.C (1:1.5:3) band of size 450mm x 150 mm. with 3 nos. of 10 mm Ø reinforcement and 8 mm Ø stirrups at 150 mm C/C.</td>
</tr>
<tr>
<td>Wall</td>
<td>Load bearing walls of Interlocking bricks. Interlocking bricks shall be of cement and soil mixed in 1:8 ratio. Two types of Interlocking blocks; normal and U shaped shall be used in full size (300 x 150x 100 mm) and half size (150 x 150 x 100 mm). These blocks shall be air cured for 1 day and water cured for 21 days. Minimum Compressive strength of the block shall be 3.5 Mpa. 12 mm Ø vertical bars shall be provided at corners and joints and grouted with micro concrete 1:2:3 (Cement, sand &amp; chips) ratio. Horizontal reinforcement requirement is stated in sill and lintel details below.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>Reinforced cement concrete sill band of 150x 100 mm size and 1:1.5:3 (1part cement, 1.5 parts sand and 3 parts aggregate). 2 nos. of 10 mm Ø reinforcement and 8 mm Ø stirrups at 150 mm C/C.</td>
</tr>
<tr>
<td>Lintel Band</td>
<td>Reinforced cement concrete lintel band of 150x 100 mm size and 1:1.5:3 (1part cement, 1.5 parts sand and 3 parts aggregate). 2 nos. of 10 mm Ø reinforcement and 8 mm Ø stirrups at 150 mm C/C.</td>
</tr>
<tr>
<td>Roof</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
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</tbody>
</table>
CONFINED HOLLOW CONCRETE BLOCK MASONRY

C.H.C.-2.1
Construction with Hollow concrete blocks as partition wall is not a new practice. In the technology proposed here, hollow concrete block walls carry the seismic loads and the Reinforced Concrete Columns of minimal size are used to confine the walls. Hollow concrete block walls with tooting are constructed up to sill level leaving space for columns and then columns and sill are monolithically casted. Same process is applied after constructing hollow concrete block wall up to lintel.

Featured Design in C.H.C.-2.1 is a two storied structure with six rooms. Structural system consists of load bearing hollow concrete walls confined with 15 cm x 15 cm R.C.C. Columns. The first floor is of R.C.C. slab and roofing consists of CGI sheet over wooden rafter and purlins.

**MATERIAL PROPERTIES**

- Block Size: 40cm X 15cm X 20cm
- Min Compressive Strength on gross area: 5 Mpa
- Min Compressive Strength on net area: 7.5 Mpa
- Density of the Block: 1600kg/m\(^3\)
- Nominal Mix Ratio: 1:1.5:3 (C:S:A)
- Min Yield Strength of Reinforcing Steel: 415 MPa

---

**C.H.C.-2.1**
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

Housing Type: Model C.H.C.-2.1

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stone</td>
</tr>
<tr>
<td></td>
<td>Cu.m.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>30.3</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30.3</td>
</tr>
</tbody>
</table>
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY  
TWO STOREY

GROUNDFLOOR PLAN
FLOOR AREA: 43.71 SQ.M.

ROOM 3  
3200 X 3020

ROOM 1  
3200 X 3020

ROOM 2  
3200 X 3020

100 MM X 100 MM  
WOOD POST

150 MM X 150 MM  
REINFORCED  
CONCRETE TIE COLUMN TYP

150 MM HOLLOW CONCRETE  
MASONRY WALL TYP

FIRST FLOOR PLAN
FLOOR AREA: 43.71 SQ.M.

ROOM 3  
3200 X 3020

ROOM 1  
3200 X 3020

ROOM 2  
3200 X 3020

1050 X 9660  
PORCH

3170

9660

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170

3170
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY TWO STOREY

SIDE ELEVATION

SIDE ELEVATION

FRONT ELEVATION

SIDE ELEVATION

BACK ELEVATION
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

HOUSING TYPE: MODEL C.H.C.-2.1
DRAWING TITLE: SECTION

SCALE: NONE
DATE: C.H.C.-2.1 4/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

Housing Type: Model C.H.C.-2.1

Details:

- **Foundation Details**
  - **Foundation Section of Column Post**
    - 8Ø stirrup at 100 mm c/c
    - 120 mm rod doweled into centre of the post
    - 2 layers 26 gauge flattened CGI strap embedded in plinth beam and connected to timber post
    - 2 - 75 mm long nails connecting strap and wooden post (4 total)
    - Grout around the connection between wood post and beam
    - Mortar or concrete cover to protect bar

- **Section of Interior Foundation**
  - Stone masonry foundation
  - P.C.C. 1:2:4
  - Stone soling with sand
  - Compacted fill

- **Foundation Section of Interior Foundation**
  - 12MMØ column bars
  - 6MMØ stirrups
  - 150MM c/c stirrups at 100MM c/c

- **Dimensions**
  - 300, 450, 600, 700, 900, 150, 200, 250, 350, 450, 500

- **Material Details**
  - Stone masonry foundation
  - P.C.C. 1:2:4
  - Compacted fill
  - Stone soling with sand
  - 12MMØ column bars
  - 6MMØ stirrups

- **Drawing Title:** DETAILS

- **Scale:** NONE

- **Date:** 5/11

- **Drawing Title:** DETAILS

- **Scale:** NONE
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL C.H.C.-2.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE: 6/11

C.H.C.-2.1

TYPICAL COLUMN SECTION: FROM GL TO FIRST FLOOR

TYPICAL COLUMN SECTION: FROM FIRST FLOOR TO ROOF

2 LAYERS OF CGI STRAP
37.5MM GUSSET PLATE
50 X 100 RAFTER
50 X 50 PURLIN

WOOD JOIST
WOOD BEAM
CAPITAL

WOODEN COLUMN POST

100MM X 100MM

50 X 100 BOTTOM CHORD

200 MM X 200 MM ROOF BEAM

STIRRUPS AT 100 MM C/C

STIRRUPS AT 150 MM C/C

12MMØ BARS

12MMØ COLUMN BARS

100MM X 100MM WOODEN COLUMN POST

200 MM X 200 MM FLOOR BEAM

50 X 100 BOTTOM CHORD

LINTEL BAND

SILL BAND
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

FLOOR SLAB DETAILING

*100MM SLAB THICKNESS

50MM X 50MM WOOD JOIST AT 300MM C/C BOTH WAYS

8MM Ø @ 200MM C/C BOTH WAYS

HOUSING TYPE: MODEL C.H.C.-2.1

DRAWING TITLE: DETAILS

SCALE: NONE

DATE: 7/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

C.H.C.-2.1

35
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

SILL/ LINTEL BAND

PLINTH BAND

TIE COLUMN PLAN

LONGITUDIONAL SECTION OF SLAB X-X

TRAVERSE SECTION OF SLAB Y-Y

RING BEAM SECTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

HOUSING TYPE: MODEL C.H.C.-2.1
DRAWING TITLE: DETAILS

SCALE: NONE

C.H.C.-2.1
8/11
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL C.H.C.-2.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE: 9/11

C.H.C.-2.1

3D VIEW CGI STRAP CONNECTION

ALL DIMENSIONS ARE IN MM
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY

**MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY**

**MEMBER 4**
- (100x50 BOTTOM TIE)
- 6-75MM LONG NAILS ON EITHER SIDE OF EACH BOTTOM

**MEMBER 5**
- (50x50 MM DIAGONAL WEB)
- CUT PORTION

**MEMBER 3**
- (KING POST)

**MEMBER 7**
- (100x50 BOTTOM TIE)
- 37.5MM THICK GUSSET PLATE ON EITHER SIDE

**MEMBER 4**
- (50x50 MM DIAGONAL WEB)

**MEMBER 5**
- (DIAGONAL WEB)

**MEMBER 7**
- (100x50 BOTTOM TIE)

**DETAIL AT CONNECTION 2**

**DETAIL OF GUSSET PLATE**

**ALIGNMENT OF GRAIN**

**MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY**

- **MEMBER 3**
  - (50x50) KING POST
- **MEMBER 4**
  - (50x50 MM DIAGONAL WEB)
- **MEMBER 7**
  - (100x50 BOTTOM TIE)
- **MEMBER 5**
  - (DIAGONAL WEB)
- **MEMBER 5**
  - (DIAGONAL WEB)
- **MEMBER 4**
  - (50x50 MM DIAGONAL WEB)

**50X50 MM KING POST**

**50X50 MM DIAGONAL WEB**

**37.5 MM THICK GUSSET PLATE**

- (2 NO.S)

**50X50 MM KING POST**

**50X50 MM DIAGONAL WEB**

**100X50MM BOTTOM TIE**

**6-75MM LONG NAILS ON EITHER SIDE OF BOTTOM TIE**

(12 NO.S)
### TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure System</strong></td>
<td>Confined Masonry structure. Structural system shall be of hollow concrete block masonry panels and slender cast in situ vertical and horizontal confining Reinforced concrete elements; tie columns and tie beams. Masonry walls shall be constructed first and then tie columns shall be casted in place. Tooothing shall be ensured for proper connection between wall and tie columns.</td>
</tr>
<tr>
<td><strong>Foundation</strong></td>
<td>Strip foundation with stone masonry casing the tie column. The depth and width of footing shall be 900mm.</td>
</tr>
<tr>
<td><strong>Plinth Band</strong></td>
<td>Tie Beam of reinforced concrete of width 200 mm and depth 150mm. Main reinforcement 4 nos. 12mm Ø bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td><strong>Wall System</strong></td>
<td>The hollow blocks of size 400 x 150 x 200 mm shall be of good quality and shall adhere to the Nepal Standards of block production. The mortar shall be 1:5 (cement: sand) or richer. The thickness of wall shall be greater than or equal to 150mm.</td>
</tr>
<tr>
<td><strong>Sill Band</strong></td>
<td>A continuous reinforced concrete sill band shall be provided throughout the entire wall at the bottom level of openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td><strong>Lintel Band</strong></td>
<td>A continuous reinforced concrete Lintel band shall be provided throughout the entire wall at the top level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td><strong>Floor Beam</strong></td>
<td>Floor Beam of reinforced concrete with 200 mm width and 200 mm depth. Main reinforcement shall be 4 nos. 12mm Ø bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td><strong>Floor</strong></td>
<td>100 mm thick reinforced concrete slab as shown in detail drawing.</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing. All trusses shall be properly cross tied with wooden braces as shown in the drawing.</td>
</tr>
</tbody>
</table>
This technology proposes load bearing structure of hollow concrete blocks. Hollow concrete blocks are seen as a good alternative to conventional brick masonry as they can be locally manufactured, cheaper and environment friendly.

Featured Design in H.C.B. 3.1 is a two storied residence with four rooms. Design features are RCC strip foundation, load bearing hollow concrete walls, precast floor and roof, precast stair slabs, horizontal bands and vertical seismic reinforcement at critical sections. The design is of modular type, affordable, structurally sound and environment friendly.

**MATERIAL PROPERTIES**
Block Size: 40cm X 20cm X 10cm
Section of pre-cast Beam: Tapered width (75mmx125mm) x Height 200mm
Min Compressive strength of block: 5 N/mm²
Grade of Steel: Fe 500Mpa
Nominal Mix Ratio: 1:1.5:3 (C:S:A)
## MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

**Drawing Title:** Estimate and 3D-View

**Level:** Two Storey

### Materials

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Hollow Concrete Bricks</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>Polythene sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Sq.m</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>447.0</td>
<td>100</td>
<td>6.1</td>
<td>12.1</td>
<td>864.6</td>
<td>19.7</td>
</tr>
<tr>
<td>Super Structure</td>
<td>2,398.0</td>
<td>163</td>
<td>8.6</td>
<td>17.5</td>
<td>1,677.3</td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>TOTAL</td>
<td>2,845.0</td>
<td>14.7</td>
<td>29.6</td>
<td>2,541.9</td>
<td>19.7</td>
</tr>
</tbody>
</table>
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

Housing Type: MODEL H.C.B.-3.1

First Floor Plan
Area: 24.7 SQ.M.

Ground Floor Plan
Area: 24.7 SQ.M.
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

Housing Type: Model H.C.B.-3.1

Drawings Title: Details

Foundation Detail

- RCC Strip Foundation (M20)
- 25mm TK, Sand Filling and Compaction
- Well Compacted Earth

Beams and Slab Details

- 4.75mm Ø Temperature Flange Rods @ 300mm C/C Over Beams (M20) Concrete
- 38mm THK. Cast in Situ (M20) Concrete

- 6mm Ø Stirrups @ 400mm C/C
- Hollow Block Wall in 1:4 C/S Mortar
- 8mm Ø @ 200mm C/C
- 4 No. of 8mm Ø

- 4.75mm Ø Temperature Flange Rods @ 300mm C/C Over Beams

- 1 No. - 10mm Ø Rebars
- 3 No. - 10mm Ø Rebars

Date: 5/11

Scale: None
MODEL H.C.B.-3.1, HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

SLAB(S1) DETAILS

SLAB(S2) DETAILS

SLAB(S3) DETAILS

SECTION AT A-A

SECTION AT B-B

SECTION AT A-A

SECTION AT B-B

HCB-3.1

MINISTRY OF URBAN DEVELOPMENT

HOUSING TYPE: MODEL H.C.B.-3.1

DRAWING TITLE: DETAILS

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE

DATE: 7/11

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MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

HOUSING TYPE: MODEL H.C.B.-3.1

DRAWING TITLE: DETAILS

SCALE: NONE

DATE:

HCB-3.1

8/11
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

TWO STOREY

REINFORCEMENT DETAIL AT CORNER

COLUMN PROJECTION DETAIL

DETAIL AT B SILL BAND

DETAIL AT A LINTEL BEAM
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

STAIRCASE DETAIL PLAN

STAIRCASE SLAB UNIT

STAIR SECTION AT B-B

STAIR SECTION AT A-A

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL H.C.B.-3.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE:

HCB-3.1
10/11
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Hollow concrete block masonry with precast floor over precast beams. Vertical and Horizontal reinforcements shall be provided in strategic locations as shown in drawings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of width 850 mm and depth 825 mm. Reinforcement 8 mm Ø at 200mm C/C both ways.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>Plinth beam of reinforced concrete of width 200 mm and depth 150 mm shall be provided. Main reinforcement shall be of 4 nos.10mm Ø bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Wall System</td>
<td>The hollow blocks shall be of size of 400 x 200 x 100 mm and be of good quality and shall adhere to the Nepal Standards of block production. The mortar shall be 1: 4 (cement: sand) or richer.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>A continuous reinforced concrete sill band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos.8mm dia. bars with 7mm Ø stirrups at 400mm C/C.</td>
</tr>
<tr>
<td>Lintel Band:</td>
<td>A continuous lintel band shall be provided throughout the entire wall at the top level of the openings. The depth of the band shall be 475mm and triangular stirrups shall connect lintel and slab. Hollow concrete blocks between lintel and slab shall be filled with 1:1.5:3 concrete. Main reinforcement shall be 3 nos. of 10mm dia. bars with 7mm Ø triangular stirrups at 400mm c/c.</td>
</tr>
<tr>
<td>Floor Beam:</td>
<td>Precast Floor Beam with details as shown in drawing.</td>
</tr>
<tr>
<td>Floor:</td>
<td>100 mm thick reinforced concrete slab as shown in detail drawing.</td>
</tr>
<tr>
<td>Roof:</td>
<td>38 mm cast in situ concrete (1:1.5:3) over 50 mm precast slab panels and precast beam of size 125 x 200 mm.</td>
</tr>
</tbody>
</table>
COMPRESSED STABILIZED EARTH BLOCK MASONRY

C.S.E.B.-4.1
C.S.E.B.-4.2
Compressed Stabilized Earth Block (CSEB) Technology makes use of mud as a predominant building material. The properties of soil used are improved by using stabilizers like cement. The proposed technology is very suitable for rural areas where local materials are used and their quality improved by adding small quantities of non local materials. Featured design C.S.E.B.-4.1 is a low cost, single storied two room residential units of load bearing stabilized earthen block walls with mud stabilized soil roof over bamboo rafter and purlins. Design Model C.S.E.B.-4.2 is a two storied residential units with eight rooms. Load bearing walls are made of Earthen block stabilized with chemicals.

**MATERIAL PROPERTIES( C.S.E.B 4.1)**
Block Size: 30cm X 20cm X10cm
Min Compressive Strength on gross area CSEB: 3.5 Mpa

**MATERIAL PROPERTIES( C.S.E.B 4.2)**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Solid Brick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>30cm X 20cm X10cm</td>
</tr>
<tr>
<td>28 days dry compressive strength</td>
<td>7.5 - 10 MPa</td>
</tr>
<tr>
<td>28 days wet compressive strength</td>
<td>3 - 4 MPa</td>
</tr>
<tr>
<td>(after 24 hours immersion)</td>
<td></td>
</tr>
<tr>
<td>Apparent bulk density</td>
<td>2100 - 2350 kg/m3</td>
</tr>
<tr>
<td>Total Water absorption</td>
<td>5 - 10 %</td>
</tr>
<tr>
<td>Moisture content</td>
<td>&lt; 0.03%</td>
</tr>
<tr>
<td>Dry Shrinkage</td>
<td>&lt; 0.04%</td>
</tr>
<tr>
<td>Shell thickness</td>
<td>-</td>
</tr>
</tbody>
</table>
MODEL C.S.E.B-4.1, COMPRESSED STABLILIZED EARTH BLOCK MASONRY

ONE STOREY

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
<th>No.</th>
<th>Bags</th>
<th>Cu.m.</th>
<th>Kg.</th>
<th>Cu.m.</th>
<th>Nos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilized block</td>
<td>Cement</td>
<td>1,758.0</td>
<td>17.0</td>
<td>2.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sand</td>
<td>Reinforcing Bar</td>
<td>1,500.0</td>
<td>8</td>
<td>1.4</td>
<td>237.3</td>
<td>0.2</td>
<td>26</td>
</tr>
<tr>
<td>Wood</td>
<td>Bamboo</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>31.0</td>
</tr>
<tr>
<td>Roofing</td>
<td></td>
<td>3,258.0</td>
<td>25</td>
<td>3.7</td>
<td>237.3</td>
<td>2.6</td>
<td>57</td>
</tr>
</tbody>
</table>

ESTIMATE AND 3D-VIEW
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

GROUNDFLOORPLAN
FLOOR AREA: 24.08 SQ.M

ROOM
2400 X 2400

ROOM
2400 X 2400

VERANDAH

Housing Type: CSEB-4.1
Drawin Title: Ground Floor Plan

Ministry of Urban Development
Department of Urban Development and Building Construction

CSEB-4.1

Date: 2/8
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

SECTION AT X-X

- 5MM CEMENT PUNNING
- ROOF OF C.S.E.B IN STABILIZED SOIL MORTAR WITH CEMENT POINTING OF 1:6 UPTO 2/3 HEIGHT AND 1:1 IN REMAINING UPPER HEIGHT
- 50 MM THK. MUD OVER POLYTHENE SHEET
- 38MM THK. BAMBOO JALI (BHATA OR TATI) @150 MM C/C TO RETAIN SOIL
- 500 GAUGE POLYTHENE SHEET
- 38MM THK. (MINIMUM) BAMBOO STRIPS PLACED TIGHTLY TOGETHER
- FULL SIZE BAMBOO RAFTERS @ 500MM C/C

- STABILIZED SOIL BLOCK PAVEMENT
- 500GAUGE POLYTHENESHEET
- EARTH FILLING AND COMPACTION

- RCC LINTEL BAND
- CEMENT PLASTERED EAVES WITH WIRE MESH
- 100 X125 TIMBER TRUSSED BEAM
- RCC SILL BAND

REFER ROOFING DETAIL

REFER FOUNDATION DETAIL

HOUSING TYPE: CSEB-4.1
DRAWING TITLE: SECTION
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

FRONT ELEVATION

BACK ELEVATION

LEFT ELEVATION

RIGHT ELEVATION
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

FOUNDATION SECTION

200MM THK. CSEB MASONRY

8MM Ø REBARS @ 200 C/C
4 NO. 6MM Ø REBARS
RCC STRIP FOUNDATION

LINTEL BAND

8MM Ø REBARS @ 200 C/C
4 NO. 6MM Ø REBARS
RCC STRIP FOUNDATION

SILL BAND

SECTION B-B

200MM THK. CSEB MASONRY

2 NO. 10MM Ø REBARS

6MM Ø @150MM C/C

FOUNDATION OF BAMBOO POST

BAMBOO POST
BITUMEN COATING
500 GAUGE POLYTHENE SHEET
WIRE MESH
C. CONCRETE (M20)

HOLLOW C. BLOCK

FOUNDATION OF BAMBOO POST

BAMBOO POST
BITUMEN COATING
500 GAUGE POLYTHENE SHEET
WIRE MESH
C. CONCRETE (M20)

HOLLOW C. BLOCK

SECTION B-B

200MM THK. CSEB MASONRY

2 NO. 10MM Ø REBARS

6MM Ø @150MM C/C
MODEL C.S.E.B-4.1, COMpressed Stabilized Earth Block Masonry

ONE STOREY

Housing Type: CSEB-4.1

Drawing Title: Details

Section A’ - A’

Roofing Details

5mm cement punning

Roof of C.S.E.B in stabilized soil mortar with cement pointing of 1:6 up to 2/3 height and 1:1 in remaining upper height

50 mm thk. mud over polythene sheet

38mm thk. bamboo jali (bhata or tati) @150 mm c/c to retain soil

500 gauge polythene sheet

38mm thk. (minimum) bamboo strips placed tightly together

Full size bamboo rafters @ 500mm c/c

5mm cement punning

Roof of C.S.E.B in stabilized soil mortar with cement pointing of 1:6 up to 2/3 height and 1:1 in remaining upper height

50 mm thk. mud over polythene sheet

38mm thk. bamboo jali (bhata or tati) @150 mm c/c to retain soil

500 gauge polythene sheet

38mm thk. (minimum) bamboo strips placed tightly together

Full size bamboo rafters @ 500mm c/c

Timber trussed beam

200mm thk. compressed stabilized soil block wall

Eaves of cement plaster with wire mesh

G.I. wire for nuts and bolts

CSEB masonry in stabilized mud mortar

Bamboo

G.I. wire or 4.75 mm Ø rod

Trussed beam

Trussed beam

200mm thk. compressed stabilized soil block wall
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

HALF CUT BAMBOO AS VERTICAL REINFORCEMENT @900mm C/C MINIMUM AND @CORNERS AND OPENINGS

ROUND END 12 GAUGE G.I. WIRE FOR NUT AND BOLT

TYPICAL ELEVATION

STRENGTHENING WALL BY BAMBOO AND G.I. WIRE

HALFCUT BAMBOO
CSEB WALL

CSEB WALL
HALF CUT BAMBOO
NUT BOLT

12 GAUGE G.I. WIRE @ 600mm C/C

PLAN AT B - B

HALFCUT BAMBOO
CSEB WALL

B
B

PLAN AT A - A

BITUMEN COATING

CROSS SECTION

BAMBOO SECTION

WIRE MESH AROUND POLYTHENE WRAPPING

CEMENT CONCRETE (M20) AROUND WIRE MESH

CSEB WALL
HALF CUT BAMBOO
NUT BOLT

500 GAUGE POLYTHENE SHEET WRAPPING

WIRE MESH AROUND POLYTHENE WRAPPING

CSEB-4.1

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## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Compressed Stabilized Earth block masonry in mud mortar with stabilized soil roof.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of Compressed stabilized Earth Block Masonry of width 400 mm and depth 400 mm over 600 x 75 mm RCC strip foundation.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>Plinth Beam of reinforced concrete of width 200 mm and depth 100mm shall be provided. Main reinforcement 4 nos.10mm Ø bars with 6mm Ø stirrups at 150mm C/C</td>
</tr>
<tr>
<td>Wall System</td>
<td>Masonry shall be of cement stabilized earth block of size 300x 200 x 100 mm size in mud mortar.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>A continuous reinforced concrete sill band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos.10mm dia. bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Lintel Band:</td>
<td>A continuous reinforced concrete Lintel band shall be provided throughout the entire wall at the top level of the openings. The minimum depth of the band shall be 100 mm. Main reinforcement shall be 4 nos.10mm dia. bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Roof</td>
<td>5mm cement punning over stabilized soil plaster on 50 mm thick mud roof on bamboo truss.</td>
</tr>
</tbody>
</table>
### Model C.S.E.B-4.2, Compressed Stabilized Earth Block Masonry

#### Two Storey

![Diagram of the two-storey house model](image)

#### Materials

<table>
<thead>
<tr>
<th>Level</th>
<th>CS Blocks</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
<th>MS Black Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>4,040.0</td>
<td>43</td>
<td>3.9</td>
<td>7.4</td>
<td></td>
<td>1,410.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>6,651.0</td>
<td>115.0</td>
<td>6.1</td>
<td>12.4</td>
<td></td>
<td>1.7</td>
<td>8.2</td>
<td>9.8</td>
<td>1,408.3</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td>1,410.1</td>
<td>8.2</td>
<td>9.8</td>
<td>1,408.3</td>
</tr>
<tr>
<td>Total</td>
<td>10,691</td>
<td>158</td>
<td>10.0</td>
<td>19.8</td>
<td>1,410.1</td>
<td>8.2</td>
<td>9.8</td>
<td>1.7</td>
<td>1,408.3</td>
</tr>
</tbody>
</table>
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

GROUND FLOOR PLAN
FLOOR AREA: 52.02SQ.M

FIRST FLOOR PLAN
FLOOR AREA: 52.02SQ.M

HOUSING TYPE: CSEB-4.2
DRAWING TITLE:FLOOR PLANS

SCALE: NONE
DATE: 2/9
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

Housing Type: CSEB-4.2

Drawing Title: Section

Section at A-A

Refer Roof Truss Detail

Refer Slab and Band Detail

Refer Foundation Detail

Bedroom

Living Room

Lobby

230 mm Hollow Concrete Block Wall in Cement Concrete (1:5).

REFER ROOF TRUSS DETAIL

REFER SLAB AND BAND DETAIL

REFER FOUNDATION DETAIL

230 MM HOLLOW CONCRETE BLOCK WALL IN CEMENT CONCRETE (1:5).
MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY

TWO STOREY

FRONT ELEVATION

SIDE ELEVATION

BACK ELEVATION

SIDE ELEVATION

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: ELEVATION

CSEB-4.2

4/9
MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY

TWO STOREY

FOUNDATION SECTION

FOUNDATION DETAIL
(FOR VERANDAH)

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDNG CONSTRUCTION

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: FOUNDATIONDETAILS

SCALE: NONE
CSEB-4.2

DATE:
5/9
MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY  TWO STOREY

Housing Type: CSEB-4.2

Floor Slab

Roof Band

Sill Band

Lintel Band

Floor Beam

Plinth Band

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: DETAILS

SCALE: NONE
DATE: 6/9

CSEB-4.2
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

LOCATION OF VERTICAL REINFORCEMENT

LAYOUT OF HORIZONTAL AND VERTICAL REINFORCEMENT

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: REINFORCEMENT DETAILS

SCALE: NONE
DATE: 7/9

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

CSEB-4.2

- ROOF BAND
- LINTEL BAND
- SILL BAND
- FLOOR BEAM
- LINTEL BAND
- SILL BAND
- PLINTH BAND

12φ VERTICAL REBAR
16φ VERTICAL REBAR

6φ VERTICAL REBAR AT EACH CORNER
2-10φ VERTICAL BAR AT EVERY 1.2M IN WALL
4-10φ VERTICAL BAR AT JAMBS OF OPENINGS
4-10φ VERTICAL BAR AT EVERY JUNCTION
MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY

Two Storey

Housing Type: CSEB-4.2

Drawing Title: Roof Details

Scale: None

Date: 8/9

Ministry of Urban Development
Department of Urban Development and Building Construction
TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Chemically stabilized earth block (solid/hollow) masonry in cement sand mortar with CGI sheet roof over metal truss. Vertical and Horizontal reinforcements shall be provided in strategic locations as shown in the drawing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Chemically compressed stabilized block masonry strip foundation of width 900 mm and depth 900 mm as shown in detail.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>Plinth Beam of reinforced cement concrete (1:1.5:3) of width 350 mm and depth 150mm shall be provided. Main reinforcement 4 nos.12mm Ø bars with 8mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Wall System</td>
<td>The chemically compressed stabilized Earth block shall be of size of 230x 100 x 55mm size and stabilized with flat plug resin chemical. Mortar shall be cement sand in 1:5 ratio or richer.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>A continuous reinforced concrete sill band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos.12mm dia. bars with 8mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Lintel Band:</td>
<td>A continuous reinforced concrete lintel band shall be provided throughout the entire wall at the top level of the openings. The minimum depth of the band shall be 150mm. Main reinforcement shall be 4 nos.12mm dia. bars with 8mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Floor:</td>
<td>130 mm thick RCC (1:1.5:3) floor over beam of width 230 mm and depth 300mm (115mm slab thickness).</td>
</tr>
<tr>
<td>Roof:</td>
<td>CGI sheet roofing over metal truss as shown in the drawing.</td>
</tr>
</tbody>
</table>
RANDOM RUBBLE MASONRY IN MUD MORTAR WITH GI WIRE CONTAINMENT

R.R.M-5.1
R.R.M-5.2
This technology is an improvement on random rubble masonry structure by introduction of GI containment wires. Vertical GI Containment wires are provided on two faces of a masonry wall to prevent flexural failure. The reinforcement on the two faces are connected by ties going through walls to prevent delamination of the walls. The proposed design makes minimal changes in local construction system.

Featured design R.R.M. 5.1 is a one storied two room unit with CGI sheet roofing. Featured design R.R.M. 5.2 is a two storied four room unit with CGI sheet roofing. Basic materials like stone and mud for walls, corrugated galvanized iron sheets on timber rafter/purlins for roof and mud flooring on timber deck for intermediate floors are proposed similar to common houses in the hills of Nepal. The basic shape and size of the building comply Nepal National Building Code, NBC 203 : 1994, Guidelines for earthquake resistant building construction: low strength masonry.

R.R.M-5.1
R.R.M-5.2
Model R.R.M-5.1, Random Rubble Masonary In Mud Mortar

One Storey

---

## Materials

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone</th>
<th>Weld Wire Mesh</th>
<th>Sand</th>
<th>Mud</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
<th>4mm Gi Wire</th>
<th>2 mm Gi Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu.m.</td>
<td>Sq.m</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Sq.m.</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td>Kg</td>
<td>Kg</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>16.1</td>
<td>10.4</td>
<td>1.3</td>
<td>7.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Super Structure</td>
<td>28.8</td>
<td>40.7</td>
<td>-</td>
<td>11.0</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
<td>19.0</td>
<td>44.0</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.1</td>
<td>9.1</td>
<td>5.6</td>
<td>-</td>
<td>4.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>44.9</td>
<td>51.1</td>
<td>1.3</td>
<td>18.4</td>
<td>4.1</td>
<td>9.1</td>
<td>6.1</td>
<td>25.0</td>
<td>62.0</td>
</tr>
</tbody>
</table>
MODEL R.R.M-5.1, RANDOM RUBBLE MASONARY IN MUD MORTAR

GROUND FLOOR PLAN
FLOOR AREA: 40.365 SQ. M

BED ROOM
2925 X 3000

BED ROOM
2925 X 3000

HOUSING TYPE: R.R.M.-5.1
DRAWING TITLE: FLOOR PLAN
DATE:

SCALE: NONE

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

R.R.M-5
2/5
MODEL R.R.M-5.1, RANDOM RUBBLE MASONARY IN MUD MORTAR

Housing Type: R.R.M.-5.1

Scale: None

Drawing Title: Elevations

Date: 

Front Side Elevation

Left Side Elevation

Back Side Elevation

Right Side Elevation
## Technical Requirements

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Stone Masonry wall in mud mortar with Vertical GI Containment wires shall be provided on two faces of a masonry wall. The GI containment wires on the two faces shall be connected by ties going through walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of stone masonry in mud mortar of size 750 x 750 mm as shown in detail.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>Red oxide coated or GI Weld Wire mesh (WWM) strap of 350 mm width with wire spacing of 31x 31 mm plus 2 nos. 4 mm GI wires laid in mud mortar. Diagonal WWM strap shall be provided for stronger corner connection securely tied to other WWM.</td>
</tr>
<tr>
<td>Wall System</td>
<td>Random rubble masonry in mud mortar with 4 mm vertical GI wire cross linked with 2 nos. 14 gauge (2mm) galvanized iron wires placed at 450mm C/C.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>Sill band shall be of weld wire mess or wooden band as shown in detail drawing.</td>
</tr>
<tr>
<td>Lintel Band</td>
<td>Lintel band shall be of weld wire mess or wooden band as shown in detail drawing.</td>
</tr>
<tr>
<td>Floor</td>
<td>Mud/timber floor over timber joist (Refer drawing).</td>
</tr>
<tr>
<td>Wall Plate</td>
<td>Wall plate shall be timber section of 100mm X 100mm placed above WWM and connected with wall (refer detail drawing)</td>
</tr>
<tr>
<td>Roof</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing. All trusses shall be properly cross tied as shown in the drawing.</td>
</tr>
</tbody>
</table>
## Model R.R.M.-5.2, Random Rubble Masonry in Mud Mortar

### Two Storey

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone</th>
<th>Weld wire mesh</th>
<th>Sand</th>
<th>Mud</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
<th>4mm GI wire</th>
<th>2 mm GI Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>16.1</td>
<td>10.4</td>
<td>1.3</td>
<td>7.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Super Structure</td>
<td>49.3</td>
<td>71.9</td>
<td>-</td>
<td>18.8</td>
<td>0.9</td>
<td>28.0</td>
<td>66.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.1</td>
<td>9.1</td>
<td>6.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>65.4</td>
<td>82.3</td>
<td>1.3</td>
<td>26.3</td>
<td>4.1</td>
<td>9.1</td>
<td>7.5</td>
<td>34.0</td>
<td>84.0</td>
</tr>
</tbody>
</table>
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

TWO STOREY

HOUSING TYPE: R.R.M.-5.2
DRAWING TITLE: FLOOR PLAN
SCALE: NONE
DATE: 2/11

GROUND FLOOR PLAN
FLOOR AREA: 40.365 SQ. M.
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

TWO STOREY

FIRST FLOOR PLAN
FLOOR AREA: 40.365 SQ. M

BED ROOM
2925 X 3000

ROOM
2925 X 3000

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

HOUSING TYPE: R.R.M.-5.2
DRAWING TITLE:FLOOR PLAN

SCALE: NONE

R.R.M.5.2
3/11
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

TWO STOREY

FRONT SIDE ELEVATION

LEFT SIDE ELEVATION

HOUSING TYPE: R.R.M.-5.2
DRAWING TITLE: ELEVATION

SCALE: NONE
DATE: 4/11
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

BACK SIDE ELEVATION

RIGHT SIDE ELEVATION

HOUSING TYPE: R.R.M.-5.2
DRAWING TITLE: ELEVATION

SCALE: NONE
DATE:

R.R.M-5.2
5/11
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

HOUSING TYPE: R.R.M.-5.2

RAFTERS - 50X100MM @ 1200MM C/C
PURLINS - 50X50MM @ 450MM C/C
GABLE WALL TO BE OF GI SHEETS OR TIMBER PLANKS (NO MASONRY)

SECTION : A-A

TIMBER RIDGE BEAM (150 DEEP X 100 WIDE)
TIMBER POST 110MM ABOVE ATTIC WALL.

CGI ROOFING

PURLINS - 50X50MM @ 450MM (C/C)
RAFTERS - 50X100MM @ 1200MM C/C

GABLE WALL TO BE OF GI SHEETS OR TIMBER PLANKS (NO MASONRY)

TIMBER RIDGE BEAM
TIMBER POST 110MM ABOVE ATTIC WALL.

CGI ROOFING

PURLINS - 50X50MM @ 450MM (C/C)
RAFTERS - 50X100MM @ 1200MM C/C

GABLE WALL TO BE OF GI SHEETS OR TIMBER PLANKS (NO MASONRY)

TIMBER RIDGE BEAM
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RAFTERS - 50X100MM @ 1200MM C/C

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PURLINS - 50X50MM @ 450MM (C/C)
RAFTERS - 50X100MM @ 1200MM C/C

GABLE WALL TO BE OF GI SHEETS OR TIMBER PLANKS (NO MASONRY)

TIMBER RIDGE BEAM
TIMBER POST 110MM ABOVE ATTIC WALL.

CGI ROOFING

PURLINS - 50X50MM @ 450MM (C/C)
RAFTERS - 50X100MM @ 1200MM C/C

GABLE WALL TO BE OF GI SHEETS OR TIMBER PLANKS (NO MASONRY)
FOUNDATION DETAIL

**ECONOMIC OPTION**
(Also to be used with existing foundation)

**RECOMMENDED OPTION**
(Only if aluminum wire are available)

### SIZE OF STRIP FOOTING FOR DIFFERENT SOIL TYPES AS PER NBC 203

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>One</th>
<th>Two</th>
<th>Two plus attic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width</td>
<td>Depth</td>
<td>Width</td>
</tr>
<tr>
<td>Hard</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Medium</td>
<td>750</td>
<td>750</td>
<td>900</td>
</tr>
<tr>
<td>Soft</td>
<td>750</td>
<td>750</td>
<td>900</td>
</tr>
</tbody>
</table>

**RED OXIDE COATED OR GI WWM STRAP 350MM WIDE WITH WIRE SPACING OF 31X31MM PLUS 2.4MM GI WIRES LAID IN MUD MORTAR - SEE NOTE 5, SHEET 4.**

**MASONRY FACE TYP.**

**DIAGONAL WWM STRAP FOR STRONG CORNER CONNECTION SECURELY TIED TO OTHER WWM.**

**CROSSLINK TIED SECURELY TO WWM WITH GALVANIZED BINDING WIRE.**

**WELD WIRE MESH BAND DETAIL.**
ATTIC WALL PLATE PLAN.

100X100MM TIMBER WALL PLATE.

TIMBER STUB LOCATIONS TO BE ALIGNED WITH CONTAINMENT WIRES FOR TYING CONTAINMENT REINFORCEMENT.

ENSURE STRONG CONNECTION WITH METAL STRAPS

ATTIC WALL

SECTION : D-D

WALL PLATE.
ATTIC FLOOR TIMBER FRAMING PLAN

50X100MM TIMBER STRUT ON JOIST UNDERSIDE

75X125MM TIMBER JOISTS AT ≤ 450MM O/C

4-14 GA GI WIRE DIAGONAL BRACING TIES PRE-TENSIONED

TIMBER PLANKS OR SPLIT BAMBOO WITH MUD FLOORING ON TOP AS PER TRADITIONAL PRACTICE

WALL PLATE

TIMBER FLOOR BEAM

Floor Joist

TWO STOREY MODEL R.R.M.-5.1/5.2
LOCATION OF CROSS LINKS TO BE PLACED IN ALL STORIES.

**DETAIL A**
GI WIRE CROSS LINK
LENGTH EQUAL TO WALL THICKNESS.

**DETAIL A ALT**
GI WIRE CROSS LINK
LENGTH EQUAL TO WALL THICKNESS.

TWO 14 GA (2MM DIA) TWISTED GI WIRES WITH LOOSE ENDS EXTENDING OUT 100MM ON BOTH SIDE WALL

CROSS LINKS APPROX. 100MM AWAY FROM JAMB (TYP.)

TWO 14 GA (2MM DIA) TWISTED GI WIRES WITH LOOSE ENDS EXTENDING OUT 100MM ON BOTH SIDE WALL

ALL CROSS LINKS TO BE PLACED AT PLINTH AND LOWER LEVELS AS SHOWN IN FOUNDATION DETAILS, AND ABOVE PLINTH LEVEL AT APPROXIMATELY 450MM VERTICAL SPACING DURING THE CONSTRUCTION OF WALL.
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Stone Masonry wall in mud mortar with Vertical GI Containment wires shall be provided on two faces of a masonry wall. The GI containment wires on the two faces are connected by ties going through walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of stone masonry in mud mortar of depth 750 mm and width as specified in details for different soil type.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>Red oxide coated or GI Weld Wire mesh (WWM) strap of 350 mm width with wire spacing of 31x 31 mm plus 2 nos. 4 mm GI wires laid in mud mortar. Diagonal WWM strap need to be provided for stronger corner connection securely tied to other WWM.</td>
</tr>
<tr>
<td>Wall System</td>
<td>Random rubble masonry in mud mortar with 4 mm vertical GI wire cross linked with 2 nos. 14 gauge (2mm) galvanized iron wires placed at 450mm.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>Sill band shall be of weld wire mess or wooden band as shown in detail drawing.</td>
</tr>
<tr>
<td>Lintel Band:</td>
<td>Lintel band shall be of weld wire mess or wooden band as shown in detail drawing.</td>
</tr>
<tr>
<td>Floor:</td>
<td>Mud /timber floor over timber joist (Refer drawing).</td>
</tr>
<tr>
<td>Wall Plate:</td>
<td>Wall plate shall be timber section of 100mm X 100mm placed above WWM and connected with wall (refer detail drawing)</td>
</tr>
<tr>
<td>Roof:</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing. All trusses shall be properly cross tied with wooden braces as shown in the drawing.</td>
</tr>
</tbody>
</table>
BAMBOO AND STONE MASONRY HYBRID STRUCTURE

B.S.M.H.-6.1
The proposed technology uses traditional, yet earthquake resistant construction using materials and skills that are indigenous and locally available. Local bamboo (*Banbusa Nutans*), *seasoned and treated*, is *used in a structural* frame with bamboo wattle and daub panels as walls on the upper floor. The frame is surrounded with a wall in Stone Masonry with Mud Mortar on the ground floor of the house. Featured design in H.B.S.M.-5.1 consists of a Ground Floor space that can be converted into two rooms using a lightweight Wattle and Daub partition. A Kitchen and a Covered Verandah flank the room on the short and the long side respectively.

**MATERIAL PROPERTIES**

**Bamboo Properties**

- Min Compressive Strength of bamboo: 45.6 Mpa
- Density of bamboo: 673 Kg/m$^3$
- Modulus of elasticity: 10.72 x 103 Mpa
### Model B.S.M.H.-6.1, Bamboo and Stone Masonry Hybrid Structure

#### Two Storey

**LEVEL** | **MATERIALS** | **Stone** (Cu.m.) | **Mud** (Cu.m.) | **CGI Sheet** (Bundle) | **GI Sheet** (Sq.m.) | **Wood** (Cu.m.) | **Bamboo** (Nos) | **TOTAL** (Cu.m.) |
---|---|---|---|---|---|---|---|---|
Up to Plinth Level | | 11.6 | 13.0 | - | - | - | - | 32.9 |
Super Structure | | 21.3 | 8.1 | 0.6 | | | | 21.1 |
Roofing | | - | - | 5.6 | 9.5 | 0.7 | | 5.6 |
TOTAL | | 32.9 | 21.1 | 5.6 | 9.5 | 1.3 | | 230.0 |

**ESTIMATE AND 3D-VIEW**
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

HOUSING TYPE: B.S.M.H.-6.1

SCALE: NONE

DATE: 2/14

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

DRAWING TITLE: PLAN

25MM DEEP LAP JOINTS USING BAMBOO PINS

50 x 40 TIMBER TIES FIXED WITH 12MM DIA BAMBOO PINS @ 500MM C/C

75 x 75 TIMBER DOOR AND WINDOW FRAME FIXED TO PLINTH BAND TO LINTEL BAND

100 x 50 TIMBER BANDS AT PLINTH LEVEL WITH ANTI-TERMITE TREATMENT

8MM DIA THREADED M.S. LONG BOLT WITH 25MM WASHERS AND NUTS THROUGH BAMBOO POSTS AND PLINTH BAND TIMBERS TYPE. REF. DETAIL XX

PLAN AT +460

PLINTH BAND IN LOCAL TREATED TIMBER

AVG. 75 MM DIA. BAMBOO

SMM BETWEEN AND OVER PLINTH TIMBER BANDS

8MM DIA THREADED M.S. LONG BOLT WITH 25MM WASHERS AND NUTS. REF DETAIL B

75 x 75 TIMBER DOOR AND WINDOW FRAME

RCC PLINTH BEAM

2 Nos. 75 x 75 VERTICAL TIMBER MEMBERS JOINING THE PLINTH, INTERMEDIATE AND LINTEL BANDS

100 x 50 TIMBER BANDS AT PLINTH, SILL AND LINTEL LEVELS

SMM BETWEEN THE BAMBOO POSTS AND STONE WALL

50MM GAP BETWEEN THE BAMBOO POSTS AND STONE WALL

BAMBOO POST CLUSTER (TYPE 1)

BAMBOO POST CLUSTER (TYPE 2)

460 X 460 BUTRESS IN LONG WALL

460 X 460 BUTRESS IN LONG WALL

130 X 130 TIMBER POST

130 X 130 TIMBER POST

AVG. 75 MM DIA. BAMBOO

SMM TILL +1070

TO PERIMETER DRAIN OUTSIDE

RCC PLINTH BEAM

75 x 75 TIMBER DOOR AND WINDOW FRAME

SMM TILL +1070

KITCHEN

COVERED VERANDAH

OPEN VERANDAH
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

PLAN AT +1000
WINDOW SILL LEVEL

610 x 100 x 75 PRECAST PCC BLOCKS LAID AT RIGHT ANGLES IN ALTERNATE COURSES

2500 7700 2200 2200 1930

75 x 75 TIMBER DOOR AND WINDOW FRAME FIXED TO PLINTH BAND TO Lintel BAND

MUD PLASTER ON WALLS

BAMBOO POST CLUSTER (TYPE 1)

460 x 460 BUTRESS IN LONG WALL

ROOM 2

130 x 120 TIMBER POST

MUD PLASTER

BAMBOO POST CLUSTER (TYPE 2)

2 Nos. 75 x 75 VERTICAL TIMBER MEMBERS

75 x 75 TIMBER DOOR AND WINDOW JAMBS

COVERED VERANDAH

MUD PLASTER ON STONE WALL

125 x 125 TIMBER POST

ROOM 1

BAMBOO POST

460 x 460 BUTRESS

STONE MASONRY IN MUD MORTAR

OPEN VERANDAH

75 x 75 TIMBER DOOR AND WINDOW JAMBS

COOKING AREA

+1070 HIGH SMM MUD PLASTER

MUD PLASTER

BAMBOO POST CLUSTER (TYPE 1)

130 x 130 TIMBER POST

MUD PLASTER

BAMBOO/TIMBER LADDER TO ATTIC

CUTOUT IN ATTIC FLOOR ABOVE

BAMBOO POST CLUSTER (TYPE 2)

125 x 125 TIMBER POST

7700

STONE MASONRY IN MUD MORTAR

MUD PLASTER

BAMBOO POST

610 x 100 x 75 PRECAST PCC BLOCKS LAID AT RIGHT ANGLES IN ALTERNATE COURSES

PLAN

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN

SCALE: NONE

DATE:

BSMH-6.1

3/14

94
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE  TWO STOREY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN

SCALE: NONE
DATE: 4/14

BSMH-6.1
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

PLAN AT +2640
LINTEL BAND

ROOM 2
BAMBOO PARTITION WALL
100 x 50 TIMBER BANDS

100 X 5 CORNER BRACING MEMBER
12MM DIA BAMBOO PIN
50 x 40 TIMBER TIES

ROOM 1
SINGLE BAMBOO TIE BEAM
FIXED TO POSTS USING BAMBOO PINS AND TIED WITH NYLON STRIPS. TOP AT +2590
75 X 130 TIMBER BEAMS
MORTISE AND TENON JOINT
50 X 40 TIMBER TIES

COVERED VERANDAH
75 X 130 TIMBER RAFTERS
FIXED TO Lintel BAND MEMBER
75 X 130 TIMBER BEAM
FIXED TO TIMBER POSTS

75 X 130 TIMBER RAFTERS
FIXED TO TIMBER Lintel BAND
DIAGONAL BRACING FOR SINGLE BAMBOO RAFTERS
BAMBOO RAFTERS
FIXED TO TIMBER Lintel BAND

DIAGONAL BAMBOO BRACING TIMBER RAFTERS
75 X 130 TIMBER posts
130 X 130 TIMBER BEAMS
MORTISE AND TENON JOINT
50 X 40 TIMBER TIES

BAMBOO LADDER TO ATTIC
12MM DIA BAMBOO PIN
75 X 130 TIMBER BEAM
FIXED TO TIMBER POSTS

75 X 130 TIMBER RAFTERS
FIXED TO TIMBER Lintel BAND
MORTISE AND TENON JOINT
50 X 40 TIMBER TIES

ROOM
BAMBOO PARTITION WALL
100 X 50 TIMBER BANDS

12MM DIA BAMBOO PIN
50 X 40 TIMBER TIES

KITCHEN
DIAGONAL BRACING FOR SINGLE BAMBOO RAFTERS
BAMBOO RAFTERS
FIXED TO TIMBER Lintel BAND

PLAN AT +2640
LINTEL BAND

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN
SCALE: NONE
DATE: 5/14

BSMH-6.1
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

PLAN AT +2790 (ATTIC FLOOR BEAMS)
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE  TWO STOREY

PRE-COATED GALVANIZED IRON ROOFING SHEETS PROTECTION OVER SMM WALL FIXED WITH J-BOLTS

130 MM THICK MUD PLASTERED DOUBLE WATTLE WALLS ON BAMBOO FRAME

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN

PLANT AT +3350 (ATTIC WINDOW SILL LEVEL)

J BOLTS WITH WATER-TIGHT WASHERS FOR FIXING GI SHEETS TO BAMBOO PURLINS

PRE-COATED GALVANIZED IRON ROOFING SHEETS TO SLOPE DOWNTAKE FOR RAINWATER HARVESTING

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN

SCALE: NONE

DATE: 7/14

BSMH-6.1
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

HAUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE
DATE: 8/14

BSMH-6.1

ROOF PLAN

J BOLTS WITH WATER-TIGHT WASHERS FOR FIXING GI SHEETS TO BAMBOO PURLINS

GI GUTTER AT ROOF LEVEL

GI GUTTER FOR VERANDAH ROOF

DOWNTAKE FOR RAINWATER HARVESTING

PRE-COATED GALVANIZED IRON RIDGE SHEET

GI GUTTER AT ROOF LEVEL

G.I. SHEET GUTTER FOR VERANDAH ROOF

G.I. SHEET GUTTER

DOWNTAKE FOR RAINWATER HARVESTING

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J BOLTS WITH WATER-TIGHT WASHERS FOR FIXING GI SHEETS TO BAMBOO PURLINS

ROOF PLAN

 SCALE: NONE
 DATE: 8/14

BSMH-6.1
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

ATTIC FLOOR

GROUND FLOOR

SECTION AT A-A

PRE-COATED C.G.I ROOFING SHEETS AND RIDGE PIECE FIXED USING J-BOLTS

TWIN BAMBOO 'A' FRAME TRUSS SUPPORTED ON MIDDLE BAMBOO OF POSTS

TRUSS BOLTED THROUGH THE OUTER BAMBOO OF THE POSTS

G.I. SHEET GUTTER

75 X 130 TIMBER RAFTER FIXED TO THE LINTEL BAND WITH BAMBOO DOWEL

G.I. SHEET GUTTER

75 X 75 TIMBER DOOR AND WINDOW FRAME (REF DETAIL WW)

75 X 130 TIMBER BEAM FOR VERANDAH FIXED TO THE POST AND RAFTERS WITH LAP JOINTS

130 X 130 TIMBER POSTS FOR VERANDAH SECURED WITH DOWEL THROUGH M.S. FLAT EMBEDDED IN RC LINTEL BAND REFERENCE DETAIL A

100 x 50 TIMBER BANDS AT LINTEL LEVEL

75 TH. DAMP PROOF COURSE IN 1:2:4 PCC

2 Nos. TRUSS BOTTOM CHORDS ON EITHER SIDE OF TWIN TRUSS MEMBERS

50 MM THICK COMPACTED MUD FLOOR OVER SPLIT BAMBOO BASE OVER POLYTHENE SHEET OVER BAMBOO MAT OVERLAY OVER TWIN BAMBOO BEAMS

100 x 50 TIMBER BANDS AT PLINTH LEVEL

400 x 100 x 75 PRECAST CONCRETE 'THROUGH STONES'

100 x 50 TIMBER BANDS AT INTERMEDIATE LEVEL

75 TH. DAMP PROOF COURSE IN 1:2:4 PCC OVER TWIN BAMBOO BEAMS

100 x 50 TIMBER BANDS AT PLINTH LEVEL

2360

1750

1060

5170

2 Nos. TRUSS BOTTOM CHORDS ON EITHER SIDE OF TWIN TRUSS MEMBERS

75 X 75 TIMBER BANDS AT LINTEL LEVEL

75 X 75 TIMBER BANDS AT INTERMEDIATE LEVEL

75 X 75 TIMBER BANDS AT PLINTH LEVEL

100 x 50 TIMBER BANDS AT LINTEL LEVEL

75 TH. DAMP PROOF COURSE IN 1:2:4 PCC

PCC BASE PAD FOR BAMBOO POST REFERENCE DETAIL B

MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD IN LAYERS OF 200MM EACH. TOP AT +460

MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED OVER TWIN BAMBOO BEAMS BOTH SIDES MUD PLASTER ON BAMBOO WATTLE MOUNTED ON BAMBOO FRAME

50 MM THICK COMPACTED MUD FLOOR OVER SPLIT BAMBOO BASE OVER POLYTHENE SHEET OVER BAMBOO MAT OVERLAY OVER TWIN BAMBOO BEAMS

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75 X 130 TIMBER BEAM FOR VERANDAH FIXED TO THE POST AND RAFTERS WITH LAP JOINTS

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75 X 130 TIMBER BEAM FOR VERANDAH FIXED TO THE POST AND RAFTERS WITH LAP JOINTS

130 X 130 TIMBER POSTS FOR VERANDA...
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

SECTION AT C-C

- BOTH SIDES MUD PLASTER ON BAMBOO WATTLE MOUNTED ON BAMBOO FRAME
- 50 MM THICK COMPACTED MUD FLOOR OVER SPLIT BAMBOO BASE OVER POLYTHENE SHEET OVER BAMBOO MAT OVERLAY OVER TWIN BAMBOO BEAMS
- 100 x 50 TIMBER BANDS AT LINTEL LEVEL
- 400 x 100 x 75 PRECAST CONCRETE
- 75 x 75 TIMBER DOOR AND WINDOW FRAME
- PLINTH BAND
- 75 THK. DPC

- ATTIC FLOOR
- 1015
- 2185
- BAMBOO POST CLUSTER (TYPE 2) OVER PCC BASE BLOCK. REF DETAIL B
- MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD
- KNEE BRACING REF DETAIL P
- REF DETAIL B

- PRE-COATED C.G.I ROOFING SHEETS AND RIDGE PIECE FIXED USING J-BOLTS
- TWIN BAMBOO TRUSS
- BAMBOO CROSS BRACING
- G.I. ROOFING SHEET OVER KITCHEN FIXED USING J-BOLTS
- 100 x 50 TIMBER BANDS AT INTERMEDIATE LEVEL
- MUD PLASTER ON BAMBOO WATTLE
- 75 TH. DAMP PROOF COURSE IN 1:2:4 PCC

- 100 x 50 TIMBER BANDS AT LINTEL LEVEL
- B.A.M. POST CLUSTER (TYPE 2) OVER PCC BASE BLOCK. REF DETAIL B
- MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD
- KNEE BRACING REF DETAIL P
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- MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD
- KNEE BRACING REF DETAIL P
- REF DETAIL B
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

FRONT ELEVATION

SIDE ELEVATION

SIDE ELEVATION

BACK ELEVATION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDNG CONSTRUCTION

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: ELEVATIONS

SCALE: NONE
DATE: 11/14
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

TWO STOREY

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: DETAILS
DATE: 12/14
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

DETAIL B (SECTION): BASE PAD FOR BAMBOO CLUSTER POSTS 'TYPE 1' AND TYPE 2'

DETAIL B (SIDE ELEVATION): BASE PAD FOR BAMBOO CLUSTER POSTS 'TYPE 1' AND TYPE 2'
ADAPTED FROM: RE-CONSTRUCTION OF MULTI-HAZARD RESISTANT HOUSES FOR THE 2008 KOSI AFFECTED DISTRICTS IN WEST BIHAR. PART - II: TECHNICAL GUIDELINES FOR BAMBOO BASED CONSTRUCTION

DETAIL B (PLAN): BASE PAD FOR BAMBOO CLUSTER POSTS 'TYPE 1' AND TYPE 2'
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Two independent structural system; bamboo structure and stone masonry in mud mortar with 150 mm gap between them as shown in the drawings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of stone masonry in mud mortar of width 850 mm and depth 750 mm. For bamboo posts, 150 x 150 mm thick PCC base pad over polythene sheet.</td>
</tr>
<tr>
<td>Bands:</td>
<td>Timber bands shall be provided at plinth, lintel and intermediate level as shown in the drawing. Band consists of two parallel timber sections of 100 x 50 mm size covering entire thickness of wall. These timber shall be laterally tied with timber sections of size 38 x 50 mm</td>
</tr>
<tr>
<td>Wall System</td>
<td>Random rubble masonry in mud mortar. Wall thickness 457 mm</td>
</tr>
<tr>
<td>Floor:</td>
<td>50 mm thick mud flooring over split bamboos laid over joists of bamboo twins (double section) @ 400 mm c/c (Refer drawing)</td>
</tr>
<tr>
<td>Roof:</td>
<td>Lightweight roof of Corrugated Iron sheet over bamboo truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
</tr>
</tbody>
</table>
RAT-TRAP BOND MASONRY

R.T.B.-7.1
Rat-Trap Bond is a modular type of masonry construction in which bricks are laid on edge, thereby creating an internal cavity within the wall. The cavity improves the thermal behavior of the wall and significantly reduces the quantity of brick and mortar in the masonry. It is a Green Building technology and an appropriate option against conventional solid brick wall masonry from sustainable point of view. Rat trap bond masonry can be used both for partition wall or as a load bearing structures. As Rat trap bond construction is a modular type of masonry construction, due care must be taken while designing the wall length and height.

The design featured in Model RTB-2.1 is a two roomed single storied load bearing structure of Rat Trap bond masonry. Horizontal bands, vertical reinforcements, corner reinforcement and reinforcement in T-junctions are provided.

MATERIAL PROPERTIES
Min Compressive Strength of Rat Trap Bond : 1.3 Mpa
Unit weight of RTB masonry: 15KN/m3
Young's Modulus: 715 Mpa
### MATERIALS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone</th>
<th>Brick</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Wood</th>
<th>Reinforcing Bar</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Cu.m.</th>
<th>No.</th>
<th>Bags</th>
<th>Cu.m.</th>
<th>Cu.m.</th>
<th>Cu.m.</th>
<th>Kg.</th>
<th>Bundle</th>
<th>Rm.</th>
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<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>19.5</td>
<td>2,225.0</td>
<td>59.0</td>
<td>10.3</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>280.4</td>
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<td></td>
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<tr>
<td>Super Structure</td>
<td>5,125.0</td>
<td>32.0</td>
<td>3.1</td>
<td>2.5</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>297.8</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Roofing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.0</td>
<td>-</td>
<td>4.2</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>19.5</td>
<td>7,350.0</td>
<td>91.0</td>
<td>13.4</td>
<td>5</td>
<td>4.6</td>
<td>578.2</td>
<td>4.2</td>
<td>10.0</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
MODEL RTB-7.1, RAT TRAP BOND MASONRY

GROUND FLOOR PLAN
FLOOR AREA: 40.36 SQ.M.

BED ROOM
3430X3585

KITCHEN
3585X3585

VERANDAH

HOUSING TYPE: R.T.B.-7.1
SCALE: NONE
DRAWING TITLE: GROUND FLOOR PLAN
DATE:

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

RTB-7.1
2/10
MODEL RTB-7.1, RAT TRAP BOND MASONRY

HOUSING TYPE: R.T.B.-7.1
DRAWING TITLE: SECTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

RTB-7.1

SCALE: NONE
DATE: 3/10
MODEL RTB-7.1, RAT TRAP BOND MASONRY

ONE STOREY

FRONT ELEVATION

SIDE ELEVATION

SIDE ELEVATION

BACK ELEVATION
TECHNOLOGY FOR EARTHQUAKE RESISTANT BUILDING CONSTRUCTION (RAT-TRAP BOND BRICK MASONRY IN CEMENT MORTAR)

**MODEL RTB-7.1, RAT TRAP BOND MASONRY**

- **WALL:** RTB BRICK MASONRY IN CEMENT MORTAR 1:4
- **CORNER STITCH:** RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 2-12MMØ, STIRRUP 7MM@150MM
- **ROOF BAND:** RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12 MMØ STIRRUP 7MM@150MM
- **SILL BAND:** RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 2-12 MMØ STIRRUP 7MM@150MM
- **PLINTH BAND:** RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12 MMØ STIRRUP 7MM@150MM
- **LINTEL BAND:** RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12 MMØ STIRRUP 7MM@150MM
- **FOUNDER:** STONE MASONRY IN CEMENT MORTAR 1:4
- **VERTICAL REINFORCEMENT:** REINFORCEMENT 12MM REBAR

**HOUSING TYPE:** R.T.B.-7.1

**DRAWING TITLE:** SECTIONAL PERSPECTIVE

**SCALE:** NONE

**DATE:** 5/10
MODEL RTB-7.1, RAT TRAP BOND MASONRY

RAT-TRAP BOND IN T-JUNCTION

RAT-TRAP BOND IN CORNER JUNCTION

DETAIL C
FOUNDATION SECTION

RAT-TRAP LAYER 1

RAT-TRAP LAYER 2
MODEL RTB-7.1, RAT TRAP BOND MASONRY

CROSS SECTION OF RC BANDS FOR TWO BARS AND FOUR BARS

REQUIREMENT OF BAR FOR RC BANDS

<table>
<thead>
<tr>
<th>BAND/BEAM</th>
<th>RC BAND MINIMUM THICKNESS</th>
<th>MIN. NO. OF BARS</th>
<th>MIN. DIAMETER OF BARS (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLINTH</td>
<td>150MM</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>SILL</td>
<td>75MM</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Lintel</td>
<td>150MM</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Roof/ Gable</td>
<td>150MM</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Corner Stitch</td>
<td>75MM</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

RCC BAND AT CORNER AND T-JUNCTION

7MM DIA. CROSS TIES @150MM C/C

7MM DIA. CROSS TIES @150MM C/C

12mm Ø VERTICAL BAR
MODEL RTB-7.1, RAT TRAP BOND MASONRY

TOP (PLAN) VIEW

ISOMETRIC VIEW

DETAILS

SIDE VIEW

RAFTER (H180 X W90)
PURLIN (H75 X W75)
RIDGE COVER
CGI SHEET MIN. 26GAGE

Wooden Post (D100 X W100)
MODEL RTB-7.1, RAT TRAP BOND MASONRY

ONE STOREY

HOUUSING TYPE: R.T.B.-7.1
DRAWING TITLE: ROOF DETAILS

SCALE: NONE
DATE: 9/10

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDNG CONSTRUCTION

GABLE BAND

CGI SHEET
75X75MM PURLIN @300MM C/C
180X90MM RAFTER @600MM C/C
100X75 MM WALL PLATE
J-HOOK
EAVES BOARD

TYPE-1

ROOF BAND
GABLE BAND
GABLE WALL
ROOF BAND

DETAIL AT-X

WOODEN NAIL
WOODEN KEY
RAFTER
75X 100 MM WALL PLATE

DETAIL AT-Y

75 X 125 RIDGE PIECE
WOODEN POST
RAFTER
NAIL

PLAN

CGI RIDGE

RIDGE PIECE
RAFTER
NAIL

RTB-7.1

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# TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Load bearing Rat Trap Bond (RTB) masonry structure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Stone masonry strip footing of width 800 mm and depth 800 mm in cement sand mortar 1:4.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>RCC (1:1.5:3) plinth band shall be provided throughout the entire wall at plinth level. The minimum depth of the band shall be 150mm. Main reinforcement shall be 4 nos. 12mm dia. bars with 7mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Wall System</td>
<td>Rat trap bond brick masonry in 1:4 cement sand mortar.</td>
</tr>
<tr>
<td>Sill Band</td>
<td>RCC (1:1.5:3) sill band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 7mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Lintel Band</td>
<td>RCC (1:1.5:3) lintel band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 150mm. Main reinforcement shall be 4 nos. 12mm dia. bars with 7mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Roof Band</td>
<td>RCC (1:1.5:3) roof band shall be provided throughout the entire wall at roof level. The minimum depth of the band shall be 150mm. Main reinforcement shall be 4 nos. 12mm dia. bars with 7mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Roof</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
</tr>
</tbody>
</table>

**TECHNICAL REQUIREMENTS**
Earthbag technology is a simple, inexpensive and sustainable method for building structures using ordinary soil found at construction site. The technology consists of Polypropylene bags filled with locally available soil, laid similarly to masonry with barbed wire serving as a mortar and provides tensile as well as shear strength. The featured design of Earthbag technology EB 8.1 consists of single storied structure with two rooms. The wall system uses Polypropylene bags filled with soil whereas CGI sheet is used for covering the roof along with wooden rafters and purlins.

**MATERIAL PROPERTIES**
Soil for Earthing: 25% - 30% clay & 70% - 75% Sandy soil
Bags: Polypropylene bags
Barbed wire: 14guage, 4 pointed
Rebar: Mild steel bar of Grade Fe 250
Nominal Mix Ratio : 1:1.5:3 (C:S:A)
## MODEL E.B.-8.1, EARTHBAG MASONRY

### ONE STOREY

**MATERIALS**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
<th>Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu.m.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Bundle</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>12.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>19</td>
<td>1.0</td>
<td>2.0</td>
<td>237.3</td>
<td>4.2</td>
<td>8.0</td>
<td>2.4</td>
<td>25.5</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.2</td>
<td>8.0</td>
<td>2.4</td>
<td>2.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>12.3</td>
<td>19</td>
<td>1.0</td>
<td>2.0</td>
<td>237.3</td>
<td>4.2</td>
<td>8.0</td>
<td>2.9</td>
<td>25.5</td>
</tr>
</tbody>
</table>

**MINISTRY OF URBAN DEVELOPMENT**

**DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION**

**HOUSING TYPE: MODEL E.B.-8.1**

**DRAWING TITLE: ESTIMATE AND 3D-VIEW**

**SCALE: NONE**

**DATE:**

E.B.-8.1

1/11
GROUND FLOOR PLAN

FLOOR AREA: 31.95 SQ.M.

Room 1
3035 X 3045

Room 2
3035 X 3045

Wooden Partition
MODEL E.B.-8.1, EARTHBAG MASONRY

HOUSING TYPE: MODEL E.B.-8.1
DRAWING TITLE: ELEVATIONS

FRONT ELEVATION
SIDE ELEVATION
BACK ELEVATION
SIDE ELEVATION
MODEL E.B.-8.1, EARTHBAG MASONRY

RIDGE H240XW180
POST H90XW90
RAFTER H180XW90
PURLIN H75XW75

REFER ROOF BAND CONNECTION DETAIL

SECTION A-A

25MM CEMENT /EARTHEN PLASTER
GALVANIZED CHICKEN WIRE MESH
380MM EARTH BAG
12MM REBAR WITH 300MM OVERLAP
3 LAYERS OF 150MM GRAVEL BAGS
DRY STONE MASONRY

450 MM THK. EARTHBAG MASONRY IN BARBED WIRE

REFER FOUNDATION DETAIL

50MM MUD FLOORING
5OOGAUGE POLYTHENE SHEET
100MM STONE SOLING

380MM EARTH BAG

450 MM THK. EARTHBAG MASONRY IN BARBED WIRE

REFER FOUNDATION DETAIL

50MM MUD FLOORING
5OOGAUGE POLYTHENE SHEET
100MM STONE SOLING

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

HOUSING TYPE: MODEL E.B.-8.1
DRAWING TITLE: SECTION

SCALE: NONE
DATE: 4/11
MODEL E.B.-8.1, EARTHBAG MASONRY

RIDGE H240XW180
POST H90XW90
RAFTER H180XW90
PURLIN H75XW75

BASE H90XW90

100X100 WOODEN DOOR FRAME
100X100 WOODEN WINDOW FRAME

450 MM THK. EARTHBAG MASONRY IN BARBED WIRE

REFER FOUNDATION DETAIL

50MM MUD FLOORING
500GAUGE POLYTHENE SHEET
100MM STONE SOLING

SECTION B-B

DRY STONE MASONRY
MODEL E.B.-8.1, EARTHBAG MASONRY

ONE STOREY

ROOF BAND CONNECTION WITH TRUSS

ROOF PLAN

MODEL E.B.-8.1, EARTHBAG MASONRY

ROOF BAND CONNECTION WITH TRUSS

ROOF PLAN
EARTHBAGS
GRAVEL FILLED BAGS
MUD FLOORING
RUBBLE SOLING
FILTER GEO-FABRIC
ENVELOPES RUBBLE TRENCH

BARBED WIRE SHOULD BE LAID CENTRALLY WITH A MINIMUM GAP OF 150MM AS SHOWN IN THE FIGURE ABOVE

BASE WIDTH OF FOOTING = 200 + 1 BAG WIDTH

FOUNDATION SECTION
CONSTRUCTION SEQUENCE

1. Survey the site and sample the soil. Get advice from an engineer.

2. Level the building site and cover with tarp to protect bags from rain & sun.

3. Mark the footprint, including corner & wall buttresses. Excavate trench 3ft deep, 2ft wide.


5. Fill and place first course of gravel bags.

6. Lay two strands of 4-point barbed wire on top of each course and add wall ties.

7. Lay second or third gravel bag layer above floor level.

8. Use sliders and always overlap the bags while building the wall.

9. Make door thresholds, install door frames and optional door bucks.

MODEL E.B.-8.1, EARTHBAG MASONRY

One Storey

Housing Type: Model E.B.-8.1

Drawing Title: Construction Sequence

Date: 9/11
CONSTRUCTION SEQUENCE

10 PREPARE SOIL FOR EARTHBAGS: SIEVE AND MAINTAIN 10% MOISTURE

11 FILL BAGS WITH EARTH, PLACE FIRST COURSE AND TAMPP

12 REPEAT STEP 6 AFTER EACH COURSE

13 PREVENT CORNER DROP

14 TAMPP, LEVEL AND FLATTEN WALLS AFTER EACH COURSE

15 PLACE THE WINDOW FRAME SO THE LINTEL LEVEL COINCIDES WITH THE BOND BEAM LEVEL

16 INSTALL VERTICAL REBARS AT SILL AND LINTEL LEVEL

17 USE ANCHOR PLATES TO ATTACH DOORS AND WINDOWS

18 INSTALL GALVINIZED/PLASTIC MESH FOR PLASTERING

19 INSTALL BOND BEAM, LIGHTWEIGHT ROOF AND ELECTRICAL WIRING

20 PLASTER AND PAINT
# TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Load bearing Earthbag masonry structure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of dry stone masonry of width 600 mm and depth 900 mm.</td>
</tr>
<tr>
<td>Plinth</td>
<td>Three polypropylene bags filled with gravel shall be placed up to plinth level.</td>
</tr>
<tr>
<td>Wall System</td>
<td>450 mm thick Earthbag masonry shall be interconnected in each layers with barbed wire. Buttress shall be provided along the unsupported length of wall as shown in drawing.</td>
</tr>
<tr>
<td>Roof Band:</td>
<td>RCC (1:1.5:3) roof band shall be provided throughout the wall at roof level. The minimum depth of the band shall be 150mm. Main reinforcement shall be 2 nos.12mm dia. bars with 8mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Roof:</td>
<td>Lightweight roof of corrugated iron sheet over wooden truss. All joints in the truss shall be properly connected as shown in the drawing.</td>
</tr>
</tbody>
</table>
LIGHT GAUGE STEEL STRUCTURE

L.G.S.-9.1
L.G.S.-9.2
Cold Form Light gauge steel construction is a structural system consisting of thin steel sections cladded with light gauge steel panel, Cellular light weight concrete, Cement fiber board, gypsum board or calcium silicate board. The steel sections used here are called cold formed sections, meaning that the sections are formed, or given shape at room temperature. This kind of technology requires high level of planning and precision as cold formed sections are fabricated at factory. Similarly skilled manpower are required in site for precise execution of designs. Featured design L.G.S 9.1 is a single storied residential unit with 2 bedrooms. Model L.G.S 9.2 is a two storied residential units with 4 bedrooms.

**MATERIAL PROPERTIES**
The raw materials used for the LGS steel frame is Galvanized cold form steel stripe
Yield strength:
Min. 450 N/mm\(^2\) for LGS 9.1
Min. 350 N/mm\(^2\) for LGS-9.2
Galvanized zinc coated: Min. 275gsm
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

**Housing Type:**

**Drawing Title:**

**Scale:**

**Date:**

---

**Materials**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone (Cu.m.)</th>
<th>Brick (No.)</th>
<th>Cement (Bags)</th>
<th>Sand (Cu.m.)</th>
<th>Aggregate (Cu.m.)</th>
<th>Reinforcing Bar (Kg.)</th>
<th>CGI Sheet (Bundle)</th>
<th>GI Sheet (Sq.m.)</th>
<th>MS angles &amp; Plates (Cu.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>42.1</td>
<td>15,702.0</td>
<td>115.5</td>
<td>13.0</td>
<td>11.1</td>
<td>468.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>2.5</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4,184.8</td>
<td>32.9</td>
<td>1,753.2</td>
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<tr>
<td>Roofing</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>8.8</td>
<td>32.9</td>
<td>1,753.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>42.1</strong></td>
<td><strong>15,702.0</strong></td>
<td><strong>118</strong></td>
<td><strong>13.3</strong></td>
<td><strong>11.1</strong></td>
<td><strong>468.5</strong></td>
<td><strong>8.8</strong></td>
<td><strong>32.9</strong></td>
<td><strong>5,938.0</strong></td>
</tr>
</tbody>
</table>
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

HOUSING TYPE: MODEL L.G.S.-9.1
DRAWING TITLE: FLOOR PLAN

GROUND FLOOR PLAN
AREA: 65.63 SQ. M

KITCHEN
3200 X 2200

BATHROOM
2200 X 1900

DINNING ROOM
3500 X 2200

LIVING ROOM
4900 X 2200

BED ROOM
3300 X 4500

BED ROOM
3300 X 4500

1500 MM WIDE PASSAGE

1500 MM WIDE PASSAGE

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

SCALE: NONE
DATE:
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

 ONE STOREY

FOUNDATION SECTION

TIE BEAM

450 MM THICK P.C.C (1:3:6)
STONE SOLING
WELL COMPACTED EARTH

75MM THICK P.C.C (1:3:6)
ONE LAYER FLAT BRICK SOLING
WELL COMPACTED EARTH

CONNECTION DETAILS AT DPC LEVEL

HEX TEK
HOOD DOWN BRACKET
WAFFER TEK

TYPICAL STRAP BRACING IN WALL

2-10X16X16 HEX TEK SCREW

4MM DIA RIVET

STRAP TENSIONER

C90X37X0.75MM BMT STUD
1RIVET/10-16 HEX TEK SCREW
0.75X50MM STRAP BRACING

MODEL L.G.S.-9.1

SHEETS 5/9

HOUSING TYPE: MODEL L.G.S.-9.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE:
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

HOUSING TYPE: MODEL L.G.S.-9.1
DRAWING TITLE: DETAILS

TYPICAL ELEVATION DETAIL AT OPENING

STRUCTURAL ELEVATION 1

STRUCTURAL ELEVATION 2

C90X37X0.75 VERTICAL STUD

WINDOW (W2)
1900x1200

DOOR (D1)
1100x1100

DOOR (D2)
1100x1100

WINDOW (W2)
1800x1200

C90X37X0.75MM HORIZONTAL NUG @500MM

75X75X4MM MS SQ. STEEL SECTION POST

C90X37X0.75MM BMT HORIZONTAL NUG @500MM C/C

RIDGE

1RIVERT/10-16-16 HEX TEX SCREW

C90X37X0.75MM BMT STUD @ 406MM C/C

0.75X50MM STRAP BRACING

C90X37X0.75MM VERTICAL STUD

C90X37X0.75MM HORIZONTAL NUG

1RIVERT/10-16-16 HEX TEX SCREW

300MM LINTEL

C90X37X0.75MM BMT STUD @ 406MM C/C

0.75X50MM STRAP BRACING

C90X37X0.75MM VERTICAL STUD

C90X37X0.75MM HORIZONTAL NUG

4MM DIA. RIVET

LINTEL JACK STUD

300MM LINTEL

2C90X37X0.75MM AT OPENING STUD

C90X37X0.75MM BMT STUD @ 406MM C/C

0.75X50MM STRAP BRACING

C90X37X0.75MM HORIZONTAL NUG

TYPICAL ELEVATION DETAIL AT OPENING

ALL SECTIONS C90X37X0.95MM BMT
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

**PLAN VIEW AT CORNER**
- 10MM THICK CLADDING BOARD
- 160MM LX12MM DIA ANCHOR BOLT
- 10X16-16 HEX TEK SCREW
- 160MM LX12MM DIA ANCHOR BOLT

**TYPICAL CONNECTION DETAILS OF STUD AND NUG.**
- M STUD
- CONNECTION PLATE
- SCREW @ 15MM OC
- NUG

**PLAN VIEW AT WALL STUD**
- 160MM LX12MM DIA ANCHOR BOLT
- 3MM THICK 75X75 SQUARE WASHER PLATE
- 3MM THICK 75X75MM BMT STUD

**PLAN VIEW AT INTERSECTION**
- 10MM THICK CLADDING BOARD
- 3MM THICK 75X75MM MS L BRACKET HOLD DOWN
- 160MM LX12MM DIA ANCHOR BOLT
- 160MM LX12MM DIA ANCHOR BOLT

**DETAIL AT A**
- C90X37X0.75MM STUD
- 4MM THICK CONNECTION PLATE
- 3-4.8MMØ SCREW @ 15MM OC
- 2-4.8MMØ SCREW ON BOTH SIDE OF STUDS
- C90X37X0.75MM NUG

**HOLES FOR CONCRETE NAIL**
- 10X16-16 HEX TEK SCREW
- 160MM LX12MM DIA ANCHOR BOLT

**DETAILS**
- HOLES FOR CONCRETE NAIL
- 10MM THICK CLADDING BOARD
- 160MM LX12MM DIA ANCHOR BOLT
- C90X37X0.75MM BMT STUD
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

ROOF LAYOUT

SUPPORT DETAIL

RIDGE
C90_37-0.75MM BMT SECTION RAFTER
C90_37-0.75MM BMT SECTION STUD
C90_37-0.75 MM BMT SUPPORT TOP CHORD
90x37x0.75MM BMT BRACE
90x37x0.75MM BMT SUPPORT BOTTOM CHORD

0.75x50MM STRAP BRACING
0.75x50MM BMT CHANNEL SECTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: MODEL L.G.S.-9.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE: 8/9

L.G.S 9.1

140
**TECHNICAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Structural system consisting of thin steel sections cladded with materials like light gauge steel panel, Cellular light weight concrete, Cement fiber board, gypsum board, calcium silicate board etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip footing of Random rubble masonry in cement sand mortar with width 900 mm and depth 850 mm.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>R.C.C (1:1.5:3) plinth band of size 230x 230 mm. Main reinforcement shall be 4 nos. of 12mm dia. Bars with 8mm Ø rings at 150mm C/C</td>
</tr>
<tr>
<td>Wall System</td>
<td>Wall frames shall be of cold formed steel channel sections of minimum thickness 0.75mm. All the vertical studs and horizontal nog of the wall frames shall be at the spacing mentioned in the drawings.</td>
</tr>
<tr>
<td>Bracing</td>
<td>K Bracing and X Bracing made up of cold formed steel channel sections of minimum thickness 0.75mm as mentioned in drawing</td>
</tr>
<tr>
<td>Roof System</td>
<td>Truss shall be of Cold formed steel channel section of minimum thickness 0.55mm and depth of web 90 mm covered with light roofing materials.</td>
</tr>
</tbody>
</table>
**MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE**

**HOUSING TYPE:** MODEL L.G.S.-9.2

**SCALE:** NONE

**DRAWING TITLE:** ESTIMATION AND 3D-VIEW

**DATE:** 1/7

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brick</td>
<td>Cement</td>
<td>Sand</td>
<td>Aggregate</td>
<td>Reinforcing Bar</td>
<td>CGI Sheet</td>
<td>GI Sheet</td>
<td>MS angles &amp; Plates</td>
<td>Wall Board</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Bundle</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td>Sq.m.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
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<td>6.4</td>
<td>9.5</td>
<td>594.5</td>
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<td>Super Structure</td>
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<td>0.3</td>
<td>-</td>
<td>-</td>
<td>4,184.8</td>
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<td>-</td>
<td>5.4</td>
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<tr>
<td>TOTAL</td>
<td>2,973.0</td>
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<td>6.7</td>
<td>9.5</td>
<td>594.5</td>
<td>5.4</td>
<td>14.8</td>
<td>6,814.6</td>
<td>246.8</td>
</tr>
</tbody>
</table>
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE  
TWO STOREY

GROUND FLOOR PLAN
FLOOR AREA: 36.19 SQ. M.

FIRST FLOOR PLAN
FLOOR AREA: 36.19 SQ. M.

KITCHEN
2615 X 2990

ROOM # 1
2615 X 2990

LIVING ROOM
2615 X 2990

STORE

ROOM 2
2615 X 2990

ROOM 3
2615 X 2990

ROOM 4
2615 X 2990

DRAWING TITLE: FLOOR PLANS

HOUSING TYPE: MODEL L.G.S.-9.2

SCALE: NONE

DATE:

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

2/7
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE

TWO STOREY

FRONT ELEVATION

SIDE ELEVATION

BACK ELEVATION

SIDE ELEVATION

HOUSING TYPE: MODEL L.G.S.-9.2
DRAWING TITLE: ELEVATIONS

SCALE: NONE

DATE:

L.G.S.-9.2

3/7
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE

TWO STOREY

REFER TYPICAL ROOF TRUSS DETAIL

REFER TYPICAL FLOOR SECTION

REFER FOUNDATION DETAIL

SECTION AT X-X

LGS POST

CGI SHEET

PUNNING
20 MM SCREEDING
50 MM RCC, 8MM DIA.
REINFORCEMENT BETWEEN
25 MM CONCRETE TILES
250MMX50 MMX15 MM FLOOR JOIST

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: MODEL L.G.S.-9.2
DRAWING TITLE: SECTION

SCALE: NONE
DATE: 4/7

L.G.S.-9.2
**MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE**

**Housing Type:** MODEL L.G.S.-9.2

**Details:**
- **Foundation and Wall Section:**
  - 50 mm concrete top
  - 6 mm rebar @ 200 mm spacing
  - 25 mm thick concrete tiles
  - 250 mm deep lattice floor joist
  - 5 mm thick ceiling boards
  - No 8 screws through the ceiling boards to the bottom chord of the joist
  - 25 mm thick concrete boards
  - Cellular light weight concrete infill (600 kg/m³)
  - 600 mm high density concrete infill between walls studs
  - 10 mm restarter bar @ 400 mm spacing

**Frame Connection to Wall L Bracket Hold Down:**
- U-track over concrete slab
  - 89x50x15 stud
  - 8.8 grade wafer head screws
  - 89x50x15 U-track
  - 8.8 grade wafer head screws
  - M12 anchor bolt with inbuilt washer

**Notes:**
- Regular concrete infill (2400 kg/m³)
- Size 10 mm bars @ 100 mm c/c
- Size 10 mm bars @ 224 mm c/c laid perpendicular to the primary reinforcement
- Size 12 mm bars laid @ 250 mm c/c horizontally as primary reinforcement
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE

TWO STOREY

TYPICAL FLOOR SECTIONS

8.8 GRADE WAFERHEAD SCREWS
VERTICAL STUDS @ 400 MM C/C
X-BRACING
NOGGING
8.8 GRADE SELF DRILLING SCREWS

TYPICAL WALL SECTION

8.8 GRADE WAFFER HEAD SCREWS

LATTICE Lintel

TYPICAL ROOF TRUSS TO STUD CONNECTIONS

STUDS @ 400 MM SPACING
8.8 GRADE HEXA HEAD SCREWS
NOGGINGS

TYPICAL NOGGING SECTION

EXPANDABLE M12 ANCHOR BOLTS @ SUITABLE SPACING
LOAD BEARING STUDS @ 400 MM C/C
U-TRACK BOLTED TO CONCRETE FOUNDATION

CONCRETE TILES
JOISTS @ 400 C/C
COUNTER SUNK SCREWS
U-TRACK ABOVE STUDS
LOAD BEARING STUDS

ISOMETRIC VIEW OF STUDS ARRANGEMENT

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL L.G.S.-9.2
DRAWING TITLE: DETAILS

SCALE: NONE
L.G.S.-9.2
DATE: 6/7
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Structural system consisting of thin steel sections cladded with Cellular light weight concrete tiles. Minimum tensile strength and yield strength of Light gauge steel to be 350 Mpa and 450 Mpa respectively.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Reinforced Concrete strip footing of size as specified in detail drawing on foundation of width 900mm and depth 950mm. LGS tracks shall be bolted to the foundation using M12 expandable bolts at an interval of 1.2m-1.8m.</td>
</tr>
<tr>
<td>Wall System</td>
<td>Wall frames shall be of cold formed steel channel sections. All the vertical studs and horizontal joists of the wall frames shall be at the spacing mentioned in the drawings.</td>
</tr>
<tr>
<td>Flooring System</td>
<td>The flooring System shall be of 50 mm RCC on 25 mm concrete tiles on 250 x 50 x 15 mm floor joists</td>
</tr>
<tr>
<td>Roof System</td>
<td>Light roof steel truss covered with CGI sheets. All members of the truss or joints shall be properly connected as shown in detail drawings.</td>
</tr>
</tbody>
</table>
STEEL STRUCTURE

S.S.-10.1
S.S 10.1 is a structural system consisting of mild steel columns and beams to make steel moment resisting frame system. Both the gravity and lateral load is resisted by moment resisting frame. The floor system is made of profile metal decking system over which the thin layer of RCC is laid. The roofing system consists of MS Steel tubes truss with CGI Sheet. The infill wall consists of light weight partition wall made of light weight material having density less than 1000Kg/m³.

The featured design consists of two storey residential building consisting of 6 nos. of room.

**MATERIAL PROPERTIES AND SPECIFICATION**

Structural Steel Yield Strength: Fe250
CGI Sheet: min 53 gauge
Infill material density $\geq 1000$kg/m³
Mix ratio grade: 1:1.5:3
Tensile Strength of rebar: Fe 500
### MODEL S.S.-10.1, STEEL STRUCTURE

**Two Storey Model**

#### MATERIALS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Brick No.</th>
<th>Cement Bags</th>
<th>Sand Cu.m.</th>
<th>Aggregate Cu.m.</th>
<th>Reinforcing Bar Kg.</th>
<th>MS pipe Kg.</th>
<th>Steel sections Kg.</th>
<th>CGI Sheet Sq.m.</th>
<th>GI Plain sheet Sq.m.</th>
<th>Aluminium Door Sq.m.</th>
<th>Aluminium Window Sq.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>3,384.0</td>
<td>130.0</td>
<td>11.0</td>
<td>13.0</td>
<td>974.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>111.0</td>
<td>5.0</td>
<td>10.0</td>
<td>582.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3,930.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>845.4</td>
<td>-</td>
<td>6.3</td>
<td>11.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,384.0</td>
<td>241.0</td>
<td>16.0</td>
<td>23.0</td>
<td>1,556.0</td>
<td>845.4</td>
<td>3,930.1</td>
<td>6.3</td>
<td>11.1</td>
<td>10.3</td>
<td>22.6</td>
</tr>
</tbody>
</table>
MODEL S.S.-10.1, STEEL STRUCTURE

TWO STOREY

GROUND FLOOR PLAN
AREA: 60.85 SQ.M

First Floor Plan
AREA: 60.85 SQ.M

ROOM
4950 x 2950

ROOM
4950 x 2850

ROOM
4950 x 2950

ROOM
4950 x 2950
MODEL S.S.-10.1, STEEL STRUCTURE

HOUSING TYPE: MODEL S.S-10.1
DRAWING TITLE: SECTION
SCALE: NONE
DATE: 4/11
MODEL S.S.-10.1, STEEL STRUCTURE

FOUNDDATION TRENCH PLAN

FOUNDATION DETAIL

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Foundation Type</th>
<th>Foundation Size (LxB)</th>
<th>Footing sizes and reinforcement details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F1</td>
<td>1200x1200</td>
<td>T10@150mm c\c-bothway</td>
</tr>
<tr>
<td>2</td>
<td>F2</td>
<td>900x900</td>
<td>T10@150mm c\c-bothway</td>
</tr>
<tr>
<td>3</td>
<td>F3</td>
<td>750x750</td>
<td>T10@150mm c\c-bothway</td>
</tr>
</tbody>
</table>
MODEL S.S.-10.1, STEEL STRUCTURE

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL S.S-10.1
DRAWING TITLE: STRUCTURE DETAILS

SCALE: NONE
DATE: 6/11

FOUNDATION PLAN

REBAR B/W 10s 150C/C

REBAR B/W 10s 150C/C

PEDESTAL COLUMN

REBAR B/W 10s 150C/C

FOUNDATION SECTION AT A-A

PLINTH LEVEL

TIE BEAM

PEDESTAL COLUMN

GROUND LEVEL

BASE PLATE

2-12s THR.

2-12s THR.

2-12s THR.

GROUND LEVEL

WALL

75mm P.C.C (1:3:6)
SINGLE LAYER BRICK SOLING RAMMED EARTH

75mm P.C.C (1:3:6)
SINGLE LAYER BRICK SOLING RAMMED EARTH

TOE WALL

8-12s REBAR.
MODEL S.S.-10.1, STEEL STRUCTURE

HOUSING TYPE: MODEL S.S-10.1

DRAWING TITLE: STRUCTURE DETAILS

SCALE: NONE

DATE: 8/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

BASE PLATE CONNECTION SECTION

BASE PLATE CONNECTION PLAN

BEAM AND COLUMN CONNECTION

BEAM AND COLUMN CONNECTION
MODEL S.S.-10.1, STEEL STRUCTURE

TWO STOREY

COMPOSITE FLOOR PLAN

SECTION AT X-X

SECTION AT Y-Y

LAP DETAIL

END ANGLE DETAIL

16 SHEAR STUDS @260mm C/C

8 @150mm C/C BOTHWAY

75mm THICK CONCRETE (M20)

DECKING PROFILE 44/130x1mm

8 @130mm C/C

DECKING PROFILE 44/130x1mm

PUDDLE WELD

22

2.5 THK x 22

11

DIA. WASHER

22

DECKING PROFILE 44/130x1mm

ISA 150x150x10

159
MODEL S.S.-10.1, STEEL STRUCTURE

TWO STOREY

TRUSS DETAIL

VERTICAL CHORD

DIAGONAL CHORD

3mm FILLET WELD ALL AROUND THE PIPE

BOTTOM CHORD

6mm PLATE

2.8x BOLTS OF CLASS 4.6

DETAIL AT A

TRUSS COLUMN CONNECTION DETAIL

BOTTOM CHORD OF TRUSS 50.8x50.8mm WITH 3mm THICK

2ISA 50x50x6

200x200mm BEARING PLATE WITH 8mm THICK

2-ISM C150

PLAN

200

SECTION AT 1-1

2ISA 50x50x6

BOTTOM CHORD OF TRUSS 50.8x50.8mm WITH 3mm THICK

38.1x38.1x2mm VERTICAL CHORD

38.1x38.1x2mm DIAGONAL CHORD

50.8x50.8x3mm TOP CHORD

50.8x50.8x3mm BOTTOM CHORD

50.8x50.8x3mm PURLIN

50.8x50.8x3mm MIDDLE VERTICAL CHORD

50.8x50.8x3mm BOTTOM CHORD

CGI SHEET

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL S.S-10.1
DRAWING TITLE: STRUCTURE DETAILS

SCALE: NONE

S.S.-10.1

DATE: 10/11
### TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Moment resisting steel frame system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Isolated footing shown in detail drawing. Depth of Pedestal Column of 1.05 meters from ground level and width shown as per design in table.</td>
</tr>
<tr>
<td>Tie beam:</td>
<td>R.C.C (1:1.5:3) tie beam of size 230x 230 mm. Main reinforcement shall be 4 nos. of 12mm dia. Bars with 8mm Ø rings at 150mm C/C</td>
</tr>
<tr>
<td>Wall System</td>
<td>Infill walls with density more than 1000 kg/m³ on moment resisting steel frame.</td>
</tr>
<tr>
<td>Column:</td>
<td>Two ISMC150 column with full penetration groove weld in factory is used in structure.</td>
</tr>
<tr>
<td>Beam:</td>
<td>ISMB 150 shall be used as primary beam. ISMC 150 shall be used for Secondary Beam.</td>
</tr>
<tr>
<td>Flooring System:</td>
<td>The flooring System shall be made of profile metal decking system. Thin layer of RC concrete shall be laid as shown in detail drawing.</td>
</tr>
<tr>
<td>Roof System:</td>
<td>Light roof steel truss covered with CGI sheets. All members of the truss or joints shall be properly connected as shown in detail drawings.</td>
</tr>
</tbody>
</table>
T.S. 11.1 is a structural system consisting of timber studs (vertical members) and horizontal member load bearing system. The gravity load is resisted by the studs and lateral load is resisted by the timber bracing located at strategic positions. The floor system consists of wooden joist over which the wooden planks are laid. The roofing system consists of wooden truss system with CGI sheet. The timber planks are used as light weight partition walls. The featured design consists of two storied resident having 6 number of rooms.

**PROPERTIES OF TIMBER**

- Density: 640 kg/m²
- Modulus of Elasticity: 9.4 x10³ N/mm²
- Binding & tension along Grains, Extreme Fiber Stress, inside location: 13.7 N/mm²
- Binding & tension along Grains, Extreme Fiber Stress, outside location: 11.4 N/mm²
- Shear Stress, Horizontal in Beams all locations: 1 N/mm²
- Shear Stress, along grains all locations: 1.4 N/mm²
- Compressive Stress, inside location (parallel to grains): 8.6 N/mm²
- Compressive Stress, outside location (parallel to grains): 7.7 N/mm²
# MODEL T.S.-11.1, TIMBER STRUCTURE

## TWO STOREY

### MATERIALS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Brick</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>MS Angle &amp; Plates</th>
<th>Wood</th>
<th>CGI Sheet</th>
<th>GI Plain Sheet</th>
<th>Aluminium Door</th>
<th>Aluminium Window</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Kg.</td>
<td>Cu.m.</td>
<td>Bundle</td>
<td>Sq.m.</td>
<td>Sq.m.</td>
<td>Sq.m.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>3,652.7</td>
<td>113</td>
<td>16.7</td>
<td>8.7</td>
<td>630.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>18</td>
<td>1.2</td>
<td>2.2</td>
<td>-</td>
<td>526.3</td>
<td>16.3</td>
<td>-</td>
<td>-</td>
<td>10.3</td>
<td>22.6</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>6.7</td>
<td>11.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,652.7</td>
<td>131</td>
<td>17.9</td>
<td>10.9</td>
<td>630.0</td>
<td>526.3</td>
<td>16.5</td>
<td>6.7</td>
<td>11.4</td>
<td>10.3</td>
<td>22.6</td>
</tr>
</tbody>
</table>
MODEL T.S.-11.1, TIMBER STRUCTURE

GROUND FLOOR PLAN
AREA: 61.64 SQ.M.

ROOM 1
4975x2950

ROOM 2
4975x2950

ROOM 3
4975x2950

ROOM 4
4975x2950

ROOM 5
4975x2950

ROOM 6
4975x2950

FIRST FLOOR PLAN
AREA: 61.64 SQ.M.

HOUSING TYPE: MODEL T.S-11.1
DRAWING TITLE: FLOOR PLANS

T.S.-11.1
2/8

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDNG CONSTRUCTION

SCALE: NONE
DATE:
MODEL T.S.-11.1, TIMBER STRUCTURE

TWO STOREY

Housing Type: Model T.S-11.1

Drawing Title: Elevations

Ministry of Urban Development
Department of Urban Development and Building Construction

T.S.-11.1

Date: 3/8

Front Elevation

Right Side Elevation

Back Elevation

Left Side Elevation
MODEL T.S.-11.1, TIMBER STRUCTURE

Housing Type: Model T.S.-11.1

Drawing Title: Foundation Detail

Date:

168

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE

T.S.-11.1
MODEL T.S.-11.1, TIMBER STRUCTURE

TWO STOREY

Housing Type: Model T.S.-11.1

Diagram showing details of corner post connection, stud connection at floor, and bracing connection.

CORNER POST CONNECTION

STUD CONNECTION AT FLOOR

BRACING CONNECTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: MODEL T.S.-11.1

DRAWING TITLE: JOIST AND JOINT DETAIL

SCALE: NONE

T.S.-11.1

DATE: 7/8
### TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>Structural system consisting of timber studs (vertical members) and horizontal member load bearing System. Timber shall be hard wood like sal, khote salla or equivalent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip Foundation of stone masonry in 1:6 cement sand mortar and of width 600 mm width and depth 750 mm as shown in detail drawing.</td>
</tr>
<tr>
<td>Plinth Band</td>
<td>R.C.C (1:1.5:3) plinth band of size 350 x 200 mm. Main reinforcement shall be 6 nos. of 12mm dia. Bars with 8mm Ø rings at 150mm C/C.</td>
</tr>
<tr>
<td>Wall System</td>
<td>Local soft wood timber planks on timber structure system.</td>
</tr>
<tr>
<td>Stud:</td>
<td>Studs of local hard wood of size 75mm X 75 mm @500 mm C/C spacing shall be used. Connection with plinth band is shown detail drawing.</td>
</tr>
<tr>
<td>Bracing:</td>
<td>Diagonal bracing of local hard wood of size 37mm X 100mm. Connection details shown in detail drawing.</td>
</tr>
<tr>
<td>Joist:</td>
<td>Timber joist of size 75mm X 75mm with spacing of 425mm.</td>
</tr>
<tr>
<td>Flooring system:</td>
<td>Flooring shall be of mud under timber planks supported on timber joists.</td>
</tr>
<tr>
<td>Roof System:</td>
<td>Light roof steel truss covered with corrugated galvanized iron sheets. All members of the truss or joints shall be properly connected as shown in detail drawings.</td>
</tr>
</tbody>
</table>
DEBRIS BLOCK MASONRY

D.B.-12.1
The technology proposes residence construction with block made from stone or brick debris stabilized with cement. The objective of the design is to contribute towards resilient models that helps in debris management as well as improves safety in future earthquakes. Featured design D.B. 12 is a single storied model house with 2 rooms. Bands are provided at plinth level, sill level, corner, lintel level and roof level. Roofing is of corrugated Galvanized Iron sheets under wooden rafters.

**MATERIAL PROPERTIES**

**For mud mortar stone masonry**
- Size: 300 mm length × 150 mm width × 200 mm height
- Color: light grey
- Density: 2000 Kg/cm³ to 2300 Kg/cm³

**For mud mortar brick masonry**
- Size: 300 mm length × 150 mm width × 200 mm height
- Color: light grey
- Density: 1700 Kg/cm³ to 2200 Kg/cm³

D.B.-12.1
**MODEL 12.1, DEBRIS BLOCK MASONRY**

**ONE STOREY**

**LEVEL**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Debris Block</th>
<th>Cement</th>
<th>Sand</th>
<th>Aggregate</th>
<th>Reinforcing Bar</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Bundle</td>
<td>Cu.m.</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>1,762.0</td>
<td>34.2</td>
<td>2.4</td>
<td>4.7</td>
<td>273.5</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>1,923.0</td>
<td>21.8</td>
<td>1.2</td>
<td>2.3</td>
<td>307.1</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.2</td>
<td>8.3</td>
<td>2.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,685.0</td>
<td>56</td>
<td>3.6</td>
<td>7.0</td>
<td>580.6</td>
<td>5.2</td>
<td>8.3</td>
<td>3.1</td>
</tr>
</tbody>
</table>

**Housing Type:** D.B.-12.1

**Drawings:** Estimate and 3D-View

**Scale:** None

**Date:**

---

**Ministry of Urban Development**

**Department of Urban Development and Building Construction**

**D.B.-12.1**

**Drawing Title:** Estimate and 3D-View

**Date:** 1/8
MODEL 12.1, DEBRIS BLOCK MASONRY

ONE STOREY

FRONT ELEVATION

SIDE ELEVATION

SIDE ELEVATION

BACK ELEVATION

ROOF CGI SHEETS
TIMBER FRAME

GABLE WALL: WOODEN BOARD

GABLE WALL: WOODEN BOARD

ROOF CGI SHEET

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: D.B.-12.1
DRAWING TITLE: ELEVATIONS

SCALE: NONE
DATE:

D.B.-12.1
3/8
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: D.B.-12.1
DRAWING TITLE: SECTION
DATE: 4/8

MODEL 12.1, DEBRIS BLOCK MASONRY
ONE STOREY

SEE ROOFING DETAILS

ROOM 1

VERANDAH

SEE ROOFING DETAILS

PURLIN: 75MMX 75 MM @450 MM
RAFTER: 180 MM X 180 MM

SECTION AT A-A

ROOF BAND: RCC: CONCRETE 1:1.5:3
REINFORCEMENT MAIN BAR 12 MM X4

LINTEL BAND: RCC: CONCRETE 1:1.5:3
REINFORCEMENT MAIN BAR 12 MM X4

VERTICAL REINFORCEMENT:
REINFORCEMENT MAIN BAR 12 MM X2

SILL BAND: CONCRETE 1:1.5:3
(Reinforcement Main Bar 12 mm x 2)

WALL: 300 MM THICKNESS, UPCYCLED
BLOCK IN MUD MORTAR

PLINTH BAND: RCC CONCRETE 1:1.5:3 REINFORCEMENT
MAIN BAR 12 MM X4

FOUNDATION: UPCYCLED BLOCK IN CEMENT MORTAR
OR BRICK MASONRY WITH CEMENT MORTAR

REFER FOUNDATION DETAIL

SEE ROOFING DETAILS

PURLIN: 75MMX 75 MM @450 MM
RAFTER: 180 MM X 180 MM

SECTION AT A-A
MODEL 12.1, DEBRIS BLOCK MASONRY

ONE STOREY

WALL: 300 MM THICKNESS

PLINTH BAND: RCC
CONCRETE 1:1:5:3
REINFORCEMENT
MAIN BAR 12 MM X4MM

FOUNDATION:
UPCYCLED BLOCK
IN CEMENT
MORTAR
OR BRICK
MASONRY WITH
CEMENT MORTAR

G.L.

800
450
50, 100, 250, 400
800

DETAIL AT C
FOUNDATION SECTION

HOUSING TYPE: D.B.-12.1
DRAWING TITLE: RCC BAND DETAIL

<table>
<thead>
<tr>
<th>BAND/BEAM</th>
<th>RC BAND MIN. THICKNESS</th>
<th>MIN. NO. OF BAR</th>
<th>MIN. DIA OF BAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLINTH</td>
<td>150 MM</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>SILL</td>
<td>75 MM</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>LINTEL</td>
<td>75 MM</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>150 MM</td>
<td>2</td>
<td>10 (top)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 (bottom)</td>
</tr>
<tr>
<td>ROOF</td>
<td>75 MM</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>300 MM</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>DOWEL (STITCH)</td>
<td>75 MM</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

PLINTH BAND

300

150

75

MAIN BAR (SEE GIVEN TABLE)

STIRRUP (DIA 6 MM)
MODEL 12.1, DEBRIS BLOCK MASONRY

VERTICAL REINFORCEMENT ON CORNERS & JOINTS

DOWEL BAR
6 MM DIA CROSS TIE
@150 MM C/C

VERTICAL STEEL

RCC BAND AT CORNER

RCC BAND AT T-JUNCTION

PLAN

VERTICAL STEEL

DOWEL BAR
180 MM
VERTICAL STEEL

6 MM DIA STIRRUP
@150 C/C

DOWEL BAR
180 MM
VERTICAL STEEL

6 MM DIA STIRRUP
@150 C/C
### Technical Details

#### Structure System
Load bearing stone/brick debris block masonry in mud mortar

#### Foundation
Strip Foundation with brick/debris block masonry in mud mortar. The depth and width of foundation shall be 800mm.

#### Plinth Band
R.C.C (1:1.5:3) plinth band of size 350 x 150 mm. Main reinforcement shall be 4 nos. of 12mm dia. bars with 6mm Ø stirrups at 150mm C/C.

#### Wall System
The debris blocks used shall be of good quality and have strength as mentioned in material properties. The thickness of wall shall be greater than or equal to 300mm.

#### Sill Band
RCC (1:1.5:3) sill band shall be provided throughout the entire wall at the bottom level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 6 mm Ø stirrups at 150mm C/C.

#### Lintel Band:
RCC (1:1.5:3) lintel band shall be provided throughout the entire wall at the top level of the openings. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 6mm Ø stirrups at 150mm C/C or as specified in the details.

#### Roof Band:
RCC (1:1.5:3) roof band shall be provided throughout the entire wall at roof level. The minimum depth of the band shall be 75mm. Main reinforcement shall be 2 nos. 12mm dia. bars with 6mm Ø stirrups at 150mm C/C.

#### Roof System:
Light roof timber truss with CGI sheet roofing. All members of the truss or joints shall be properly connected as shown in detail drawings.
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