



ILLUSTRATED GUIDELINES for CONSTRUCTION of STONE MASONRY HOUSES in SEISMIC REGIONS of NEPAL



First Edition: July, 2017



Empowered lives.
Resilient nations.

ILLUSTRATED GUIDELINES for CONSTRUCTION of STONE MASONRY HOUSES in SEISMIC REGIONS of NEPAL

**Bishnu Pandey
Svetlana Brzev
Robert Culbert
Glade Schoenfeld**

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Translation

These Guidelines have been translated from the original English. In the event of any inconsistency between the English and Nepali versions, the English version governs. As part of UNDP's efforts to support affected people with disaster resistant construction, UNDP conducted the translation of these Guidelines to Nepalese from English and disclaims any liability with the substance and subject matter of these Guidelines that have been created by the Authors and Reviewers.

Contents

i	Preface
iv	Acknowledgements
1	Essentials of an Earthquake Resistant Stone Masonry House
2	Site Selection
3	Building on Sloped Sites
4	Planning for Construction
6	Site Preparation for Construction
8	Stones
9	Sand and Gravel
10	Cement
11	Mixing Cement Mortar
12	Mixing Mud Mortar
13	Mixing Concrete
14	Steel Reinforcing Bars
15	Building the Foundation
16	Building Random Rubble Stone Walls
17	Through - Stones for Stone Masonry Walls
18	Vertical Reinforcement
19	Wall Corners
20	Seismic Bands
21	Reinforced Concrete Bands
22	Timber Bands & Cross Ties
23	Timber Band Details
24	Floor Construction
25	Floor-Wall Connection
26	Roof Construction
27	Roof Connection to Walls with Timber Bands
28	Roof Connection to Walls with Concrete Bands
29	References
30	Important Information

Preface

Earthquakes occur when underground rocks break along a fault causing a sudden release of energy in the Earth's crust that cause ground shaking. The surface location above the center of breaking rocks is called the epicenter of the earthquake. Depending upon magnitude, depth, duration and proximity to its epicenter, an earthquake can cause destruction of buildings, landslides, avalanches, loss of life, and hardship for survivors.

Nepal is located in a the 'Himalayan Arc', an area of high seismic hazard, where the Indian sub-continent is moving northward under the Eurasian continent. Prior to the April 25th 2015 7.8 magnitude Gorkha Earthquake, one of the strongest earthquakes in Nepal occurred in 1934 with an estimated magnitude of 8.4. In the recent past, South Asia has been hit by several strong earthquakes, including the 2001 earthquake in Gujarat, Western India, and in 2005 in Noth-West Pakistan and Kashmir - both with magnitudes of 7.6, and in October 2015 in north-eastern Afghanistan with a magnitude of 7.5.



2015 Gorkha Earthquake & Aftershock

Initial consideration of general Guidelines for stone masonry house construction in seismic regions began after the devastating Gorkha Earthquake by the first two Authors at the British Columbia Institute of Technology ('BCIT'). The work benefited by a trip to Nepal in July 2015 organized by the Canadian Association for Earthquake Engineering ('CAEE'). During that time the six-person CAEE team collaborated closely with the National Society for Earthquake Engineering ('NSET') in Kathmandu. Many sites of collapsed buildings, heritage structures and houses were studied in Kathmandu Valley and in two other districts (Dolakha and Sindhupalchok) in the hills north-east of Kathmandu.

Preface (cont'd)



Bishnu Pandey and Svetlana Brzev in Dolaka Village, Nepal in July 2015.

Photo: Robert Culbert, BWB.

Stone masonry has existed since humanity could make and use tools creating buildings, structures, and sculptures using stone. Stone is used extensively for housing in several regions around the world including high seismic zones. These illustrated Guidelines are specifically directed to the building of houses in areas where stone is a readily available building material and access to other materials is severely limited. In Nepal this is most common in the more remote areas where access is difficult – increasing with distance and elevation into the foothills and the Himalayas. As a result of the Gorkha Earthquake and its aftershocks it is estimated that more than six hundred thousand buildings were destroyed or damaged beyond repair.

These Guidelines begin with a summary of the essentials of earthquake-resistant stone masonry house construction – the use of good quality materials on level and firm ground using stones, seismic bands, vertical and horizontal reinforcement and proper connections of the walls to the floor and roof. Site selection is discussed, followed by recommendations for building on sloped grounds (site preparation, building foundation layout) and planning the size and interior of the dwelling.

Preface (cont'd)

Building materials are then discussed in more detail – proper shaped stones, sand and mud for mortar, aggregate for concrete, cement, and reinforcing bars. Actual construction topics begin with the foundation followed by the random rubble stone walls, seismic bands (timber or reinforced concrete), use of through-stones, and the important placement of reinforcement at wall corners. Details are presented for wall corners, junctions, floor and floor-wall construction, and ending with construction and proper attachment of the roof to the structure. These Guidelines meet the minimum requirements set by the Nepal's National Building Code Guidelines for Earthquake Resistant Building Constructions: Low Strength Masonry ('NBC 203:2015').

The illustrations provided in these Guidelines are intended to convey much of the understanding of stone masonry construction. It should be noted that stone masonry, even when constructed according to NBC 203:2015 and with proper care taken to use quality materials and construction, is more vulnerable to earthquake effects than other construction materials. It is therefore expected that stone masonry construction would likely suffer more damage compared to otherwise similar buildings constructed with the addition of reinforced concrete components.

These Guidelines, in printed form, will be distributed widely in the areas in need of assistance and direction in stone masonry construction, which in Nepal will predominately be in the hills and mountainous areas. The future involvement of knowledgeable trainers to facilitate the distribution will be of great importance. This first edition, written in English, has been translated into a Nepali edition.

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The work in Nepal was aided by the NSET staff in Kathmandu led by Deputy Director Dr. Ramesh Guragain.

The support and encouragement of Dean Wayne Hand and Associate Dean Jennie Moore of the BCIT School of Construction and the Environment, and the financial support for the July 2015 visit to Nepal provided by BCIT and CAEE is gratefully acknowledged.

The Authors acknowledge Jitendra Bothara (New Zealand), Vivek Rawal (India), and Dr. Ron Devall of Reid Jones Christoffersen Ltd. ('RJC') who reviewed the document and provided valuable input. The Authors also acknowledge United Nations Development Programme, Nepal for the publication support of these Guidelines.

These Guidelines benefitted from the material presented in several resources. NBC 203:2015 Guideline was a valuable resource for the development of this publication. A few illustrations related to timber-reinforced stone masonry were adapted from the publication *Bhatar Construction - An Illustrated Guide for Craftsmen*, which was developed by Tom Schacher for the Swiss Agency for Development and Cooperation.

The Authors also acknowledge Martijn Schildkamp, Smart Shelter Research, for providing photographs on page 9; other photographs in these Guidelines were provided by the Authors. A few illustrations were also adapted from the publication *A Tutorial: Improving the Seismic Performance of Stone Masonry Buildings* by Jitendra Bothara and Svetlana Brzev, published by the Earthquake Engineering Research Institute, which was another important resource for the development of these Guidelines.

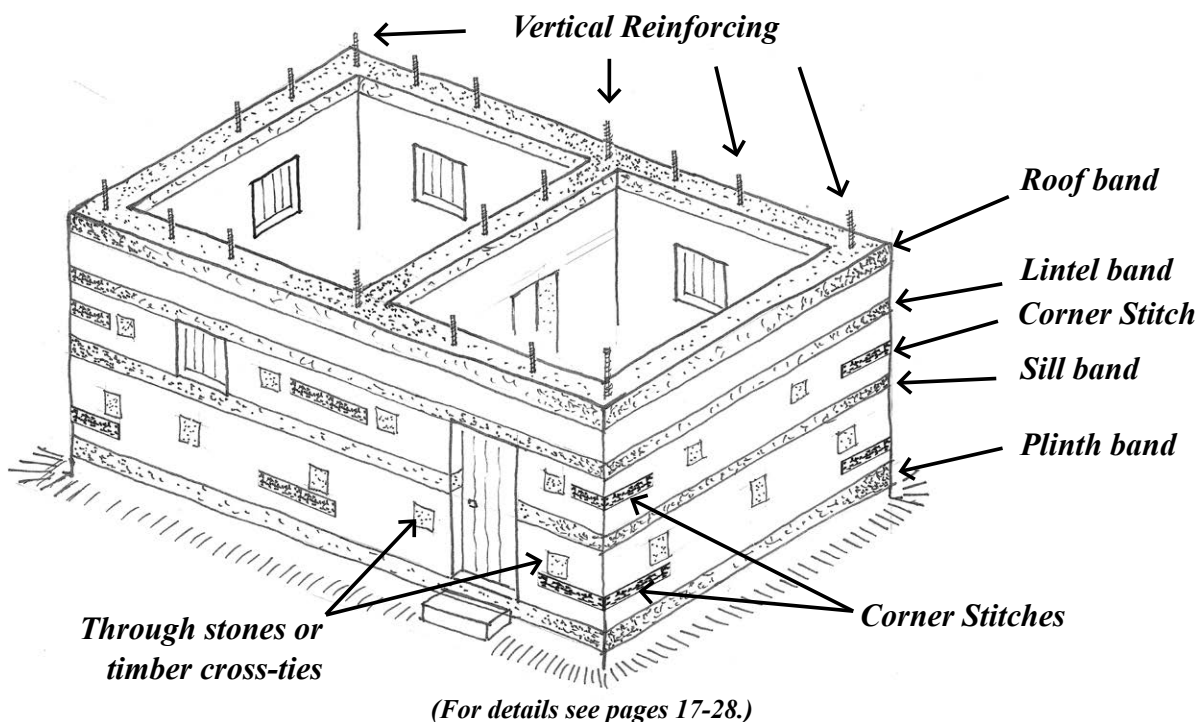
Recommendations for irregular buildings on page 4 in the Guidelines were adopted from IS4326:2013 *Indian Standard Earthquake Resistant Design and Construction of Buildings - Code of Practice*. A recommendation on page 11 regarding the useful time of mortar (under two hours) has been adopted from CSA 179:2004 *Mortar and Grout for Unit Masonry*, Section 6.3.1.

Cover Photo: Stone masonry construction in Solukhumbu District, 2015, Photo: Milan Bagale, Kathmandu.

Document production: Digitech Printing Inc., Vancouver B.C., Canada.

Essentials of an Earthquake Resistant Stone Masonry House

1. Locate the house on firm and level ground.
2. Use good quality materials.
3. Use thin walls with through-stones or timber cross-ties.
4. Use vertical steel reinforcing bars and stitches at wall corners, intersections and around openings.
5. Use seismic bands made of reinforced concrete or timber.
6. Connect walls securely to the floors.
7. Connect a light roof securely to the walls.
8. Build a maximum two-storey house using random rubble stone masonry.



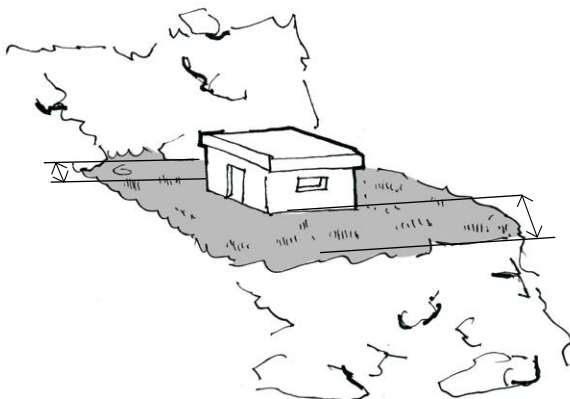
Guidelines for construction of stone masonry houses.

Site Selection



Maintain sufficient distance to steep ground on all sides of the house.

Minimum 15 feet



Minimum 15 feet



Do not build on the following sites:



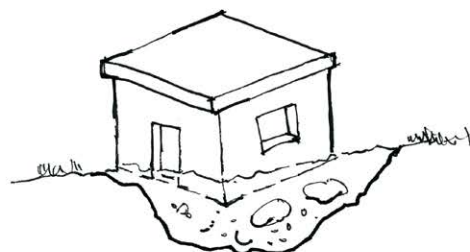
1. Loose embankments.



2. Near cliffs.



3. Sites requiring props.



4. Loose soils.

Guidelines for construction of stone masonry houses.

Building on Sloped Sites



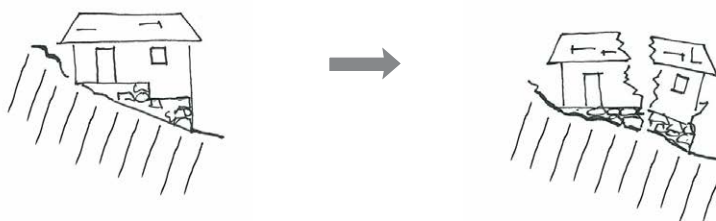
Build houses on flat land between retaining walls.



Do not build on top or against a retaining wall.



Do not build a house on a stepped foundation.



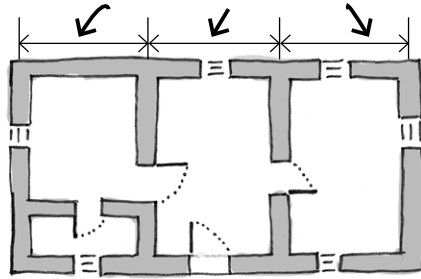
Guidelines for construction of stone masonry houses.

Planning for Construction



Draw a plan of the house to scale.

- 11'-8" for 14" thick wall
- 15' for 18" thick wall



Note: the wall thickness is 14 or 18 inches, the room width (c/c) equals ten times wall thickness.

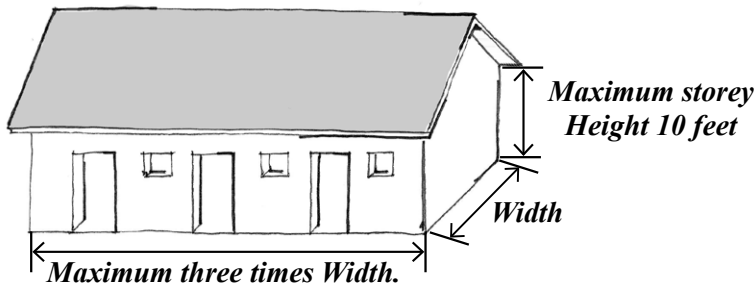
Typical Plan View of the House



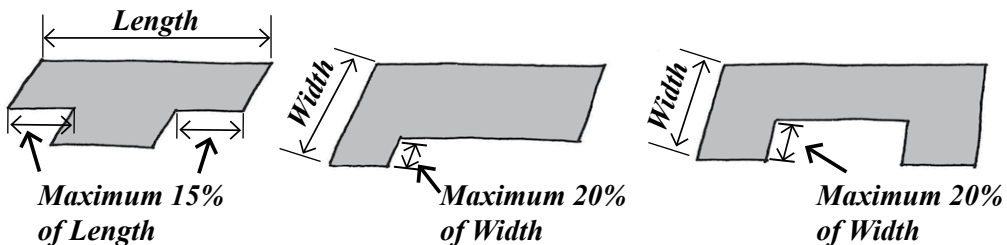
Ensure that the plan is not too long and irregular.



The length should not exceed 3 times the width of a house



Do not build houses with irregular shaped plan that exceed the dimensions shown below.



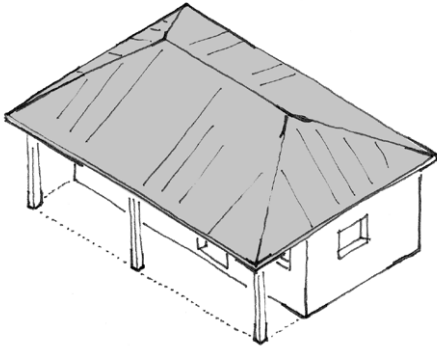
Irregular Plan Views

Reference Source: IS4326-2013

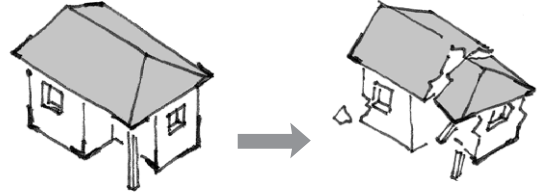
Guidelines for construction of stone masonry houses.

Planning for Construction (cont'd)

- ✓ Build verandah along the entire side of the house.



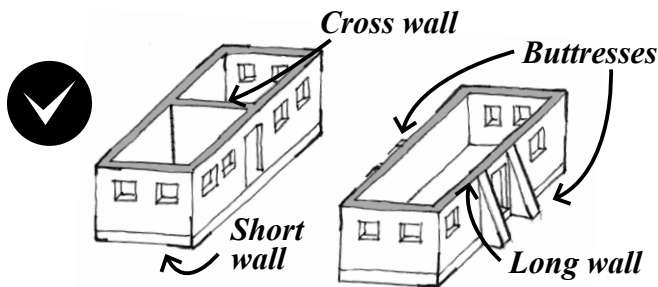
- ✗ If not continuous, the wall adjacent to verandah may collapse.



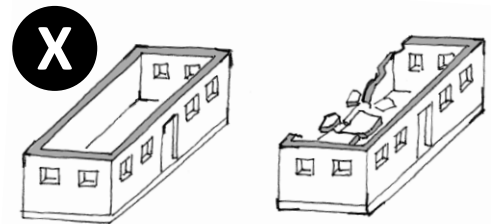
BEFORE

AFTER

Build at least one cross wall or buttresses if either the long or short walls length exceeds 10'-8" for 14" thick walls and 13'-6" for 18" thick walls.

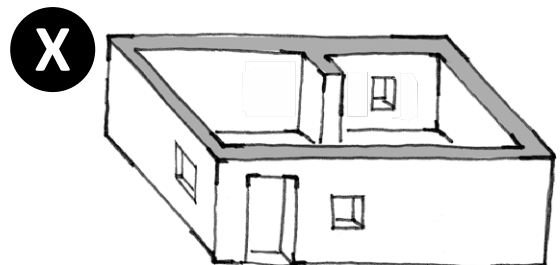
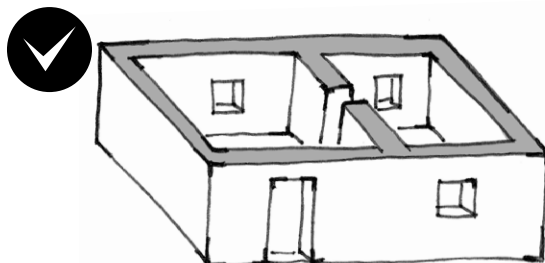


Cross walls or buttresses provide lateral support to the long walls.



Long walls may collapse if not supported.

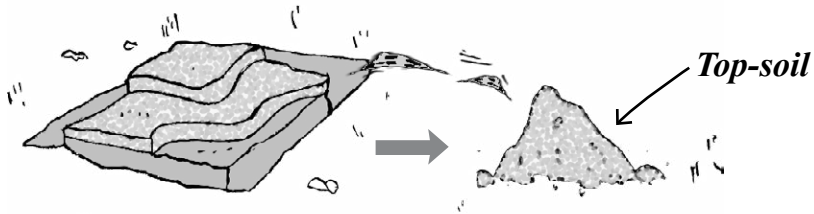
Place doors and windows uniformly on each side of the house.



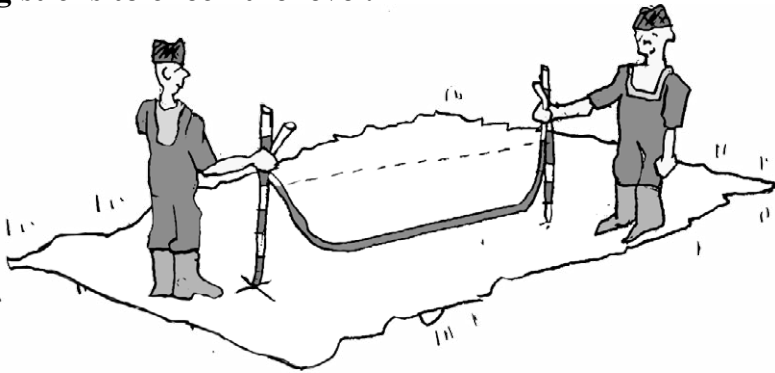
Guidelines for construction of stone masonry houses.

Site Preparation for Construction

1. Remove the loose top-soil from the site.



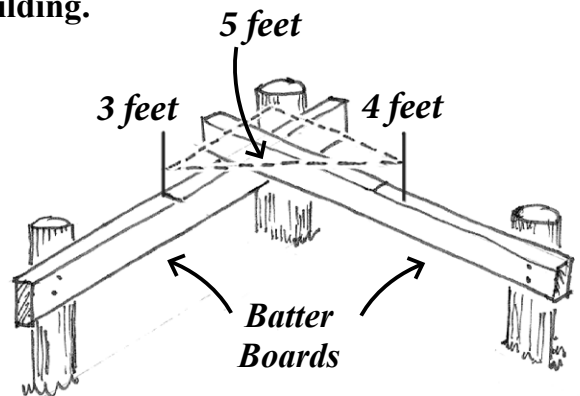
2. Level the site using a transparent hose filled with water and with equal measuring sticks to check the level.



3. Use batter boards to establish building corners. A 3-4-5 triangle will make a 90 degree corner. Set the first batter board corner post about 3 feet past the size of the proposed building.

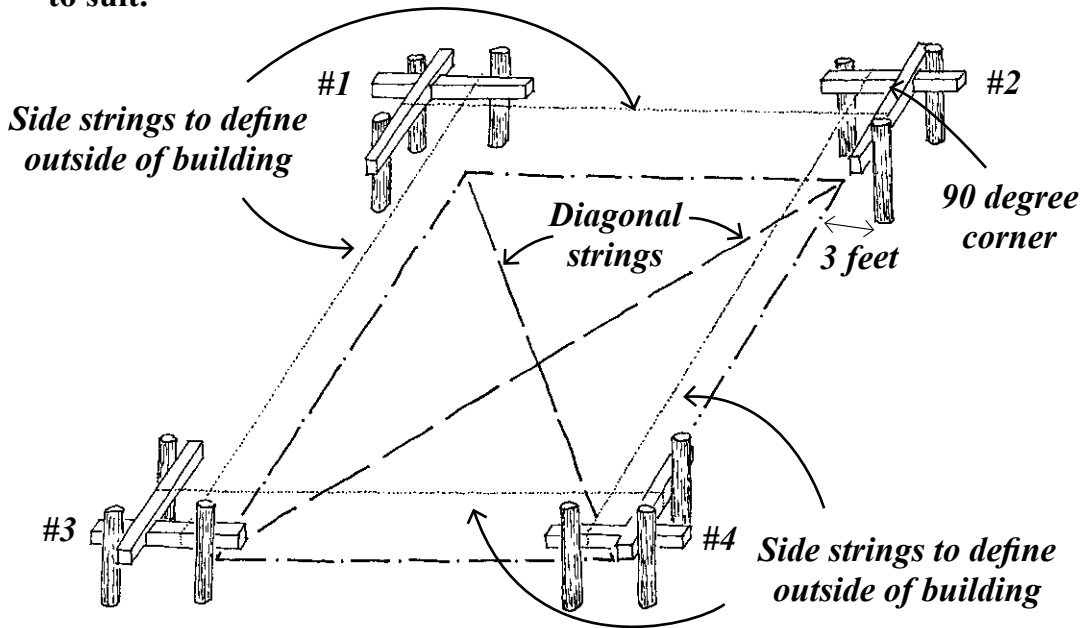
4. Next use a string line aligned with the batter board to establish the next two corner posts about 3 feet past the edge of the proposed building and construct 90 degree corners of batter boards.

5. Finally, use a string line to establish the fourth corner post and construct 90 degree corner of batter boards.

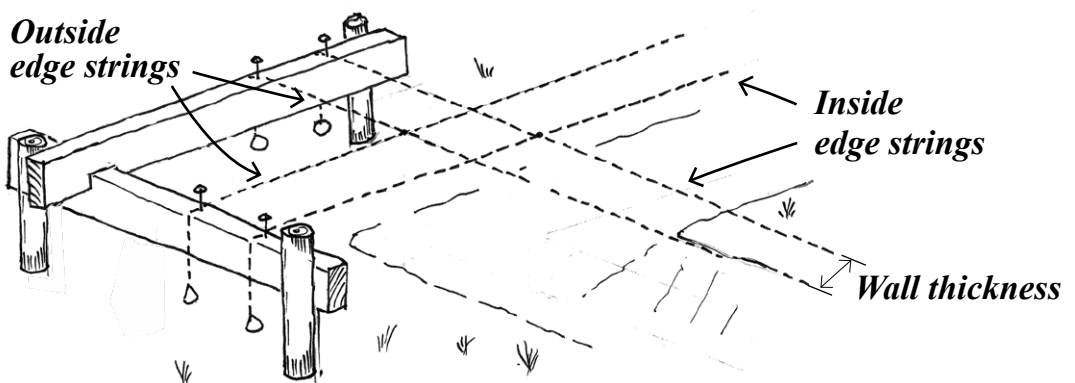


Site Preparation for Construction (cont'd)

6. Use batter boards to set the four foundation corners and measure along batter boards to set 4 strings for outline of the building. Make sure that the two additional diagonal strings are of equal length. Adjust side string to suit.



7. Drive the nails into the boards in order to pull the inside and outside of wall marking strings tight. Use strings to establish interior & exterior wall surfaces.



Guidelines for construction of stone masonry houses.

Stones



Use cut stones or well-shaped mountain stones.



Stacked dressed stones.



Well-shaped mountain stones.



Do not use round river stones with smooth texture, or soft stones that can be scratched with a knife.



Guidelines for construction of stone masonry houses.

Sand and Gravel

SAND



Coarse sand is good for concrete and mortar.



Fine sand is good for plaster.



Sieve and wash the sand to remove dust, clay, and other foreign matter.



Do not use sand mixed with foreign matter like clay and leaves, or fine matter like silt and dust.

GRAVEL



Use gravel ranging in size from sand to $\frac{3}{4}$ inch.



Do not use round pebbles as gravel for concrete construction.



Poor quality concrete construction may be due to excessively large gravel size, lack of compaction, dry concrete or poorly graded gravel.



Photos: Martijn Schildkamp, of Smart Shelter Foundation, Netherlands

Guidelines for construction of stone masonry houses.

Cement



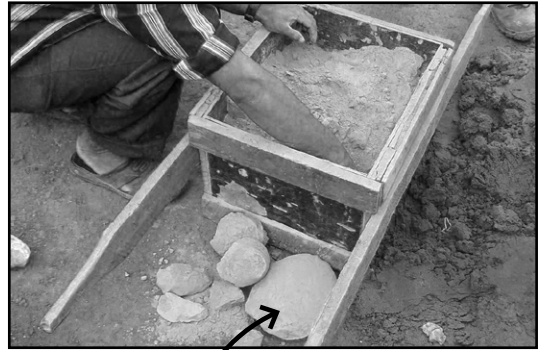
DO:

- Use cement which is dry and powdery in the bag.
- Store cement in a cool and dry place.
- Use cement from bags with Nepal Standard ('NS') mark.



DO NOT:

- Place cement bags directly on the ground during storage.
- Use cement with large lumps caused by moisture or staleness.



*Large lumps of cement
in the concrete mix.*

Photos: Martijn Schildkamp, of Smart Shelter Foundation, Netherlands

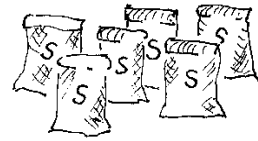
Guidelines for construction of stone masonry houses.

Mixing Cement Mortar



1 bag of cement

—————→ to —————→



6 bags of sand

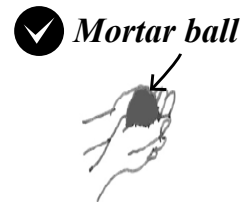
Mix 1 bag of cement with 6 bags of sand.



1. Thoroughly mix sand and cement without adding water.



2. Slowly add water; continue to mix gently while adding water as needed.



3. Make a mortar ball to confirm that consistency is adequate

DO:

- Mix dry sand and cement together before adding water.
- Protect the mortar mixing area from wind, rain and sunshine.

DO NOT:

- Refresh dried mortar by adding water.
- Use the mortar that has started to harden.
- Mix more mortar than can be used in :
 - 1.5 hours when the air temperature exceeds 25⁰c
 - 2 hours when the air temperature is less than 25⁰c

Source : CSA Standards A179-04

Guidelines for construction of stone masonry houses.

Mixing Mud Mortar

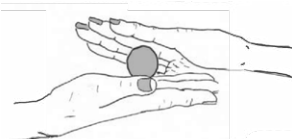
✓ DO:

- Use mud mortar only when cement mortar is not possible.
- The soil should be a mixture of clay, sand and fine gravel.
- When mixed with water the soil should be easy to knead, mold and shape.
- Test the mud mortar using dry strength test.

✗ DO NOT:

- Use mud with less than one-third sand.
- Use mud with organic matter, pebbles or other large particles.
- Mix more mortar than can be used in four hours.

Mud mortar dry strength test:



Make five balls of mixed mortar then dry under cover for two days.

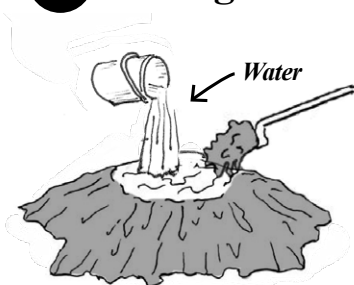


✓ If none of the balls break when squeezed, the mortar can be used.

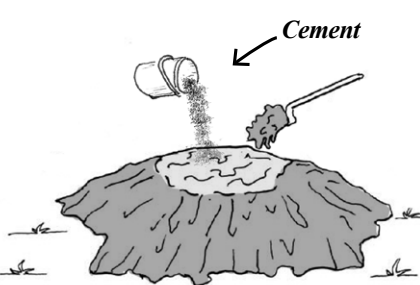


✗ If any of the balls break when squeezed, add more clay to the mixture.

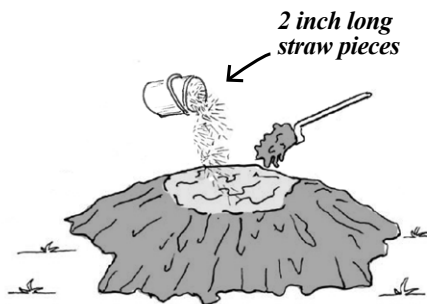
✓ Mixing mud mortar



Slowly add water; mix the mud thoroughly to form a dense mortar paste; let sit for two days.



If cement is available, add 1 part cement to 15 - 20 parts mud; mix and knead well.



OR
Add 1 part straw to 5 parts mud; mix and knead well.

Mixing Concrete



1 bag of cement

2 bags of sand

4 bags of well-graded gravel

Mix 1 bag of cement with 2 bags of dry clean sand and 4 bags of clean gravel.



1. Thoroughly mix cement, sand and gravel without adding water.

2. Add water slowly; start mixing gently and continually; add water until the mixture flows in the forms to fill voids.

3. Perform a slump test using freshly mixed concrete



DO:

- Calculate how much finished concrete is needed and estimate the required amount of cement, sand, gravel, and water.
- Inspect the form work to ensure its stability, dimensions, water tightness and placement of steel bars before mixing and placing the concrete.
- Mix only enough concrete that can be placed within two hours.
- Concrete should be cured for seven days before removing form work.

Source : CSA Standards A179-04



DO NOT:

- Refresh dried concrete by adding water.
- Use concrete that has started to harden.

Guidelines for construction of stone masonry houses.

Steel Reinforcing Bars



✓ Deformed steel for main bars

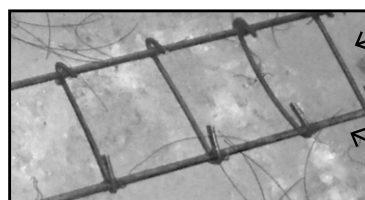


✓ Plain steel for links and ties

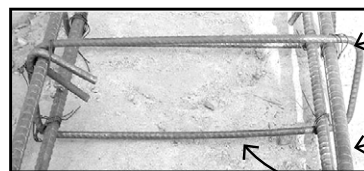


DO:

- Use deformed steel bars for main reinforcement.
- Use plain steel or deformed bars for links and ties.
- Tightly connect links and ties to main bars with tie-wire.
- Only use bars from bundles that have quality assurance tag (NS mark).



Links



Ties



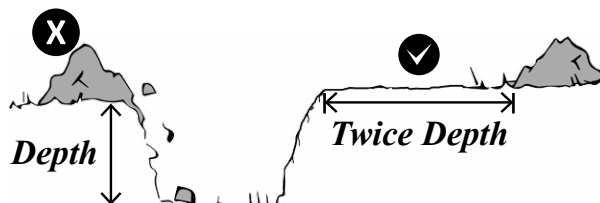
DO NOT:

- Use steel bars from bundles without quality stamp (NS mark).
- Store steel bars directly on the ground.
- Use bars which are corroded or are covered by dirt.
- Use straightened and re-bent bars.

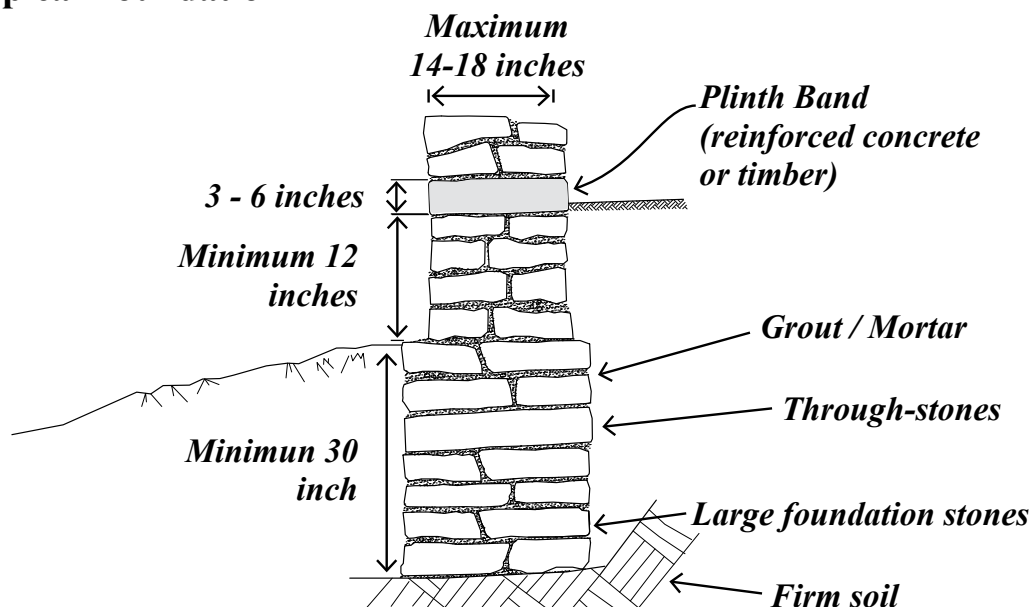
Building the Foundation

Digging a Trench

1. Excavate the trench as deep as needed to reach firm soil.
2. Trench must be shored if deeper than 48 inches.
3. Place the excavated soil a minimum of twice the depth of trench away from the trench.



Typical Foundation



1. Minimum foundation depth is 30 inches, but it is recommended to use 72 inch depth in soft soil areas.
2. Excavate until firm soil has been reached.
3. Use 30 inch wide foundation for a single-storey house.
4. Use 36 inch wide foundations for two-storey houses.
5. Use a 3 to 6 inch deep reinforced concrete plinth band (alternatively a timber band could be used without any soil contact).

Guidelines for construction of stone masonry houses.

Building Random Rubble Stone Walls

Through-stone



Wall built using shaped stones and through-stones.



Thick wall built using rounded stones without through-stones and filled with dirt.



DO:

- Build walls with maximum thickness of 18 inches.
- Use shaped stones and through-stones with mortar.
- Random rubble masonry should be levelled every 18 inches.
- Build walls up to 36 inches maximum height per day.
- Roughen the top of the wall at the end of the day.



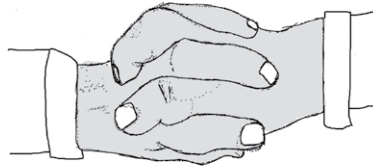
DO NOT:

- Lift stones up for final adjustment after placing them into a mortar bed.
- Level / top-up the wall with mortar at the end of the day.
- Use round stones and rubble as fill for the wall.
- Stand on top of a newly built wall for at least two days.

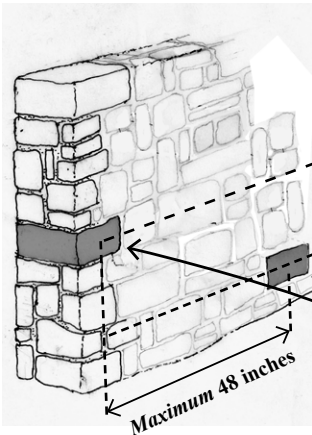
Through - Stones for Stone Masonry Walls



Through-stones act like interlocked fingers and prevent collapse of stone masonry walls.



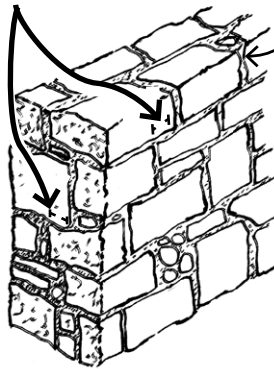
*Stagger stones
minimum 4 inches*



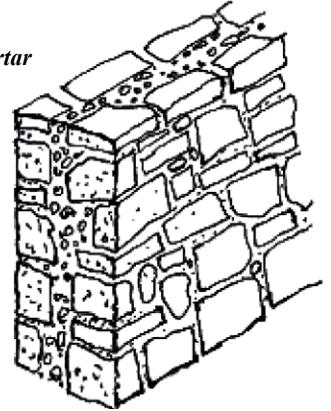
*Maximum
24 inches*

*Through
Stones*

Maximum 48 inches



Mortar



Staggered through-stones.



Use stagger stones.

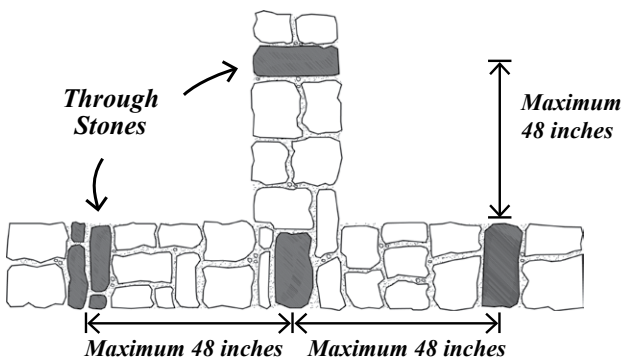


Do not use round stones & rubble to fill wall.



Place through-stones at 24 inch spacing in the vertical direction and maximum 48 inch spacing in the horizontal direction.

T - Connection in plan



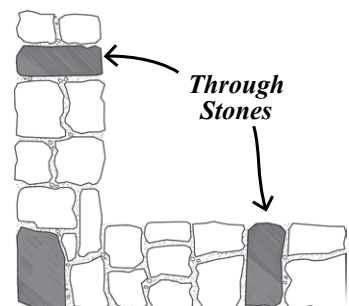
*Through
Stones*

*Maximum
48 inches*

Maximum 48 inches

Maximum 48 inches

L - Connection in plan



*Through
Stones*

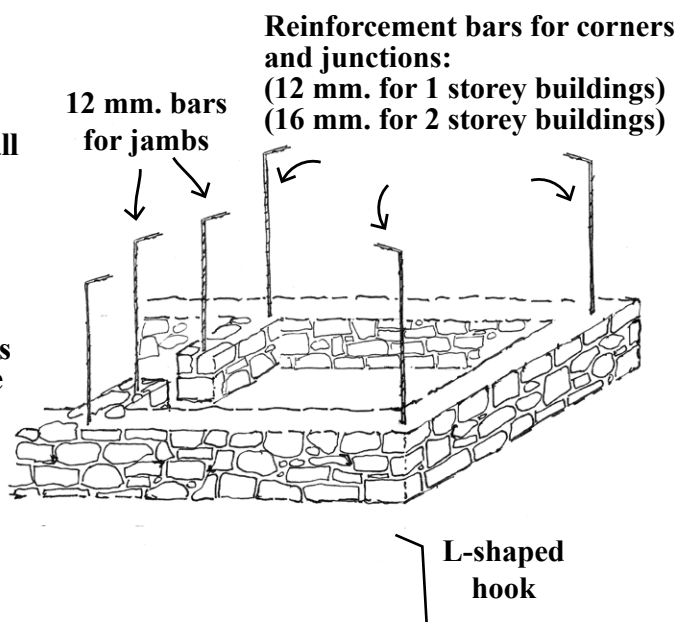
Guidelines for construction of stone masonry houses.

Vertical Reinforcement



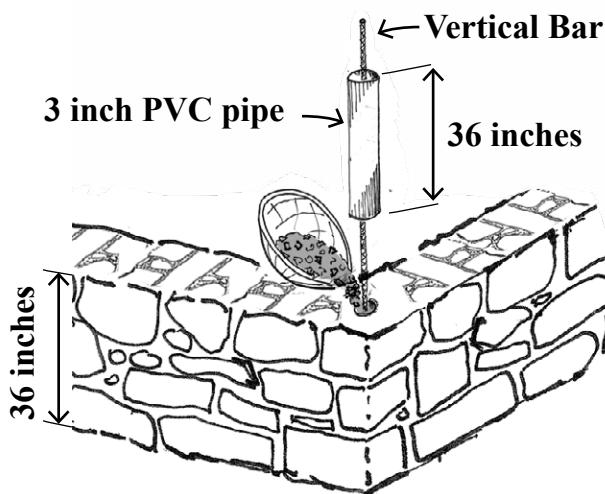
DO:

- Place vertical reinforcement only when cement mortar is used for wall construction.
- Use 12 mm. vertical bars for wall corners, junctions and jambs of openings.
- In 2 storey buildings use 16 mm. bars at wall corners and junctions at the ground floor level only and 12mm in upper floor.
- Each bar should be continuous from the foundation to the roof band and anchored by means of L-shaped hooks.
- The bars must be properly embedded in concrete.



Construction Steps:

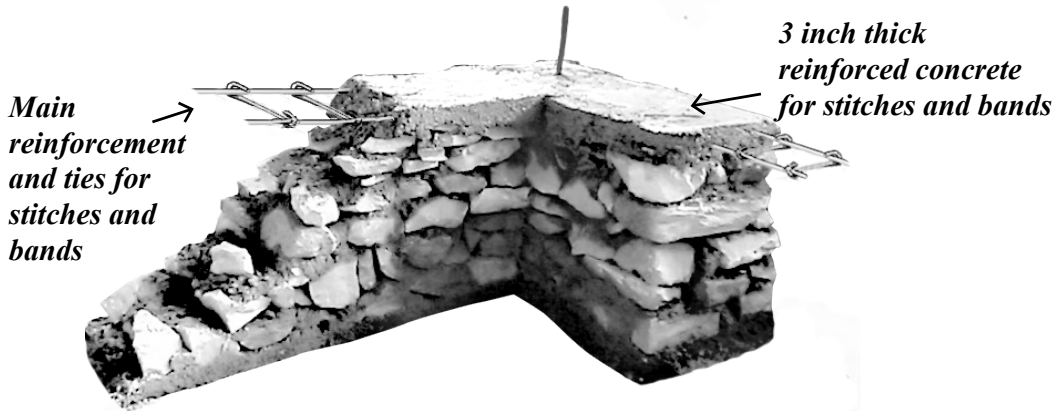
1. Place 3 inch diameter PVC pipe sleeve around the bar starting at the foundation.
2. Build the wall around the pipe leaving enough exposed pipe to pull out.
3. Lift the pipe sleeve leaving the hole empty around the bar.
4. Fill the empty hole with concrete. (maximum gravel size $\frac{1}{2}$ inch).
5. Tap the bar with a hammer to settle the concrete to bottom of hole.
6. Repeat the process for every 36 inches of wall height.



Guidelines for construction of stone masonry houses.

Wall Corners

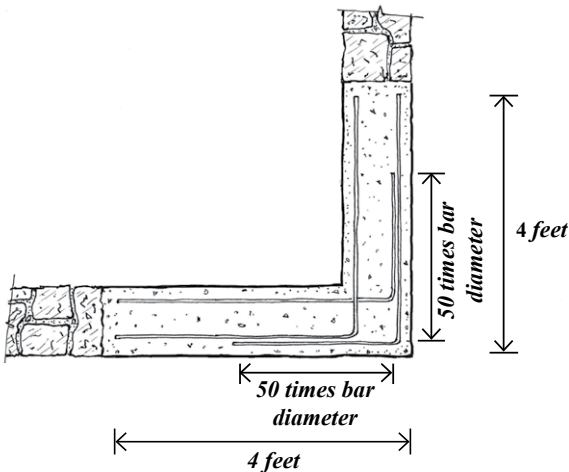
Seismic bands and stitches at wall corners



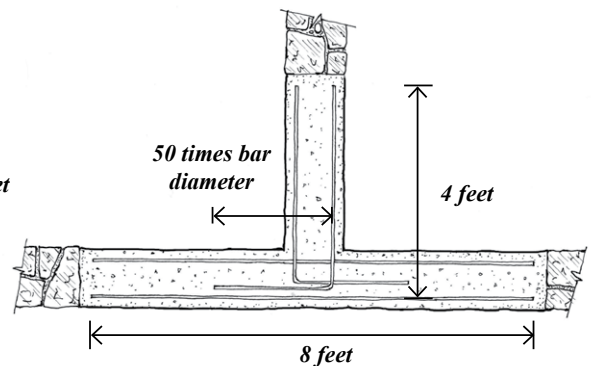
✓ DO:

- Construct reinforced concrete stitches at wall corners and intersections.
- Make corner stitches 3 inches thick and 4 ft long from the wall corner or intersection.
- For stitches use 10 mm diameter main bars and 6 mm diameter bars for ties at 6 inch spacing.
- Use same reinforcement details for reinforced concrete bands at wall corners and intersection.

L-Connection in Plan



T-Connection in Plan

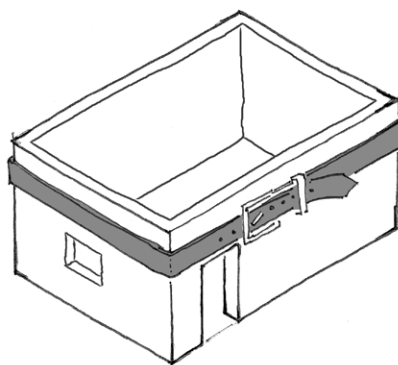


Guidelines for construction of stone masonry houses.

Seismic Bands

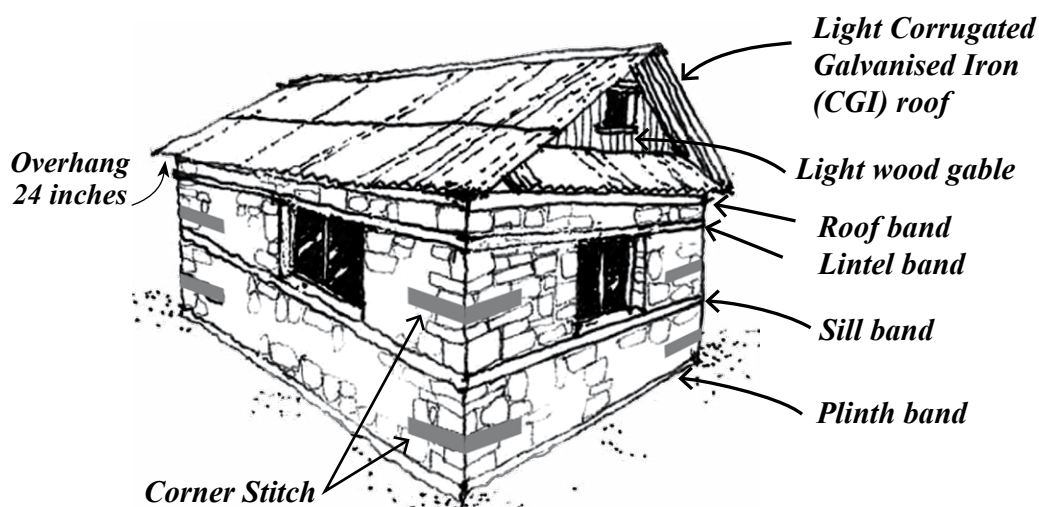


The seismic bands tie the walls together to help prevent the house from collapsing in an earthquake.



A seismic band must be continuous like a belt.

Seismic bands must be provided in all masonry houses.



- Use timber or reinforced concrete for constructing seismic bands.
- Provide 24 inch roof overhang to shelter the walls from moisture.

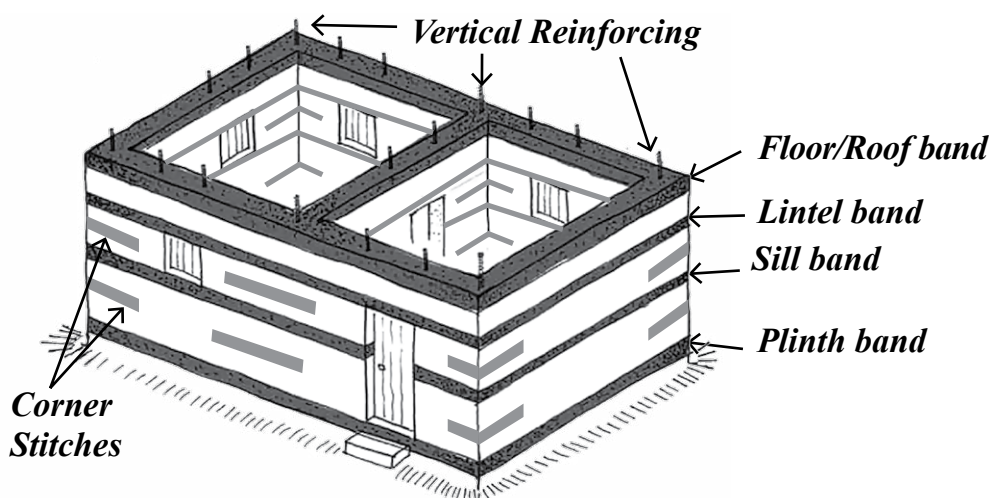
Guidelines for construction of stone masonry houses.

Reinforced Concrete Bands



DO:

- Provide plinth, sill, lintel, corner stitches & floor/roof bands for walls.
- Minimum band depth is 3 inches, however a 6" thick lintel band is necessary for larger openings & 3 inch bands for smaller openings & other places.
- Plinth band in general is 6" thick.

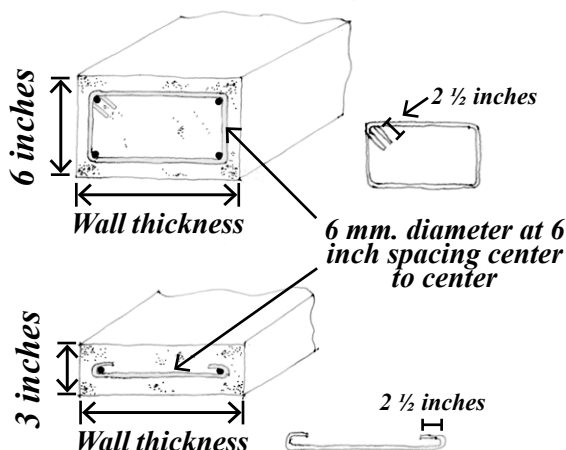


Band reinforcement



DO:

- Band width to be equal to the wall thickness.
- Use four main bars for 6 inch deep roof band and two main bars for 3 inch deep bands.
- Main bars minimum 8 mm. diameter deformed steel bars for stitches, 10 mm. for sill bands and 12 mm. for others.
- Ties and links: 6 mm. diameter at 6 inch spacing mild steel.

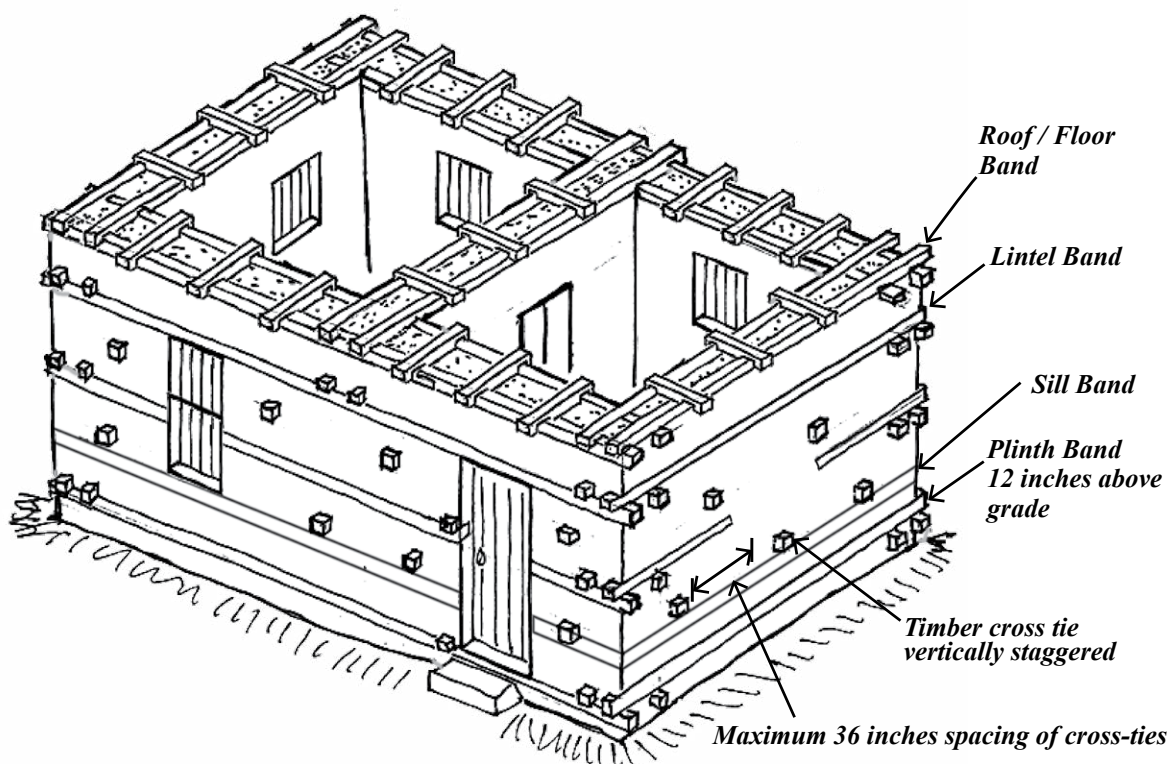


Guidelines for construction of stone masonry houses.

Timber Bands & Cross Ties

✓ DO:

- Use timber bands whenever reinforced concrete is not available.
- Provide timber bands at floor, sill, lintel, and roof levels.
- Place timber plinth band at least 12 inches above ground level.



✗ DO NOT:

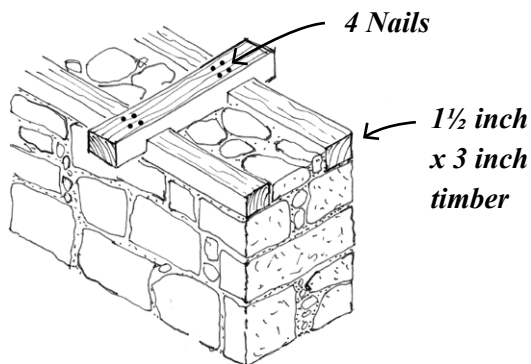
- Use timber below ground level.
- Use low quality timber, below the required grade.

Guidelines for construction of stone masonry houses.

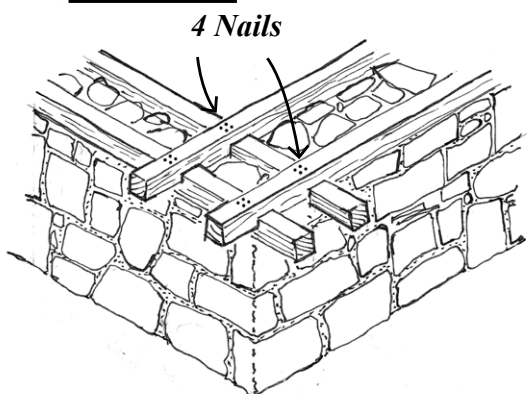
Timber Band Details

✓ DO:

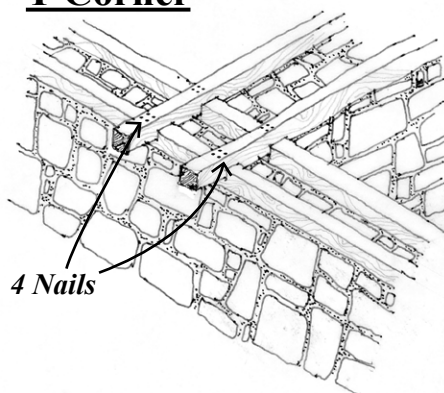
- Connect timber bands at corners.
- Use 1½ inch x 2 inch timber battens.
- Provide notched and nailed connections and lap joints.
- Provide cross-ties at every 2 feet spacing.



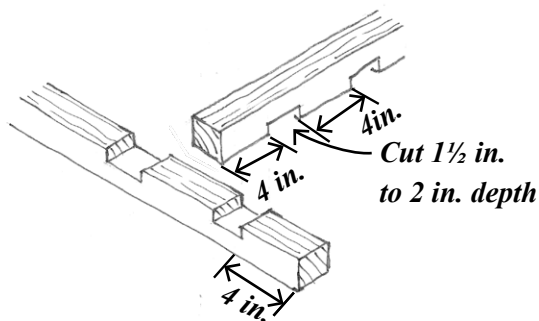
L-Corner



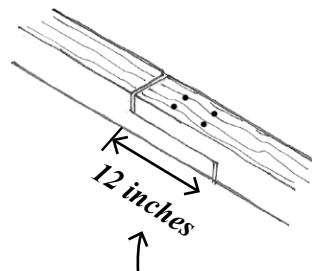
T-Corner



Typical Connections



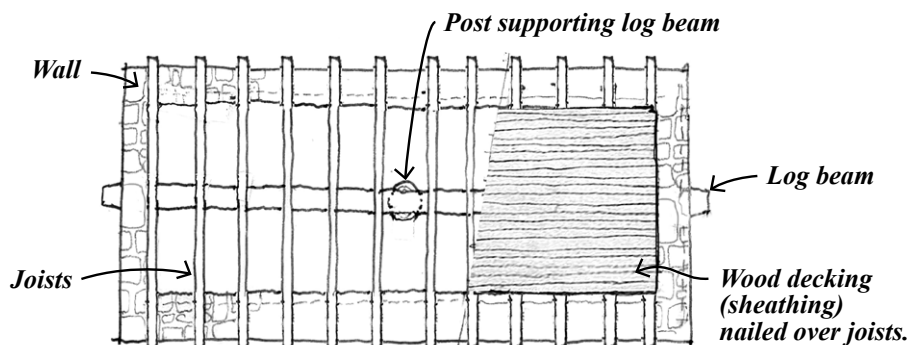
Partial connection between main batten and cross-tie.



Lap joint should be at least 12 inches long.

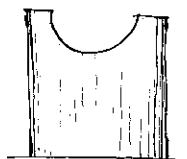
Guidelines for construction of stone masonry houses.

Floor Construction

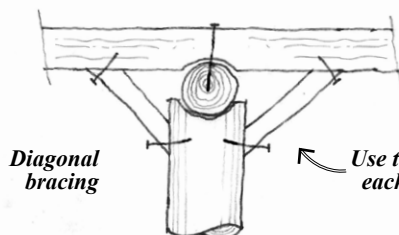


(Note: Plinth band omitted in this drawing)

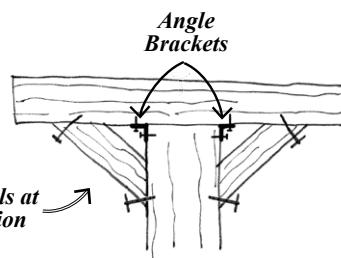
Beam-Post Connection



1. Cut a round groove in the post to accommodate the beam.

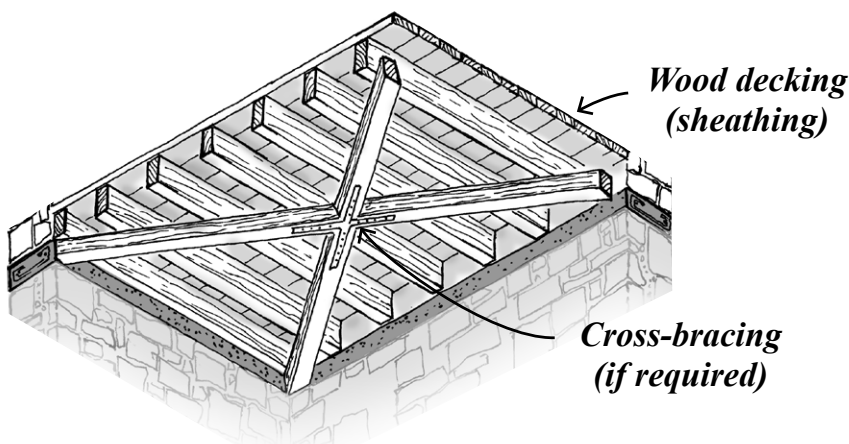


2. Place a round log beam into the groove and nail top and bottom of the diagonal bracing.



3. Alternatively, beam-post connection can be achieved using rectangular beams.

Floor Bracing

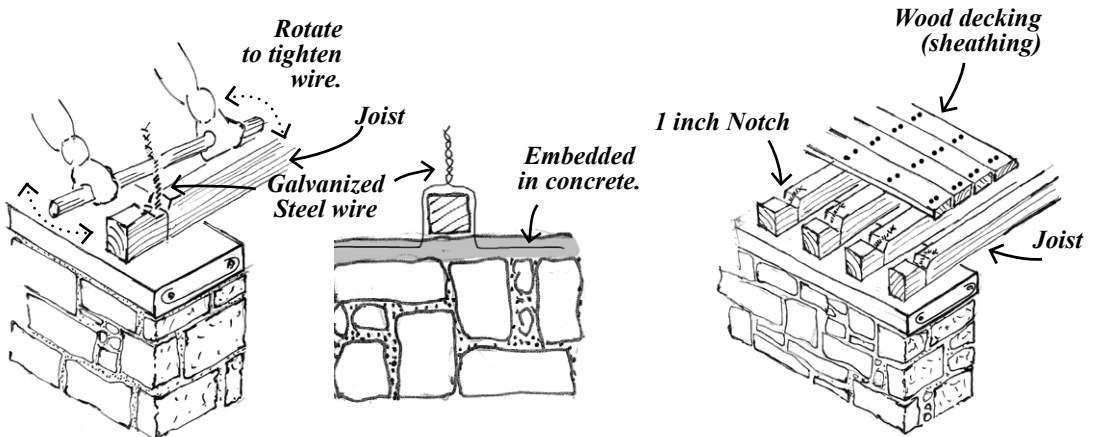


- ✓ Use cross-bracing only when joists are used for the floor construction, and when room length is more than 15 feet.
- ✓ Drive at least two nails into wood decking (sheathing) at to each joist location.

Guidelines for construction of stone masonry houses.

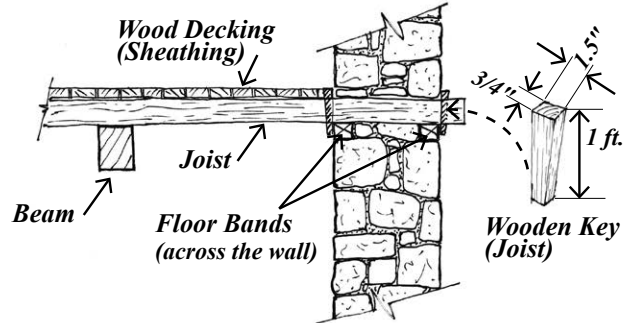
Floor-Wall Connection

Concrete Connection

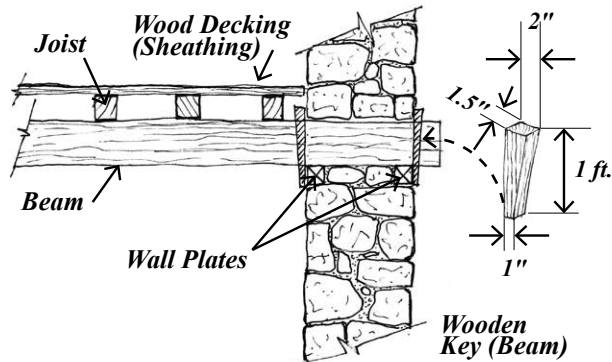


- ✓ Anchor joists to the floor band with steel wires.

Section Along the Joist

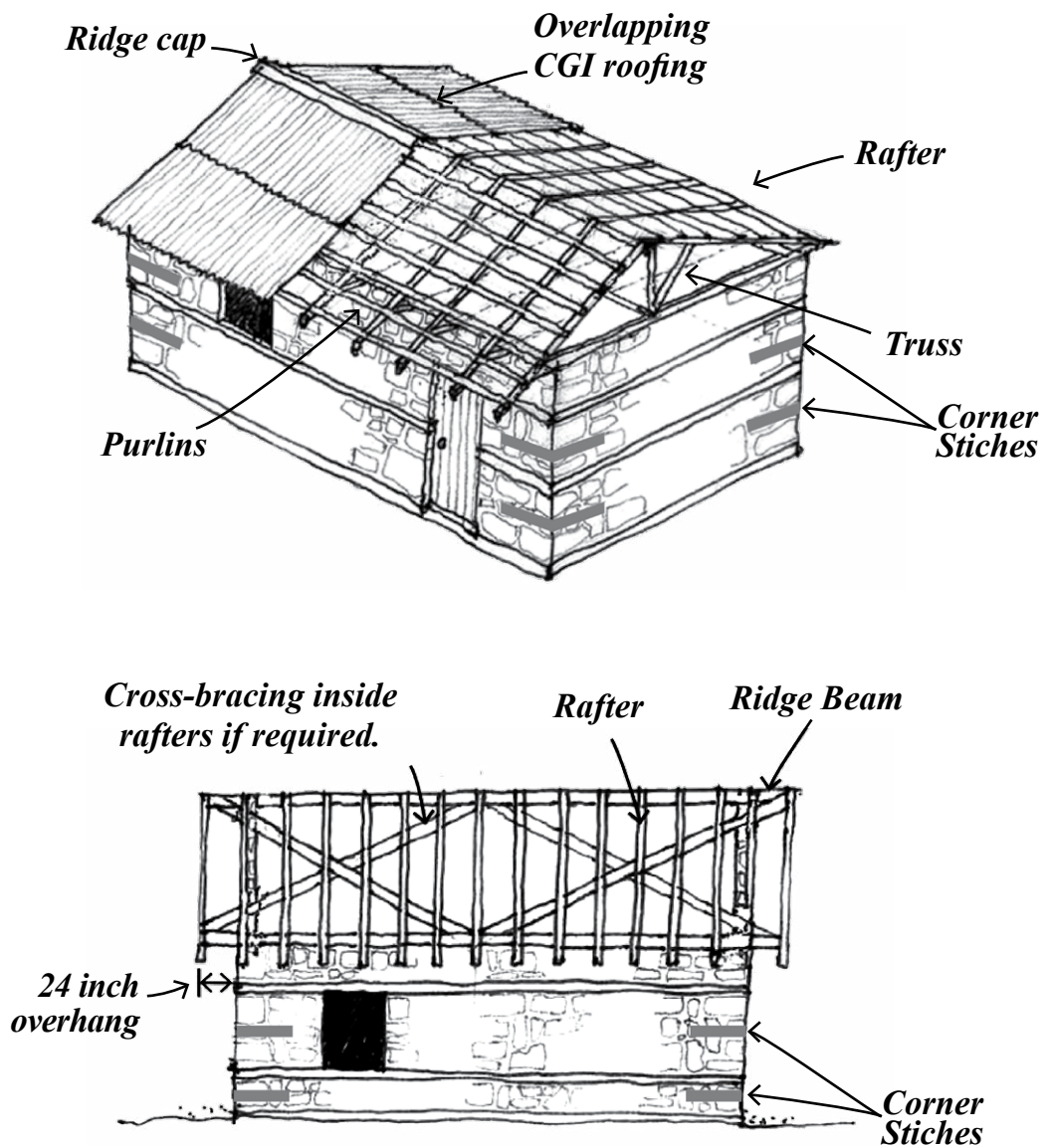


Section Along the Beam



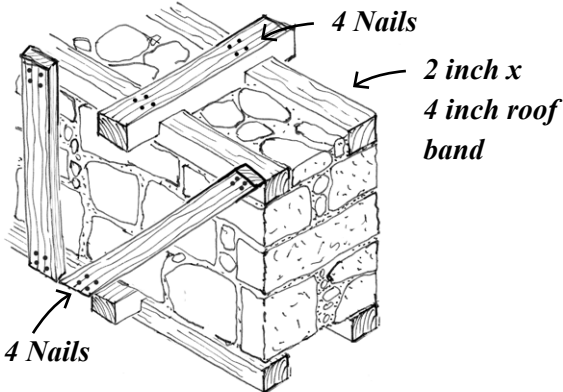
Guidelines for construction of stone masonry houses.

Roof Construction

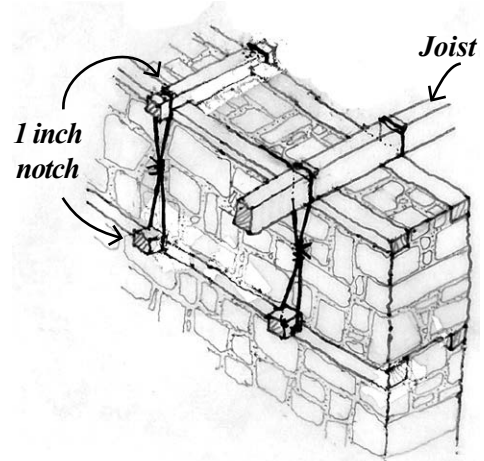


Guidelines for construction of stone masonry houses.

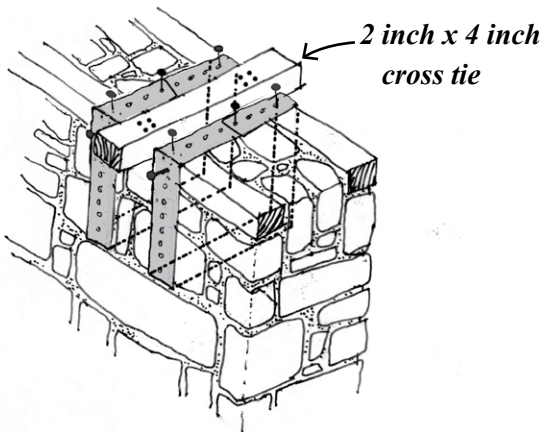
Roof Connection to Walls with Timber Bands



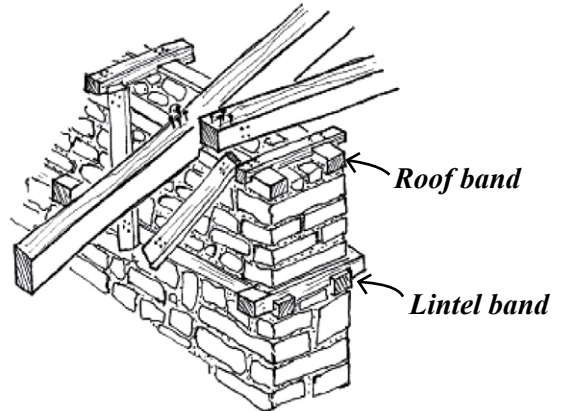
- ✓ Link the roof and lintel bands with nailed boards.



- ✓ Link the roof and lintel bands and joist using tied wire.



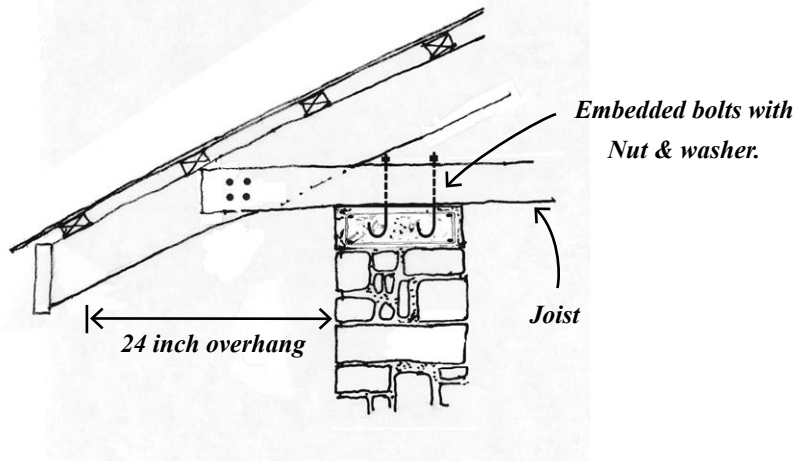
- ✓ Connect the roof band to the wall using embedded galvanized metal straps overlapping from each side.



- ✓ Attach the trusses to the roof band with nails long enough to secure to the roof band.

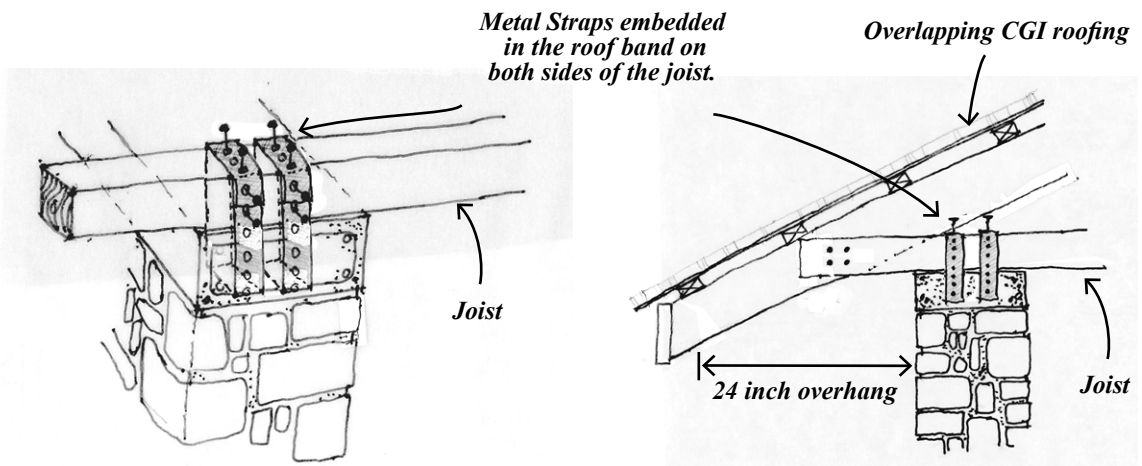
Roof Connection to Walls with Concrete Bands

- ✓ Use anchor bolts through joist.



Or

- ✓ Use embedded galvanized metal straps.



Guidelines for construction of stone masonry houses.

References

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SDC/EERI (2015) *Guide Book for Building Earthquake-Resistant Houses in Confined Masonry*, Nadia Carlevaro and Guillaume Roux-Fouillet, Swiss Agency for Development and Cooperation and Earthquake Engineering Research Institute (www.confinedmasonry.org/wp-content/uploads/2015/09/Guide_CCR_EN-A5-XS.pdf).

Smart Shelter Foundation (2015) *Ten Rules of Thumb for Single-Storey Buildings in Rubble Stone Masonry* (www.smartsHELTERfoundation.org/25-eqr-schools-in-rubble-stone).

Important Information

These Guidelines were prepared and reviewed by the Authors and Reviewers cited in the Preface and Acknowledgements of this document. The work was supported and encouraged by the British Columbia Institute of Technology ('BCIT'), Builders Without Borders Canada ('BWB'), and Read Jones Christoffersen Ltd. ('RJC') all of Vancouver B.C., Canada.

These Guidelines do not promote the use of stone masonry construction. It is important to note that even when Nepal's National Building Code Guidelines for Earthquake Resistant Building constructions – Low strength masonry (NBC 203:2015) is complied with and proper care is taken to use quality materials, stone masonry construction may be more vulnerable to earthquake effects than buildings made of other construction materials. It is expected that stone masonry construction would likely suffer more damage compared to otherwise similar buildings built with other materials.

All images in these Guidelines are for illustrative purposes only, may not reflect actual circumstances, and are not intended to replace drawings, specifications, or inspections by, without limitation, any architect, engineer, contractor, or government inspector (collectively 'Building Professionals').

The Authors and Reviewers strongly recommend that any design or construction be conducted under the guidance and supervision of Building Professionals, but recognize that this is not always possible in remote and poor regions of Nepal. However, these Guidelines are not in any way a substitute for the design, specification, advice, inspection or supervision of construction by Building Professionals and these Guidelines do not diminish or reduce the standard of care owed by any Building Professional for a project.

Based on their expert knowledge and experience, the Authors do not necessarily agree with some of the prescribed requirements of NBC 203:2015 which are included in these Guidelines. For example, the Authors believe that the use of single vertical reinforcing bar and reinforced concrete corner stitches at wall corners and/or intersections would not significantly improve seismic safety of stone masonry buildings. In order to implement these provisions, additional financial resources and sophisticated technical workmanship which are not easily available in rural areas of Nepal would be required. However, the resulting benefits in terms of improving seismic safety may be minimal. It is also possible that, unless properly constructed, the wall corner areas may be weakened because the bond may be inadequate. However, the Authors have agreed to include these provisions in these Guidelines because they are a part NBC 203:2015.

These Guidelines may be amended by the Authors and Reviewers without notice. Users of these Guidelines should make their own enquiries prior to any design or construction as to the latest edition of these Guidelines. These Guidelines may not be modified, revised, improved or amended, without the prior written consent of BCIT, BWB and RJC.

