

UN HABITAT
UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

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CONFINED MASONRY

Step by Step Construction Guide for Masons and Craftsmen



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INTRODUCTION

UN-Habitat is the United Nations agency for human settlements mandated by the UN General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all. UN-Habitat is currently working in more than 60 countries around the globe, focusing on the provision of technical assistance in areas of governance, land and property rights, environmental management, disaster mitigation, post-conflict rehabilitation, urban safety, water management and poverty reduction. UN-Habitat resumed in Pakistan after devastating earthquake of October 2005 through relief, rehabilitation and reconstruction. Since then, UN-Habitat has been proactively involved in post-disaster interventions related to earthquakes, the floods of 2010 and 2011 and outcomes related to IDPs in Khyber Pakhtunkhwa since 2009.

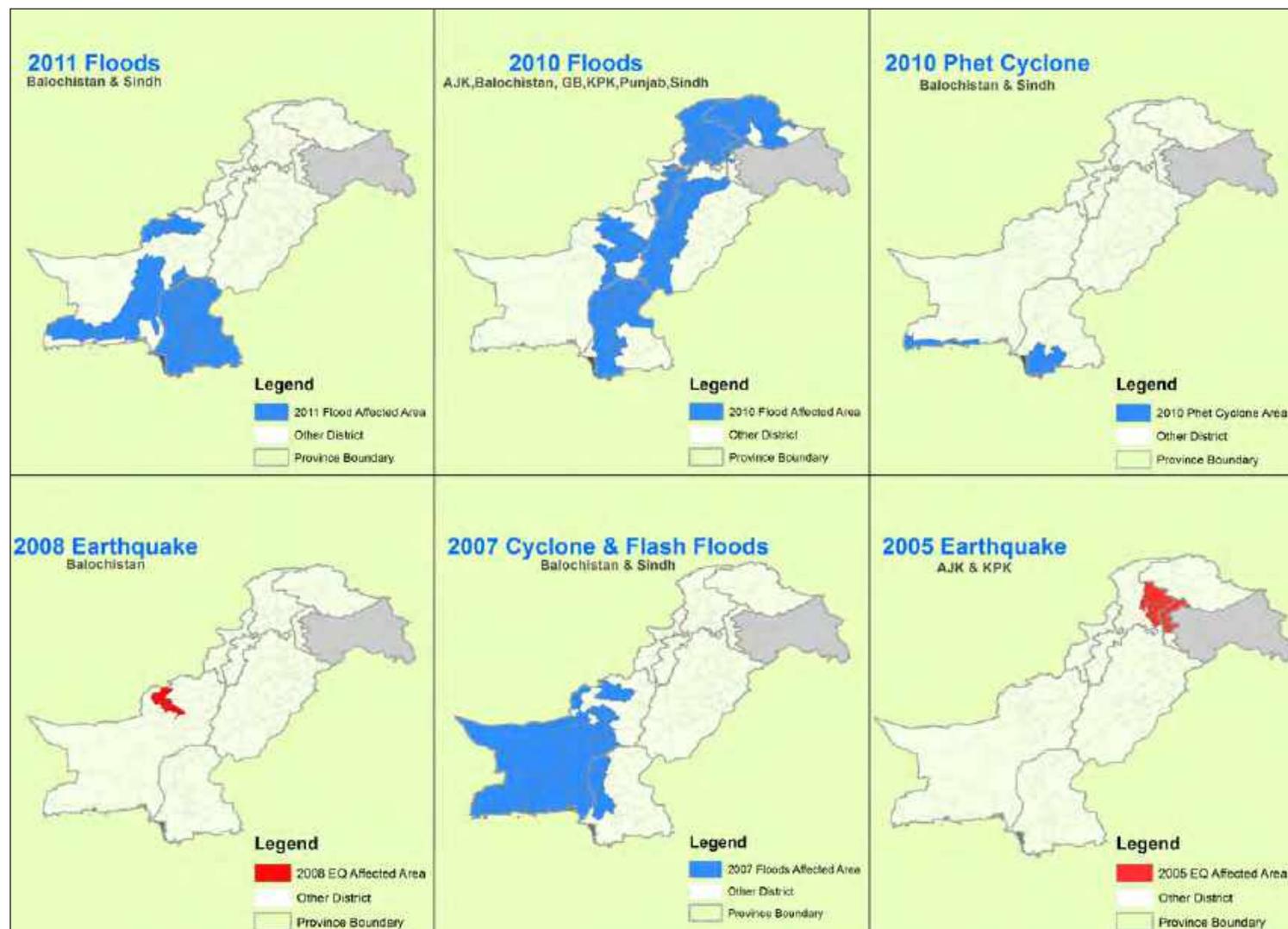
In Azad Jammu and Kashmir, UN-Habitat promoted earthquake resistant construction through direct interventions under the guidance of the Government. Safe construction as per standards in accordance with the Disaster Risk Management (DRM) have been successfully incorporated in all the flood affected areas.

With regards to the different types of construction being applied in Pakistan, UN-Habitat has worked on confined masonry which is being applied in almost all the parts of the country. The aim of this document is to develop and disseminate a guide for construction workers in a simple language which can be kept with the concerned people for proper utilization to achieve the goal of safe construction. It is believed that the guide on confined masonry will ensure adoption of earthquake resistant construction techniques which will certainly help the buildings to perform well during earthquakes and floods to minimize human and material losses.

May 2012, Islamabad.



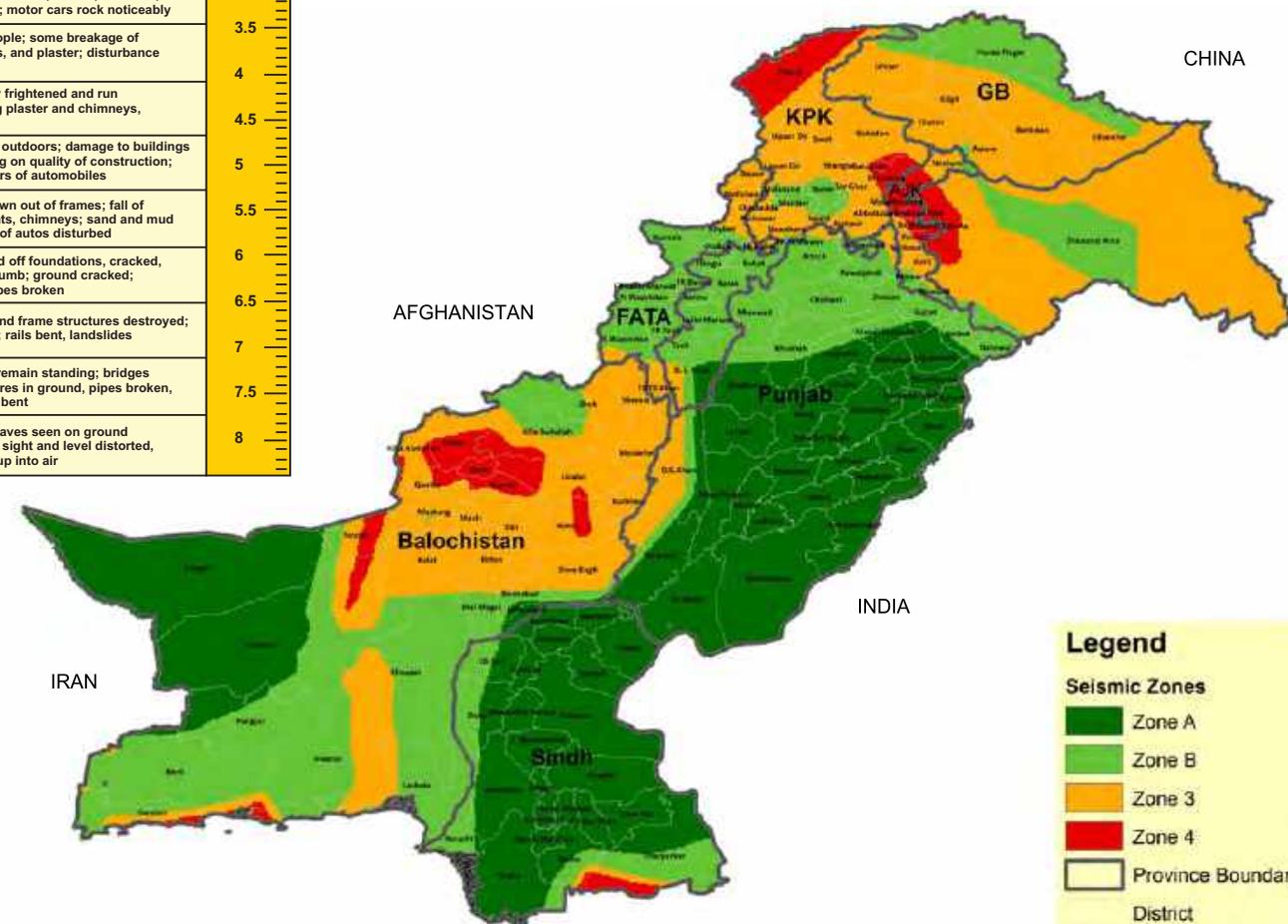
DISASTERS IN PAKISTAN 2005 - 2011



SEISMIC HAZARD MAP OF PAKISTAN

Modified Mercalli Scale		Richter Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibration like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at right some may awaken; dishes, windows, doors disturbed; motor cars rock noticeably	3
V	Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects	3.5
VI	Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small	4
VII	Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of automobiles	4.5
VIII	Panel walls thrown out of frames; fall of walls, monuments, chimneys; sand and mud ejected; drivers of autos disturbed	5
IX	Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken	5.5
X	Most masonry and frame structures destroyed; ground cracked; rails bent, landslides	6
XI	Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent	6.5
XII	Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up into air	7

Zone Description	MMI Scale
1	Very low IV and less
2A	Low IV-VI
2B	Moderate VI-VII
3	High VII-VIII
4	Very high IX and above



CONFINED MASONRY CONSTRUCTION

Confined Masonry is a type of construction in which masonry is confined by reinforced concrete beams and columns. The walls (Bricks, Stones and Blocks) are designed to be able to resist earthquakes.

In confined masonry, walls are built first, and the columns and beams are poured in afterwards to enclose (confine) the wall.

Why confined masonry?

- It greatly enhances the connection between walls;
- It improves the stability of constructed walls;
- It improves the strength of constructed walls;
- It provides ductility under earthquake loading; and
- It improves the integrity and confinement of constructed walls.

How to handle the factors affecting the performance of confined masonry?

Configuration: Keep the configuration simple, construct simple and regular shaped houses such as square or rectangular.

Avoid complex shapes.

Connections: The structure must be strongly connected from the foundation through walls and to the roof band.

Construction Quality: Do not compromise on the quality of construction, materials and workmanship. Construction quality has a significant impact on the performance of buildings against earthquakes.

Consideration before construction

Hazard

Choose appropriate site and location keeping in mind the expected natural hazard.

Availability of skilled labour

The quality of construction depends mainly on workmanship; poor workmanship results in poor performance.

Costs

House construction should be planned according to the available budget. Do not skip important structural elements to construct more rooms or to reduce costs.

PREREQUISITE FOR CONSTRUCTION

Key things to do

- Identify a safe site where you want to construct your house;
- Consult an architect or engineer for the design of your house;
- Follow the building by-laws for construction; and
- Get your house registered in your local municipal authority.

Limitations

Storey

Limit the height of your house to 2 storeys. For more than 2 storeys, consult a qualified engineer.

Distance between columns and tie beams

Distance between columns should not be more than 15 feet and vertical spacing of tie-beams should not exceed 10 feet.

Openings

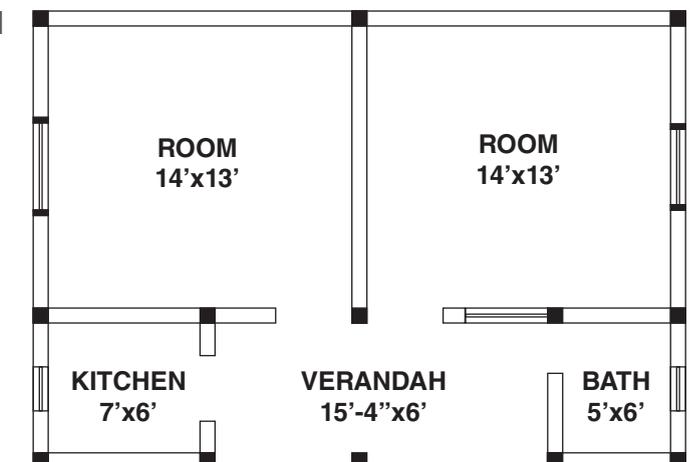
Opening area should not be more than 50% of the wall area in load bearing construction.



Have your complete set of drawings & plans ready before construction



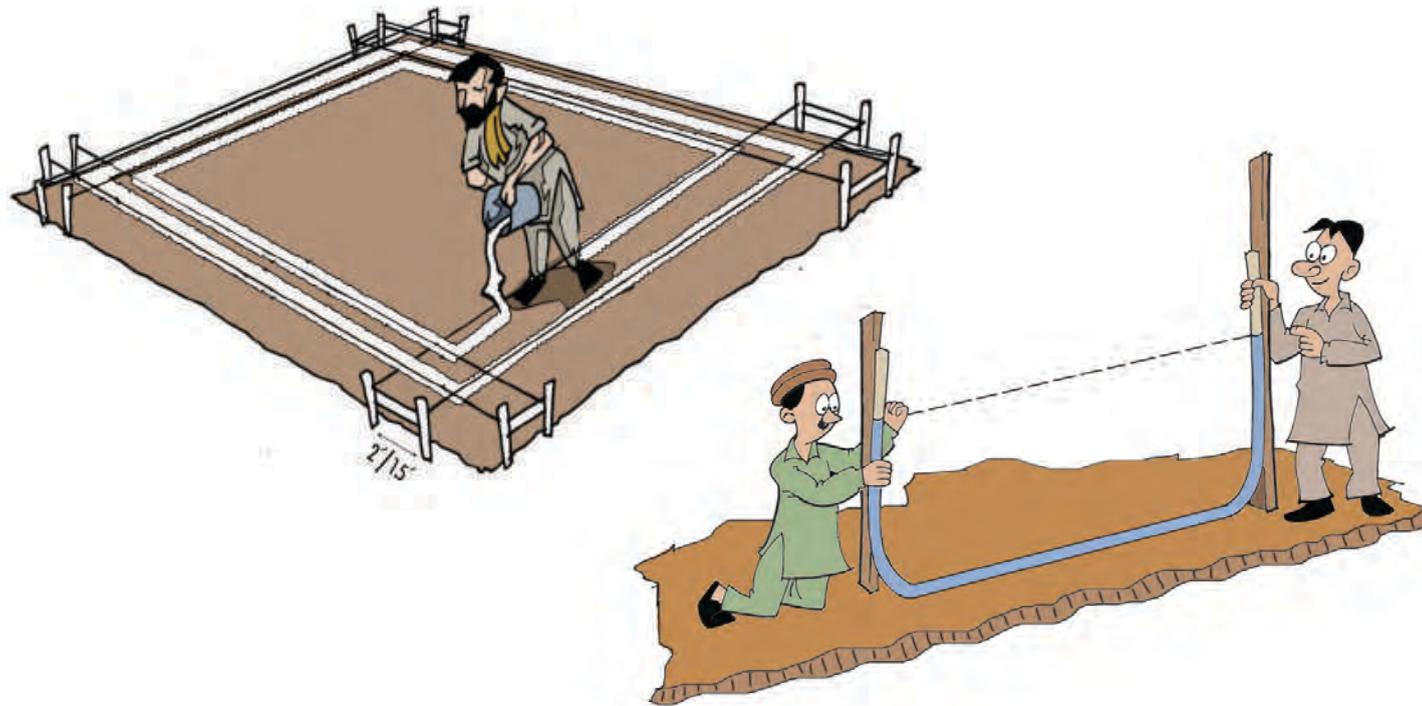
PLAN



Note: Recommended wall thickness: 8-9 inches.

LAYOUT OF BUILDING

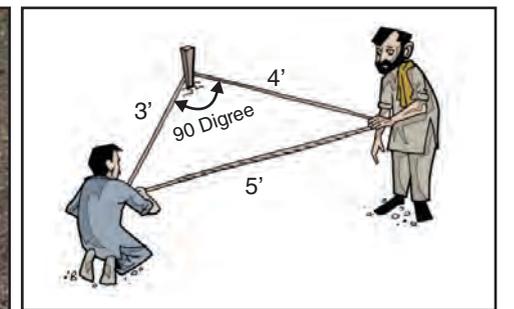
- Clear and level the site from rubbish and any organic material;
- Set out the reference line;
- Mark the plan on the ground with lime/chalk;
- Tie the ropes using pegs made by wooden poles nailed to the ground;
- The walls should be upto at a right angle (90°) by making a triangle of 3-4-5;
- Re-check the layout by measuring diagonals; and
- Use bench mark for future reference.



Make sure the walls intersect each other at 90° degree angle



Mark the foot print of the plan with help of lime/chalk



Use 3,4,5 method to make right angle at corners



EXCAVATION

Excavation of trench

- Excavate the foundation according to the proposed design and drawings. Allow work space on both sides;
- Start excavation with reference to an arbitrary bench mark; and
- Check the excavation level.

“Compact the foundation bed” to:

- Increase load-bearing capacity;
- Prevent soil settlement and frost damage;
- Provide stability; and
- Reduce water seepage, swelling and contraction.

Field testing of soil

- Perform the following field test to check whether the soil is hard or soft;
- Dig a 1.5 feet deep pit/trench of size 1.5 feet x 1.5 feet in the ground;
- Dump the excavated soil near the pit. Then refill the pit by using all excavated soil;
- If this infill remains below the ground level in the pit, the soil will be considered as soft/loose; and
- If surplus soil remains after completely filling the pit, the soil will be considered hard.

Compact the soil after excavation



Excavation with reference to Arbitrary Bench Mark (A.B.M)

- Construction of an Arbitrary Bench Mark from concrete (size 1 feet x 1 feet x 1 feet) relatively at a higher level;
- You can also use a mark on any permanent object (such as a big stone or tree etc.) as a reference object close to the site for equal/level excavation; and
- The A.B.M is used as a reference for smooth and level excavation (i.e. with the same depth at each and every point from the bench mark). As a minimum, establish the A.B.M 2 feet away from the trench.



Fix bench mark



Excavate 2 feet in hard soil and 4 feet in soft soil



Take readings from bench mark, using iron bar and spirit level or a water level. Flexible tube can also be used



FOUNDATION

Materials

Foundation can be constructed with any of the following materials:

- Brick, Plumb Concrete (using 40% stone/brick, 60% concrete 1:3:6) and Block or Stone; and
- Reinforcement (2 pcs of ϕ 10mm (#3) or 2 pcs of ϕ 12mm (#4) from the longitudinal bars) is also necessary in foundation for Soft Soil.

Size of foundation-strip footing

- Height = 6 inches and Width = 24 inches; and
- Moreover, the depth of the foundation also depends upon the type and weight of the structure.

Construction procedure

- Level and compact the foundation bed with a rammer;
- Place the foundation in hard, well compacted surface;
- Lay 1:4:8 PCC as a base with a thickness of minimum 3 inches; and
- In case of soft soil, provide RCC foundation band ϕ 12mm (#4) @ 8 inches c/c horizontal bar with ϕ 6mm (#2) @ 6 inches c/c c-rings.

Masonry foundation

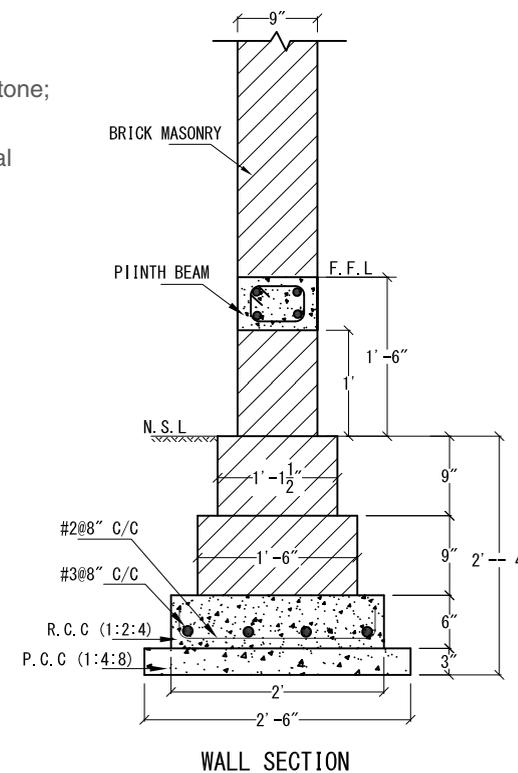
- Tie the string at both sides of the walls according to the given width of the wall footing;
- Make sure the walls are at a right angle along the centre line of the wall; and
- Lay the masonry courses in 1:4 cement sand mortar leaving the column spaces in a toothed manner.

Points to remember

- Check the level of the corners before the laying of the plinth beam;
- Pour cement concrete 1:2:4 in columns upto masonry level; and
- In case of stone masonry use through stone @ 2 feet vertical and 4 feet horizontal.



Note: Foundation should be designed before hand in future expansion this planned.



Cement: Sand 1:4:8



Lay 3 inches thick PCC1:4:8 as base



If the soil is very soft, use RCC band



COLUMN FIXING

Materials

The following materials are required for fixing columns:

- Reinforcement steel and concrete mix 1:2:4.

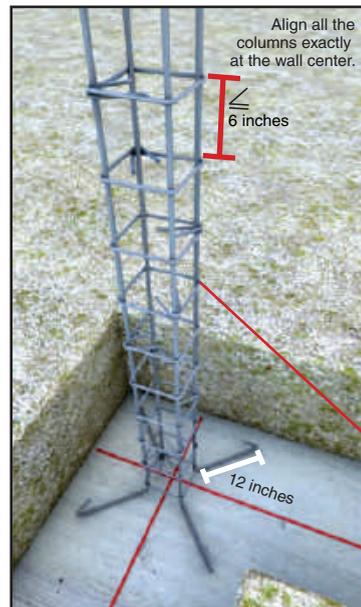
Size of column

- 9x9 inches (8x8 inches minimum); and
- 4# 4/8 inches dia steel bar, vertical stirrups 3/8 inches dia @ 6 inches c/c squaring.

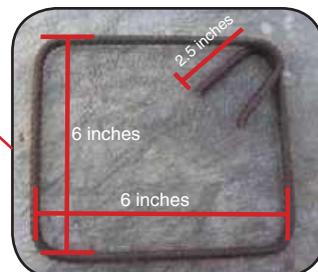
Stirrup ring size depends upon thickness of masonry wall size, stirrup size will be 3 inches less than total wall thickness considering 1.5 inches concrete cover on both sides of the ring. Provide 2.5 inches stirrup hooks on both sides in 135° bent angle.

Construction procedure

- To erect the column at specific location, first mark the centre line of the plinth;
- Erect the column along the intersection of the lines;



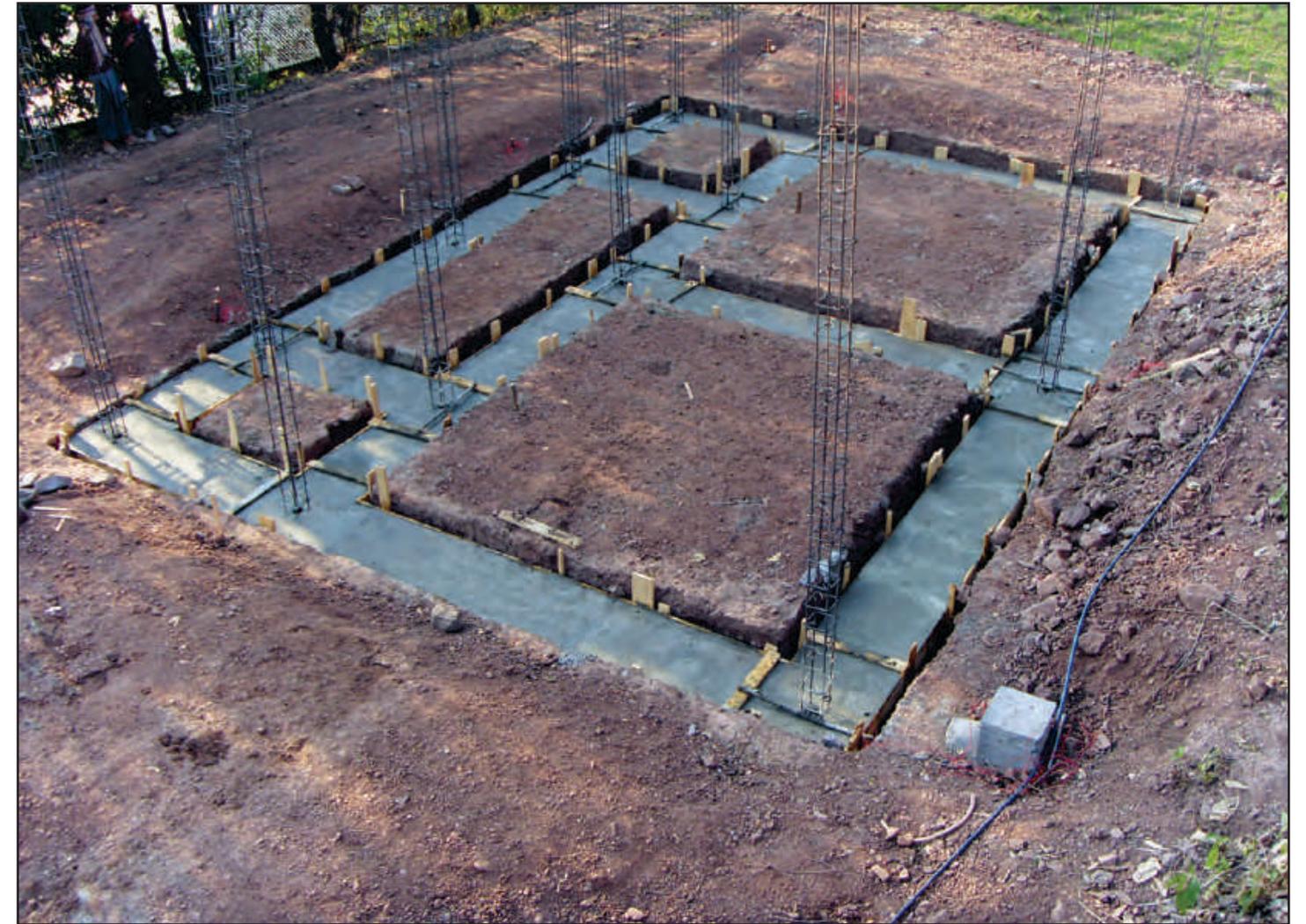
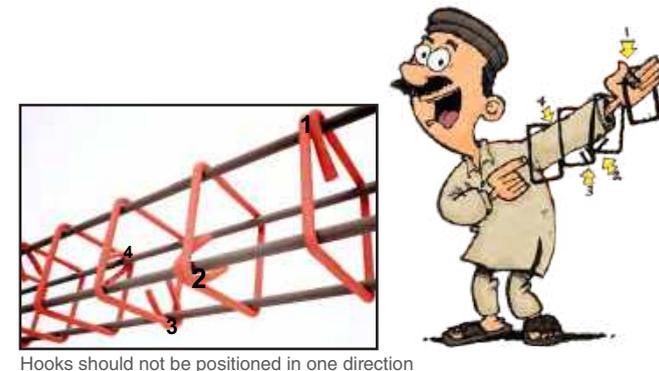
Provide 1 feet length of bent bar of vertical bar at the base.



- Make sure that the center of the column is placed in the center of the intersection;
- To assure that the columns are vertical, fasten them with minimum # 3/8 bars;
- Pour the concrete with a ratio of 1:2:4 minimum 6 inches thick in column footing;
- Use 25 litres of clean water to make concrete from 1 bag of cement; and
- Use available material for shuttering.

Points to remember

- Fix columns reinforcements on the base well;
- Cast/pour concrete 1:2:4 PCC for foundation;
- Ensure the equal surface level of the foundation; and
- Cure the concrete for at least 3 weeks clean water.



Tie the vertical reinforcement with steel mesh



Reinforcement extension should be 1.0 feet



Level the poured concrete



PLINTH BEAM

Materials

Plinth beam should be constructed with:

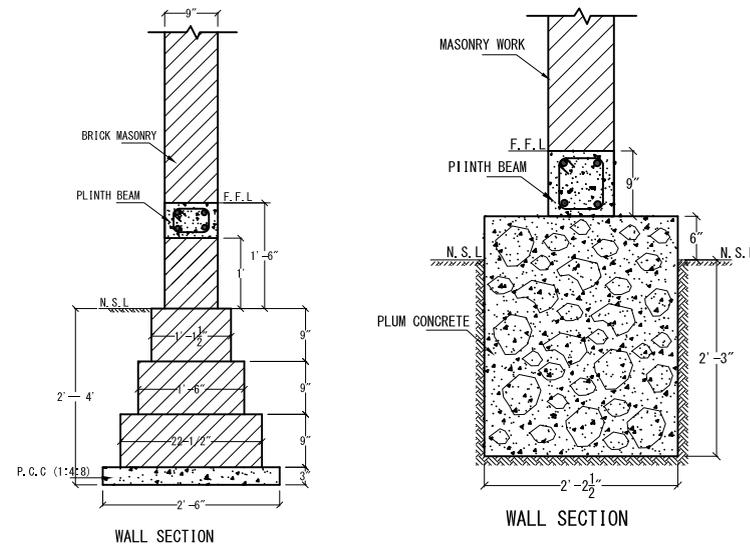
- Reinforcement, Concrete (RCC).

Size

Provide with 4 pcs of ϕ 12mm (#4) of horizontal bars
10mm (#3) 6 inches c/c steel stirrups to tie them.

Construction procedure

- Place the plinth beam in line with the wall;
- Provide form-work for plinth beam;
- Pour 1:2:4 concrete;
- Cure it for at least 14 days; and
- Make sure that the top of the plinth is levelled.

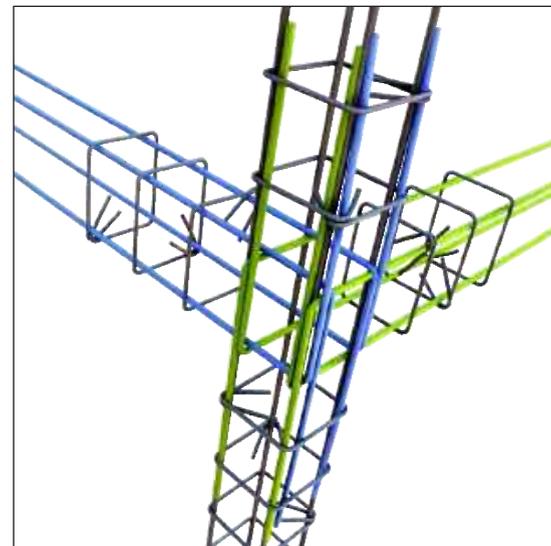


Remember!
Plinth band transmits the load from the walls down to the foundation. It also protects the ground floor walls from excessive settlement in soft soil conditions and moisture penetration into the building.

Construct plinth beam on top of the foundation

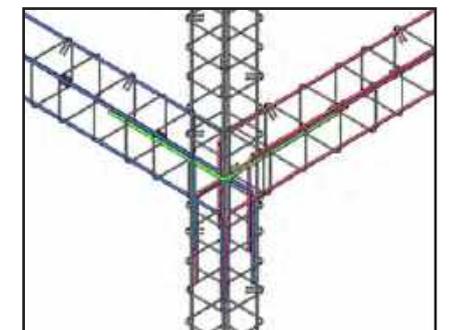
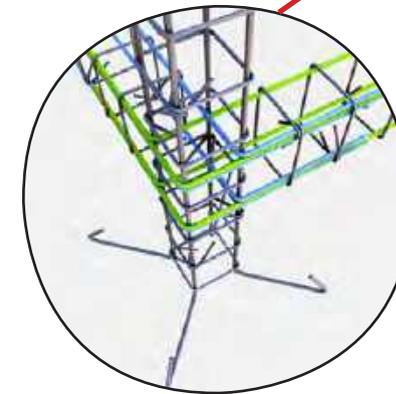
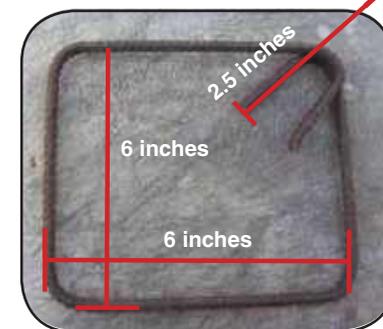
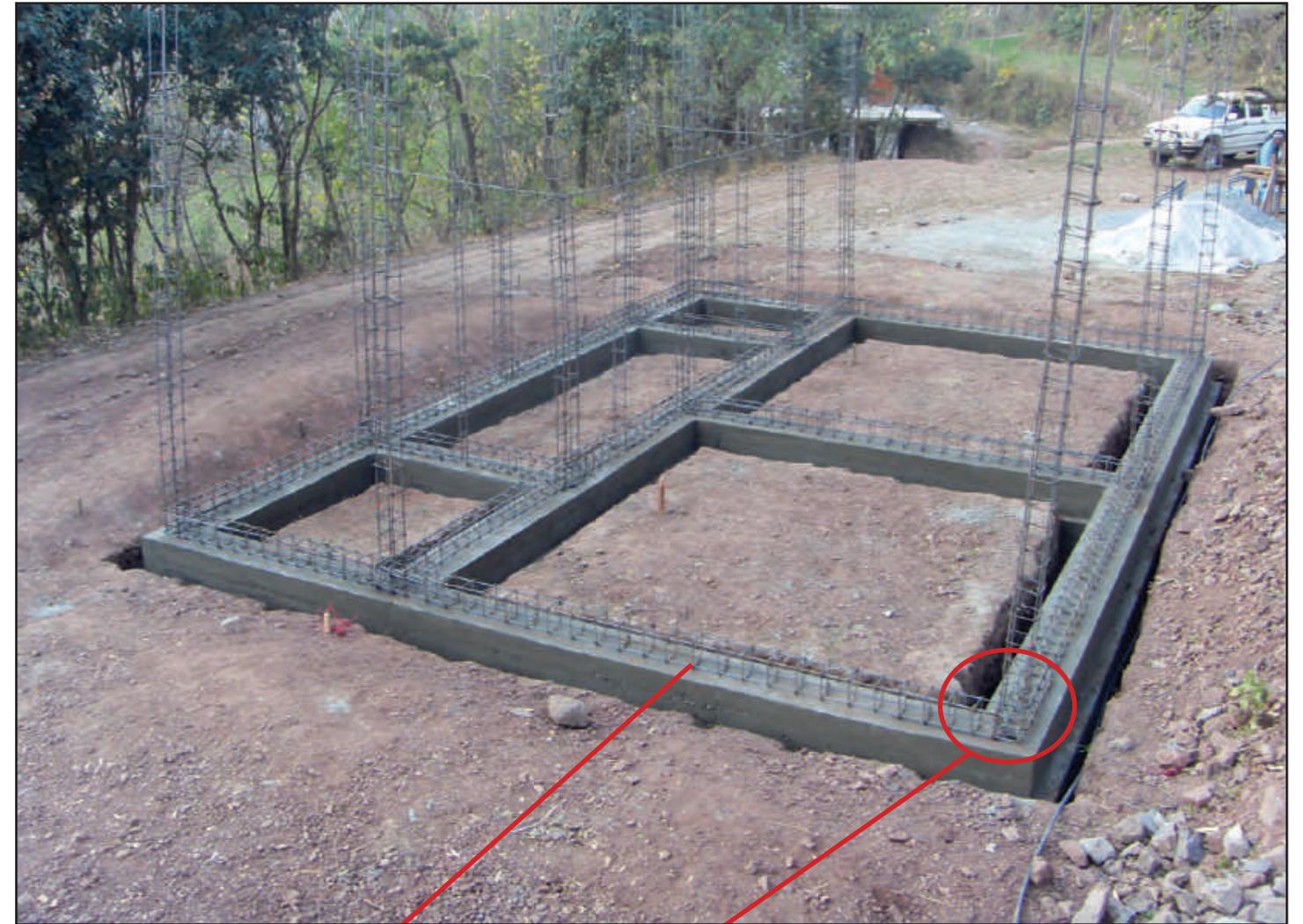


Note: All reinforcement of the beam should be inside the pillar reinforcement.



Points to remember

- Spacer to keep the concrete cover of 1-1/2 inches during form-work;
- Make sure that the steel at corners is anchored adequately; and
- Keep holes in the beam to drain out water.



T-junction reinforcement detail



MASONRY WALLS (CONCRETE BLOCKS)

Materials

Material required for construction of concrete block walls.

- Block, Cement Mortar 1:2:4.

Size of block

- 12x8x8 inches (LxWxH).

Construction procedure

- Masonry walls are constructed first;
- Columns are cast in place (situ); and
- Tie-beams are constructed on top of the walls, with the floor/roof slab construction.

Points to remember

- Always use good quality blocks for masonry;
- Construct wall upto 4 feet in one day maximum;
- Block laying should be at level. Use appropriate bonding (english/flemish) so that every alternate vertical joint is on top of another;
- Level the courses and lay the blocks so that every alternate vertical joint is on top of another;
- Keep toothed edges at corners;
- Maximum thickness of mortar between two courses should not be more than 1/2 inch;
- Cure the masonry work of minimum 7 days, use sprinkled clean water for curing;
- There should be at least two confining walls in one direction;
- Walls should come on top of each other in case of two storeys; and
- Bricks/blows should be fixed in vertical joints.

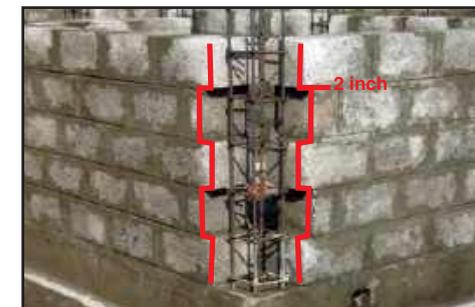


The joints must be sealed properly.

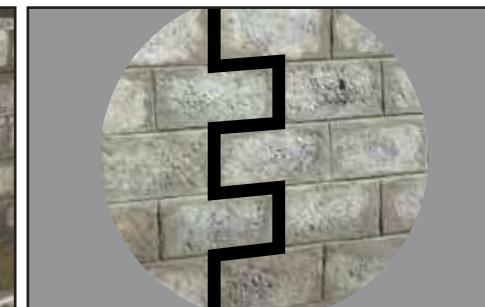
Masonry walls confined with reinforced columns and beams are expected to resist both vertical and lateral loads.



Mortar joints should be same and not more than 1/2 inch.



Provide proper toothing with columns at a corner, at least 2 inches of tooth length



Vertical joints



The intersecting walls should be leveled



MASONRY WALLS (BRICK)

Materials

Material required for construction of brick walls:

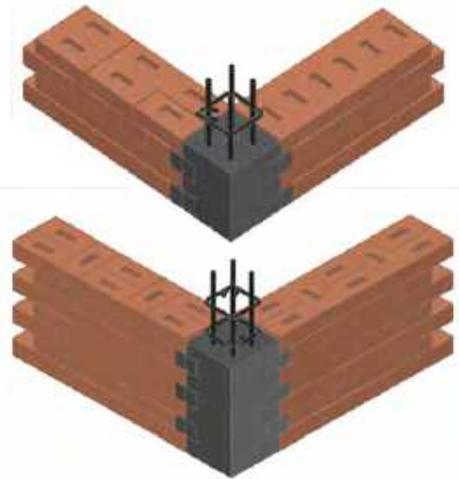
- Brick, Cement Mortar 1:4.

Size of brick

- (9x4x3 inches) (LxWxH).

Brick masonry

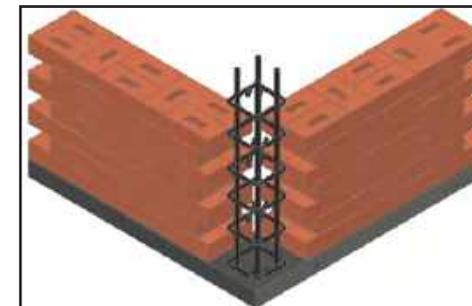
- Do not compromise on the quality of bricks. Always use good quality for masonry construction;
- Avoid using old bricks. If they are used, they should be cleaned properly;
- Soak the brick in water for a minimum of 7 hours;
- Joints should be with half inch cement mortar; and
- Construct all the walls daily at maximum of 4 feet height.



Use English or Flemish joint for laying the bricks



Note: A reinforced concrete hollow block of 8 inches is an alternate.



Detail of corner reinforcement



Bricks should be laid in alternate course keep provision for tothing for stronger connection



Concrete should be poured simultaneously for stronger connection



CONFINING ELEMENTS (COLUMNS)

Materials

- Reinforcement steel and concrete 1:2:4.

Size

Column: 9x9 inch (8x8 inch min) reinforcement 4pcs of ϕ 12mm (#4) vertical bars with ϕ 10mm (#3) @ 6 inch c/c, stirrups.

Stirrup ring size depends upon the thickness of the masonry wall size. Stirrup size will be 3 inches less than the total wall thickness considering the 1.5 inches concrete cover on both sides of the ring. Stirrup hooks should be bent at 135° and for 2.5 inch hook length.

Points to remember

- Construct the wall up to sill level;
- Clean the space for columns before pouring concrete;
- Pour concrete for columns and beams at the same time if possible;
- Do not pour concrete from more than 5 feet height to prevent segregation of materials and displacement of reinforcing bars. Use closed ducts, pipes or channel during pouring;
- Compact the concrete with a vibrator or a stick;
- Use water to cure;
- Leave sufficient tothing around confining columns; and
- When concreting is completed then construct the wall upto lintel level.

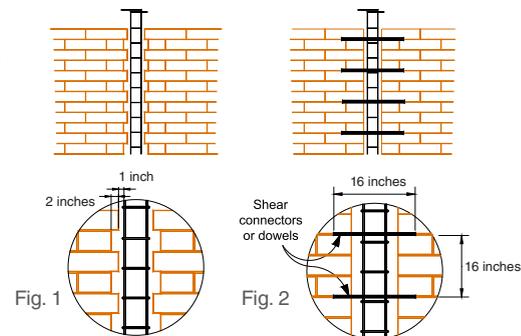
Tothing

Good bonding is important to prevent failure of columns against seismic loads and for delaying separation at the wall-to-tie column interface.

Bonding is an essential feature of confined masonry construction and it can be achieved by interlocking at corners with wall to column interface.

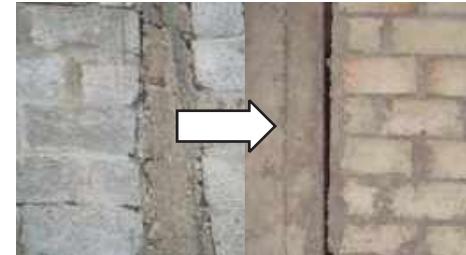
Toothed edges are recommended on both sides of the wall.

Detail of Tothing



Provide horizontal reinforcement when tothing is not possible, see Fig. 2

Substandard Column No Connection to Walls



Substandard construction.

Wall disconnects during shaking if appropriate tothing is not provided.

Remember!
Pour the mixed concrete within 30 minutes



Laying of lintel beam



Connect lintel band and column at corners



Pour concrete mix and make sure that there are no gaps between reinforcements



CONFINING ELEMENTS (BAND)

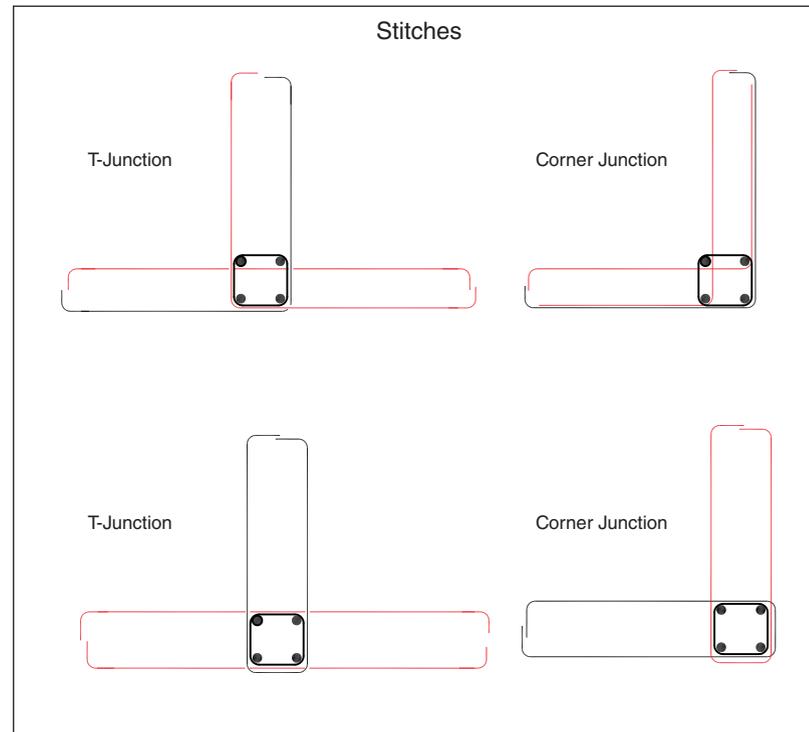
Materials

- Steel reinforcement of concrete.

Size of band

- 3 inches band, with 2 pcs of $\phi 10\text{mm}$ (#3) reinforcement;
- Continuous horizontal bands are required at different levels in “Confined Masonry” construction and it’s number also depends upon the seismic zone;
- Fix the band steel bars inside, into the columns’ reinforcement; and
- Pour the concrete for the column and the band at the same time.

Note: Wherever there is more than 4-0 inches distance between consecutive horizontal bands, stitches may be added at the corners and T-junctions.



Corner junction



T-Junction



1:2:4 concrete



Additional interlocking/stitches for reinforcement



Band reinforcement interlocking into column



Pour concrete for band and column at the same time



OPENINGS

Materials

Opening should be constructed of:

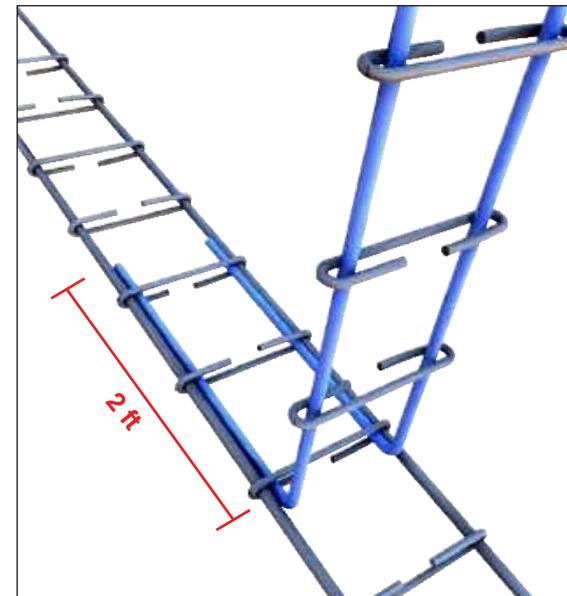
- Timber frame, reinforcement of confining elements in opening; and
- Provide 2 pcs of $\phi 10\text{mm}$ (#3) dia steel for confining band and dia 6mm (#2) @ 6 inches c/c one leg stirrups.

Size/dimension

- 3 inches thick vertical band; and
- If opening size is wider than 3 feet, it will require reinforced confinement.

Points to remember

- Opening ratio should not exceed 50% of the surface area of the wall;
- Avoid placement of the doors and windows at the corner. At least 2 feet from the corner;
- Vertical reinforcement should be placed at both sides of any opening;
- Openings should be vertically aligned from storey to storey;
- The top ends of openings in the floor should be horizontally aligned;
- Openings should be located symmetrically;
- Provide RC Frame Reinforcement around Door Openings;
- Connect properly with plinth beam reinforcement; and
- Use holdfasts in appropriate manner internally in vertical side of the frame.



Anchor confining elements into tie-band/beam



Continuous lintel beam



Corner junction of lintel beam



Fixing of window frame



Embed the holdfast 9 inch into the masonry



Opening should have reinforced vertical framing on both sides



Details of steel reinforcement lintel band



ROOF BEAM

Materials

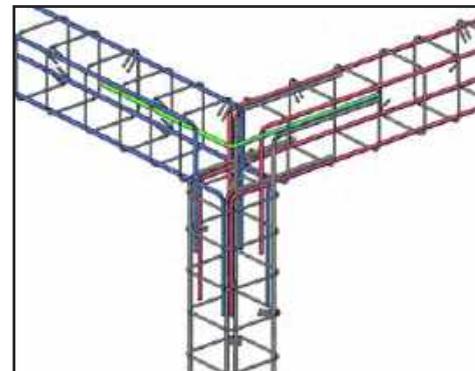
- Steel reinforcement, concrete.

Size of roof band

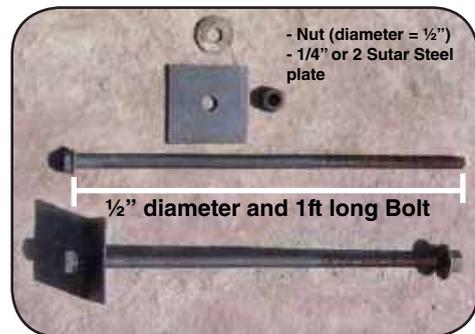
- 9 inches thick; and
- Reinforcement: Provide 4 pcs of ϕ 12mm (#4) horizontal bars in roof beam and ϕ 10mm (#3) @ 6 inches c/c steel stirrups.

Points to remember

- On top of lintel band, lay the block/brick masonry;
- At roof level, provide continuous roof band; and
- Fix bolts during concreting of roof/top beam to fix the timber roof truss to wall and columns.



Detail of corner junction



Fixing of timber roof truss on top beam



Lay the block/brick on top of the lintel band



Detail reinforcement



Pouring of concrete



PITCHED ROOF

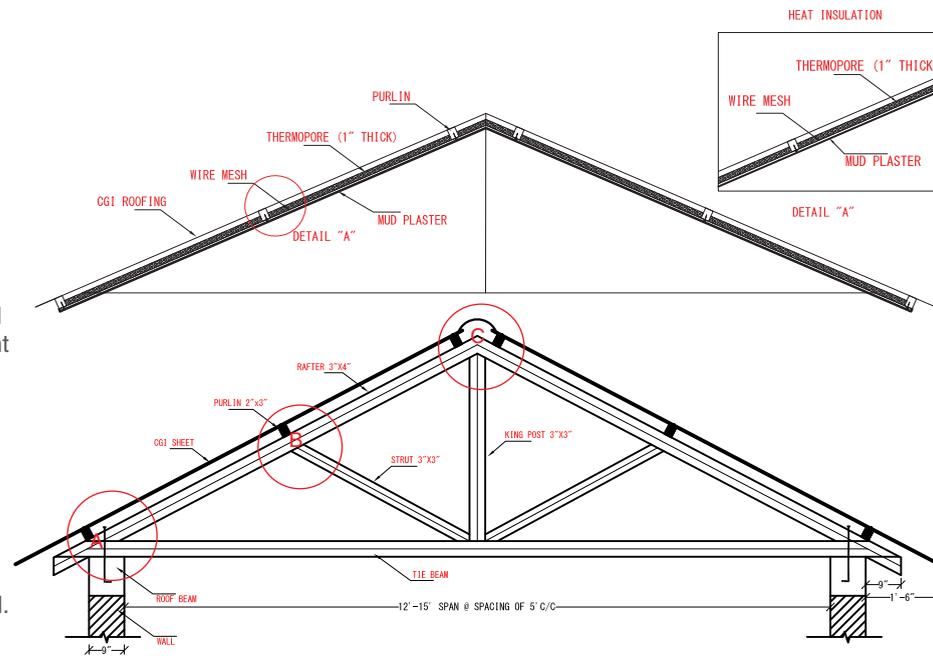
Materials

Pitched roof should be constructed with:

- Timber: Purlin, Rafters, Tie-beam, Kingpost, Struts; and
- CGI sheets.

Construction procedure

- In case of CGI (Corrugated Galvanized Iron) sheet roof, the timber beams or joists should be tied well with wall plates (by reinforcement bar, binding wire, bolts or lashes);
- Tie the rafters properly;
- Fix roof timber members by appropriate joinery;
- Install diagonal bracing wall; and
- Proper water proofing and insulation is required Thermalpal can be used for thermal.

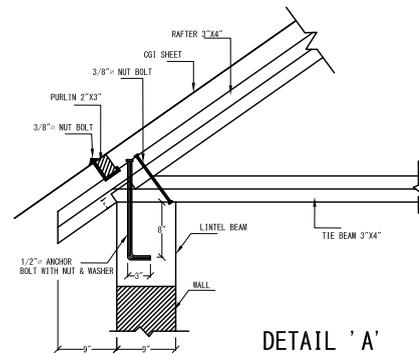


Point to remember for timber roof

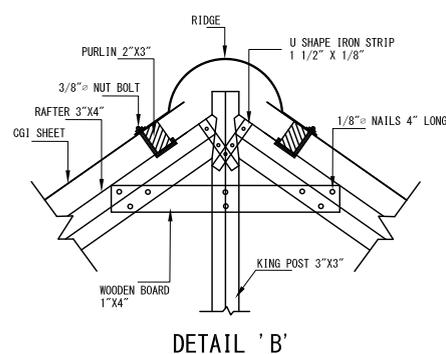
- Roof should be light weight;
- Center to center spacing between trusses shall be five to six feet;
- Trusses shall be tied down to the roof band/beam using 1/2 inch bolts anchor;
- Straps may be protected from rust by painting; and
- Fix steel straps on both faces of truss.



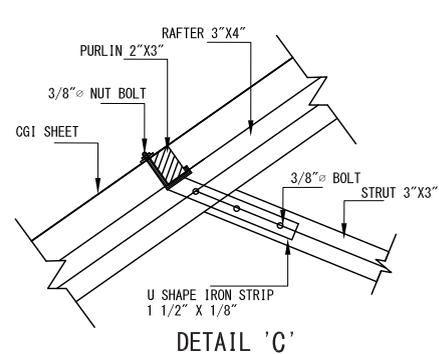
Kashmiri joint



DETAIL 'A'



DETAIL 'B'



DETAIL 'C'



FLAT ROOF

Materials

- Reinforcement in roof consists of Primary/main re-bar and Secondary/distribution re-bar;
- Place the primary re-bar first in the shorter direction;
- Concrete 1:2:4 aggregate size 3/4 inches down; and
- Use water cement ratio of 1/2 (25 litre water for 1 bag cement.)

Size

- Minimum slab thickness 4 inches.

Construction procedure

- Place form-work adequately for roof size;
- Seal the shuttering joints;
- Prepare spaces to keep the minimum concrete cover of 1 inch;
- Lay the main bars on shorter direction;
- Lay the distribution re-bars in, above the main bars;
- Place/tie spacer underneath main bars;
- Provide additional steel re-bars at the wall location;

- The negative steel bar should be extended to both sides of the wall, upto 1/3rd of span; and
- Provide down spouts for drainage at the appropriate location.

Insulation of roof

- RCC slab roofs tend to be very hot during summer and colder during winter seasons thereby affecting inmates. Similarly lightweight CGI roofing has proved to be very ineffective in maintaining a comfortable temperature during both weathers.
- A range of tested and applied solutions is available to insulate the roof with varying costs and efficiency.
- White washing is a low cost but effective way to minimize heat penetration by reflecting heat in hotter climates.

Points to remember

- The slab should have a slope of about 0.5% to allow for proper drainage;
- Incorporate waterproofing, insulation;
- The roof slab should support dead and live load;
- Plinth 12b for testing of water leakage. Let the waste stay for a minimum of 14 days; and
- Curing should be done for 14 to 21 days.



For reinforcement details consult engineer.

Provide reinforcement for flat roof structure because without reinforcement slab would deform



Maintaining adequate concrete corner



Conceding of slab



Finishing of slabs



BUILDING MATERIALS AND PROPERTIES

Bricks

- Always use A-class bricks in masonry walls;
- All the bricks should be of the same size; and
- The bricks should be properly burnt. The edges and corners of the bricks should not be deformed or damaged.



Concrete Blocks

- The blocks used in construction of masonry walls should be constructed of concrete with a ratio of 1:4:8. If this proportion of sand and crush is exceeded, blocks constructed from such concrete would be very weak. The use of such blocks in the construction of masonry may prove to be dangerous;
- If the amount of cement used in the construction of the concrete blocks (with proportions described in 1) is one bag (50 kg) and there is no moisture in the sand and crush, then the amount of water used for its mixing should not be more than 5 to 6 oil tins of 5 kg. If sand and crush already contain moisture, the amount of water used for mixing of concrete should be further reduced; and
- The use of blocks that are cracked, warped or have broken edges and corners should be avoided.



Cement

- Fresh portland cement should be used for construction. There should be no lumps so as to reduce the strength of the cement. Therefore, the cement bag once opened should be used as soon as possible;
- Lumps in cement also appear if their sealed bags are stocked for a long period. The formation of lumps in cement is one of the major indications of old cement. The use of such cement should be avoided; and
- Always use a trusted brand of cement with good quality and avoid the use of substandard cement.



Steel reinforcement

- Steel free from rust and oil should be used; and
- If large quantities of steel is to be used, it should be tested for its properties from a reputed organization. All engineering universities in Pakistan as well as most government and non-government organizations involved in construction activities have the facility of steel testing.



Sand

- Sand, Khaka and Crush should be cleaned from soil particles and vegetation. The presence of such impurities reduces the strength of concrete and mortar. Pick-up a handful of the sand and rub it between your palms. If your palms stay clean, the sand is varonbly clean if they become stained, further tests and washing is required; and
- Always prefer the gravel (crush) obtained from crushing machines.

Aggregate

- The gravel (cursh/aggregate) should be well graded and contain aggregates of different sizes in proper proportions. Concrete prepared from gravel having one side is relatively weaker;
- Aggregate for constructions shall consist of crushed stones of 25mm (1 inch) maximum size; and
- Rounded river stone shall not be used under any circumstances.

Concrete

- Cement, sand, crush and water for use in concrete should be according to aforementioned instructions;
- The constituents of concrete should be mixed with concrete. In case of non-availability of mixer, the dry constituents should be mixed three to four times with the help of shovels followed by gradual addition of water and subsequent remixing;
- A simple way to assess the quantity of water in concrete is to press the wet concrete in hand. In case of good quality concrete, the cement slurry does not flow out between the fingers;
- When cement, sand and crush are thoroughly mixed together and water is added, the cement combines with water to form a glue type substance. Similarly concrete, when not used within one hour after its mixing with water, would become dry and useless. Thus it is very important to use the concrete within one hour after water is added to it. If more than one hour passes after the concrete is mixed with water, the beams, columns and slabs constructed of such a concrete would be weak;

- If it happens to use concrete by dropping from a height, the height of fall should not be more than 5 feet, because it leads to segregation of concrete which causes severe reduction in its strength;
- Concrete should be compacted with the help of a vibrator after placing each layer of 1 to 2 feet when pouring beams, slabs or columns. If a vibrator is not available then compaction can be done by tamping it with a thick steel rod; and
- All the concrete members such as columns, beams and roof slabs should be kept wet by pouring water for at least fourteen days.

Mortar

- Constituents of mortar i.e. cement, sand or khaka should be thoroughly mixed in dry from two to three times, followed by a gradual addition of water in small quantity and remixing;
- Do not add water at once so that during mixing, cement water may not be washed by bleeding;
- Mortar should always be prepared on clean and metalled floor;
- Use such amount of water in mortar so that the mortar produced is easy to use. Remember the use of extra (excessive) water reduces the strength of mortar significantly; and
- The ratios of mortar for plastering should be 1:4 which means the addition of one bag of cement to two wheelbarrows of sand. The masonry walls should be thoroughly soaked with water before the application of plaster.

Water

- Water lubricates the mixture. However, increased water content will cause a decrease in strength, produce cracks (shrinkage) and decrease density;
- Quality and quantity of water is important for producing a good mortar and bricks masonry work;
- Clean natural water should be use for construction; and
- Water should be stored where no contamination is possible.



نقصانات



- زلزلے میں کالموں کا سریا کالموں سے باہر نکل آیا
- کالم اپنی جگہ سے سرک گئے۔
- کالم کا سریا کالم کے نیچے یا اوپر والے حصوں سے نمایاں ہوا۔

نقصانات



- زلزلے میں اکثر تعمیرات کے کالموں کا بنیادوں کے ساتھ جوڑ کھل گیا اور وہ سری طرح تباہ ہو گئیں۔
- زلزلے میں اکثر عمارت کالم اور تہم کے کمزور جوڑ کی وجہ سے بری طرح متاثر ہوئیں اور بڑے نقصان کا باعث بنیں۔

وجوہات



- زلزلہ مزاحم ہنگ استعمال نہ کرنے سے
- کالم زلزلے کے دوران کھل جاتے ہیں
- رنگوں کے سریوں کا غیر معیاری سائز۔
- رنگوں کے سریوں کو سیدھا رکھنے سے۔

وجوہات



- مکان کی بنیاد کالموں کے کمزور جوڑوں کی وجہ سے کمزور ہو جاتی ہے۔
- کالموں کا سریا بنیادوں تک موجود نہیں تھا۔

صحیح طریقہ



- زلزلہ مزاحم رنگ کا استعمال کریں
- رنگ کا سریا 45 ڈگری اندر کی طرف موڑیں
- کالمز کے رنگوں کا زیادہ سے زیادہ فاصلہ 4 انچ رکھیں۔

صحیح طریقہ



- کالم کا "L" کم از کم 12 انچ رکھیں
- کالم کی بنیاد میں سریے کا جال ضرور چھجا سیں
- کالم میں سریے کا LAP کم از کم ڈھائی فٹ ہونا چاہیئے۔

نقصانات



- اس طرح کے نقصانات سے اکثر مکانات کھڑے رہے
- لیکن مستقبل کے لیے غیر محفوظ ہو گئے۔
- زلزلے کے دوران کئی عمارتوں کے کالمز اور تہمز کا باہمی جوڑ کھل گیا اور وہ بری طرح تباہ ہو گئیں۔

وجوہات



- کالموں میں رنگوں کا فاصلہ زیادہ رکھا گیا۔
- کالموں میں کم سریوں کے استعمال کی وجہ سے۔
- کالم اور تہم کے سریوں کا آپس میں جوڑ نہ ہونا۔
- کالم اور تہم میں رنگوں کے درمیان زیادہ فاصلہ

صحیح طریقہ

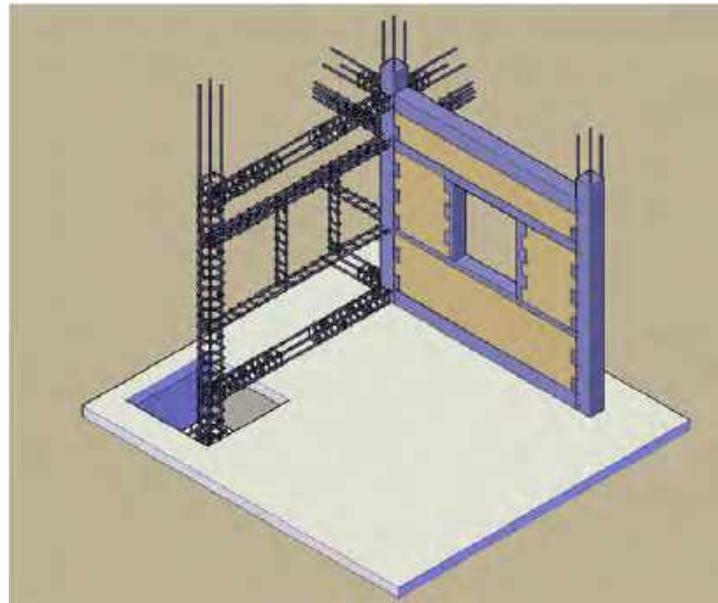


- رنگوں میں 45 ڈگری پر 3 انچ کی کبوں کا استعمال کریں۔

یاد رکھیں

بنیادیں

- کالموں کا سریا زمین میں 2 فٹ نیچے لے جائیں اور 12 انچ کا "L" فراہم کریں۔
- کالم اور تہم کا جوڑ:
- جوڑوں پر کالم یا تہم کے سریوں کا ڈیڑھ فٹ چڑھاؤ فراہم کریں
- اوور لیپ:
- کم از کم 2.5 فٹ سے 3 فٹ تک سریوں کا اوور لیپ رکھنا لازمی ہے۔
- کالم میں سریوں کا اوور لیپ درمیان میں رکھیں۔
- رنگ
- رنگوں کا باہمی فاصلہ زیادہ سے زیادہ 4 انچ ہونا چاہیئے
- اس کے علاوہ 3 انچ کی 135 ڈگری پر ہمیں فراہم کریں۔
- بالائی منزل:
- بالائی منزل کے لیے سریوں کو چھت کے اوپر کم از کم 4 فٹ تک نکالیں۔



GLOSSARY

Beam

- A longitudinal frame member on a structure which is responsible for carrying the gravity weights of walls, slabs and other superimposed loads and then transmits these loads to the columns, walls or other supporting frame members.

Band

- A perimeter beam placed along the perimeter of the structure normally placed in roof level or above the ground floor level (i.e. plinth band or roof band).

Column

- A vertical frame member of a structure supporting the beams or slabs. It transfers the load from the superstructure to the foundation or substructure.

Plinth

- Transmits the load from the walls down to the foundation. It also protects the ground floor walls from excessive settlement in soft soil conditions.

Sill band

- A continuous reinforcement band below the sill.

Roof Band

- A continuous reinforcement band along the perimeter at roof level. It carries the load from roof structure.

Reinforcement

- Primarily used in concrete construction to strengthen the concrete.

Insulation

- Primarily used in roof, wall and ceiling system to limit or control the heat onto the structure. It is used also to protect rainwater from penetrating inside the roof trusses and ceiling.

Water proofing

- A construction material used to prevent water or moisture to penetrate inside or outside the surface of walls, beams and other frame members in consideration.

Foundation

- Transmits the loads from the superstructure to the ground or underlying soil beneath footings.

Slab

- A horizontal concrete element normally used in floors and access areas.

Confining elements

- These are composed of masonry walls which are confined with reinforced members like beams and columns.

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