DESIGN CATALOGUE FOR RECONSTRUCTION OF EARTHQUAKE RESISTANT HOUSES

Approved by Nepal Government (Minister Level/ Minister of Urban Development) 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)
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.
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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 galvanized 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 X10cm of Full Size
15cm X 15cm X10cm 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

I.B.-1.1
I.B.-1.2
I.B.-1.3
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

### ONE STOREY

#### MATERIALS

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone (Cu.m)</th>
<th>Interlocking Bricks No.</th>
<th>Cement (Cu.m)</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>Wood Cu.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>8.4</td>
<td>-</td>
<td>39.9</td>
<td>5.3</td>
<td>3.2</td>
<td>112.1</td>
<td></td>
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</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>4,912.0</td>
<td>16.2</td>
<td>0.9</td>
<td>1.7</td>
<td>167.3</td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.5</td>
<td>6.5</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>8.4</strong></td>
<td><strong>4,912.3</strong></td>
<td><strong>56.1</strong></td>
<td><strong>6.1</strong></td>
<td><strong>4.9</strong></td>
<td><strong>279.4</strong></td>
<td><strong>3.5</strong></td>
<td><strong>6.5</strong></td>
<td><strong>1.0</strong></td>
</tr>
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</table>
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

GROUND FLOOR PLAN
FLOOR AREA: 20.16 SQ.M.

HOUSING TYPE: I.B.-1.1
DRAWING TITLE: GROUND FLOOR PLAN
DATE: 2/5
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

HOUSING TYPE: I.B.-1.1

DRAWING TITLE: SECTION

SCALE: NONE

DATE: 4/5

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

 Refer Roofing and Band Details

Refer Foundation Details

26 Gauge CGI Roofing Materials

75MM x 75MM Battens @ 300MM C/C

180MM x 90MM Rafters @ 600MM C/C

1 Layers U-Block with 10Φ Horizontal Reinforcement @ Roof Tie Level

2 Layers 10Φ Horizontal Reinforcement @ Lintel

2 Layers U-Block with 10Φ Horizontal Reinforcement @ Sill Level

150MM Interlocking Brick Wall Grouted with Micro-Concrete of Cement, Sand and Chips (1:2:3).

6 Nos. 10Φ Reinforcement

Mortar Layer under 1st Layer of Brick to Make it Perfectly Horizontal

10Φ Vertical Reinforcement Anchored at Foundation with 1:4 Cement Mortar with Min. Clear Cover 25MM

SECTION AT A-A

One Storey

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

Refer Roofing and Band Details

Refer Foundation Details

26 Gauge CGI Roofing Materials

75MM x 75MM Battens @ 300MM C/C

180MM x 90MM Rafters @ 600MM C/C

1 Layers U-Block with 10Φ Horizontal Reinforcement @ Roof Tie Level

2 Layers 10Φ Horizontal Reinforcement @ Lintel

2 Layers U-Block with 10Φ Horizontal Reinforcement @ Sill Level

150MM Interlocking Brick Wall Grouted with Micro-Concrete of Cement, Sand and Chips (1:2:3).

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Mortar Layer under 1st Layer of Brick to Make it Perfectly Horizontal

10Φ Vertical Reinforcement Anchored at Foundation with 1:4 Cement Mortar with Min. Clear Cover 25MM

SECTION AT A-A

One Storey
## 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>
</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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### MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

#### TWO STOREY

**Materials Table**

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<th>LEVEL</th>
<th>Stone (Cu.m)</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>CGI sheet (Bundle)</th>
<th>GI Sheet (Sq.m.)</th>
<th>Wood (Cu.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>18.1</td>
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<td>80.2</td>
<td>10.9</td>
<td>6.1</td>
<td>177.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Super Structure</td>
<td>-</td>
<td>6,447.0</td>
<td>57.1</td>
<td>3.0</td>
<td>6.1</td>
<td>493.9</td>
<td>-</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.2</td>
<td>8.7</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>18.1</td>
<td>6,447.0</td>
<td>137.3</td>
<td>14.0</td>
<td>12.3</td>
<td>671.1</td>
<td>4.2</td>
<td>8.7</td>
<td>2.8</td>
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</table>
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 BUILDING CONSTRUCTION

GROUND FLOOR PLAN
AREA: 40.36 SQ.M.

FIRST FLOOR PLAN
AREA: 40.36 SQ.M.

BED ROOM
2850 X 2550

LIVING
3600 X 3300

KITCHEN
2850 X 2100

VERANDA
3600 X 2250

UP

BEDROOM
2850 X 2100

LIVING
3600 X 3300

VERANDA
3600 X 2250

UP

DN
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDNG CONSTRUCTION

SCALE: NONE
DATE: 4/5

TWO STOREY

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

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

WOODEN OR RCC
CONCRETE FLOOR

SECTION AT A-A

6 NOS. 10Φ REINFORCEMENT

150MM D.P.C BAND
12Φ VERTICAL
REINFORCEMENT
ANCHORED AT FOUNDATION

REFER ROOFING AND BAND DETAILS

REFER FOUNDATION DETAILS

2 LAYERS U-BLOCK WITH 12Φ HORIZONTAL REINFORCEMENT @ ROOF TIE LEVEL
2 LAYERS 12Φ HORIZONTAL REINFORCEMENT @ LINTEL
2 LAYERS U-BLOCK WITH 12Φ HORIZONTAL REINFORCEMENT @ SILL LEVEL
2 LAYERS U-BLOCK WITH 12Φ HORIZONTAL REINFORCEMENT @ BOTTOM WALL LEVEL
## TECHNICAL REQUIREMENTS

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<tr>
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<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>
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<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

DRAWING TITLE: STRUCTURAL DETAILS

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

SCALE: NONE

FOUNDATION OF STONE MASONRY IN CEMENT MORTAR

- 3" P.C.C
- Flat brick soling
- Compacted earth

- 3" P.C.C
- 150mm stone soling
- Compacted earth

- 2 layers 12Φ horizontal reinforcement @ sill
- 2 layers 12Φ horizontal reinforcement @ lintel
- U-block with 12Φ horizontal reinforcement @ roof tie level

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

- 6 nos. 10-12Φ reinforcement

- 150mm D.P.C band

- 12mm Φ vertical reinforcement anchored at foundation covered in 1:4 cement mortar with min. 25mm cover

ROOF, LINTEL AND SILL LEVEL

- 3" P.C.C
- 150mm stone soling
- Compacted earth

- 12mm Φ vertical reinforcement anchored at foundation covered in 1:4 cement mortar with min. 25mm cover

- 2 layers 12Φ horizontal reinforcement @ sill
- 2 layers 12Φ horizontal reinforcement @ lintel
- U-block with 12Φ horizontal reinforcement @ roof tie level
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

TYPICAL ELEVATION (REBAR DETAIL IN WALL)

- 2 NO.S OF 12 ø HORIZONTAL REBAR AT LINTEL LEVEL THROUGH OUT WALL SECTION
- 2 NO.S OF 12 ø HORIZONTAL REBAR AT SILL LEVEL THROUGH OUT WALL SECTION
- 2 NO.S 12 ø VERTICAL REBAR AT BOTH SIDES OF OPENING

- REGULAR FULL BRICK
- REGULAR HALF BRICK
- LATERAL FULL LOCK BRICK
- U FULL BRICK
- U HALF BRICK
- LATERAL U FULL LOCK BRICK
MODEL I.B.-1.1, INTERLOCKING BRICK MASONRY

FRAMING PLAN (REBAR DETAIL)

- 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

NOTE:
GROUTING FOR THE HOLE IS DONE WITH MORTAR
MODEL I.B.-1.1 AND I.B.-1.2, INTERLOCKING BRICK MASONRY

REBAR DETAIL PLAN AT PLINTH, ROOF, SILL & LINTEL BANDS

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

- 2 nos. of 12mm Ø vertical rebar at each side of window
- 2 nos. of 12mm Ø horizontal rebar at lintel lvl

TYPICAL DETAIL @ DOOR OPENING

- 2 nos. of 12mm Ø vertical rebar at each side of door
- 2 nos. of 12mm Ø horizontal rebar at lintel lvl

- 2 nos. of 12mm Ø horizontal rebar at sill lvl

HOUSING TYPE: I.B.1.1 AND I.B. 1.2
DRAWING TITLE: STRUCTURAL DETAILS
SCALE: NONE
DATE: 6/8
MODEL I.B.-1.1 AND I.B.-1.3, INTERLOCKING BRICK MASONRY

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HOUSING TYPE: I.B.-1.1 AND I.B.-1.2
DRAWING TITLE: ROOF DETAILS
SCALE: NONE
DATE: 7/8

Housing Type:
- Model I.B.-1.1 and I.B.-1.3, Interlocking Brick Masonry

Details:
- CGI Sheet
- 75x75mm Purlin @ 300mm C/C
- 180x90mm Rafters @ 600mm C/C
- 100x75mm Wall Plate
- Gable Band
- Eaves Board
- Wooden Nail
- Wooden Key
- Rafter
- 75x100mm Wall Plate
- Roof Band
- Roof Details
- Type-1
- Wood Post
- Rafter Nail
- Ridge Piece
- Plan

Legend:
- X
- Y

Notes:
- Type-1 Gable Band
- J-Hook
- CGI Ridge
- 75 x 125 Ridge Piece
- Wooden Post

Model Details:
- Model I.B.-1.1 and I.B.-1.3
- Interlocking Brick Masonry

Supplementary Information:
- CGI Sheet
- Purlins
- Rafters
- Wall Plates
- Eaves Board
- Roof Details
- Gable Band
- Type-1

Diagram:
- Illustrations of structural elements
- Diagrams of roof details
- Model representations

Conclusion:
- Comprehensive diagrammatic representation
- Technical specifications
- Clear indications of materials and dimensions
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

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

SCALE: NONE
DATE:

I.B.-1.3
8/8
# MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

## One Storey

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stone</td>
</tr>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>33.5</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>33.5</strong></td>
</tr>
</tbody>
</table>

**STONE**
- No. 33.5
- 2,406.0 bags
- 128.1 cu.m.
- 18.3 cu.m.
- 7.7 kg.

**INTERLOCKING BRICKS**
- No. 33.5
- 2,406.0 bags
- 128.1 cu.m.
- 18.3 cu.m.
- 7.7 kg.

**Cement**
- 18.3 cu.m.

**Sand**
- 0.9 cu.m.

**Aggregate**
- 1.3 cu.m.

**Reinforcing Bar**
- 1.3 cu.m.

**Clay Tile**
- 1,021.3 sq.m.

**Clay Tile Ridge**
- 1,579.3 sq.m.

**Wood**
- 282.0 cu.m.
- 3.1
MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

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

SCALE: NONE

DATE: 2/6

GROUND FLOOR PLAN
AREA: 54.26 SQ.M.

BEDROOM
3500X3500

KITCHEN
3380X3500

LIVING ROOM
3500X3380

DECK

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MODEL I.B.-1.3, INTERLOCKING BRICK MASONRY

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: ELEVATIONS
SCALE: NONE
DATE: 3/6

ONE STOREY

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

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

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

REFER ROOFING DETAILS
REFER FOUNDATION DETAILS

SECTION AT A-A

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: SECTION
MODEL I.B.-1.2, INTERLOCKING BRICK MASONRY

HOUSING TYPE: I.B.-1.3
DRAWING TITLE: DETAILS
SCALE: NONE
DATE: 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>
</tr>
</tbody>
</table>
CONFINED HOLLOW CONCRETE BLOCK MASONRY
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 toothing 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**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Size</td>
<td>40cm X 15cm X20cm</td>
</tr>
<tr>
<td>Min Compressive Strength on gross area</td>
<td>5 Mpa</td>
</tr>
<tr>
<td>Min Compressive Strength on net area</td>
<td>7.5 Mpa</td>
</tr>
<tr>
<td>Density of the Block</td>
<td>1600kg/m³</td>
</tr>
<tr>
<td>Nominal Mix Ratio</td>
<td>1:1.5:3 (C:S:A)</td>
</tr>
<tr>
<td>Min Yield Strength of Reinforcing Steel</td>
<td>415 MPa</td>
</tr>
</tbody>
</table>

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

### TWO STOREY

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stone (Cu.m)</th>
<th>Hollow Concrete Bricks (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>Wood (Cu.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>30.3</td>
<td>-</td>
<td>77.1</td>
<td>12.3</td>
<td>3.5</td>
<td>252.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>1,330.0</td>
<td>101.6</td>
<td>8.7</td>
<td>7.5</td>
<td>1,388.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>30.3</strong></td>
<td><strong>1,330.0</strong></td>
<td><strong>178.7</strong></td>
<td><strong>21.0</strong></td>
<td><strong>11.0</strong></td>
<td><strong>1,640.0</strong></td>
<td><strong>5.0</strong></td>
<td><strong>6.5</strong></td>
<td><strong>3.2</strong></td>
</tr>
</tbody>
</table>

---

**ESTIMATE AND 3D VIEW**
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY
TWO STOREY

HOUSING TYPE: MODEL C.H.C.-2.1
DRAWING TITLE: FLOOR PLANS
SCALE: NONE
DATE: 2/11

GROUND FLOOR PLAN
FLOOR AREA: 43.71 SQ.M.

FIRST FLOOR 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

150MM X 150MM REINFORCED CONCRETE TIE COLUMN TYP

150MM HOLLOW CONCRETE MASONRY WALL TYP

PORCH 1050 X 9660

UP

1050 4525
3350 1050
4525 3350

150MM X 150MM HOLLOW CONCRETE MASONRY WALL TYP

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

TWO STOREY

FRONT ELEVATION

SIDE ELEVATION

SIDE ELEVATION

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

TWO STOREY

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

FOUNDATION SECTION OF COLUMN POST

STRIPPED AT 100 MM C/C
12MMØ COLUMN BARS
6MMØ STIRRUPS

STRIPPED AT 150 MM C/C

STONE MASONRY FOUNDATION

STONE SOLING WITH SAND

COMPACTED FILL

COMPACTED FILL

P.C.C. 1:2:4

150
50

SECTION OF INTERIOR FOUNDATION

150
50

STONE MASONRY FOUNDATION

GROUT AROUND THE CONNECTION BETWEEN WOOD POST AND BEAM

MORTAR OR CONCRETE COVER TO PROTECT BAR

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

TWO STOREY

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

DRAWING TITLE: DETAILS

SCALE: NONE

DATE: 7/11

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SLAB DETAILING FOR BARS

*100MM SLAB THICKNESS

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

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

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

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS

8MM @ 200MM C/C BOTH WAYS
MODEL C.H.C.-2.1, CONFINED HOLLOW CONCRETE BLOCK MASONRY  

**SILL/ LINTEL BAND**
- 2-12MMØ BARS
- 6MMØ STIRRUPS

**PLINTH BAND**
- 4-12MMØ RIBBED BARS
- 6MMØ CLOSED TIE

**COLUMN PLAN**
- 4-12MMØ RIBBED BARS
- 6MMØ CLOSED TIE

**LONGITUDIONAL SECTION OF SLAB X-X**
- 8MMØ @ 200MM C/C BOTH WAYS
- 3170

**TRAVERSE SECTION OF SLAB Y-Y**
- 8MMØ @ 200MM C/C BOTH WAYS
- 200
- 150
- 1050

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

C.H.C.-2.1 8/11

DATE:
ROOF TRUSS ELEVATION WITH GUSSET PLATE

CGI SHEET
50x50 PURLIN, TYPE

C.1
C.2
C.3
C.4
C.5
C.6

50x100MM RAFTER
2 LAYERS OF CGI STRAP
32.5MM GUSSET PLATE

200x200MM RING BEAM

75MM LONG NAIL B/W STRAPS AND RAFTER

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

DETAIL OF CGI STRAP

WRAP OVER TRUSS AND DOWN OPPOSITE FACE EACH SIDE

2 LAYER OF 26 GAUGE FLATTENED CGI STRAP

50X100MM MAIN ROOF RAFTER

37.5MM RAFTER

2 LAYERS OF GAUGE FLATTENED CGI STRAP (30 MM LONG)

50X50 PURLIN
32.5MM GUSSET PLATE

75MM LONG NAILS B/W STRAP AND RAFTER ON EACH SIDES (4 TOTAL)

1-75MM LONG NAILS B/W STRAP AND RAFTER ON EACH SIDES

250X200 CONCRETE BEAM

195 MM HOLLOW BLOCK MASONRY WALL

3D VIEW CGI STRAP CONNECTION

ALL DIMENSIONS ARE IN MM

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DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE
DATE: C.H.C.-2.1 9/11
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: 10/11

MEMBER 3 (50x50) KING POST
- 2-75MM LONG NAILS ON EITHER SIDE OF KING POST

MEMBER 4 (50x50 MM DIAGONAL WEB)
- 2-75MM LONG NAILS ON EITHER SIDE OF EACH DIAGONAL WEB

MEMBER 5 (50x50 MM DIAGONAL WEB)
- 6-75MM LONG NAILS ON EITHER SIDE OF EACH BOTTOM

MEMBER 6 (50x50 MM KING POST)
- 2-75 LONG NAILS ON EITHER SIDE OF KING POST

37.5MM THICK GUSSET PLATE ON EITHER SIDE

6-75MM LONG NAILS ON EITHER SIDE OF BOTTOM TIE (12 NO.S)

37.5 MM THICK GUSSET PLATE
(2 NO.S)

50X50 MM KING POST

50X50 MM DIAGONAL WEB

100X50MM BOTTOM TIE

6-75 MM LONG NAILS ON EITHER SIDE OF BOTTOM TIE (12 NO.S)

CUT PORTION

ALIGNMENT OF GRAIN

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

CUT PORTION

DIAGONAL WEB

MEMBER 3 (KING POST)

CUT PORTION

MEMBER 5 (DIAGONAL WEB)

MEMBER 7 (100x50 BOTTOM TIE)

CUT PORTION

MEMBER 4 (100x50 BOTTOM TIE)

DIAGONAL WEB

MEMBER 5 (DIAGONAL WEB)
### TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Structure System</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Strip foundation with stone masonry casing the tie column. The depth and width of footing shall be 900mm.</td>
</tr>
<tr>
<td>Plinth Band</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>Wall System</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>Sill Band</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>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 75mm. Main reinforcement shall be 2 nos.12mm dia. bars with 6mm Ø stirrups at 150mm C/C.</td>
</tr>
<tr>
<td>Floor Beam</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>Floor</td>
<td>100 mm thick reinforced concrete slab as shown in 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>
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-caste 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**

**TWO STOREY**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hollow Concrete Bricks</td>
</tr>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>447.0</td>
</tr>
<tr>
<td>Super Structure</td>
<td>2,398.0</td>
</tr>
<tr>
<td>Roofing</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>2,845.0</td>
</tr>
</tbody>
</table>

**LEVEL**

- Up to Plinth Level
- Super Structure
- Roofing

**MATERIALS**

- Hollow Concrete Bricks
- Cement
- Sand
- Aggregate
- Reinforcing Bar
- Polythene sheet

**Estimate and 3D View**
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

GROUND FLOOR PLAN
AREA: 24.7 SQ.M.

FIRST FLOOR PLAN
AREA: 24.7 SQ.M.

HOUSING TYPE: MODEL H.C.B.-3.1
DRAWING TITLE: FLOOR PLANS
SCALE: NONE
DATE: 2/9

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

HCB-3.1
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

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

CANTILEVER PANEL
LINTEL BAND
U-SHAPE BLOCK FOR SILL BAND
LINTEL BAND

200 MM HOLLOW CONCRETE BLOCK WALL IN CEMENT CONCRETE (1:5).

REFER FOUNDATION DETAIL

REFER STAIRCASE DETAIL

REFER BEAM DETAIL

CEMENT PUNNING FINISHING
38MM THK. CAST IN SITU CONCRETE(M20)
50MM THK. PRECAST PANEL
FLOOR FINISHING
38MM THK. CAST IN SITU CONCRETE(M20)
50MM THK. PRECAST PANEL

38MM THK. CAST IN SITU CONCRETE(M20)
50MM THK. PRECAST PANEL
38MM THK. CAST IN SITU CONCRETE(M20)
50MM THK. PRECAST PANEL

50MM TK. SCREED/PUNNING
100MM K. CSEB BLOCKS
500 GAUGE PLASTIC LAY
WELL COMPACTED EARTH

TERRACE
ROOM
STAIRS

STAIRS

GROUND LVL.

SECTION AT A-A

REFER BEAM DETAIL

REFER BEAM DETAIL

REFER BEAM DETAIL

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

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION

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

DRAWING TITLE: ELEVATIONS

SCALE: NONE

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

TWO STOREY

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

SCALE: NONE

DRAWING TITLE: DETAILS

DATE: 5/9

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

PRECAST SLAB PANEL
PRECAST BEAM

4.75MM Ø TEMPERATURE FLANGE RODS @ 300MM C/C OVER BEAMS

38MM THK. CAST IN SITU (M20) CONCRETE

BEAM AND SLAB DETAILS

HCB-3.1

FOUNDATION DETAIL

RCC STRIP FOUNDATION (M20)
25MM TK. SAND FILLING AND COMPACTION
WELL COMPACTED EARTH

4 NO. OF 8 MM Ø

2 - 8 MM Ø
M20 CONCRETE
HOLLOW BLOCK WALL

4.75MM Ø TEMPERATURE FLANGE RODS @ 300MM C/C OVER BEAMS

6MM Ø STIRRUPS @ 400MM C/C
HOLLOW BLOCK WALL IN 1:4 C/S MORTAR

8 MM Ø @ 200MM C/C

DETAIL AT X
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY
TWO STOREY

Housing Type: Model H.C.B.-3.1
Drawing Title: Details

Longitudinal Section of Precast Beam

- 1-10 mm Ø Rebar
- 2-10 mm Ø Rebar
- 3-10 mm Ø Rebar

Longitudinal Section of Lintel Beam

- 1-8 mm Ø Rebar
- 3-8 mm Ø Rebar

Precast Beam Cross Section

- 3 No. - 10 mm Ø Rebars
- 4.75 mm Ø Stirrups
- 7 mm Ø Stirrups @ 400 mm C/C

Concrete Slab

Hollow Blocks filled with M20 Concrete

M20 Concrete Lintel Band

Scale: None

Date: 6/9
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

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

SECTION AT B-B

HCB-3.1

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

TWO STOREY

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

DRAWING TITLE: DETAILS

SCALE: NONE

DATE: 8/9

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

WALL SECTION AT OPENING

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

- **Housing Type:** MODEL H.C.B.-3.1
- **Detail Title:** DETAILS
- **Scale:** NONE
- **Date:** 7/9

**Reinforcement Detail at Corner**
- 6mm Ø Stirrups @ 200mm C/C
- 3- 12mm Ø Rebar

**Column Projection Detail**
- 12mm Ø Rebar
- 6mm Ø Stirrups @ 200mm C/C

**Detail at B Sill Band**
- 8mm Ø Rebars
- 7mm Ø Stirrups @ 400mm C/C

**Detail at A Lintel Beam**
- 8mm Ø Rebar
- 7mm Ø Stirrups @ 400mm C/C

**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:** 7/9
MODEL H.C.B.- 3.1, HOLLOW CONCRETE BLOCK MASONRY

STAIRCASE DETAIL PLAN

STAIRCASE SLAB UNIT

M20 CONCRETE SLAB

STAIR SECTION AT B-B

STAIR SECTION AT A-A

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

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

MINISTRY OF URBAN DEVELOPMENT

SCALE: NONE

DATE:

HCB-3.1

8/9
**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 150mm 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 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 6mm Ø stirrups at 150mm 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 600mm 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 150mm.</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>230<em>110</em>55 mm</td>
</tr>
<tr>
<td>28 days dry compressive strength</td>
<td>7.5 - 10 MPa</td>
</tr>
<tr>
<td>28 days wet compressive strength (after 24 hours immersion)</td>
<td>3 - 4 MPa</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 Stabilized Earth Block Masonry

One Storey

## Materials

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Stabilized block</th>
<th>Cement</th>
<th>Sand</th>
<th>Reinforcing Bar</th>
<th>Wood</th>
<th>Bamboo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Cu.m.</td>
<td>Nos</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>1,758.0</td>
<td>17.0</td>
<td>2.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Super Structure</td>
<td>1,500.0</td>
<td>7.2</td>
<td>1.4</td>
<td>237.3</td>
<td>0.2</td>
<td>25.5</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.4</td>
<td>31.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3,258.0</strong></td>
<td><strong>24.2</strong></td>
<td><strong>3.7</strong></td>
<td><strong>237.3</strong></td>
<td><strong>2.6</strong></td>
<td><strong>56.5</strong></td>
</tr>
</tbody>
</table>
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

GROUND FLOOR PLAN
FLOOR AREA: 24.08 SQ.M

ROOM
2400 X 2400

ROOM
2400 X 2400

VERANDAH

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.1
DRAWING TITLE: GROUND FLOOR PLAN

SCALE: NONE
DATE: 2/8
MODEL C.S.E.B-4.1, COMPRESSED STABLILIZED EARTH BLOCK MASONRY ONE STOREY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.1
DRAWING TITLE: SECTION

SCALE: NONE
DATE: 3/8

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

REFER ROOFING DETAIL

REFER FOUNDATION DETAIL

CEMENT PLASTERED EAVES WITH WIRE MESH

BAMBOO POST

STABILIZED SOIL BLOCK PAVEMENT
500 GAUGE POLYTHENE SHEET
EARTH FILLING AND COMPACTION

RCC LINTEL BAND
RCC SILL BAND

100 X 125 TIMBER TRUSSED BEAM

3105 1200 680
900 475 600
500

2200

200 MM THK. CSEB BLOCK MASONARY WALL

400
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

ONE STOREY

HOUSING TYPE: CSEB-4.1
DRAWING TITLE: DETAILS

SCALE: NONE
DATE: 5/8

FOUNDATION SECTION

200MM THK. CSEB MASONRY

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

LINTEL BAND

4 NO. 10MM Ø REBARS
6MM Ø @150MM C/C

SECTION B-B

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

HOLLOW C. BLOCK

FOUNDATION OF BAMBOO POST

FOUNDATION OF BAMBOO POST

2 NO. 10MM Ø REBARS
6MM Ø @150MM C/C

SILL BAND

300
200

600
425
MODEL C.S.E.B-4.1, COMPRESSED STABLILIZED EARTH BLOCK MASONRY
ONE STOREY

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

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
TIMBER TRUSSED BEAM

G.I. WIRE OR 4.75 mm Ø rod

200mm THK. COMPRESSED STABILIZED SOIL BLOCK WALL

SECTION A' - A'

ROOFING DETAILS

G.I. WIRE FOR NUTS AND BOLTS
CSEB MASONARY IN STABILIZED MUD MORTAR
BAMBOO
TRUSSED BEAM

EAVES OF CEMENT PLASTER WITH WIRE MESH

CSEB-4.1

HOUSING TYPE: CSEB-4.1
DRAWING TITLE: DETAILS
SCALE: NONE
DATE: 6/8
MODEL C.S.E.B-4.1, COMPRESSED STABILIZED EARTH BLOCK MASONRY

Housing Type: CSEB-4.1

Scale: None

Date:

CSEB-4.1

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

Drawing Title: Details

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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**

---

**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></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>Kg.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>4,040.0</td>
<td>42.7</td>
<td>3.9</td>
<td>7.4</td>
<td>1,410.1</td>
<td>-</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>8.2</td>
<td>9.8</td>
<td>1.7</td>
<td>1,408.3</td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.2</td>
<td>9.8</td>
<td>-</td>
<td>1,408.3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10,691.1</td>
<td>157.6</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

HUNTING TYPE: CSEB-4.2
 SCALE: NONE
 DRAWING TITLE: FLOOR PLANS
 DATE: 2/9
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

HOUSING TYPE: CSEB-4.2

REFER ROOF TRUSS DETAIL

REFER SLAB AND BAND DETAIL

LIVING ROOM

BEDROOM

230 MM HOLLOW CONCRETE BLOCK WALL IN CEMENT CONCRETE (1:5).

REFER FOUNDATION DETAIL

SECTION AT A-A

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.2

SCALE: NONE

DATE: 3/9
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

FRONT ELEVATION

BACK ELEVATION

SIDE ELEVATION

SIDE ELEVATION

HOUSING TYPE: CSEB-4.2

DRAWING TITLE: ELEVATION

SCALE: NONE

DATE: 4/9

CSEB-4.2

MINISTRY OF URBAN DEVELOPMENT

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

66
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

FOUNDATION SECTION

FOUNDATION DETAIL

(FOR VERANDAH)

CEMENT PUNNING OVER 75MM THICK PCC (1:3:6)
ONE LAYER FLAT BRICK SOLING
COMPACTED EARTH

CEMENT PUNNING OVER 75MM THICK PCC (1:3:6)
ONE LAYER FLAT BRICK SOLING
COMPACTED EARTH

75MM THICK PCC (1:3:6)
ONE LAYER FLAT BRICK SOLING
COMPACTED EARTH

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: FOUNDATIONDETAILS

SCALE: NONE
DATE:

CSEB-4.2
5/9
MODEL C.S.E.B-4.2, COMPRESSED STABILIZED EARTH BLOCK MASONRY

TWO STOREY

Housing Type: CSEB-4.2

Scale: None

Drawing Title: Details

Date: 6/9

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: REINFORCEMENT DETAILS

SCALE: NONE

CSEB-4.2
7/9

MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY
TWO STORY

HAUSING TYPE: CSEB-4.2

DRAWING TITLE: REINFORCEMENT DETAILS

SCALE: NONE

CSEB-4.2
7/9

LOCATION OF VERTICAL REINFORCEMENT

LAYOUT OF HORIZONTAL AND VERTICAL REINFORCEMENT

12φ VERTICAL REBAR

16φ VERTICAL REBAR

ROOF BAND

LINTEL BAND

SILL BAND

FLOOR BEAM

LINTEL BAND

SILL BAND

PLINTH BAND

2-10φ VERTICAL BAR AT EVERY 1.2M IN WALL

4-10φ VERTICAL BAR AT EVERY JUNCTION

4-10φ VERTICAL BAR AT EACH CORNER

2-10φ VERTICAL BAR AT JAMBS OF OPENINGS

4-10φ VERTICAL BAR AT JAMBS OF OPENINGS
MODEL C.S.E.B-4.2, COMPRESSED STABLILIZED EARTH BLOCK MASONRY
TWO STOREY

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: CSEB-4.2
DRAWING TITLE: ROOF DETAILS

SCALE: NONE
DATE: 8/9

ROOF TRUSS DETAILS

VERANDAH POST END PLATE DETAILS

BASE CONNECTION DETAILS

JOINT PLATE DETAILS

PURLIN CLEAT DETAILS

RUNNER CLEAT DETAILS

CSEB-4.2
## 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 300 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 (inc. 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**

---

**LEVEL**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>No.</th>
<th>Sq.m</th>
<th>Cu.m.</th>
<th>Cu.m.</th>
<th>Bundle</th>
<th>Sq.m.</th>
<th>Cu.m.</th>
<th>Kg</th>
<th>Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Up to Plinth Level</strong></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><strong>Super Structure</strong></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><strong>Roofing</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.1</td>
<td>9.1</td>
<td>5.6</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></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>

**MATERIALS**

- Stone
- Weld wire mesh
- Sand
- Mud
- CGI Sheet
- GI Sheet
- Wood
- 4mm GI wire
- 2 mm GI Wire

---

**STONE**

- Weld wire mesh
- Sand
- Mud
- CGI Sheet
- GI Sheet
- Wood
- 4mm GI wire
- 2 mm GI Wire

---

**LEVEL MATERIALS**

- 44.9
- 51.1
- 1.3
- 18.4
- 4.1
- 9.1
- 6.1
- 25.0
- 62.0

---

**HOUSING TYPE**: R.R.M.-5.1

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

**SCALE**: NONE
MODEL R.R.M-5.1, RANDOM RUBBLE MASONARY IN MUD MORTAR

Housing Type: R.R.M-5.1

Drawing Title: Floor Plan

Floor Area: 40.365 SQ. M

Bed Room
2925 X 3000

Bed Room
2925 X 3000

Ground Floor Plan

Scale: None

Date: ONE STOREY
MODEL R.R.M-5.1, RANDOM RUBBLE MASONARY IN MUD MORTAR

HOUSING TYPE: R.R.M.-5.1

DRAWING TITLE: ELEVATIONS

SCALE: NONE

DATE:
MODEL R.R.M-5.1, RANDOM RUBBLE MASONARY IN MUD MORTAR

HOUSING TYPE: R.R.M-5.1

SECTION : A-A

1. Timber Ridge Beam (150 Deep x 100 Wide)
2. CGI Roofing
3. Purlins: 50x50mm (2"x2") @ 300mm (1' 6") C/C
4. Rafters: 50x100mm (2"x4") @ 1200mm (4' 0") C/C

WWM Band at Top of Wall

Timber Floor Typ.

Timber Post 110Ø Above Attic Wall.

Gable Wall to be of GI Sheets or Timber Planks (No Masonary)

450mm (18") RR Wall in Mud Mortar

WWM Band Typ.

WWM Plinth Band.

Timber Joint

Random Rubble Masonary in Mud Mortar.

Ties, if any, under ground must be aluminium wires

Refer Wall Plate Details

Refer Foundation Details
## 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 31 x 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>
### 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>2mm GI Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Sq.m</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td></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>6.0</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>49.3</td>
<td>71.9</td>
<td>-</td>
<td>18.8</td>
<td></td>
<td>0.9</td>
<td>28.0</td>
<td>66.0</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>4.0</td>
</tr>
<tr>
<td>TOTAL</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>7.4</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

GROUND FLOOR PLAN
FLOOR AREA: 40.365 SQ. M.

BED ROOM
2925 X 3000

BED ROOM
2925 X 3000

450 900 900 1125 450 1125 900 900 450

3900 3000

450 900 900 2700 900 900 450

7200

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE
R.R.M-5.2
DATE: 2/11
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

DN

FLOOR PLAN
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

Housing Type: R.R.M.-5.2

Scale: None

Back Side Elevation

Right Side Elevation
MODEL R.R.M.-5.2, RANDOM RUBBLE MASONARY IN MUD MORTAR

TWO STOREY

RAFTERS- 50X100MM (2"X4") @ 1200MM (4' 0") C/C
PURLINS- 50X50MM (2"X2") @ 450MM (1' 6") 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 1100 ABOVE ATTIC WALL
CGI ROOFING

WWM BAND AT TOP OF WALL
WWM BAND TYP.
WWM PLINTH BAND.
TIES, IF ANY, UNDER GROUND MUST BE ALLUMINIUM WIRES

RANDOM RUBBLE MASONRY IN MUD MORTAR.
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: R.R.M.-5.1/5.2
DRAWING TITLE: DETAIL

SCALE: NONE

DATE: 7/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: R.R.M.-5.1/5.2
DRAWING TITLE: DETAIL

SCALE: NONE

DATE: 7/11

ECONOMIC OPTION
(Also to be used with existing foundation)

RECOMMENDED OPTION
(Only if aluminum wire are available)

FOUNDATION DETAIL

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

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

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

WALL PLATE.

SECTION : D-D

ATTIC WALL

WWM BAND
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

SECTION : C-C

50X100MM TIMBER FLOOR BEAM

WALL PLATE

TWO STOREY MODEL R.R.M.-5.1/5.2

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

HOUSING TYPE: R.R.M.-5.1/5.2
DRAWING TITLE: DETAIL

SCALE: NONE

R.R.M.

DATE: 9/11
LOCATION OF CROSS LINKS TO BE PLACED IN ALL STORIES.

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

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

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.

TWO 14 GA (2MM DIA) TWISTED GI WIRES WITH LOOSE ENDS EXTENDING OUT100MM ON BOTH SIDE WALL

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

TWO 14 GA (2MM DIA) TWISTED GI WIRES WITH LOOSE ENDS EXTENDING OUT100MM ON BOTH SIDE WALL

MAIN POST

SEE DETAIL TYP.
## 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>
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

![Image of a two-storey model](image)

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
<th>Stone</th>
<th>Mud</th>
<th>CGI Sheet</th>
<th>GI Sheet</th>
<th>Wood</th>
<th>Bamboo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Bundle</td>
<td>Sq.m.</td>
<td>Cu.m.</td>
<td>Nos</td>
<td></td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>11.6</td>
<td>13.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>230.0</td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>21.3</td>
<td>8.1</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>5.6</td>
<td>9.5</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>32.9</td>
<td>21.1</td>
<td>5.6</td>
<td>9.5</td>
<td>1.3</td>
<td>230.0</td>
<td></td>
</tr>
</tbody>
</table>

### 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
DRAWING TITLE: PLAN

PLINTH BAND IN LOCAL TREATED TIMBER

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE
DATE: 2/14

BSMH-6.1

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, SILL AND LINTEL LEVELS

GROUND FLOOR

GAP BETWEEN THE BAMBOO POSTS AND STONE WALL

460 X 460 BUTRESS IN LONG WALL

AVG. 75 MM DIA. BAMBOO

BAMBOO POST CLUSTER (TYPE 1)

BAMBOO POST CLUSTER (TYPE 2)

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

SMM BETWEEN AND OVER PLINTH TIMBER BANDS

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

50MM GAP BETWEEN THE BAMBOO POSTS AND STONE WALL

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

75 x 75 TIMBER DOOR AND WINDOW FRAME

RCC PLINTH BEAM

75 x 75 TIMBER DOOR AND WINDOW FRAME

130 x 130 TIMBER POST

130 x 130 TIMBER POST

TO PERIMETER DRAIN OUTSIDE

PLAN AT +460

PLINTH BAND IN LOCAL TREATED TIMBER
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: 3/14

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

- Two Storey Model B.S.M.H.-6.1
- Bamboo and Stone Masonry Hybrid Structure

**Plan at +1000 Window Sill Level**

- Covered Verandah
- Open Verandah
- Kitchen
- Cooking Area
- Butress in Long Wall
- Bamboo Door
- 130 x 130 Timber Post
- Mud Plaster on Stone Wall
- 125 x 125 Timber Post
- 75 x 75 Timber Door and Window Jamb
- Stone Masonry in Mud Mortar
- Cut Out in Attic Floor Above
- Bamboo/ Timber Ladder to Attic
- Mud Plaster
- Bambo Post Cluster (Type 2)
- Bamboo Door Cluster (Type 1)
- 50mm Gap Between the Bamboo Posts and Stone Wall
- 460 x 460 Butress in Long Wall
- 130 x 130 Timber Post
- 610 x 100 x 75 Precast PCC Blocks Laid at Right Angles in Alternate Courses
- 75 x 75 Timber Door and Window Frame Fixed to Plinth Band to Lintel Band
- Mud Plaster on Walls
- Precast PCC Blocks @ 610 C/C
- 75 x 75 x 75 Timbers Door and Window Jamb
- 460 x 460 Butress
- 125 x 125 x 100 Precast PCC Blocks
- 2 Nos. 75 x 75 Vertical timber members
- 130 thick Bamboo Partition with Mud Plaster
- Mud Plaster on Walls
- 50mm Gap Between the Bamboo Posts and Stone Wall
- 460 x 100 x 75 Precast PCC Blocks Laid at Right Angles in Alternate Courses

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

HOUSING TYPE: B.S.M.H.-6.1
DRAWING TITLE: PLAN
DATE: 4/14

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

Housing Type: B.S.M.H.-6.1

Plan at +2640
Lintel Band

ROOM 1
75 x 130 Timber Rafters
Fixed to Lintel Band

Mortise and Tenon Joint

COVERED VERANDAH

75 x 130 Timber Beam
Fixed to Timber Posts

12MM Dia Bamboo Pins

12MM Dia Bamboo Pin

50 x 40 Timber Ties

100 x 50 Timber Bands

Single Bamboo Tie Beam
Fixed to Posts using Bamboo Pins and Tied with Nylon Strips. Top at +2590

Corner Bracing Member

50 x 40 Timber Bands

100 x 50 Timber Bands at Lintel Level. Top at +2641

Lintel Band

75 x 130 Timber Rafters
Fixed to Lintel Band

Mortise and Tenon Joint

100 x 50 Timber Rafters Fixed to Timber

Lintel Band

50 x 40 Timber Bands

12MM Dia Bamboo Pins

50 x 40 Timber Ties

96
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: 6/14

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

Housing Type:

Drawing Title:

Scale:

Date:

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: 6/14

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

Housing Type:

Drawing Title:

Scale:

Date:

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: 6/14

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

Housing Type:

Drawing Title:

Scale:

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

Housing Type: B.S.M.H.-6.1

Drawing Title: Plan

Ministry of Urban Development
Department of Urban Development and Building Construction

DATE: 7/14

Scale: None

B.S.M.H.-6.1

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

ATTIC FLOOR LVL +2850

COVERED VERANDAH BELOW

WOVEN BAMBOO MAT UNDERLAY

WOVEN BAMBOO MAT UNDERLAY

TWIN BAMBOO TRUSS ABove SUPPORTED ON MIDDLE BAMBOO POSTS AND BOLTED

CROSS BRACING IN TRUSS PLANE BELOW THE PURLINS

PRE-COATED GALVANIZED IRON ROOFING SHEETS TO SLOPE

DOWNTAKE FOR RAINWATER HARVESTING

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

BAMBOO POSTS IN A CLUSTER OF 3 FROM GROUND FLOOR LEVEL BOLTED TO EACH OTHER AND TO THE DOUBLE BAMBOO ROOF TRUSS

CROSS BRACING IN TRUSS PLANE BELOW THE PURLINS

SPLiT BAMBOO (HALF ROUND)

Woven BAMBOO MAT UNDERLAY

CROSS BRACING

SLOPE

KITCHEN BELOW

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

2500 2200 2200 2200 9910

SLOPE

PLAN AT +3350 (ATTIC WINDOW SILL LEVEL)
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

SECTION AT A-A

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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

DRAWING TITLE: SECTION

TWO STOREY

daqk

DATE:

BSMH-6.1

9/14

100
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE
DATE: 10/14

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 LINTER LEVEL
- 400 x 100 x 75 PRECAST CONCRETE
- 75 x 75 TIMBER DOOR AND WINDOW FRAME
- PLINTH BAND
- 75 THK. DPC

GROUND FLOOR

- REF DETAIL B

ATTIC FLOOR

- REF DETAIL P

TWIN BAMBOO TRUSS

- BAMBOO CROSS BRACING

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

G.I. ROOFING SHEET OVER KITCHEN FIXED USING J-BOLTS

BAMBOO RAFTER

MUD PLASTER ON BAMBOO WATTLE

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

100 x 50 TIMBER BANDS AT INTERMEDIATE LEVEL

BAMBOO POST CLUSTER (TYPE 2) OVER PCC BASE BLOCK, REF DETAIL B

MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD

- MUD FLOOR OVER COMPACTED CLAY OVER STONE COMPACTED WITH MUD

100 x 50 TIMBER BANDS AT INTERMEDIATE LEVEL
MODEL B.S.M.H.-6.1, BAMBOO AND STONE MASONRY HYBRID STRUCTURE

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

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'

DETAIL B (PLAN): 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

AVG. 76 MM DIA. BAMBOO POSTS TIED WITH LASHING @ 900 C/C AND PAINTED WITH CREOSOTE TILL 300 MM FROM BASE

10 MM DIA. NUTS AND BOLTS

50 MM WIDE 6 MM TH. M.S. FLAT PLATE EMBEDDED IN 305 TH P.C. BASE PAD

PLINTH LEVEL +457

305 MM TH. PRE-CAST P.C.C. BASE PAD

12 MM BOLT THROUGH BAMBOO POST AND TIMBER BAND AT PLINTH LEVEL

102 X 51 MM TIMBER BAND AT PLINTH LEVEL

75 MM DEEP TWO BAR R.C.C. PLINTH BEAM

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE

DATE: 13/14
# 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*50 mm</td>
</tr>
<tr>
<td>Wall System</td>
<td>Random rubble masonry in mud mortar. Wall thickness 450 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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu.m.</td>
<td>No.</td>
<td>Bags</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Cu.m.</td>
<td>Kg.</td>
<td>Bundle</td>
<td>Rm.</td>
</tr>
<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>280.4</td>
<td></td>
<td></td>
</tr>
<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>297.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.0</td>
<td></td>
<td></td>
<td>4.2</td>
<td>10.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19.5</td>
<td>7,350.0</td>
<td>91.0</td>
<td>13.4</td>
<td>4.9</td>
<td>4.6</td>
<td>578.2</td>
<td>4.2</td>
<td>10.0</td>
</tr>
</tbody>
</table>
MODEL RTB-7.1, RAT TRAP BOND MASONRY

Housing Type: R.T.B.-7.1

Drawing Title: Ground Floor Plan

Floor Area: 40.36 SQ.M

Ground Floor Plan

Bed Room: 3430x3585

Kitchen: 3585x3585

Verandah

Scale: None

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

HOUSING TYPE: R.T.B.-7.1

SECTION AT A-A

REFER ROOF DETAIL

230 MM RAT TRAP BOND MASONRY WALL IN CEMENT MORTAR (1:4)

PLASTER PUNNING 3MM

PCC 1:2:4 5CM THK.

BRICK SOLING COMPACTED 110MM

SOIL FILLING COMPACTED

COMPACT EARTH

RTB-7.1

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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MODEL RTB-7.1, RAT TRAP BOND MASONRY

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

SCALE: NONE
DATE: 4/10

FRONT ELEVATION
SIDE ELEVATION
SIDE ELEVATION
BACK ELEVATION
MODEL RTB-7.1, RAT TRAP BOND MASONRY

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

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

PLINTH BAND: RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12MMØ STIRRUP 7MM@150MM

SILL BAND: RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 2-12MMØ STIRRUP 7MM@150MM

LINTEL BAND: RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12MMØ STIRRUP 7MM@150MM

ROOF BAND: RCC: CONCRETE 1:1.5:3 REINFORCEMENT MAIN BAR 4-12MMØ STIRRUP 7MM@150MM

FOUNDATION: 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

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

DETAIL C
FOUNDATION SECTION

RAT-TRAP BOND IN T-JUNCTION

RAT-TRAP BOND IN CORNER JUNCTION

RAT-TRAP LAYER 1

RAT-TRAP LAYER 2

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

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

SCALE: NONE
DATE:

RTB-7.1
6/10
MODEL RTB-7.1, RAT TRAP BOND MASONRY

ONE STOREY

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</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
MODEL RTB-7.1, RAT TRAP BOND MASONRY

Housing Type: R.T.B.-7.1

Drawing Title: Roof Details

Details:
- CGI Sheet
- Ridge Cover
- Rafter (H180 X W90)
- Purlin (H75 X W75)
- Post (D100 X W100)

Scale: None

Date: 8/10

Ministry of Urban Development
Department of Urban Development and Building Construction
MODEL RTB-7.1, RAT TRAP BOND MASONRY

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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDNG CONSTRUCTION

SCALE: NONE
DATE: 9/10
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>
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)

**E.B.-8.1**
### MODEL E.B.-8.1, EARTHBAG MASONRY

#### ONE STOREY

<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>18.4</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></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>12.3</td>
<td>18.4</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: 1/11*
GROUND FLOOR PLAN
FLOOR AREA: 31.95 SQ.M.

MODEL E.B.-8.1, EARTHBAG MASONRY
ONE STOREY

Model E.B.-8.1, Earthbag Masonry

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

Scale: None

Date: 3/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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MODEL E.B.-8.1, EARTHBAG MASONRY

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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE
DATE: 4/11

SECTION A-A

- Ridge: H240xW180
- Post: H90xW90
- Rafter: H180xW90
- Purlin: H75xW75
- Base: H90xW90

Refer Roof Band Connection Detail

- 25mm Cement/Earten Plaster
- Galvanized Chicken Wire Mesh
- 380mm Earth Bag
- 12mm Rebar with 300mm Overlap
- 3 Layers of 150mm Gravel Bags
- Dry Stone Masonry

- 450mm Thk. Earthbag Masonry in Barbed Wire
- Refer Foundation Detail

- 50mm Mud Flooring
- 50Gauge Polythene Sheet
- 100mm Stone Soling

2895
1960
150
1205
600
150
600
905
600
1205
600
MODEL E.B.-8.1, EARTHBAG MASONRY

HOUSING TYPE: MODEL E.B.-8.1

DRAWING TITLE: SECTION

SCALE: NONE

DATE: 5/11

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

RIDGE H240XW180
POST H90XW90
RAFTER H180XW90
PURLIN H75XW75

REFER ROOF BAND CONNECTION DETAIL

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

DRIY STONE MASONRY

SECTION B-B
MODEL E.B.-8.1, EARTHBAG MASONRY

FOUNDATION SECTION

BASE WIDTH OF FOOTING = 200 + 1 BAG WIDTH

- EARTH BAGS
- GRAVEL FILLED BAGS
- MUD FLOORING
- RUBBLE SOLING
- FILTER GEO-FABRIC ENVELOPES RUBBLE TRENCH
- \( \varnothing 100 \text{MM} \) PERFORATED PIPE
- RUBBLE TRENCH
- TOP SOIL
- SUB SOIL

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

8/11
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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
HOUSING TYPE: MODEL E.B.-8.1
DRAWING TITLE: CONSTRUCTION SEQUENCE
SCALE: NONE
DATE: 9/11
E.B.-8.1
128
CONSTRUCTION SEQUENCE

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

11 FILL BAGS WITH EARTH, PLACE FIRST COURSE AND TAMM

12 REPEAT STEP 6 AFTER EACH COURSE

13 PREVENT CORNER DROP

14 TAMP, 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/mm² for LGS 9.1
- Min. 350 N/mm² for LGS-9.2

Galvanized zinc coated: Min. 275gsm
### 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</th>
<th>GI Sheet</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>115.1</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>2.2</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4,184.8</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td>8.8     32.9  1,753.2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>42.1</td>
<td>15,702.0</td>
<td>117.2</td>
<td>13.0</td>
<td>11.1</td>
<td>468.5</td>
<td>8.8</td>
<td>32.9</td>
<td>5,938.0</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
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

SECTION ALONG A-A

- RIDGE
- C90x37x0.75MM BMT STUD
- C90x37x0.75MM BMT RAFTER
- 2C90x37x0.75MM BMT SUPPORT TOP CHORD
- 3C90x37x0.75MM BMT SUPPORT BOTTOM CHORD
- C90x37x0.75MM RAFTER

REFERENCES:
- ROOM
- VERANDAH
- REFER FOUNDATION DETAIL
- REFER ROOF TRUSS DETAIL
- C90x37x0.75MM BMT BRACE
- 75x75x4MM SQUARE SECTION

DIMENSIONS:
- 3175
- 1200
- 900
- 450
- 850
- 900

DRAWING TITLE: SECTION

SCALE: NONE

DATE: 4/9

HOUSING TYPE: MODEL L.G.S.-9.1

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

ONE STOREY

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

FOUNDATION SECTION

CONNECTION DETAILS AT DPC LEVEL

TYPICAL STRAP BRACING IN WALL

2-10X16X16 HEX TEK SCREW

2-10X16-16 HEX TEK SCREW

C90X37X0.75MM HORIZONTAL NUG

C90X37X0.75MM BMT STUD

1RIVERT/10-16 16 HEX TEX SCREW

0.75X50MM STRAP BRACING
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

ONE STOREY

Housing Type: MODEL L.G.S.-9.1

Drawing Title: DETAILS

Structural Elevation 1

Structural Elevation 2

Typical Elevation Detail at Opening

1. Door (D1) 1100x2100
2. Door (D2) 1000x2100
3. Window (W2) 1000x1200

75x75x4mm MS SQ. STEEL SECTION POST

C90x37x0.75mm horizontal nug @500mm

C90x37x0.75mm vertical stud

0.75x50mm strap bracing

300mm depth lintel

1 rivet/10-16-16 hex tex screw

4mm dia. rivet

RIDGE

1 rivet/10-16-16 hex tex screw

Lintel jack stud

300mm lintel

2 C90x37x0.75mm at opening stud

0.75x50mm strap bracing

C90x37x0.75mm vertical stud

C90x37x0.75mm horizontal nug

C90x37x0.75mm BMT stud @ 406mm C/C

L.G.S 9.1

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Housing Type: MODEL L.G.S.-9.1

Drawing Title: DETAILS

Scale: None

Date: 6/9

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MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

HOUSING TYPE: MODEL L.G.S.-9.1

SCALE: NONE

DATE:

139
MODEL L.G.S.-9.1, LIGHT GAUGE STEEL STRUCTURE

ROOF LAYOUT

SUPPORT DETAIL

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

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

SCALE: NONE
DATE: 

L.G.S. 9.1
8/9
## TECHNICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td><strong>Structure System</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Foundation</strong></td>
<td>Strip footing of Random rubble masonry in cement sand mortar with width 900 mm and depth 850 mm.</td>
</tr>
<tr>
<td><strong>Plinth Band</strong></td>
<td>R.C.C (1:1.5:3) plinth band of size 230x230 mm. Main reinforcement shall be 4 nos. of 12mm dia. Bars with 8mm Ø rings at 150mm C/C</td>
</tr>
<tr>
<td><strong>Wall System</strong></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><strong>Bracing:</strong></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><strong>Roof System:</strong></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**

**TwO STOREY**

**Housing Type:**

**Drawing Title:** ESTIMATION AND 3D-VIEW

**Date:**

**Materials Table:**

<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>CGI Sheet Bundle</th>
<th>GI Sheet Sq.m.</th>
<th>MS angles &amp; Plates Cu.m.</th>
<th>Wall Board Sq.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to Plinth Level</td>
<td>2,973.0</td>
<td>87.6</td>
<td>6.4</td>
<td>9.5</td>
<td>594.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.5</td>
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<tr>
<td>Super Structure</td>
<td>-</td>
<td>2.2</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4,184.8</td>
<td>244.3</td>
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<td>Roofing</td>
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<td>5.4</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<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>
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</table>
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE

TWO STOREY

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

SCALE: NONE
DATE: 2/7

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

GROUND FLOOR PLAN
FLOOR AREA: 36.19 SQ. M.

FIRST FLOOR PLAN
FLOOR AREA: 36.19 SQ. M.
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
MODEL L.G.S.-9.2, LIGHT GAUGE SHEET STRUCTURE

DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE
DATE: 5/7

MINISTRY OF URBAN DEVELOPMENT

Housing Type: Model L.G.S.-9.2

Details

Foundation and Wall Section

Detail at C

Frame Connection to Wall L Bracket Hold Down

U-Track over Concrete Slab

Regular Concrete Infill (2400 KG/M3)
Size 10 mm bars @ 100 mm C/C
Size 12 mm bars laid @ 250 mm C/C horizontally as primary reinforcement

Regula r Concrete Infill (300 KG/M3)
Size 10 mm bars @ 224 mm C/C laid perpendicular to the primary reinforcement

No 8 screws through the ceiling boards to the bottom chord of the joist

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

Cellular Light Weight Concrete Infill (600 KG/M3)
600 mm high density concrete infill between walls studs
10 mm restart bar @ 400 mm spacing

25 mm thick concrete boards

Regular Concrete Infill (2400 KG/M3)
Size 10 mm bars @ 100 mm C/C
Size 12 mm bars @ 224 mm C/C laid perpendicular to the primary reinforcement

5 mm thick ceiling boards

8.8 grade wafer head screws

100 mm bracing plate

89X50X15 stud

89X50X15 U-track

8.8 grade wafer head screws

M12 anchor bolt with inbuilt washer

Ground Level

Plinth Level

Detail at C Foundation and Wall Section

U-Track over Concrete Slab

Frame Connection to Wall L Bracket Hold Down
MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION
HOUSING TYPE: MODEL L.G.S.-9.2
DRAWING TITLE: DETAILS
SCALE: NONE
DATE: 6/7

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

TYPICAL FLOOR SECTIONS

ISOMETRIC VIEW OF STUDS ARRANGEMENT

TYPICAL ROOF TRUSS TO STUD CONNECTIONS

TYPICAL WALL SECTION

TYPICAL NOGGING SECTION
### 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>
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 ≥ 1000kg/m³
Mix ratio grade: 1:1.5:3
Tensile Strength of rebar: Fe 500
### MODEL S.S.-10.1, STEEL STRUCTURE

**TWO STOREY**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brick</td>
</tr>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>Up to Plinth Level</td>
<td>3,384.0</td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
</tr>
<tr>
<td>Roofing</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,384.0</td>
</tr>
</tbody>
</table>
MODEL S.S.-10.1, STEEL STRUCTURE

HOUSING TYPE: MODEL S.S-10.1
DRAWING TITLE: FLOOR PLANS

SCALE: NONE
DATE: 2/11

GROUND FLOOR PLAN
AREA: 60.85 SQ.M

FIRST FLOOR PLAN
AREA: 60.85 SQ.M

ROOM
4950x2950

ROOM
4950x2950

ROOM
4950x2950

ROOM
4950x2950
MODEL S.S.-10.1, STEEL STRUCTURE

HOUSING TYPE: MODEL S.S-10.1

DRAWING TITLE: SECTION

SCALE: NONE

DATE: 4/11

MINISTRY OF URBAN DEVELOPMENT
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CGI SHEET
50.8X50.8X3 MM PURLIN
50.8X50.8X3 MM TOP CHORD
38.1X38.1X2 MM TOP CHORD
50.8X50.8X3 MM BOTTOM CHORD

SECTION AT A-A

PRE-CAST RCC SLAB

INFLOW WITH DENSITY MORE THAN 1000 KG/M³

REFER TRUSS DETAIL
REFER BEAM DETAIL
REFER FOUNDATION

DIAGONAL CHORD
38.1X38.1MM

450
1200
1200
5025
1625
1900
1300
600
2200
2300
50.8X50.8X3 MM BOTTOM CHORD
MODEL S.S.-10.1, STEEL STRUCTURE

TWO STOREY

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></td>
<td></td>
<td>Depth (D)</td>
<td>Rebar</td>
</tr>
<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>

FOUNDATION TRENCH PLAN

HOUSING TYPE: MODEL S.S-10.1

DRAWING TITLE: STRUCTURE DETAILS

SCALE: NONE

DATE: 5/11
MODEL S.S.-10.1, STEEL STRUCTURE

TWO STOREY

FOUNDATION PLAN

REBAR B/W 10s 150/C/C
REBAR B/W 10s 150/C/C

FOUNDATION SECTION AT A-A

PLINTH LEVEL
2-ISMC150
BASE PLATE
GROUND LEVEL

TIE BEAM
2-12s THR.
2-12s THR.

TOE WALL

REBAR B/W 10s 150/C/C
75mm P.C.C (1:3:6)
SINGLE LAYER BRICK SOLING
RAMMED EARTH

GROUND LEVEL
PLINTH LEVEL
WALL

PEDESTAL COLUMN
8-12s REBAR.

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

SCALE: NONE
DATE: 6/11

S.S.-10.1
MODEL S.S.-10.1, STEEL STRUCTURE

BEAM-COLUMN PLAN

ISMC150
(SECONDARY BEAM)

ISMB150
(PRIMARY BEAM)

FULL PENETRATION GROOVE WELD

2-ISMC150(COLUMN)
MODEL S.S.-10.1, STEEL STRUCTURE

HOUSING TYPE: MODEL S.S-10.1
SCALE: NONE
S.S.-10.1

DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

DRAWING TITLE: STRUCTURE DETAILS
DATE: 8/11

MINISTRY OF URBAN DEVELOPMENT
MODEL S.S.-10.1, STEEL STRUCTURE

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND BUILDING CONSTRUCTION

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

SCALE: NONE
DATE: 9/11

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
ISMB150

8 @130mm C/C

DECKING PROFILE 44/130x1mm
ISMB150

8 @150mm C/C BOTHWAY
75mm THICK CONCRETE(M20)

2.5 THK x 22 DIA. WASHER

22
11

PUDDLE WELD

DECKING PROFILE 44/130x1mm
ISA 150x150x10

DECKING PROFILE 44/130x1mm
ISMB150

8 @130mm C/C
MODEL S.S.-10.1, STEEL STRUCTURE

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

CGI SHEET

50.8x50.8x3mm BOTTOM CHORD

50.8x50.8x3mm PURLIN

50.8x50.8x3mm TOP CHORD

38.1x38.1x2mm VERTICAL CHORD

50.8x50.8x3mm BOTTOM CHORD

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

SECTION AT 1-1

MINISTRY OF URBAN DEVELOPMENT
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HOUSING TYPE: MODEL S.S-10.1
DRAWING TITLE: STRUCTURE DETAILS

SCALE: NONE
DATE: 10/11

S.S.-10.1

50.8x50.8x3mm THICK MIDDLE VERTICAL CHORD

38.1x38.1x2mm DIAGONAL CHORD

TRUSS DETAIL

DETAIL AT A

CLEAT DETAIL

200
# 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 12 mm dia. Bars with 8 mm Ø rings at 150 mm 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>
TIMBER STRUCTURE

T.S.-11.1
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/m$^2$
Modulus of Elasticity: 9.4 x10$^3$ N/mm$^2$
Binding & tension along Grains, Extreme Fiber Stress, inside location: 13.7 N/mm$^2$
Binding & tension along Grains, Extreme Fiber Stress, outside location: 11.4 N/mm$^2$
Shear Stress, Horizontal in Beams all locations: 1 N/mm$^2$
Shear Stress, along grains all locations: 1.4 N/mm$^2$
Compressive Stress, inside location (parallel to grains): 8.6 N/mm$^2$
Compressive Stress, outside location (parallel to grains): 7.7 N/mm$^2$
**MODEL T.S.-11.1, TIMBER STRUCTURE**

**TWO STOREY**

![Three-story house diagram](image)

<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 Angle &amp; Plates Cu.m.</th>
<th>Wood Bundle</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>3,652.7</td>
<td>112.9</td>
<td>16.7</td>
<td>8.7</td>
<td>630.0</td>
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<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td>-</td>
<td>17.5</td>
<td>1.2</td>
<td>2.2</td>
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<td>526.3</td>
<td>16.3</td>
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<td>10.3</td>
<td>22.6</td>
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<tr>
<td>Roofing</td>
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<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>130.4</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

Housing Type: MODEL T.S-11.1

Drawing Title: FLOOR PLANS

Area: 61.64 SQ.M.

Ground Floor Plan

First 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

Scale: None

Date: 2/7

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: MODEL T.S-11.1
DRAWING TITLE: FLOOR PLANS
SCALE: NONE
DATE: 2/7
MODEL T.S.-11.1, TIMBER STRUCTURE

GROUND LEVEL
500
250
200
125
125
600

FOUNDATION

PLINTH LEVEL

RCC (1:1.5:3) BAND (350x200mm)

STIRRUPS T8s @ 150mm C/C

T12s @ 1200mm C/C

M10 BOLT OF CLASS 4.6

75mm WIDTH, 6mm THICK METAL PLATE

STUD CONNECTION TO FOUNDATION OTHER THAN BRACING

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD
BRACING

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE

FOUNDATION STONE WALL
75mm P.C.C (1:3:6)
SINGLE LAYER BRICK SOLING

M20 BOLT OF 425mm LENGTH

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE

PLINTH BAND

STIRRUPS T8s @ 150mm C/C

M20 BOLT OF CLASS 4.6

6-T12s

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE

6-T12s

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE

6-T12s

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE

M20 BOLT OF 425mm LENGTH

STUD CONNECTION TO FOUNDATION AT BRACING

FULL PENETRATION WELD

4-M20 BOLT
ISA 105x75x6
12mm THICK MS PLATE
MODELS T.S.-11.1, TIMBER STRUCTURE

TWO STOREY

HOUSING TYPE: MODEL T.S.-11.1
DRAWING TITLE: JOIST AND JOINT DETAIL

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

SCALE: NONE

DATE: 6/7

FLOOR JOIST PLAN

CORNER BRACING POSITION

M10 BOLT

CORNER POST CONNECTION

M10 BOLT

FLOOR JOIST PLAN

FLOOR JOIST(75x135)

BRACING CONNECTION

M12 BOLT OF CLASS 4.6
8mm THICK METAL PLATE
FLOOR JOIST(37x100mm)

POST

BRACING(37x100mm)

BRACING(37x100mm)

M20 BOLT OF GRADE 4.6
FLOOR JOIST(75x135)

3-M20 BOLT OF GRADE 4.6
75x75 VERTICAL STUD (UPPER FLOOR STUD)

75x75 VERTICAL STUD (LOWER FLOOR STUD)

75x75 VERTICAL STUD (UPPER FLOOR STUD)

STUD CONNECTION AT FLOOR

FLOOR JOIST PLAN

FLOOR JOIST(75x135)
## 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
MODEL 12.1, DEBRIS BLOCK MASONRY

Housing Type: D.B.-12.1

Level: Up to Plinth Level
- Debris Block: 1,762.0
- Cement: 34.2
- Sand: 2.4
- Aggregate: 4.7
- Reinforcing Bar: 273.5
- CGI Sheet: -
- GI Sheet: -
- Wood: -

Level: Super Structure
- Debris Block: 1,923.0
- Cement: 21.8
- Sand: 1.2
- Aggregate: 2.3
- Reinforcing Bar: 307.1
- CGI Sheet: -
- GI Sheet: -
- Wood: 0.3

Level: Roofing
- Debris Block: -
- Cement: -
- Sand: -
- Aggregate: -
- Reinforcing Bar: -
- CGI Sheet: -
- GI Sheet: -
- Wood: 5.2

Total
- Debris Block: 3,685.0
- Cement: 55.9
- Sand: 3.6
- Aggregate: 7.0
- Reinforcing Bar: 580.6
- CGI Sheet: 5.2
- GI Sheet: 8.3
- Wood: 3.1
MODEL 12.1, DEBRIS BLOCK MASONRY

ONE STOREY

FLOOR PLAN
AREA: 31.75 SQ. M.
MODEL 12.1, DEBRIS BLOCK MASONRY

FRONT ELEVATION

SIDE ELEVATION

SIDE ELEVATION

BACK ELEVATION

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

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

SECTION AT A-A

ROOM 1

VERANDAH

ROOF BAND: RCC: CONCRETE 1: 1.5: 3
REINFORCEMENT MAIN BAR 12 MM X 4

Lintel Band: RCC: CONCRETE 1: 1.5: 3
REINFORCEMENT MAIN BAR 12 MM X 4

Vertical Reinforcement:
REINFORCEMENT MAIN BAR 12 MM X 2

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 X 4

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

Purlin: 75MMX 75 MM @ 450 MM

Rafter: 180 MM X 180 MM

See Roofing Details

Housing Type: D.B.-12.1

Drawing Title: Section

Scale: None

Date: 4/8

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

WALL: 300 MM THICKNESS

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

DETAIL AT C FOUNDATION SECTION

<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>12 (top)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</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>

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

G.L.

PLINTH BAND

MAIN BAR (SEE GIVEN TABLE)

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

VERTICAL REINFORCEMENT ON CORNERS & JOINTS

PLAN

RCC BAND AT CORNER

RCC BAND AT T-JUNCTION

MINISTRY OF URBAN DEVELOPMENT
DEPARTMENT OF URBAN DEVELOPMENT AND
BUILDING CONSTRUCTION

HOUSING TYPE: D.B.-12.1
DRAWING TITLE: STRUCTRAL DETAILS
DATE: 6/8

SCALE: NONE

DOWEL BAR
VERTICAL STEEL

6 MM DIA CROSS TIE @150 MM C/C

180 MMM VERTICAL STEEL

6 MM DIA STIRRUP @150 C/C
MODEL 12.1, DEBRIS BLOCK MASONRY

Housing Type: D.B.-12.1
Drawing Title: Roofing Details

Plan View

Side View

Roofing Detail

Ministry of Urban Development
Department of Urban Development and Building Construction

Housing Type: D.B.-12.1
Drawing Title: Roofing Details
Scale: None
Date: 7/8

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

#### 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 6mm 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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