

UNHABITAT
FOR A BETTER URBAN FUTURE

website: www.unhabitat.org.pk | email: mailbox@unhabitat.org.pk

GUIDELINES

for building flood resistant houses



UNHABITAT
FOR A BETTER URBAN FUTURE



United Nations
Pakistan
improving lives and helping people

INTRODUCTION

Pakistan is located in a region where disasters like floods and earthquakes occur frequently that cause major destruction to infrastructures and houses. The 2010 floods were the worst in the history of Pakistan in which 1.8 million houses have been damaged.

UN-HABITAT has prepared guidelines for flood resistant houses in local languages and distributed to the flood affected beneficiaries. By following the guidelines given in this booklet you can make your house flood and earthquake resistant.



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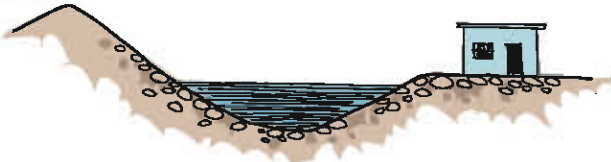
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LOCATION

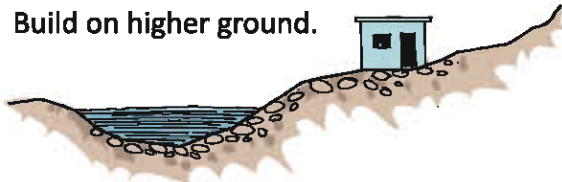
- ❌ Avoid land sliding areas.



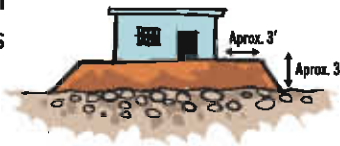
- ❌ Avoid low laying/river beds.



- ✅ Build on higher ground.

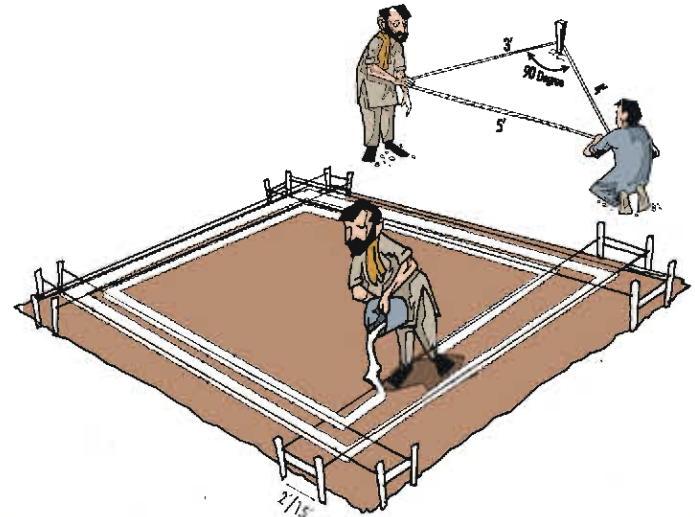


- ✅ Raise platform if higher ground is not available.



LAYOUT

- Keep width of foundation 1.5 to 2 ft for proper transfer of wall weight on ground underneath.
- Use rope to put chalk/lime for demarcation.
- Do Squaring of dimensions and walls using diagonals and 3:4:5 right triangle at corners.
- Keep Fired Brick/stone/concrete block walls upto maximum length 16 ft and mud walls maximum length 14 ft.



EXCAVATION



- Construct deep and strong foundations.
- Compact soil after excavation, in case of soft and filled soil.
- Excavate 4 ft for soft or filled soil and 2 ft for hard soil.
- Keep a minimum 3 ft distance from outer edges of platform, for construction on platform.



FOUNDATION & PLINTH



Foundation

- Build strong foundation with fired bricks/stones/concrete blocks in 1:4 C/S mortar.



Pointing

- Do pointing with 1:4 C/S, if it is mud and no mortar is used in case of masonry work.



Plinth Level

- Build plinth minimum 1.5 ft above ground level.

DPC

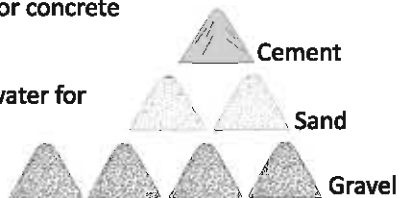


DPC (Damp Providing Course) stops dampness from upward movement in walls and gives a long life to houses and walls.

DPC is a proving a layer of concrete band, bitumen and plastic sheet at plinth level.

PROCEDURE:

- Provide 2 inches thickness of 1:2:4 concrete band at plinth level.
- Use 1 portion cement, 2 portions sand and 4 portions gravel for concrete preparation.
- Use 30 liters of water for 1 cement bag.



DPC

- Provide 2 mm thickness of bitumen layer over concrete band.



- Lay 0.2 mm thickness of plastic sheet over bitumen layer.



FLOOD RESISTANT HOUSE



Fired Brick House



Adobe House

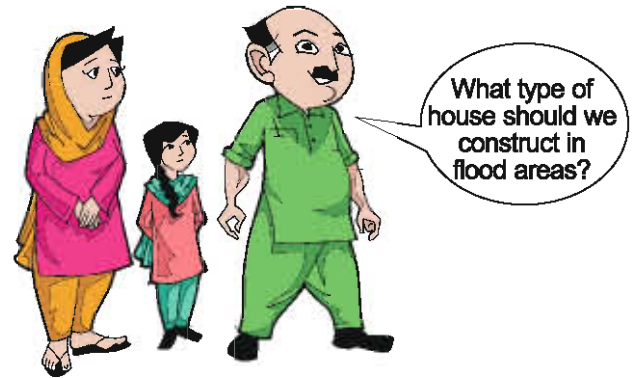


Mud House



Loh-Katt House

SELECTION OF HOUSE



Don't worry!!!

Adopt any one of the mentioned below designs for flood resistant house in which you have expertise and that is relevant or common to your area.

- Fired Brick House
- Adobe House
- Mud House
- Loh-Katt House

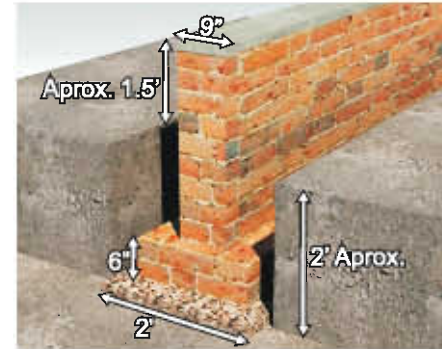




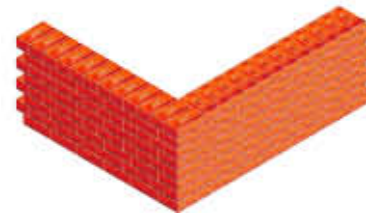
FIRED BRICK HOUSE

FOUNDATION

- Keep wall thickness minimum 9 inches.



- Start all corners together to ensure proper bonding.



**For more information see page#5,6,7, & 8.*

FLOOD PROTECTION

- Apply 1:4 C/S plaster at internal and external face of footing walls upto flood level.



Use steel brush to remove mud/dust from the joints.

- Sprinkle water on masonry before applying plaster.

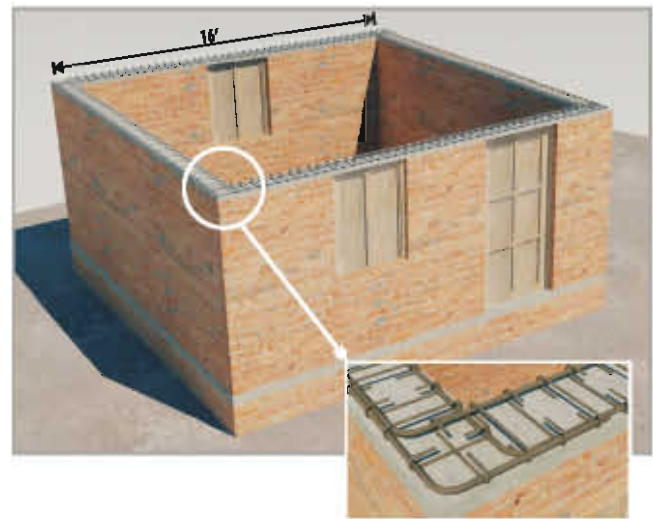


Use cement mortar within 30 minutes.

EARTHQUAKE PRONE AREAS

Provide lintel and roof bands/beams in houses constructed in earthquake prone area.

- Use minimum 3 inch thickness of 1:2:4 concrete band/beam. Place two horizontal #3 bars with #2 stirrups at 6 inch c/c.
- Keep room height at maximum 10 ft and wall length upto 16 ft.

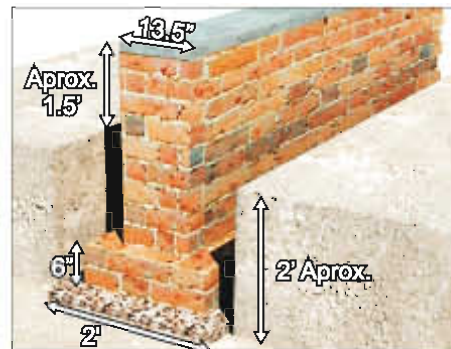




ADOBE BRICK HOUSE

FOUNDATION

- Keep wall thickness minimum 13.5 inches.



REMEMBER!!!
Use fired brick/
stone/concrete
foundation in
adobe brick
house.

** For more information see page#5,6,7,&8.*

FLOOD PROTECTION

- Use fired brick/stone/concrete block masonry with 1:4 C/S mortar upto flood level.



Use steel brush to remove mud/dust from the joints.

- Sprinkle water on masonry before applying plaster.
- Apply cement plaster or pointing of joints or water proof mud plaster, incase masonry is done with mud mortar.

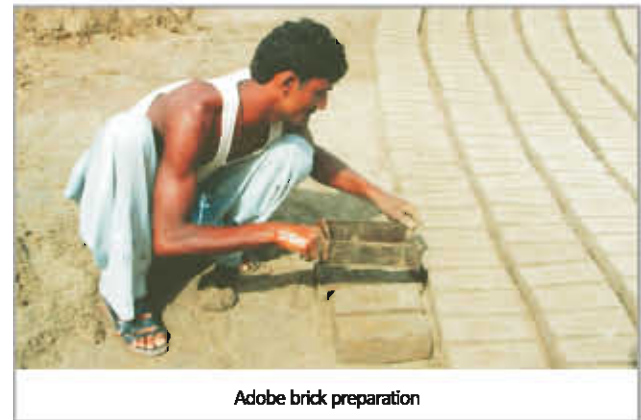


Use cement mortar within 30 minutes.

** See water proof mud mortar preparation on next page*

ADOBE BRICK PREPARATION

- Select clean soil, free of stones, leaves, grass and debris.
- Add sand incase soil is clayey.
- Add required quantity of water and knead it.
- Pour kneaded mud in brick moulds and compact it.
- Take our adobe brick and let it dry on dry sand platform.
- Turn the bricks on all edges until it gets uniform in colour.



Adobe brick preparation

WATER PROOF MUD

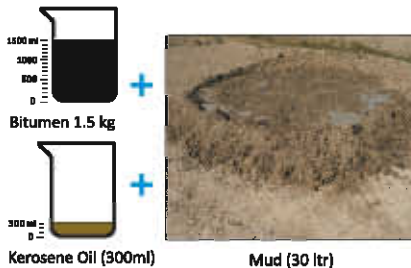


Always plaster your walls with C/S mortar from inside and outside, incase no C/S plaster affordable apply water proof mud plaster.

PROCEDURE:

- Prepare mud by mixing sufficient sand and straw in clayey soil.
- Add bitumen (tar-coal) in mud for water proofing. Use kerosene oil to flux bitumen and pour it over mud and knead it well.
- Apply water proof mud before bitumen (tar-coal) dries.

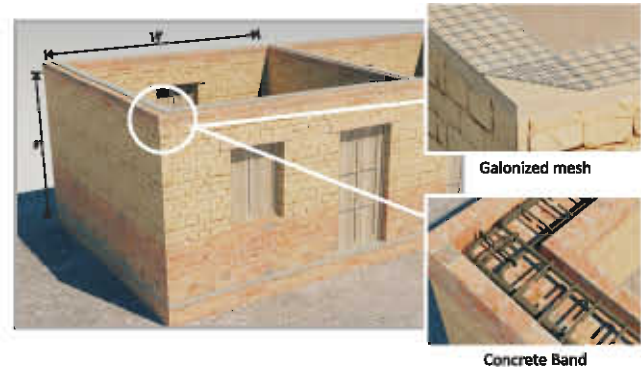
Mix 1.5 kg hot melted bitumen with 300 ml kerosene oil. Pour mixture on approx. 30 litres of mud mortar and shovel it thoroughly.



EARTHQUAKE PRONE AREAS

Provide lintel and roof bands/beams in houses constructed in earthquake prone areas.

- Keep room height upto 8 ft maximum and wall length upto 14 ft maximum.



- Provide Reinforced Brick (RB) Band: Place fired bricks on bricks on adobe bricks. Place bricks with C/S mortar on edges leaving a cavity for placing two horizontal #3 bars with #2 stirrups at 6 inch c/c. fill the cavity with 3 inch thickness of 1:2:4 concrete.

OR

- Provide 16 SWG GI wire with 1.5 "x1.5" squares.



MUD HOUSE

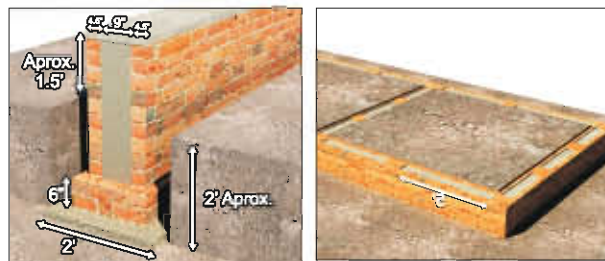
FOUNDATION

- Keep wall thickness minimum 18 inches at base and 12 inches at top.



BRICK REDUCTION ADVICE

- Construct 4.5 inch wall on both edges of the foundation to reduce number of bricks. Join the brick walls at every 5 ft. Fill the gap with sand and compact it. Provide 2 inch thick 1:2:4 concrete band (DPC) at plinth level.



*For more information see page#5,6,7,&8.

FLOOD PROTECTION

- Select clean soil, free of stones, leaves, grass and debris.
- Add sufficient sand and straw in clayey soil to reduce shrinkage and cracking in mud.
- Start mud masonry above plinth and construct a 1.5 ft high layer in one day. Wet the surface before placing the next layer.
- Apply water proof mud plaster on both sides of the wall upto flood level for flood water resistance.
- Build all corners together to have strong corner joints.

For flood water resistance apply water proof mud plaster on both sides of wall up to flood level



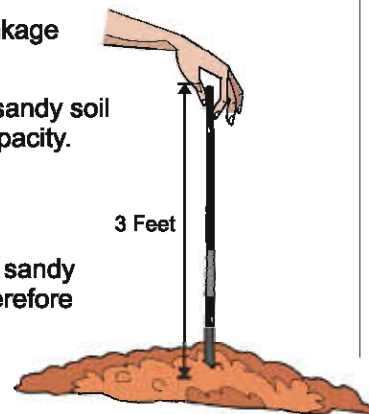
* See water proof mud mortar preparation on next page

MUD PREPARATION

- Add sufficient amount of sand, straw and water in clayey soil for mud preparation.
- Add sand to reduce shrinkage and cracking.
- Avoid too much sand or sandy soil as it has less bonding capacity.

FIELD TESTS:

- If the soil is too clayey or sandy soil, it is not suitable. Therefore the following simple field test can be done to identify a suitable mud for construction.



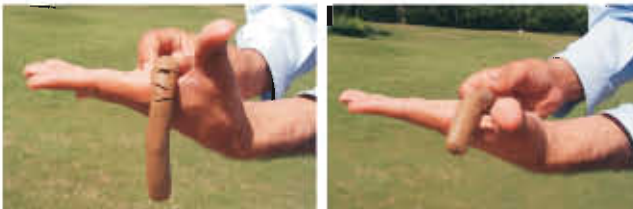
WATER RATIO(WORKABILITY)

- Take a small lump of mud from the prepared mix and place it on a plane surface. Take 15 inch #3 bar and rest it on the surface of the damp soil.
- Allow the bar sink with its own weights.
- If the bar sinks in 1 inch, not more or less, then the water content is right and mud can be used for masonry work, otherwise; add more sand and clay.

MUD PREPARATION

SAND: CLAY RATIO (PLASTICITY)

- Take enough clayey soil and make a roll about the diameter of a thumb but about two or three times longer.
- Place a roll on your hand and flatten it between the thumb and forefinger to form a ribbon 0.5-1 inch diameter and 8 inch long if possible.
- Slide the roll across the palm until it breaks.
- Measure the broken piece, if length is 6 inches or more, then the clay content is high and need to add more sand.
- If the length is between 3-4-5 inches, the sand and clay contents are fine and the soil is suitable for mud construction.
- Short length means the clay is not enough and requires more clay. Otherwise it cannot be used for construction.



WATER PROOF MUD

Always plaster your walls from inside and outside with water proof mud plaster.



PROCEDURE:

- Prepare mud by mixing sufficient sand and straw in soil.
- Add bitumen (tar-coal) in mud for water proofing. Use kerosene oil to flux bitumen and pour it over mud and knead it well.
- Apply water proof mud before bitumen (tar-coal) dries.

Mix 1.5 kg hot melted bitumen with 300 ml kerosene oil. Pour mixture on approx. 30 litres of mud mortar and shovel it thoroughly.



Mud (30 ltr)

EARTHQUAKE PRONE AREAS

Provide lintel and roof bands/beams in houses constructed in earthquake prone areas.

- Keep room height upto 8 ft maximum and the wall length upto 14 ft maximum.

Horizontal Bands/Beams

- Provide 3 to 4 inch thickness of 1:2:4 concrete band with two horizontal #3 bars with #2 stirrups at 6 inch c/c.

OR

- Provide 16 SWG GI wire with 1.5 "x1.5" squares.

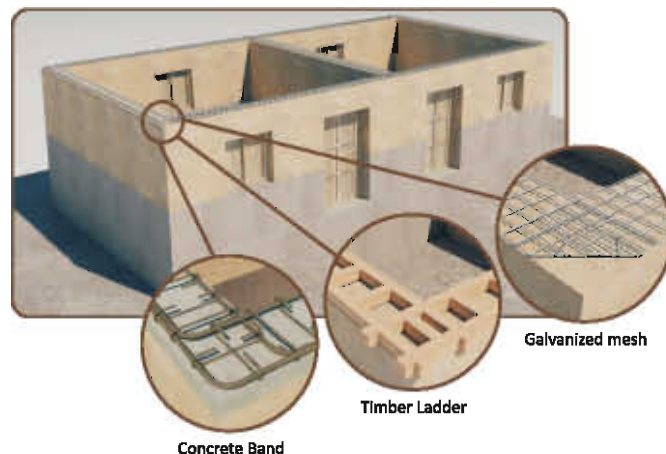
OR

- Provide wooden (ladder type) band with two horizontal pieces of 3" x 1.5" size in longitudinal direction and the tie them with cross pieces of 2" x 1.25" size timber at 18 inch c/c with the help of nails.

*Band photos are shown at next page.

HORIZONTAL BANDS

Provide lintel and roof bands/beams in houses constructed in earthquake prone areas.





ROOF & WATER DRAINAGE

ROOFING

Girders transfer roof load on walls therefore remember the following!!!

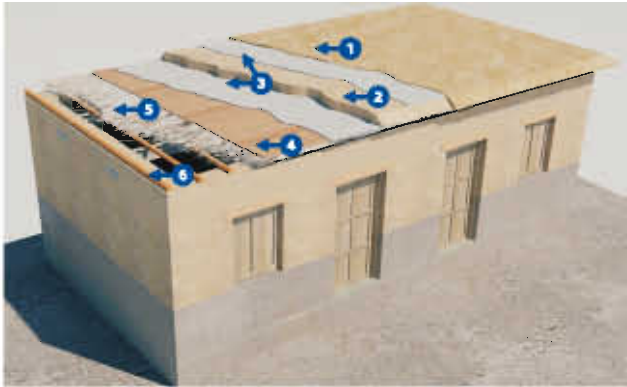


- Place girders that have bearing on walls not less than $\frac{3}{4}$ the thickness of the wall.
- Provide bearing pad to concrete, wooden plate or burnt bricks under girders for uniform distribution of load.
- Provide 4 inch wide girder at maximum 5 ft c/c spacing.
- Provide 1:50 slope to drain water quickly.



Concrete Pad for Girder

ROOFING



ROOF DETAILING:

- ① 1 inch mud plaster.
- ② 4 inch compacted mud.
- ③ 2 layers of plastic sheet.
- ④ Available thin branches of timber.
- ⑤ 3/8 inch thick chick.
- ⑥ 3 inch dia. bamboos at 1 ft c/c spacing.

HEALTH/HYGIENE & WATER DRAINAGE



- Keep latrine pit minimum 30 ft away from the water source.
- Cover the pit and drain all water away from the house.



Mound latrine



Distance between hand pump and latrine too short.



LOH-KAAT HOUSE

FOUNDATION AND POLES

- Dig a 1 ft hole at every 3 ft space to erect poles.
- Dig holes 4 ft deep in soft soils and 2 ft deep in hard soil.
- Use 4 inch dia poles. Be sure to use larger diameter poles at corners if all are not available in the same size.



Treatment of poles

FIXING OF POLES

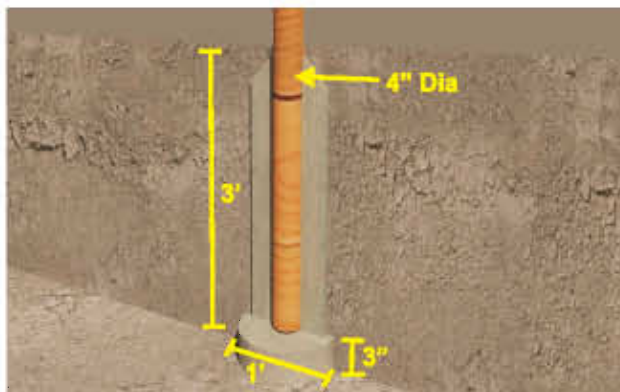
- Lay concrete (1:4:8) around poles.

OR

- Fill sand around poles and compact it.

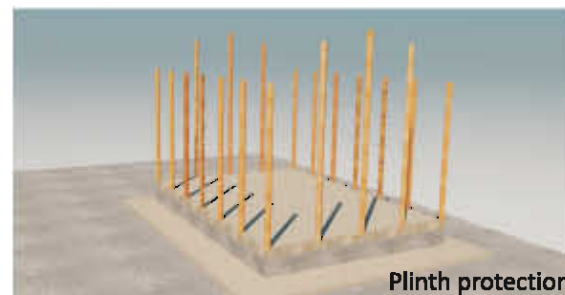
OR

- Fill concrete (1:4:8) in holes and fix timber poles on it with metal straps.



PLINTH

- Keep height of plinth upto 1 ft and properly compact it.
- Use brick or stone masonry apron with an outward slope for plinth protection.



FRAME

- Tie that poles together at plinth level with a 4"x2" size wooden platform outside (optional).
- Provide wall plate at maximum 8 ft height.
- Fix 2" dia twigs with steel wire/nails at 1 ft spacing horizontally on outer face.



Poles & wall plate



Bracing & horizontal plates

IN-FILLING

- Place bushes between poles and tie it with timber poles and twigs with steel wire/nylon rope.
- Fix 2" dia twigs with steel wire/nails at 1 ft spacing horizontally on inner face.
- Use sufficient quantity of straw in mud plaster to protect against rain splashes.



Infill with bushier



Mud Plaster

ROOF

- Make a truss of 3" dia bamboo or timber that should be well tied with each other and walls.
- Lay a ridge pole over the posts at the gable ends.
- Provide a bamboo of 1.5 inch dia or wood as purlin. Provide local matting and plaster it with mud mortar.



Tie trusses properly with nylon ropes.

ROOF



- 1 Mud plaster.
- 2 Grass.
- 3 Plastic sheet.
- 4 Chick/Grass mat.
- 5 Wood trusses.

Thank you

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TELEPHONE INDEX

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