Leepa

Guidelines for the compliant construction of Leepa-type timber post and beam houses

Leepa

Plinth and back wall

A good plinth protects the base plate and ensures it dries quickly.

Plinth

- The plinth should be stable and well packed.
- The base plate and frame should be kept dry.
- The plinth may be raised above ground level, for protection from snow. In this case the ground floor should be maximum 8 ft high.
- The plinth or back wall may be constructed as retaining walls, but should not retain a height greater than 8 ft.

Traditional practice is to have back wall of stone.

RCC bands can strengthen the wall.

Back wall

- A rear wall may be constructed of good quality stone masonry with through and corner stones.
- The wall should be min 24 inches at top and wider at base, the wall may be stepped or sloped on rear side.
- The posts supporting the upper floor must be separate and inside the wall.

Timber posts inside and separate to the wall. RCC bands between well laid dry stone masonry.

Upper storey frame is fixed to top of the wall.

Configuration

Configuration / Plan

- The building should be symmetrical and balanced.
- The best plan shape is square.
- The traditional layout of 3 equal bays wide x 3 equal bays long is recommended.
- The external walls should be balanced in weight, with all sides equal.
- The building length should not be greater than 3 times its width.

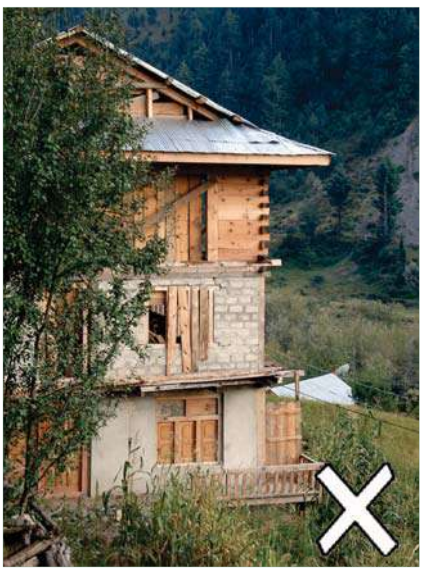
Core and stiffness

- There should be full height walls provided in both plan directions.
- Load bearing walls should be placed over each other.

Section

- The building should be heavier in lower storeys and lighter in upper storeys.
- Max storey height 10 ft. Storey heights should be equal.
- Stone basement storey height max 8 ft. Stone masonry walls should follow Bhatar construction principles.
- The total building height should not be greater than the plan length.

More than 1 storey retaining wall. Plan area not same for each storey.



Building height greater than length or width.

Leepa

Timber Frame Sizes

Horizontal

- Each storey should be a box with its own top and bottom plates and posts.
- The building is a series of separate boxes stacked on top of each other.
- Base plate should be provided under all posts and wall plates above all posts.
- Base and wall pates minimum size 6 x 5 inches.
- Plates should be long continuous good quality seasoned timber.
- Floor joists should be spaced at maximum 2 ft cc and may be overlapped over the floor beam.
- These timber sizes are good for double storey construction.

Vertical

- Posts should provided at maximum 6 ft spacing.
- Posts min section size: 6 x 5 inches
- Posts should be made of a single piece.
- Where there are larger clear spans the posts should be larger section or closer spaced.
- All timber sizes recommended are good for double storey construction

Walls and openings

Distance from the corner to opening must be minimum 5 ft.

Large opening

Large window frames should have sub frames like this.

Walls

- External walls may be constructed of load bearing timber planks, timber boarding or dhajji infill.
- The maximum unrestrained wall length is 15 ft.
- The building should be divided into small regular rooms.
- The walls should be constructed of dhajji infill in lower storeys and solid timber planks in upper storeys.

Floors

- Floors and ceilings add stiffness to the frame.
- It is recommended to use solid floor boards minimum 3/4 inch thick.

Verandahs

- Verandah frames may be constructed of smaller timber sections. The frames may be stiffened with balustrades or other infilled sections
- Knee braces can also be used from the post to the wall plate.

Corners and Openings

- Openings should not be greater than 25% of the overall wall area.
- Plan length of the wall between the corner and nearest opening should not be less than 5 ft.
- Plan length between any other two openings should not be less than 2.5 ft.
- Openings should not be larger than 5 ft wide.
- Openings should distributed equally in the plan.
- Openings should be fully framed.
- Frames greater than 2 ft wide should have sub frames.

Joints and Framing

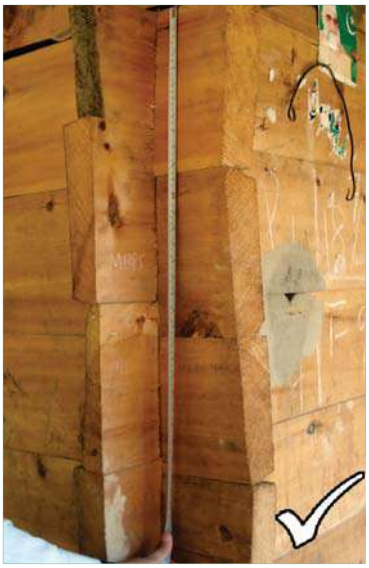
Vertical

- Posts should be fixed to base plates and wall plates with mortice and tenon joints.
- Joints should also be nailed.
- In new construction the timber sizes have been reduced making it more difficult to make a correct joint. Timber section sizes should be minimum 5 x 6 inches in the main frame.
- Tenon size and location should be correct to avoid breaking off.

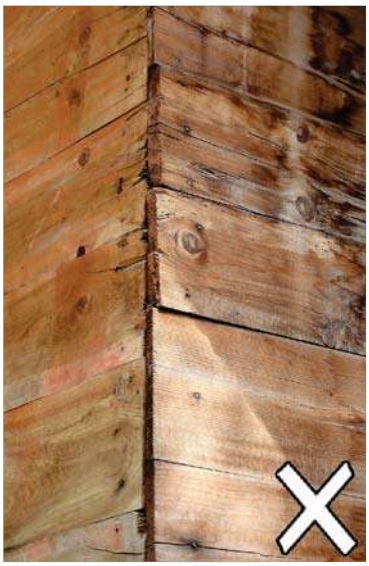
Horizontal

- Base and wall plates should be connected at the perpendicular joint with an overlap cross halved joint.
- Bases and wall plates should be spliced with a scarf joint or Kashmiri joint. These joints should be pegged.
- In new construction the horizontal joints are butt or lap jointed, these need to be improved.
- The timber section used in the base plate should be best quality seasoned heartwood. It carries the load of the building and is most exposed to weathering.

Joints and Boarding



Boards ends not protected, nailed at weak location.



Thin boards may split or warp, nailed at weak location.

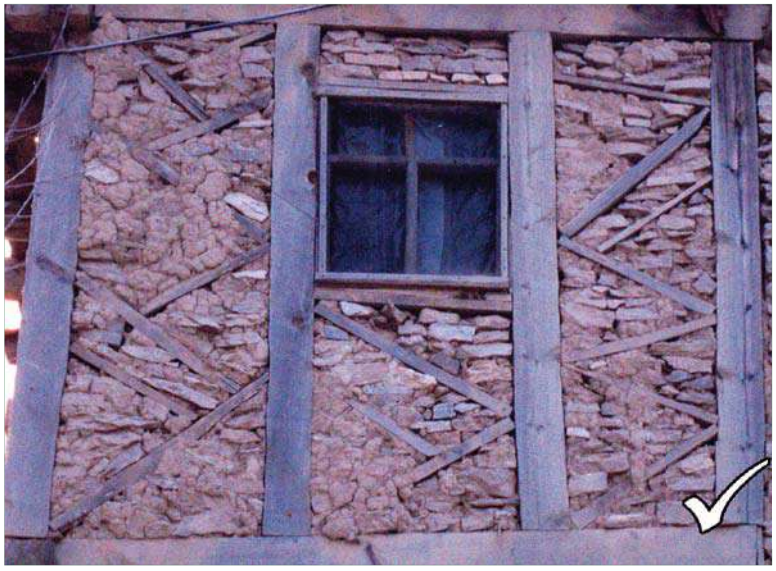
Timber Boarding

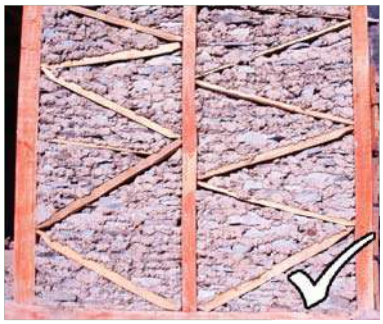
- Use timber planks of approximately 1 1/2 inches thick to make timber load bearing walls, or as cladding to a timber frame.
- The boards should be interlocked at the corners to provide excellent earth-quake resistance.
- The boards should be fixed to each other by pegging to the board above and below.
- The fixing method and board thickness ensures the boards do not warp or weather..
- At intermediate posts, boards should be inserted in grooves for better fixing.

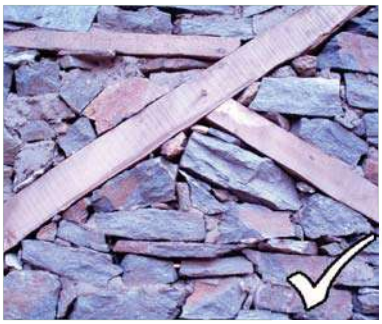
- Boards should not be cut off without proper interlocking. This is a weaker detail.
- Boards should not be nailed close to the end grain weakening the planks at the corners.
- Boards overlapped but not interlocked at the corners are not sufficient.
- Thinner boards and poor fixing by face nailing means increased warping and weathering.
- Boarding should not be used as only short wall lengths.

Leepa

Dhajji and Infill







Dhajji

- Previous construction used well packed dhajji infill masonry of minimum 6 inch usually 8-10 inch thickness.
- Flat boards were used between the main posts to hold the infill and brace the frame.
- The infill performed well in the earthquake, with minor loosening or falling out of infill stones. The mortar should be weak.
- The earthquake energy is shed by the Dhajji. This protects the main timber frame.

In situ concrete infill.

New Infill

- In new construction, in situ concrete, stone masonry with sand cement mortar and concrete blocks are being used.
- All of these are too stiff and will not perform as well as weaker Dhajji infill. They may fall out as entire panels or break the timber frame.
- They also provide no timber bracing for the timber frame.
- Stone masonry laid dry or with weak mortar may not be used without Dhajji bracing in upper floors.
- Sand cement mortar is not good for timber durability.

Even small areas of in situ may weaken the frame.

Masonry with sand cement mortar.

Stonework with no bracing.

Mixed Construction

Platform Frame

- Each storey should be constructed as a box with its own base plate, posts and wall plate. This is a platform frame.
- In new construction some houses do not have continuous plates, and posts are bearing on the wall plate of the storey below.
- The plates are necessary to act as continuous bands and to allow each storey to act independently.

Base plate not continuous, posts fixed on wall plate below.

RCC column fixed to timber beam. This is not permitted.

RCC frame members

- RCC beams and columns should not be used in combination with timber framing.
- They do not have proper connections with the timber and they will not perform well in earthquakes, as they are a different weight, and unrestrained.

Insulation

- Use of heavy mud or concrete in the floors or roof for insulation should be discouraged. It adds to the load of the building. The roof should be light.
- Lightweight insulation options should be developed.

RCC beam has no connection to the timber posts. The frame is not well connected. Framing must be all timber

Heavy insulation in the roof is dangerous.

Leepa Progress

Reconstruction

- **705** New Leepa type houses were reconstructed using the ERRA Leepa Standards
- Leepa traditional skills have been reinforced.

Rehabilitation and Retrofitting

- **1872** Previous Leepa type houses have been rehabilitated and retrofitted appropriately to improve their seismic safety
- Leepa traditional buildings and landscapes have been conserved.

Technical advice available from UN-HABITAT for:

Repair of damaged houses

Construction of new houses

UN-HABITAT
United Nations Human Settlements Programme
Tel: +92 51 261 2923, Fax: +92 51 261 2924
mailbox@unhabitat.org.pk, www.unhabitat.org.pk