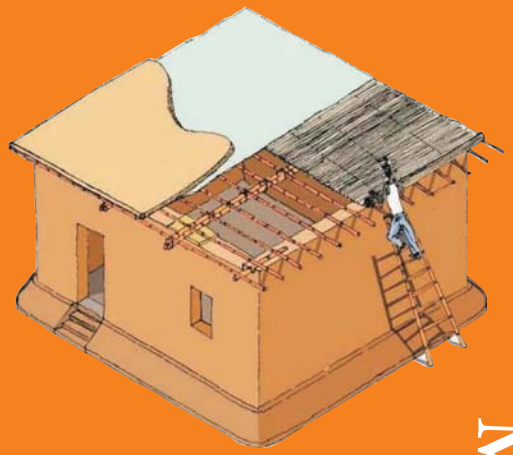
IASC Inter Agency Standing Committee
PAKISTAN FLOODS SHELTER CLUSTER

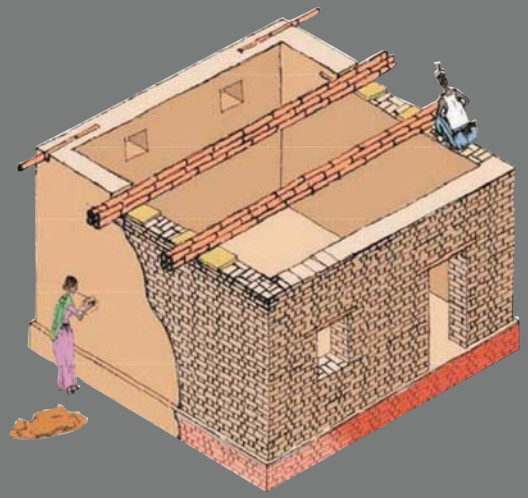
Early Recovery Shelter Cluster Guidelines

ONE ROOM SHELTER

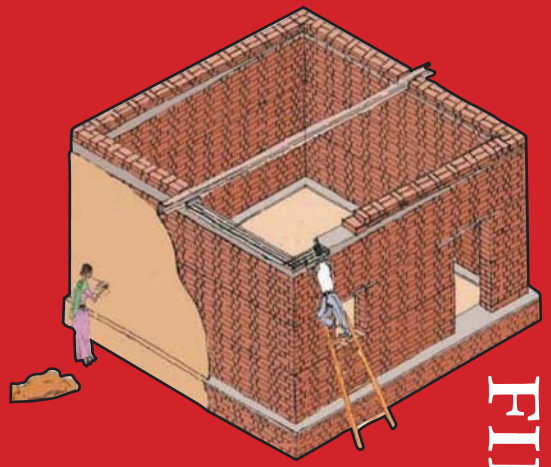
HANDS هینڈز



MUD



ADOBE BRICK



FIRED BRICK

ONE ROOM SHELTER

IASC Inter Agency Standing Committee PAKISTAN FLOODS SHELTER CLUSTER

Mud, Adobe brick & fired Brick (MAB) Technical Guideline

INDEX OF THE CONTENTS

MUD

ADOBE BRICK

FIRED BRICK

Message from the Chief Executive

Health and Nutrition Development Society (HANDS) is an organization that has been doing the empowerment of people through socio-economic development of the Society for over the last 34 years. HANDS has been striving to foster sustainable rural development objected to bring changes in the lives of vulnerable people also through low cost shelter models, and it is because of the fact that today HANDS stands one of the pioneer and largest organization in the region especially in the field of provision of low cost community shelters.

This technical manual with the help and permission of IASC (Inter Cluster Standing Committee) will prove to be a source of useful and quick reference information for the community based social activists, volunteers, development practitioners, researchers and academia for construction of low cost shelter in flood resilience.

In publishing this document, we have aimed at producing an output as succinct and user friendly as possible, focusing on portraying the key elements of low cost shelters.

In addition to descriptive contents, this guideline module provides advice through figures and illustrations to make it more user-friendly. It covers the requisite designing almost needed for construction of low cost shelters.

I take this opportunity to acknowledge, with thanks, the special efforts made in the preparation of these guidelines by the members of IASC (Inter Cluster Standing Committee). I also pay my gratitude to our IDEAS (Infrastructure Development Energy WASH & Shelter) program for publishing this manual as sustainable step for the benefit of our poor rural communities.

Let me assure you that we will keep doing our efforts both towards expanding HANDS development outreach to as maximum number of beneficiaries and producing as much quality resource material as possible.

Sheikh Tanveer Ahmed
Chief Executive HANDS

Acknowledgment

IASC Inter Agency Standing Committee PAKISTAN FLOODS SHELTER CLUSTER

This illustrative guideline module is produced in collaboration with IASC (Inter Agency Standing Committee). This guideline module will provide a quick reference for our community members, social activists, development practitioners, academia and research.
I would like to express my deep gratitude to our revered philanthropists, donors, Governing board, our Chief Executive Sheikh Tanveer Ahmed for providing us opportunity to bring about this manual, his guidance, enthusiastic encouragement and useful critiques of this document. I would also like to thank members of shelter cluster technical working group from DFID, UN-Habitat, IOM, HANDS, ACTED, OFDA chaired by National Shelter Cluster.

I also wish to recognize the technical input of Mr Nadir Mansoor and efforts of Dr Anjum Fatima for her contribution in editing this document for us. I wish to appreciate consistent efforts of my team members Naeem Memon, Waseem Solangi, Shoaib Jagirani, Syed Ali Raza Zaidi, Afsheen and Bilal Memon.

Ghulam Mustafa Zaor
General Manager
Infrastructure development Energy WASH and Shelter (IDEAS)

Mud, Adobe brick & fired Brick (MAB) Technical Guideline

INTRODUCTION

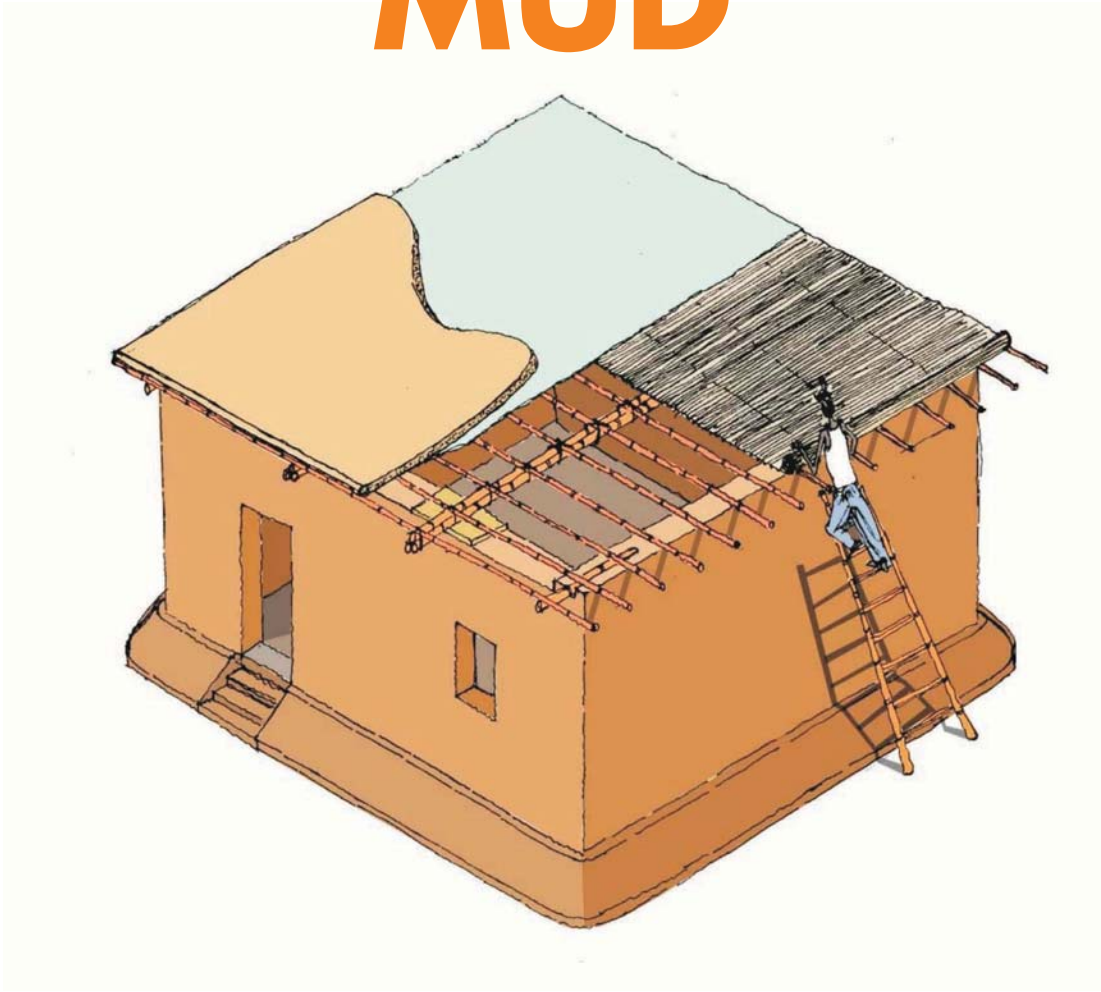
ONE ROOM SHELTER

One Room Shelter (ORS) is a flexible, beneficiary-driven approach, which leads to the final product of a safer shelter through the active participation of the beneficiaries. This a type of low cast shelter that uses familiar vernacular construction practices improved with DRR measures, to ensure the construction of safer shelter and its maintenance with the participation of beneficiaries. The ORS is a process that promotes the transferring of knowledge on safer construction techniques to vulnerable groups, as a way to improve communities' resilience to disasters; it may be considered as the first step towards reconstruction and beneficiaries can upgrade it according to their capacities and resources.

DIMENSIONS

The dimension of ORS may be different depending on the needs of the family, the technique adopted and the financial resources. The minimum standard for a family of 6/7 persons is a surface area of 16/20 mq, i.e. 170/260 square feet. Thus the dimension may be from 14'x14' up to 16x16'. The internal height should be never less the 10' from the floor level. The plinth has to be raised at least 1'6" above the Natural Surface Level (NSL)

ONE ROOM SHELTER
MUD



MUD VERNACULAR SHELTER

Mud shelter is completely built up with mud, which has been kept soaked in the water for at least 24 hours. The foundations may be built with stones and the raised plinth protected by mud toe. The foundation may be of fired brick masonry and cement sand mortar as Disaster Risk Reduction (DRR). The superstructure has to be raised up by ramming layers of 12" height per day, each cured before executing the next. The thickness of the walls has to be 18" minimum at the base and never less than 13" at the top.

DRR measures against floods includes doing plaster at least upto the sill level of the walls, (external and internal) with stabilized mud or a mixture of mud, bitumen and kerosene. The whole plastering of wall upto the roof level ensures a better protection against the rain flash. The same DRR has to be applied upon the roof, ensuring continuity between the roof application and the plastering of the walls.

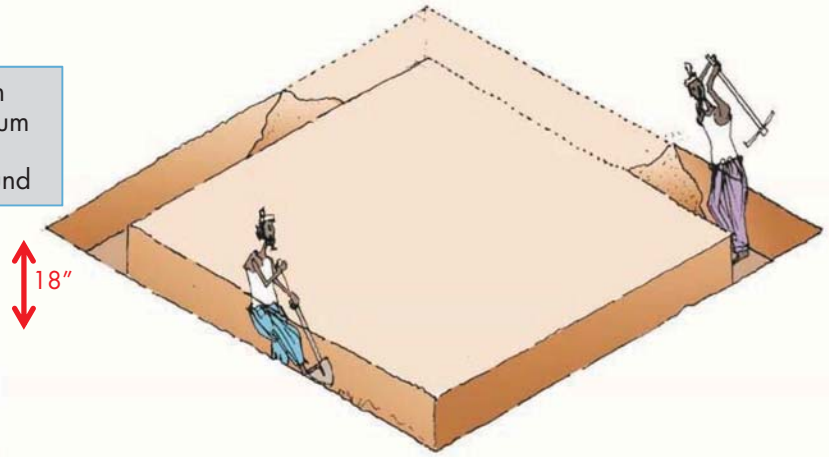
DRR for the earthquake resistance may include a reinforcement with a vertical frame, at the corner and reinforced bands at floor, sill, lintel and roof level. The roof band is always suggested.

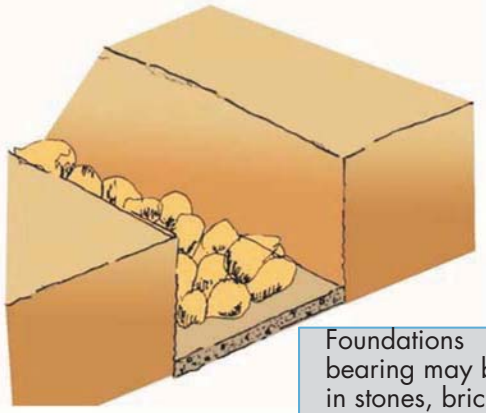
The eaves may protect the walls from the eroding action of the rain.

MUD SHELTER

Phase 1: Excavation

Excavation depth should be minimum 18″ under undisturbed ground



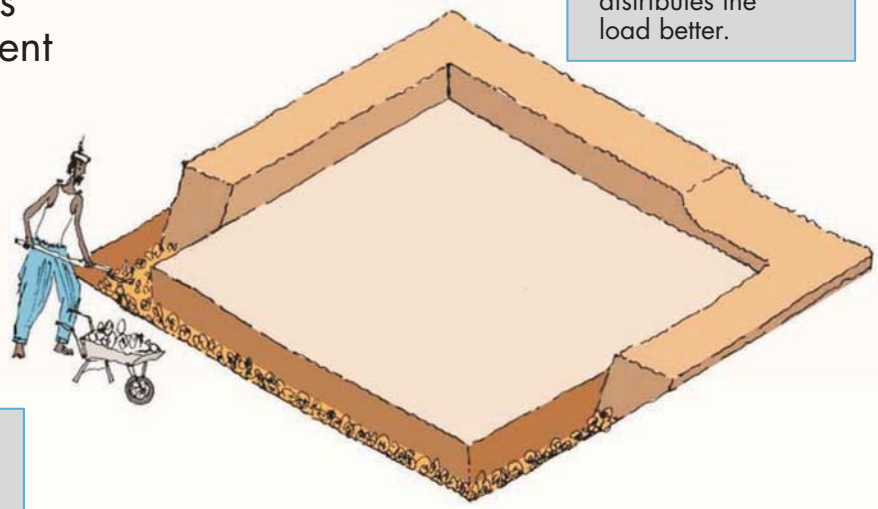


Foundations bearing may be in stones, brick ballast or concrete.

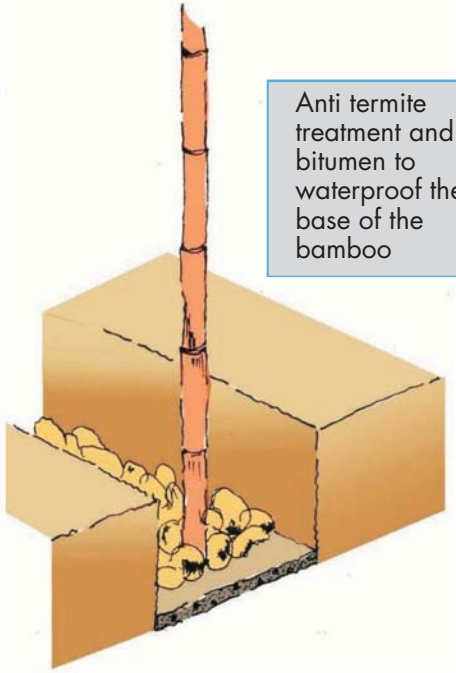
Phase 2: Foundation

- Bearing foundation
- Foundations
- Reinforcement

Tapered foundation distributes the load better.



Adding lime or cement gives waterproofing



Anti termite treatment and bitumen to waterproof the base of the bamboo

MUD SHELTER

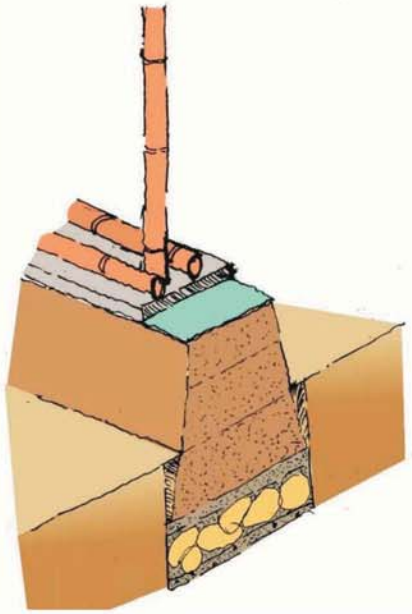
PHASE 1 and 2	EXCAVATION, BEARING FOUNDATIONS AND FOUNDATIONS
Generic Guidance	- Excavation depth minimum 18" below undisturbed ground or compacted soil. - The bearing foundations (under-foundations) should be of stones - The wall structure needs to penetrate to a minimum of 18" in the ground reaching the solid layer and being reinforced with cement or lime / mud posts, to ensure stability of the shelter - Minimum dimension for the foundations are 2.5' wide footings founded 2' below the Natural Surface Level (NSL), dimension may be increased with mud mortar
Specific Guidance	- Excavation depth minimum 18" below undisturbed ground or compacted soil. - If there is a skeleton (wall columns), the wall structure needs to penetrate to a minimum of 18" in the ground reaching the solid layer and being reinforced with cement or lime / mud posts, to ensure stability of the shelter
Notes and recommendations	- A tapered foundation (continuous plinth) distributes the load better to the ground. It can be obtained by ramming in well compacted framework - The foundations can be in stones, in fired bricks, in concrete; cement-sand mortar should be used - Tapering or ramming mud framework may be improved by adding cement and lime for waterproofing - Wall columns in wooden pole or bricks may reinforce the structure (DRR against earthquake) - When the mud shelter has a skeleton, appropriate anchoring details for the foundation should be considered

MUD SHELTER

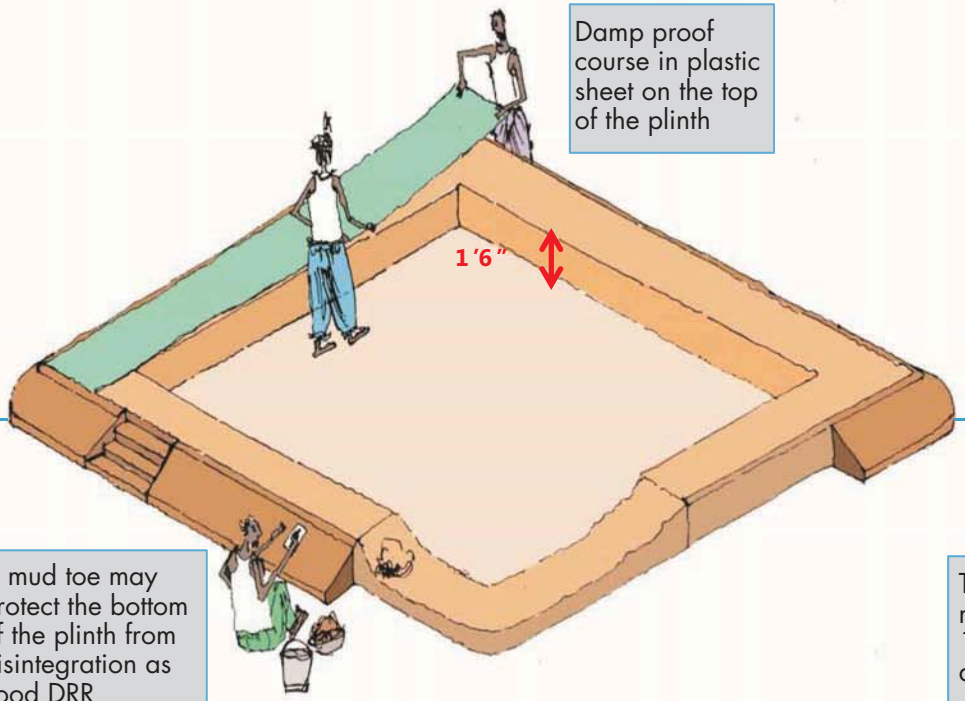
Phase 3: Raised Plinth

- Plinth
- DPC
- DRR measures

Reinforcement with horizontal band as seismic DRR. Ensure appropriate anchoring with the vertical frame



Damp proof course in plastic sheet on the top of the plinth



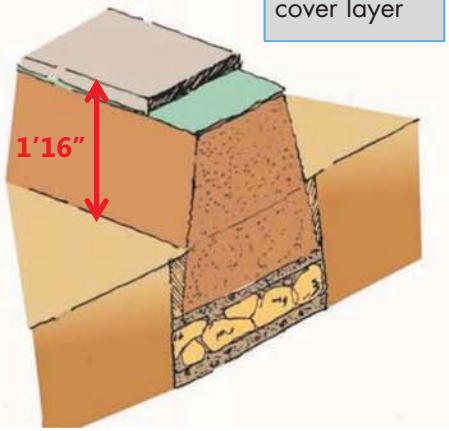
NSL

NSL

A mud toe may protect the bottom of the plinth from disintegration as flood DRR

Tapered plinth raised minimum 1'6" up to 3' above NSL

DPC with plastic sheet and concrete cover layer



MUD SHELTER

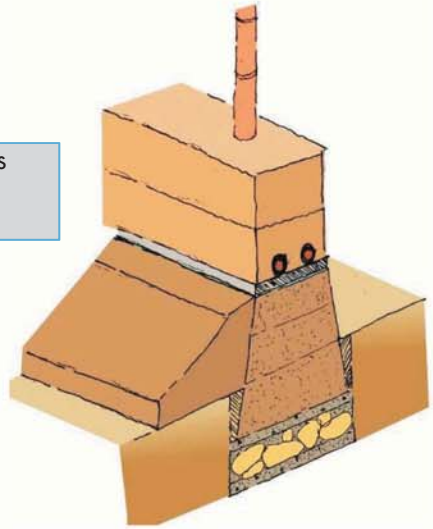
PHASE 3	RAISED PLINTH FLOOR
Generic Guidance	- The floor level should be raised to at least 1'6" up to 3' above the Natural Surface Level (NSL) adopting a continuous plinth. - General recommendation for further protection of the foundations below floor level is by raising an earth platform 3' wide at the top and tapering to NSL over 6'. (i.e 1 in 2 slope minimum.) The top of this platform should be 6" below floor level. - A Damp Proof Course (DPC) at plinth level is compulsory in order to prevent moisture rising into the walls. A DPC is either a thin layer of concrete at plinth level with plastic on one surface or simply a strong plastic layer
DRR improvements (Flood and earthquake)	- Tapered or ramming framework mud may be improved by adding cement and lime for waterproofing - The plinth may be in stones, fired bricks, concrete, cement/sand mortar. - At the top of the plinth a horizontal reinforcement is proposed, with bamboos or timber, well connected with the vertical poles, overlapped and tied at the corners
Maintenance	- Re-plaster the raised plinth with lime/mud/cement mortar at least once a year, before the monsoon season, and whenever necessary

MUD SHELTER

Phase 4: Elevation

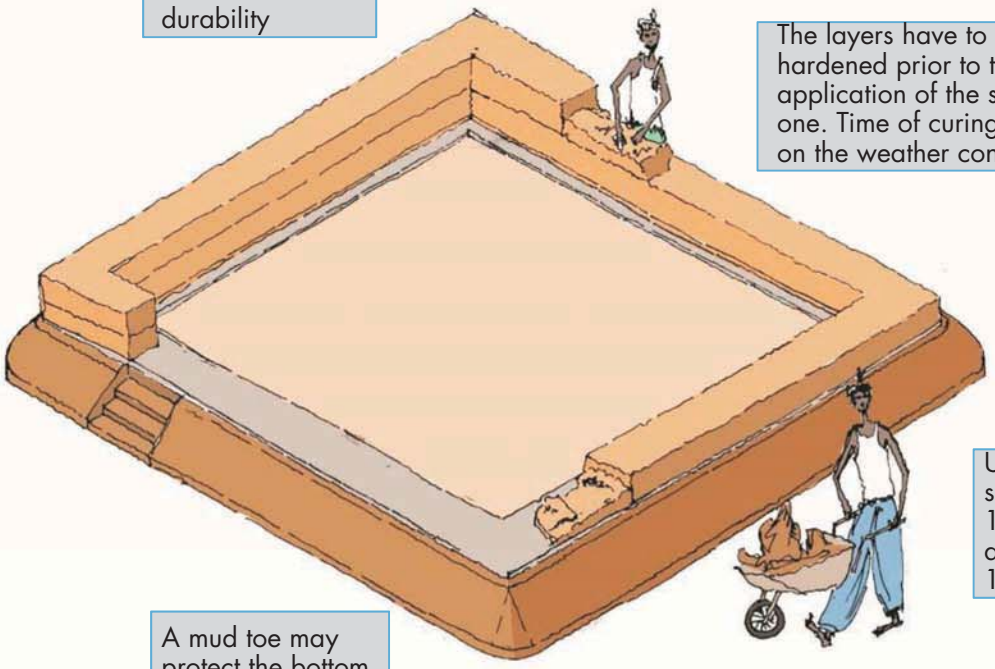
- Execution by ramming layers

Reinforce walls with bamboo skeleton

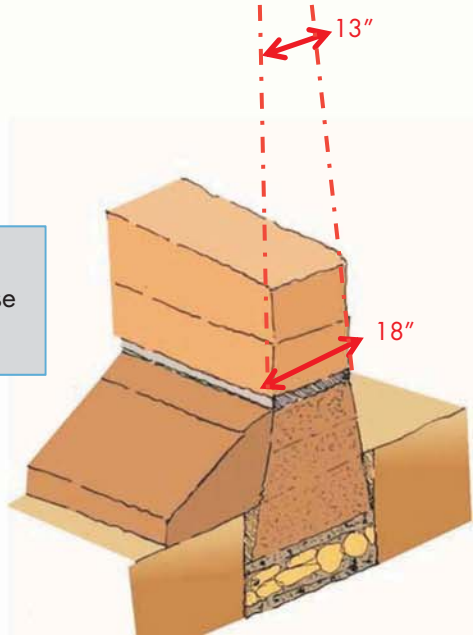


Ramming the walls improves the compaction, this increases the durability

The layers have to be cured or hardened prior to the application of the subsequent one. Time of curing depends on the weather conditions.



Unreinforced walls should be minimum 18" thick at the base and never less than 13" at the top.



A mud toe may protect the bottom of the plinth from disintegration as flood DRR

MUD SHELTER

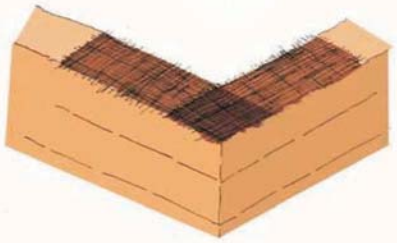
PHASE 4	SUPERSTRUCTURE
Walls Core materials and techniques	- Mud walls (mixture of mud and straw) unreinforced with any other materials should be minimum 18" thick at the base (2' -2.5' preferred). Walls should not taper to less than 13" at the top. (1.5' is preferred) - The thickness will provide resilience and distribution of the load from roof to ground. - The resistance and the durability of the wall depend on the compaction. - The compaction can be improved by ramming the walls. - Unreinforced mud walls should be built up in layers of not greater than 12" thickness per day. These layers have to be cured or hardened prior to application of subsequent layers. Time of fermentation of mud will vary according to weather conditions at the time of construction. An estimate of 3 to 4 days per layer is suggested. Local knowledge should be sought regarding appropriate length of time for curing. - The right plinth width and the plumb of the walls themselves ensure the stability
Notes and recommendations	- The mud used for the walls has to be carefully selected. - Sand, lime and cement may be added in different proportions.

MUD SHELTER

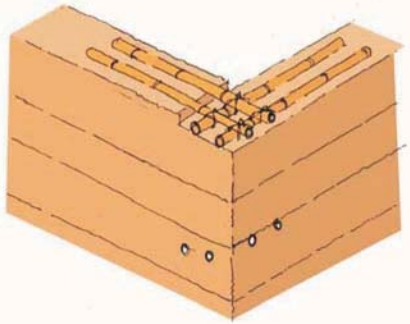
Phase 4: Elevation

- Reinforcement at corners

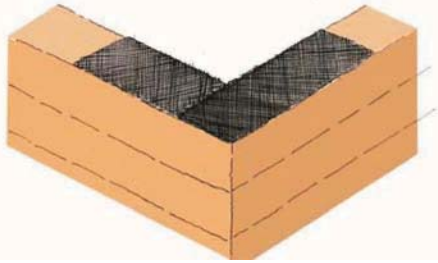
Horizontal reinforcements avoid the separation of the walls at the corners.



Horizontal reinforcements may be in overlapped jute rolls. They should be applied after every 2mud layers and extended to 2'

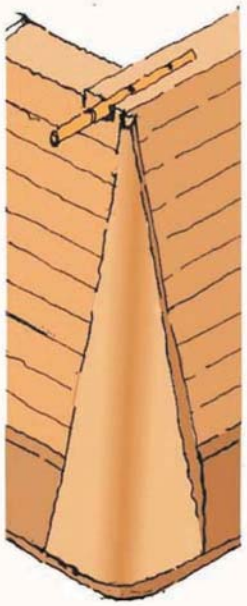


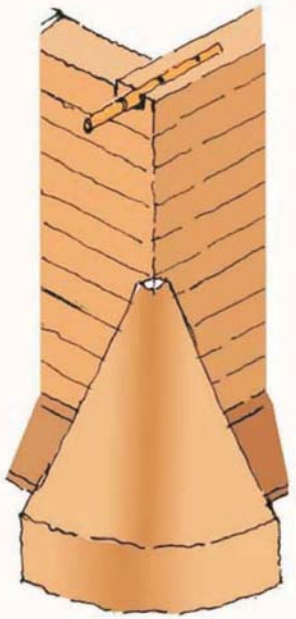
Bamboos or timbers are an option. They should be inserted after every 2-3 mud layers, overlapped at the corner and prolonged to 2"



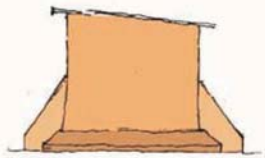
Wire mesh is also an option, if protected by a cement casting

Buttresses may support the stability of the corner.





Buttress may have the same height as of the walls, with a base almost wide like the toe at the bottom



Buttress may have the half height of the walls, with a base larger than the toe at bottom

MUD SHELTER

PHASE 4	SUPERSTRUCTURE
DRR flood resistance (plaster as protective and expendable surface)	- A lime-mud mix (1 : 3 mixture) for plaster may provide some waterproof resistance to the inner structure. - Bitumen stabilized mud mortar is also an effective treatment, it makes the wall waterproof and fire resistant. It should be prepared by mixing bitumen with kerosene oil (5:1) and mud (1.5 kg of bitumen for 30 kg of mud) - A mud toe may further protect the bottom of the walls from disintegration - The walls have to be plastered till the roof level with 2/3 coats
DRR for earthquake resistance Joint and binding Reinforced bands	- The mud walls are heavy and will perform badly in earthquake - Mud walls longer than 14' should have intermediate cross partition wall. - The use of buttresses may support the stability of long wall and corner. - Buttresses can be of full or partial height, straight or inclined - DRR earthquake resistance of mud walls may be improved by vertical and horizontal reinforcement and stitches at corner and intersection of partition walls. - Vertical elements as bamboos or timber provide confinement to the walls and directly support the roof - The horizontal reinforcements avoid the separation of the wall, they may be done with steel, wire mesh, timber, bamboo and seven jute rolls. - The band at roof level should always be executed - Stitches of cut timber or cane may be inserted in each corner and junction. They should be extend 3' from each side and vertically provided at every 2'
Maintenance	- Re-plaster the walls with lime/mud/cement mortar at least every year or whenever necessary (worn-out plaster) - Re-apply the film of bitumen yearly before the monsoon season

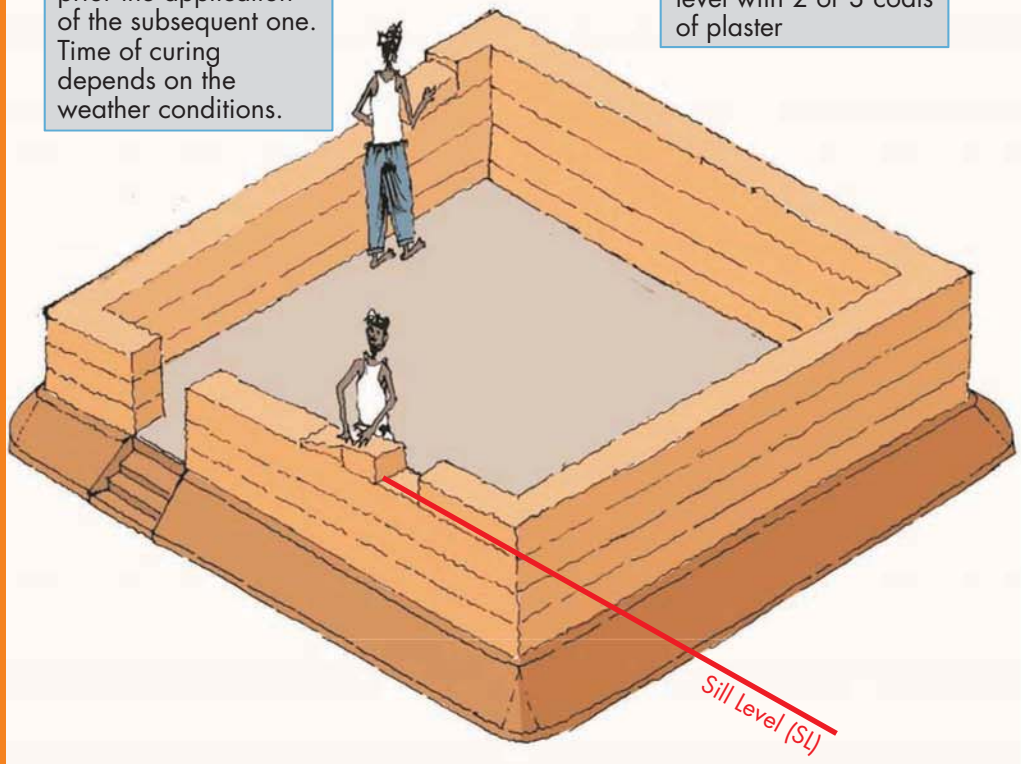
MUD SHELTER

Phase 4: Elevation

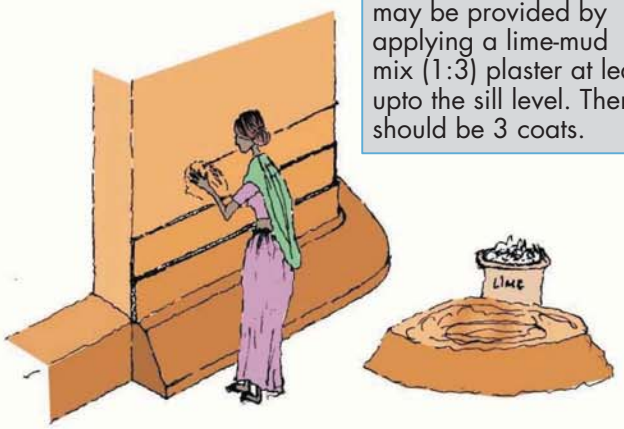
- Sill level
- DRR measures

The layers have to be cured or hardened prior the application of the subsequent one. Time of curing depends on the weather conditions.

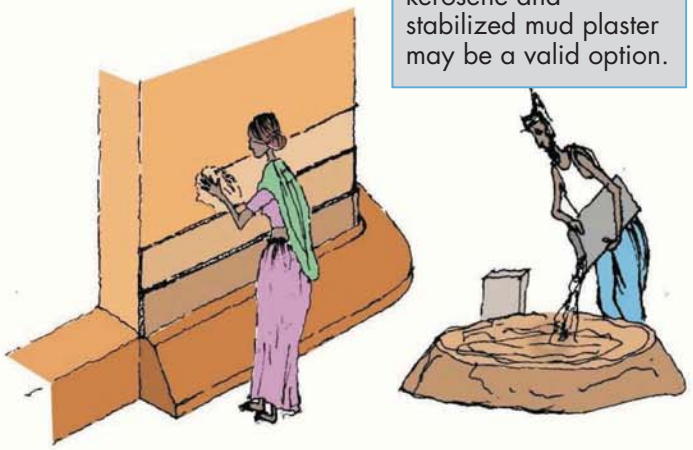
The walls have to be plastered till the roof level with 2 or 3 coats of plaster



Waterproof measures may be provided by applying a lime-mud mix (1:3) plaster at least upto the sill level. There should be 3 coats.



Bitumen mixed with kerosene and stabilized mud plaster may be a valid option.



MUD SHELTER

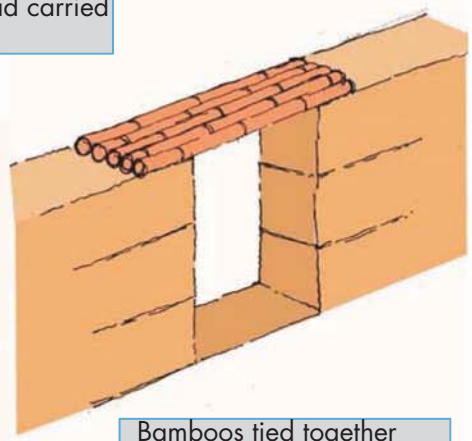
PHASE 4	SUPERSTRUCTURE
Opening door window	- Openings within the wall space should not take up an area greater than 50% of the wall. - Openings should be higher than wider - Windows and doors should be kept at minimum of 2 ft from corners and from each other and open outwards. - The doors should open outwards for fire safety purpose

MUD SHELTER

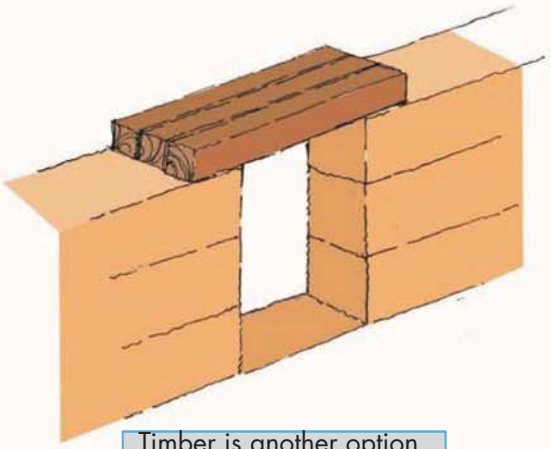
Phase 4: Elevation

- Lintel level
- Opening
- Lintel and options

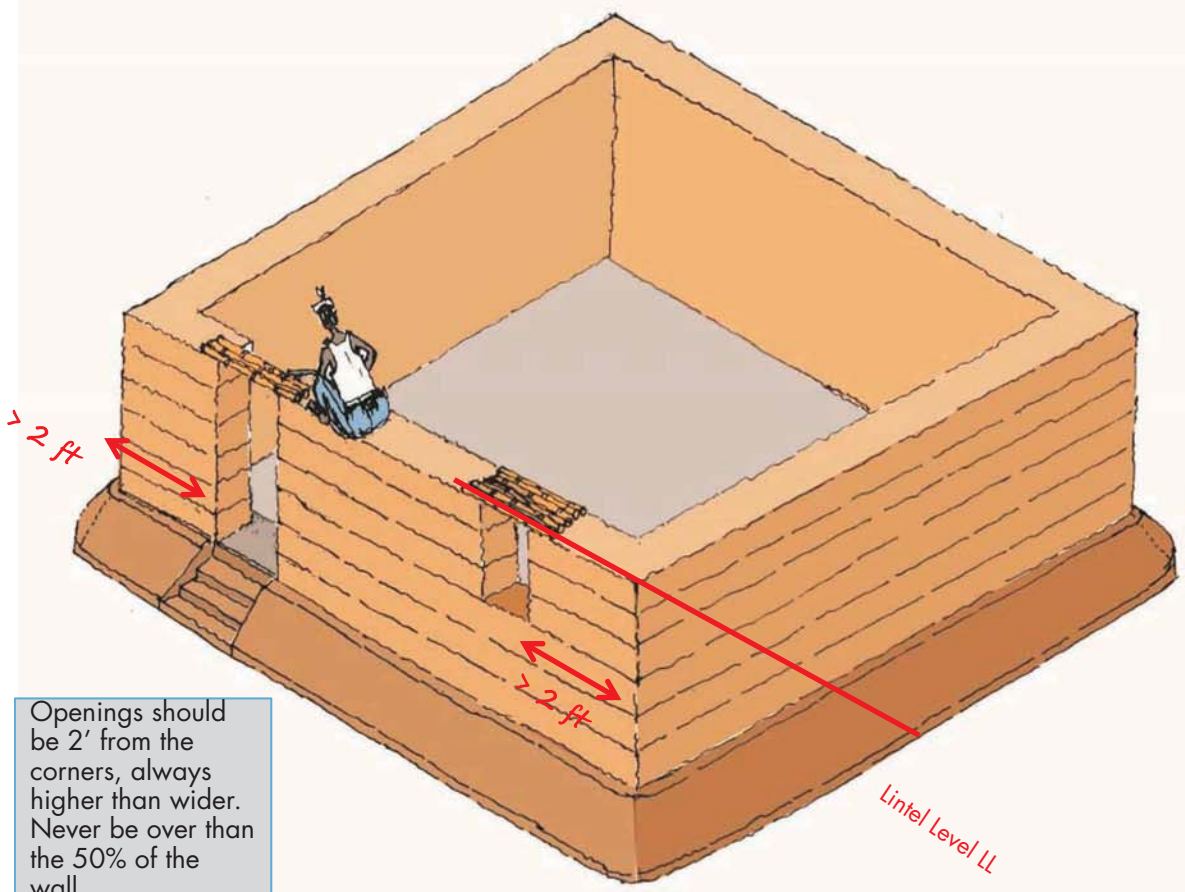
Lintels should be designed according to the load carried overhead.



Bamboos tied together may be an option. They should be 2″ diameter and 6″ longer than the opening for each side.



Timber is another option for short span, they should be 6″ longer than the opening for each side, and the thickness should be 2″



Openings should be 2′ from the corners, always higher than wider. Never be over than the 50% of the wall.

MUD SHELTER

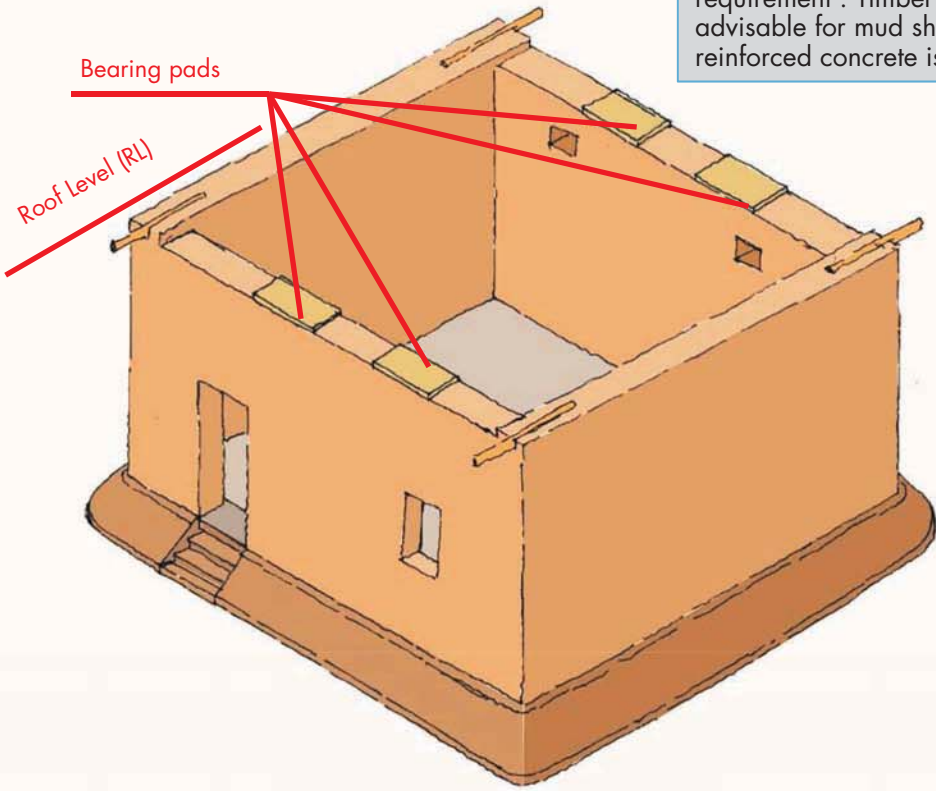
PHASE 4	SUPERSTRUCTURE
Lintels	- In order to bear and distribute the load of the wall above the openings, lintels should be installed. - Lintels should be minimum 2" thick and 6" longer than the opening on each side. - Lintels should be designed based on the load being carried overhead - For short spans, timber plate or tied bamboos (2-3) may be an option, which sounds more appropriate to the mud structure. - The pre-cast concrete lintel may be a good option - The lintel may be executed with bricks system using n.2 steels #3 and cement mortar.

MUD SHELTER

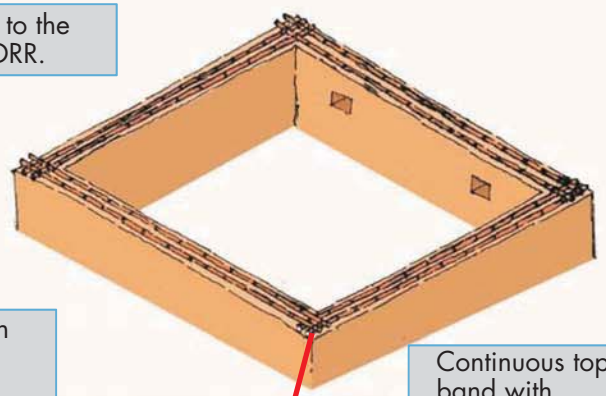
Phase 4: Elevation

- Roof level
- Bearing pad and continuous roof band
- Ventilation

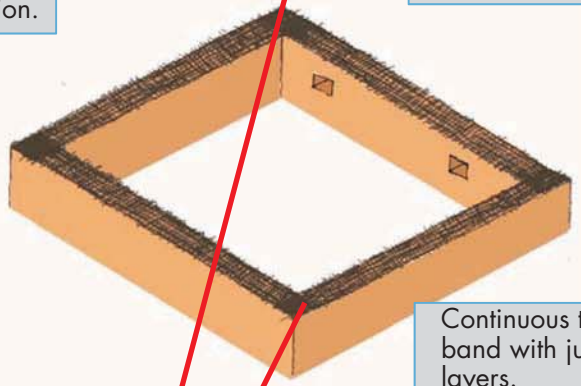
The band at roof level is preferable to the bearing pads, since it is a seismic DRR.



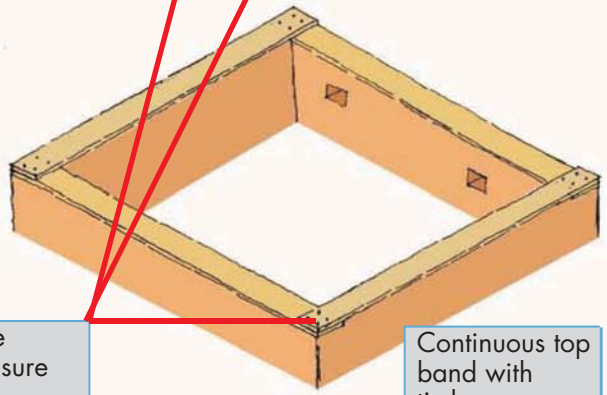
Bearing pads underneath the main beams are the minimum requirement . Timber pads are advisable for mud shelters, but reinforced concrete is also an option.



Continuous top band with bamboos.



Continuous top band with juta layers.



Continuous top band with timber.

Overlapping the elements of the reinforcement at the corners, ensure confined action.

MUD SHELTER

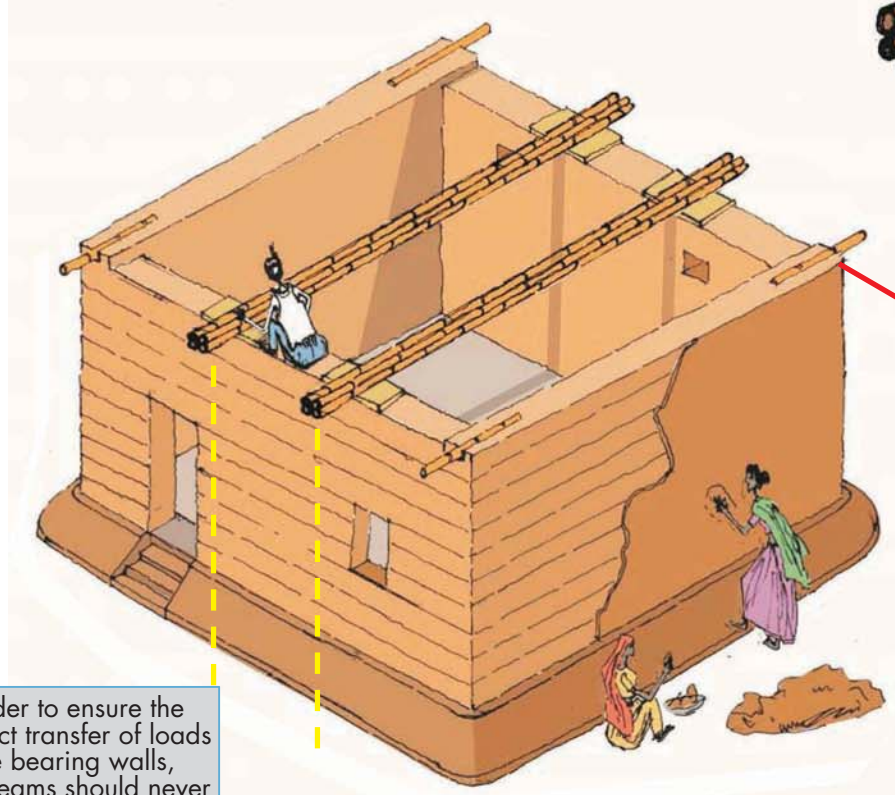
PHASE 4	SUPERSTRUCTURE
Ventilation	- The ventilation is very important mainly during the summer which is very hot in several areas. - Two windows may ensure ventilation. Alternatively one or two ventilators, executed on the opposite side of the window (generally on the back wall) may ensure a good ventilation. - The dimensions depend on the size of the shelter, it may be one of 2' x 1' or two 1'x1' - In some areas, where the summer is very hot, it may be suggested to increase the height of the shelter to improve the internal ventilation. In this case the entire structure of the shelter has to be re-calculated (note this will increase the cost of the shelter)

MUD SHELTER

Phase 5: Roof

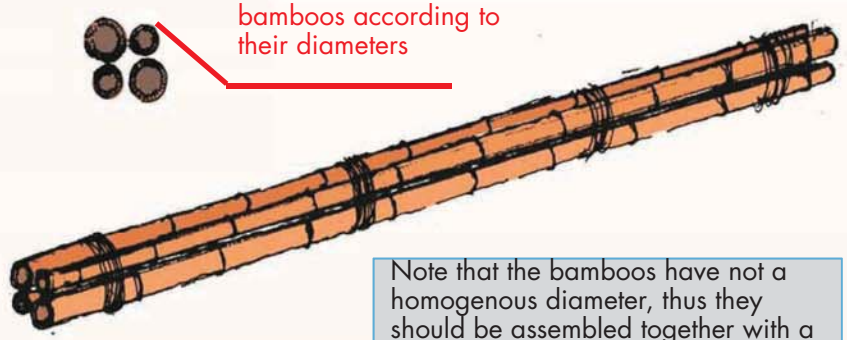
- Roofing structure: main beams

3 or 4 bamboos tied together or other lightweight roof may be used as beams for mud shelters. The minimum requirement is two beams, Bearing pads underneath the main beams are compulsory.



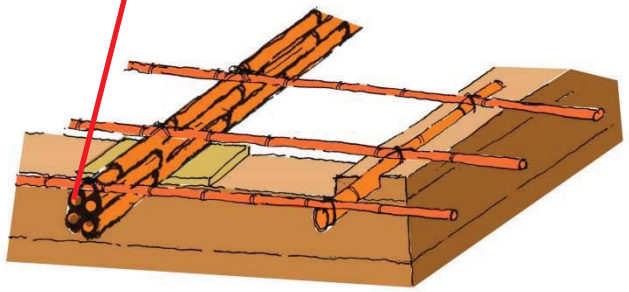
In order to ensure the correct transfer of loads to the bearing walls, the beams should never be placed in line with opening, which are the weak portion of the masonry.

Placement of the 4 bamboos according to their diameters



Note that the bamboos have not a homogenous diameter, thus they should be assembled together with a rotation of 180, if necessary, alternating bigger diameter with smaller.

Eaves or overhang of the roof of 15" may prevent rainwater from running down wasting the mud plaster



MUD SHELTER

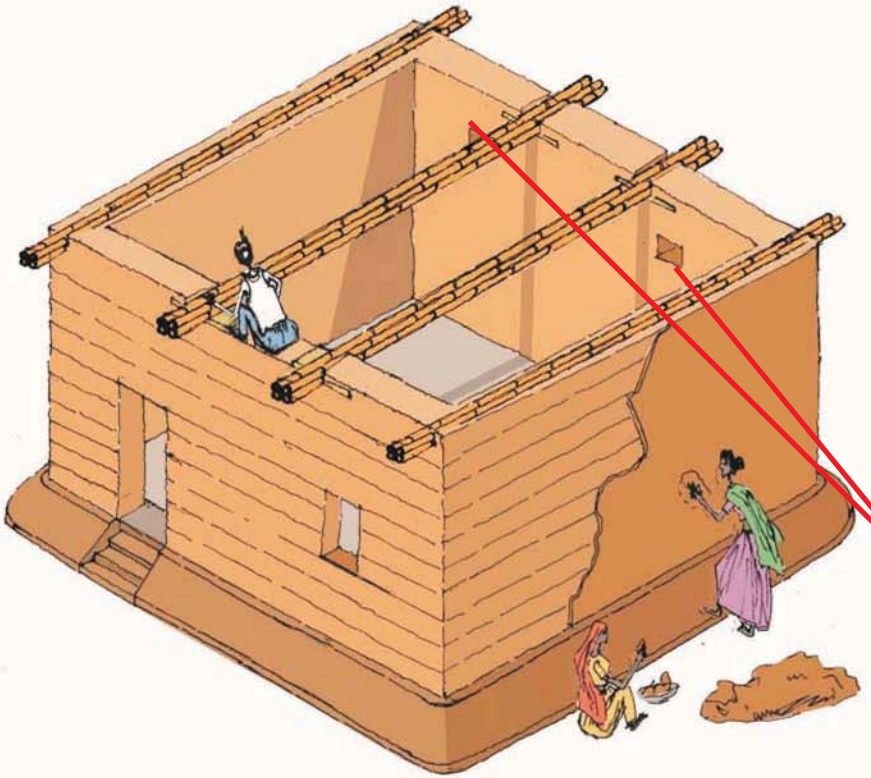
PHASE 5	ROOF
Generic guidance	- Roof design should allow for live and dead loads. Live loads are applied loads such as rain, wind, snow or usage for grain or livestock. Dead loads are those including the makeup of the roof structure such as beams, straw, mud, cement etc. - A bamboo or other lightweight roof can be used for all construction methodologies, while steel girder roof or similar heavy roof requires a strong bearing structure. Therefore it is only suitable for fired brick, concrete block, engineered steel frame shelters - A thick mud layer will add a lot of load to the roof and may cause severe damaging strain to the roof structure and loadbearing walls. - Timber elements may in some cases be larger loads than steel or other alternatives. - Bamboo and timber are susceptible to termites. Adequate treatment should be provided to timber and bamboo materials - Timber, bamboo or straw roofs are not suitable for indoor cooking or heating fires. - A conical or four-sided pitched roof is preferable in areas where wind loads are a consideration, particularly cyclone vulnerable areas. - Gable ends or flat surfaces may be more stressed by resisting to the wind force - The pitch of a roof will vary based on the wind conditions in the area, however a maximum pitch of 30º is advised for simple pitched roofs. - A mono-pitched roof may have a pitch of up to 10º to allow adequate drainage of rainwater. - In the flat roof, they should be a minimum slope of 3/8" per foot.

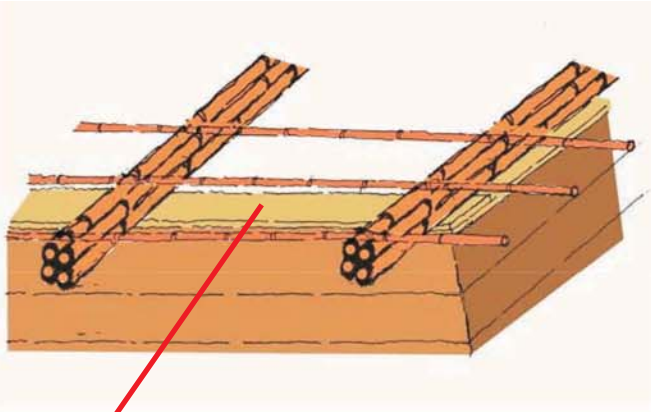
MUD SHELTER

Phase 5: Roof

- Roofing structure: main beams

For thicker covering packages 4 beams are suggested. Bearing pads underneath the main beams are compulsory.





The continuous band underneath the beams is preferable for a better transfer of loads and a seismic DRR.

Remember that the bamboos or timbers have to be treated with anti termite products

Two openings on the opposite side of the window and door can ensure internal ventilation. They may be 2' x 1' depending on the volume of the shelter. Ventilation is very important mainly during the summer season.

MUD SHELTER

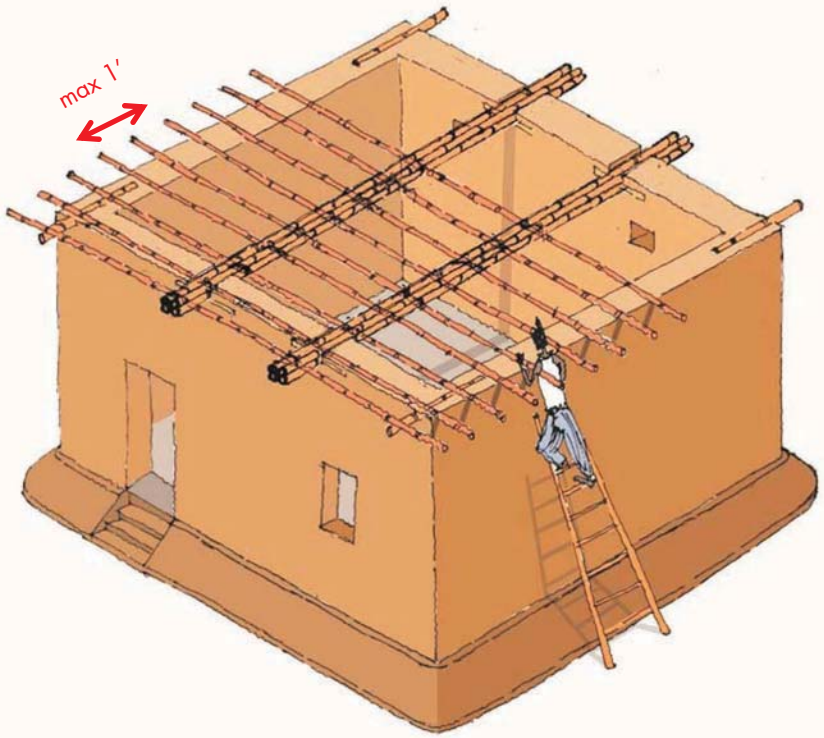
PHASE 5	ROOF
Main structure	- A bamboo or other lightweight roof can be used for all construction methodologies. - As main beams three or four bamboos tied together may work. The number of main bamboo beams should be two. - Timber of adequate section and weight may be an option; a bearing pad should be placed underneath. - Steel girders are not advisable, in such case a bearing plate has to be inserted underneath the girder in order to distribute its load - The secondary structure of purlin may be made by well sized bamboos. The distance between bamboos should be not more than 1' (1 brick), their length has to be enough to overlap the thickness of walls - Above the bamboos a mat of chick, straw, thatch or plastic sheet is generally used. Straw and plastic sheet have to be incorporated in the top of the walls at the final plastering. - Bamboos, timber and straw should be treated against termites. T-iron and tiles are forbidden for mud walls

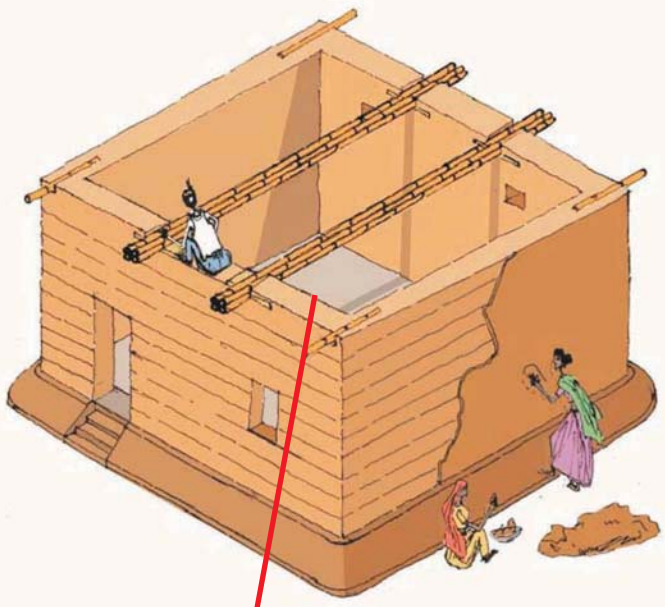
MUD SHELTER

Phase 5: Roof

- Roofing structure: purlins

The secondary structure of purlins may be done with bamboos of minor diameter i.e. 2". The distance between the purlins should be maximum 1', a brick may be used to interspace them





There should be no gaps between the walls and the roof.

MUD SHELTER

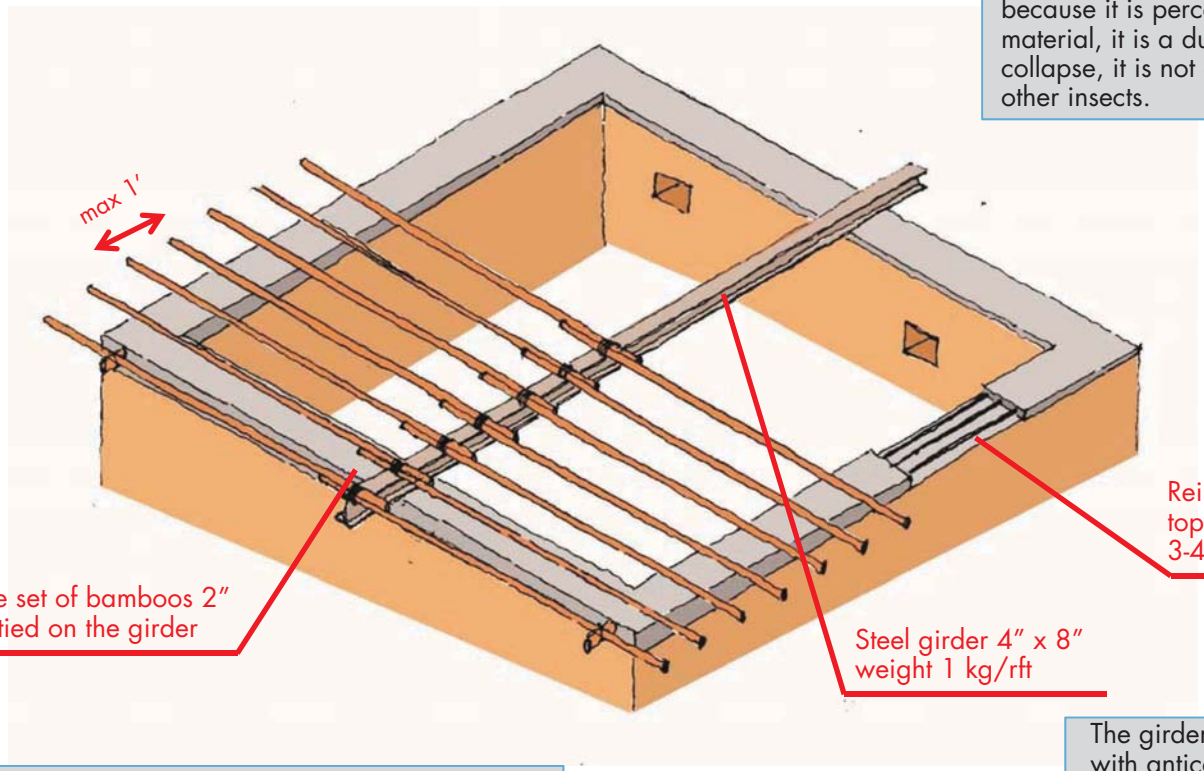
PHASE 5	ROOF
Note and recommen-dations DRR for earthquake resistance	- All loadbearing elements of the roof structure, columns, beams and joints should not be placed above door or window openings. Any openings provide weaknesses in the walls, because of reduced portion of bearing walls, thus placing the loadbearing elements right above the openings which may cause failure in the walls with cracks and even collapse of the portion. - All elements of the roof structure should be tied to each other. All joints or beams in the roof structure need to be individually tied to purlins. The roof must also be securely tied to the wall structure. Good fastening ensures a good resistance to the strong wind and is a kind of DRR against earthquake - Roofs have different load distribution arrangements, as there is concentration of loads underneath the beams. In order to equally distribute the roof loads, a top plate/band or ring beam should be provided at the top of the walls. It should be continuously encircling the walls, this provides a way of fastening the walls together at the top to prevent pushing outward forces of the roof and in case of horizontal seismic forces. - In case of pitched roof with two gables placing plates/bands at the top of the wall (without gables) distribute the loads and constrains the pushing forces of the rafters. - It is suggested to assemble trusses instead of rafters, since the horizontal bottom chord ties the inclined top chords constraining their pushing outward forces.

MUD SHELTER

Phase 5: Roof

- Roofing structure: options

Although it is not recommended, another solution preferred by the beneficiaries is to use girders as main structure for the roof. The reasons why girders are preferred, because it is perceived as highly resistant material, it is a durable material in case of collapse, it is not affected by termites and other insects.



The girder has to be treated with anticorrosive solution to prevent the rust.

Due to its higher weight it is compulsory to execute the roof ring band in reinforced concrete. As alternative, at least longer bearing pad always in reinforced concrete. Furthermore it is advisable to place only one girder in the middle. The secondary structure of purlins may consist of a double set of bamboos, this allows also to select their right size .

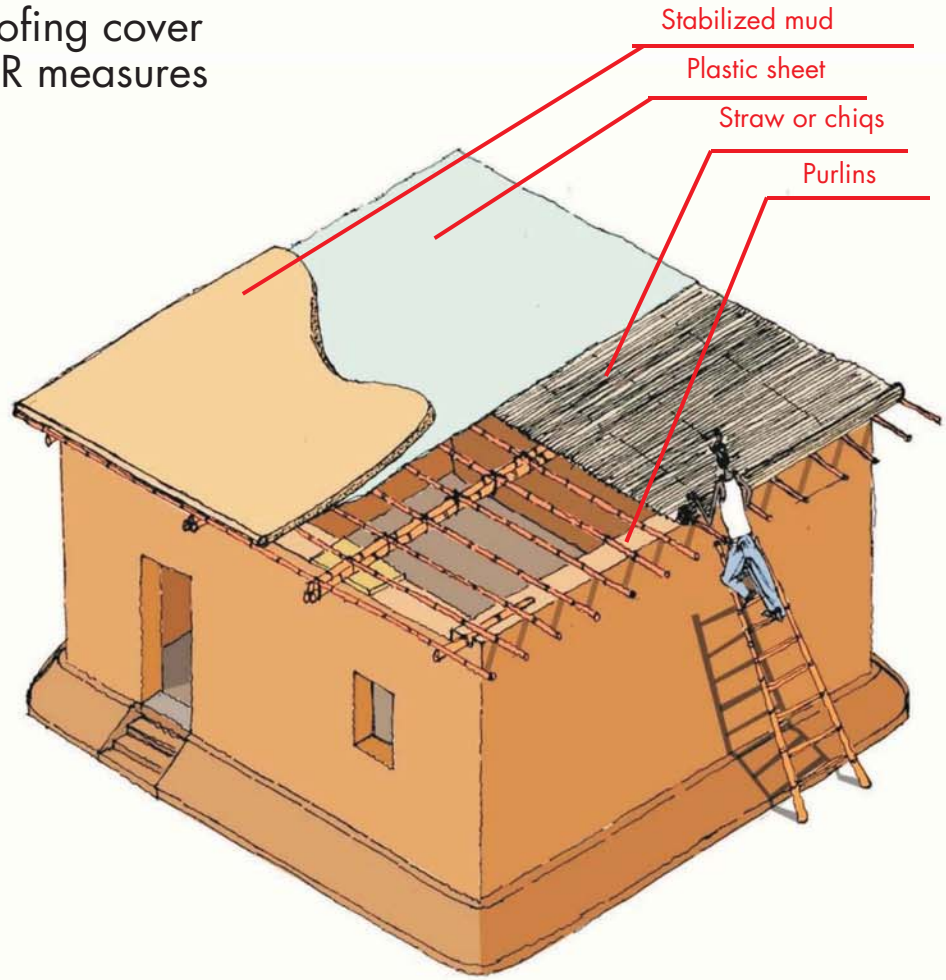
MUD SHELTER

PHASE 5	ROOF
Covering package Generic guidance	- Roof topping can be made with many different materials as long as the items are lightweight, strong, durable, secured, waterproof, insulating and maintainable. - Any material that soaks water or melt should be avoided - A common practice is the use of a thatch or other structural system, plastic sheeting with a mud plaster layer, protected with a final waterproofing layer. - Lime plaster or a bitumen mixture may provide a water-resistant finish to the roof that should be reapplied prior and after annual rains.
Covering package Specific guidance	- Above the semi structural mat of straw or thatch, a polythene sheet, a layer of stabilized mud have to be applied in 2-3 coats, the thickness may be 3" maximum. The mud layer may make the structure heavy. - The last coat should be a waterproofing. Lime /mud plaster may improve the water resistance. - Bitumen mixed with stabilized mud mortar is an effective treatment, it is waterproofing and fire resistant. It should be prepared by mixing (5:1) bitumen with kerosene oil and mud (1.5 kg of bitumen for 30 kg of mud). - The animal dump, mixed with mud, may also be a kind of waterproofing as an eco-friendly option - In case of flat roof, the coats of plaster have to be incorporated at the top of the walls and the parapet, protecting the matting of plastic sheet and straw and the structure of roof, as a kind of waterproofing capping. This is a DRR that will avoid the rain water to penetrate in the connection of roof/walls.

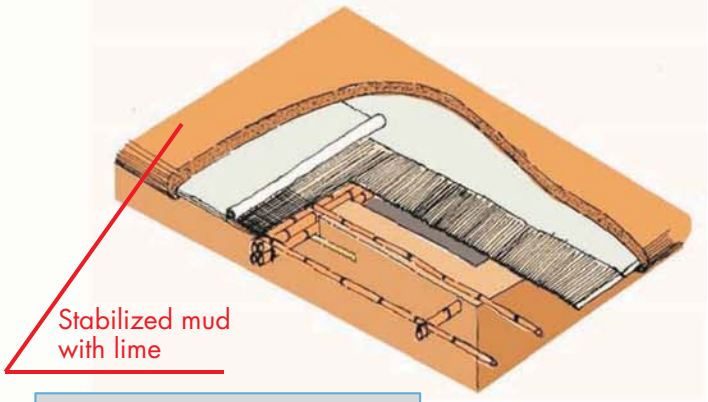
MUD SHELTER

Phase 5: Roof

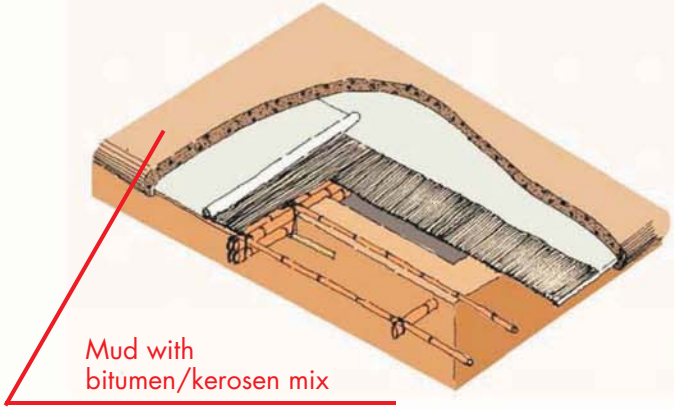
- Roofing cover
- DRR measures



Covering package may be executed with straws or chiqs, polythene sheet and 2-3 coats of mud. The maximum thickness of the mud should be 3" in order to avoid heavy loads on the beams and the walls



The covering package with straw, plastic sheet and 2-3 coats of mud. The last layer has to ensure waterproofing protection to the roof, thus it may be with stabilized mud or with lime. The thickness should be 3" maximum.



Another option for the last waterproofing layer may be by adding bitumen mixed with kerosene to the mud. The thickness may be less than 3". Animal dump may also be an ecofriendly option.

MUD SHELTER

PHASE 5	ROOF
DRR waterproofing and drainage	- An overhang of the roof, or eaves, of 15" minimum will prevent rainwater from running down mud or plaster of the walls and soaking into the structure and the plinth. This will aid the structure's resistance. - For flat roof it is important to have a right slope to allow the rain water to wash away quickly, the stagnancy on the roof will allow the rain water to soak in the top layers and penetrate in the core of walls. - Where there is a parapet it is compulsory to provide 1 or 2 waterspouts, the slopes have to be arranged accordingly (minimum 1%). - The waterspouts should be minimum 2.5"and project minimum 8". - The waterspouts have to be well sealed with bitumen without any discontinuity in order to prevent rain water to penetrate in the structure of roof and walls. - Another option may be CGI spout in "U" shape. - The use of gutters to catch rain water may be considered; obviously the slope has to be adequate in case of flat roof

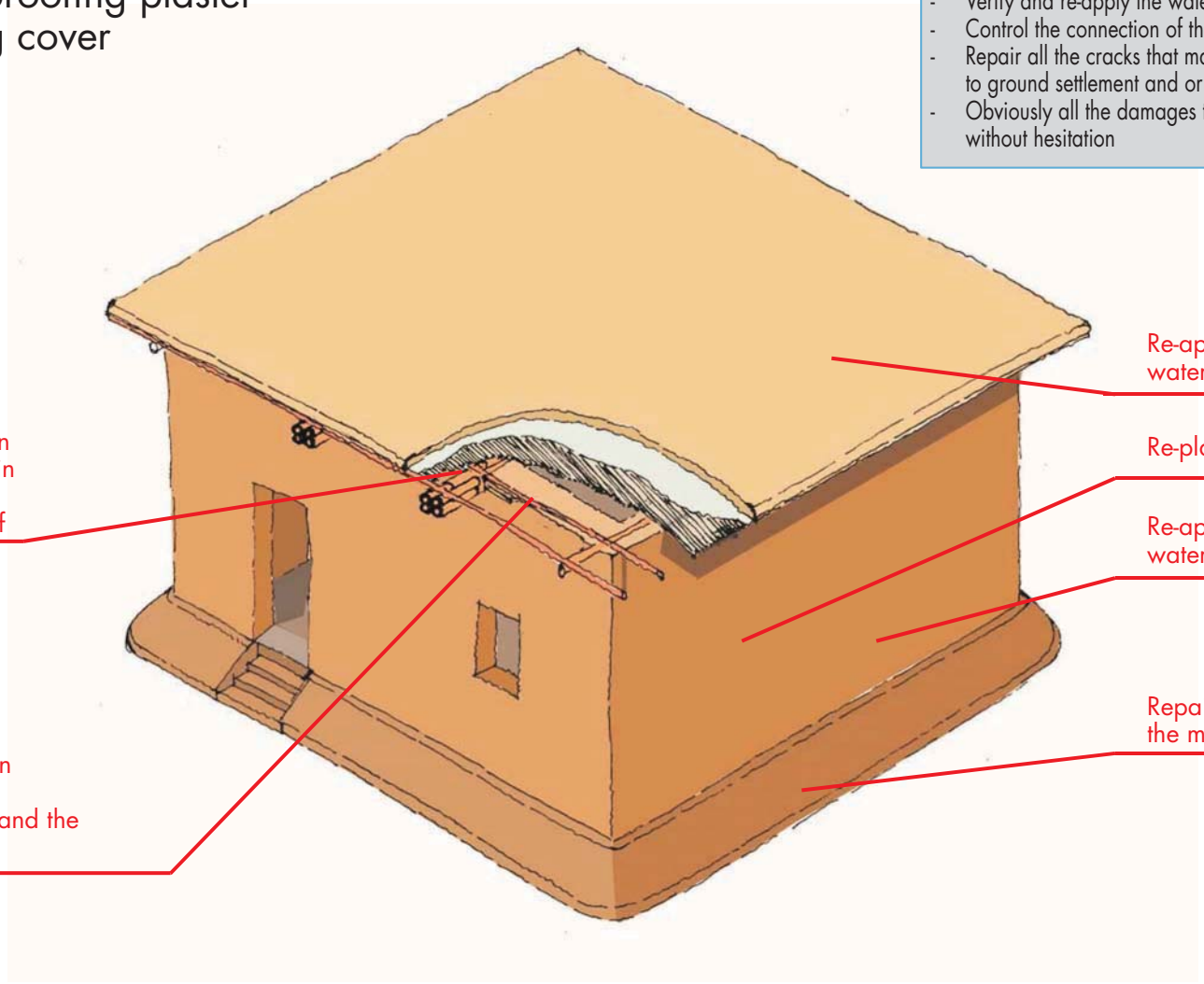
MUD SHELTER

Maintenance:

- DRR
- Waterproofing plaster
- Roofing cover

Maintenance of the structure and DRR ensures a longer and safer life of the shelter. the main treatments to be applied periodically, i.e. yearly, are:

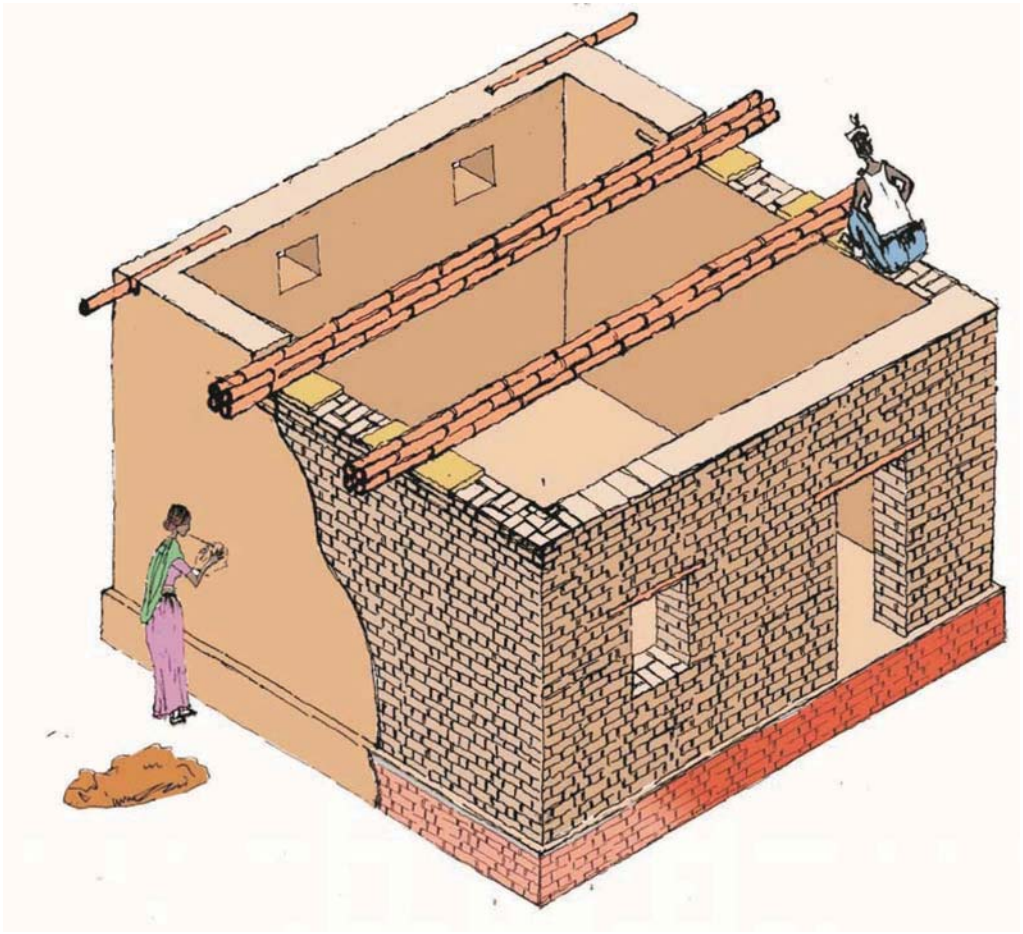
- Re-plastering before the raining season
- Verify and re-apply the waterproof layer of bitumen stabilized mud till the SL
- Verify and re-apply the waterproof layer of the roof
- Control the connection of the main structure of the walls
- Repair all the cracks that may have appeared on the walls due to ground settlement and or dry weather
- Obviously all the damages that might occur should be repaired without hesitation



MUD SHELTER

PHASE 5	ROOF
Maintenance	- Re-plaster the roof with lime mud or bitumen mud mortar at least once an year or whenever necessary - Periodic cleaning of the waterspouts - Re-apply the film of bitumen yearly before the monsoon season - Verify the good connection of the element of the structures (beams and purlin) - Re-treat the bamboos and wooden elements against termite once an year or whenever necessary - Inform the owners regarding periodic termite treatment, annual re-plastering of the roof, periodic cleaning of the waterspouts

ONE ROOM SHELTER
ADOBE BRICK



ADOBE BRICK SHELTER

Walls of adobe houses are constructed with sun dried bricks/blocks laid in mud mortar. The foundation and the raised plinth should be in fired brick masonry and cement sand mortar as DRR.

The thickness of the walls has to be 13.5" minimum, increasing up to 18". The improves the stability and the DRR against earthquake.

DRR measure against floods includes plastering at least upto the sill level of the walls, (external and internal) with stabilized mud or a mixture of mud bitumen and kerosene. The whole plastering of the wall upto the roof level ensures a better protection against the rainflash too.

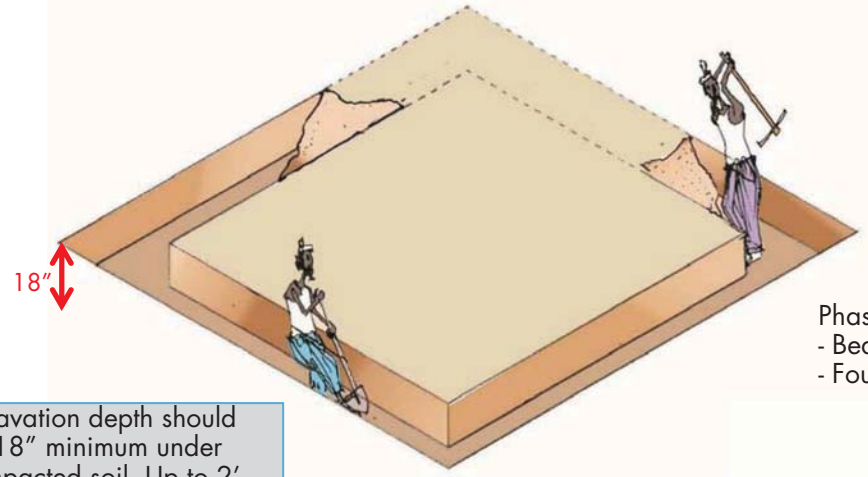
The same DRR has to be applied upon the roof, ensuring continuity between the roof application and the plastering of the walls.

DRR for the earthquake resistance may include a reinforcement with a vertical frame, at the corner and reinforced bands at floor, sill, lintel and roof level. The roof band is always suggested.

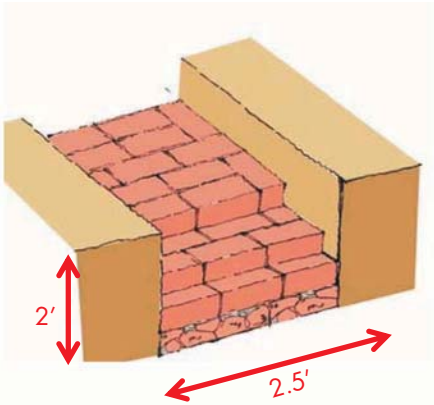
The eaves may protect the walls from the eroding action of the rain.

ADOBE BRICK SHELTER

Phase 1: Excavation
- Excavation

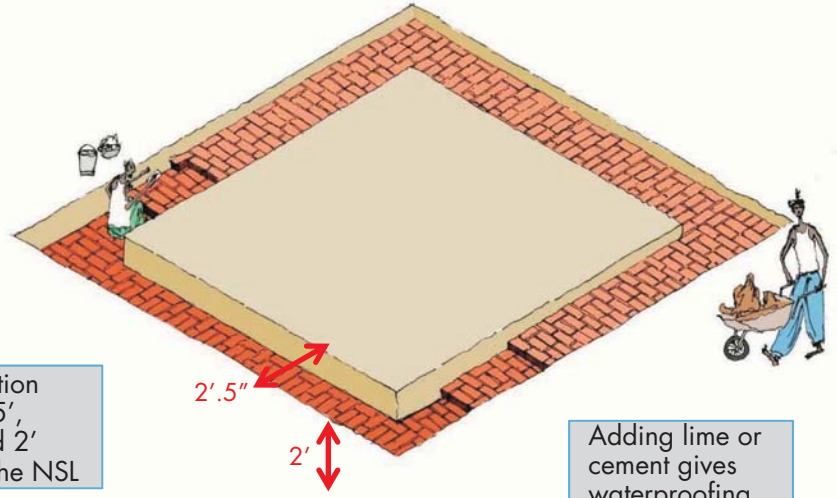


Excavation depth should be 18″ minimum under compacted soil. Up to 2′ - 3′ when not compacted



Phase 2: foundation
- Bearing foundation
- Foundations

Phase 2: Foundation
- Bearing foundation
- Foundation



Foundation with 2.5′, founded 2′ below the NSL

Adding lime or cement gives waterproofing resistance

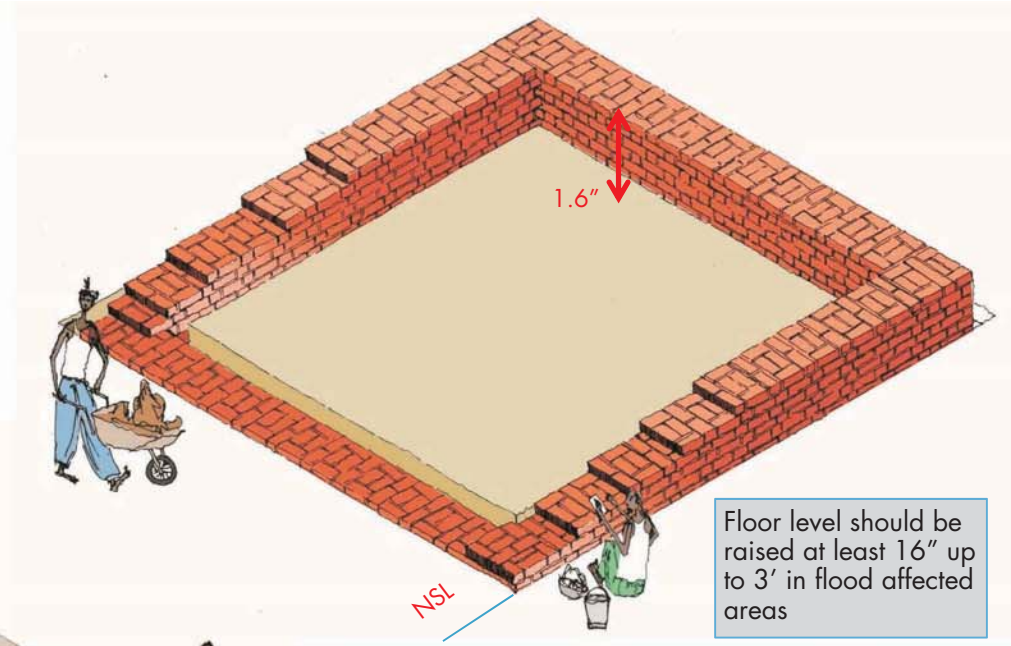
ADOBE BRICK SHELTER

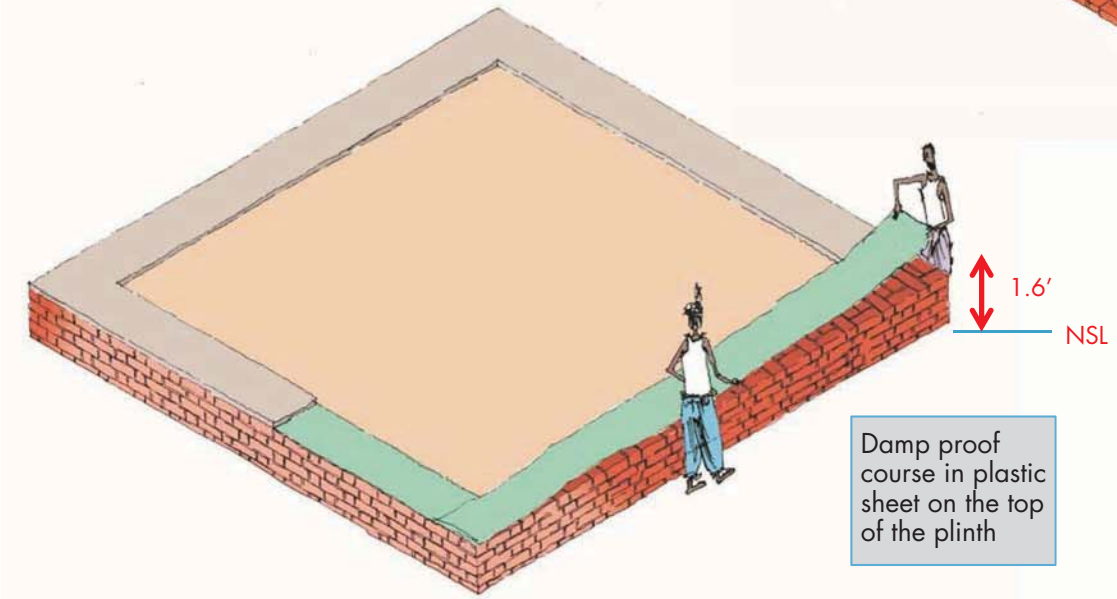
PHASES 1 and 2	EXCAVATION, BEARING FOUNDATIONS AND FOUNDATIONS
Generic Guidance	- Foundations and platforms specification, depth and height depending on the site, characteristics (soil, elevation), super structure, materials and loads. Thus the depth and width have to be designed on a case to case basis. - The excavation depth may be more than 2'- 3' in not compacted soils. - Generally the width of the platform should be almost one third for each side=1.6-2 times the thickness of the walls. - Increasing the width of walls at the base will improve resistance and help keep longer the flood water away from the base of the walls which will extend or prevent the time of disintegration (depending on the time of stagnancy) - The foundations need to have a sealed barrier at the base to prevent water penetration into the structure both from the ground (dampness) or from stagnancy. - Reinforce the walls at ground level by adding concrete plaster /pointing layer or mud / lime
Specific Guidance	- Excavation depth minimum 18" below undisturbed ground or compacted soil. - If there is a skeleton (wall columns), the wall structure needs to penetrate to a minimum of 18" in the ground reaching the solid layer and being reinforced with cement or lime / mud posts, to ensure stability of the shelter - Minimum dimension for the foundations are 2.5'wide footings founded 2' below the Natural Surface Level (NSL). Dimension may increase with mud mortar
Notes and recommendations	- Tapered foundation may distribute the load better to the ground and are also economical. - The foundations can be in stones, in fired bricks, in concrete, cement/sand mortar - Adobe brick are not suggested for the foundations, but in case cement mortar has to be used, then they have to be plastered with cement/sand/lime to improve the waterproofing - Wall columns in wooden pole or bricks may reinforce the structure (DRR against earthquake) - When the adobe has a skeleton, appropriate anchoring details for the foundation should be considered

ADOBE BRICK SHELTER

Phase 3: Raised Plinth

- Execution of plinth
- DPC





ADOBE BRICK SHELTER

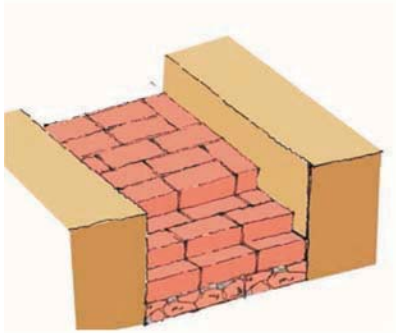
PHASES 3	RAISED PLINTH FLOOR
Generic Guidance	- The floor level should be raised to at least 1.6′ upto 3′ above the Natural Surface Level (NSL) adopting a continuous plinth. - General recommendation is to further protect the foundations below floor level by raising an earth platform 3′ wide at the top and tapering to NSL over 6′. (i.e 1 in 2 slope minimum.) - The top of this platform should be 6″ below floor level. - A damp proof course (DPC) at plinth level is compulsory in order to prevent moisture rising into the walls. A DPC is either a thin layer of concrete at plinth level with plastic on one surface or simply a strong plastic layer
DRR improvements (Flood and earthquake)	- The plinth may be in stones, in fired bricks in concrete, cement/sand mortar can be used. - At the top of the plinth a reinforce band with 2 bars can ensure the earthquake resistance, in case of concrete plinth it may be reinforced with 4 bars
Maintenance	- Re-plaster the raised plinth with lime/mud/cement mortar at least once a year before the monsoon season and whenever necessary - In case of reinforced band: verify that the bars are not exposed and corroded, paint them with red oxidant varnish

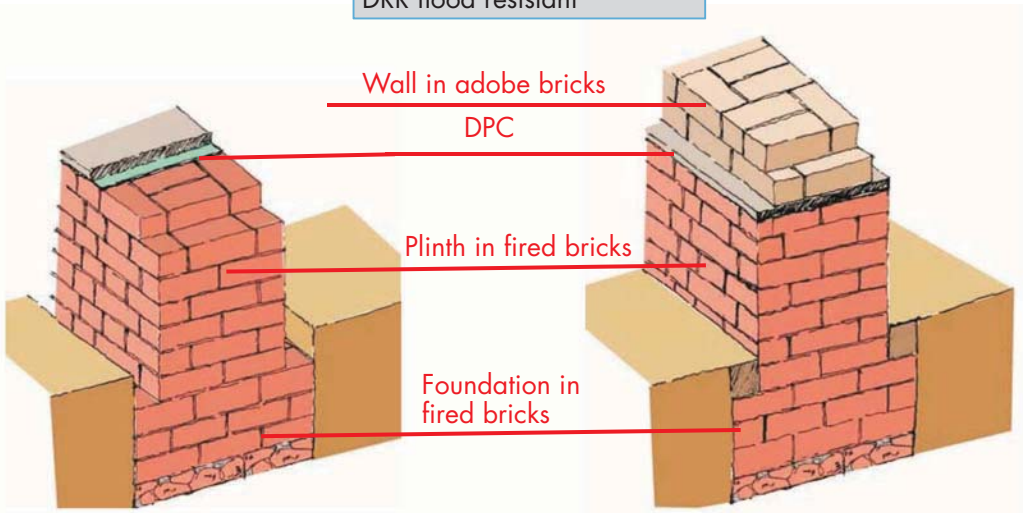
ADOBE BRICK SHELTER

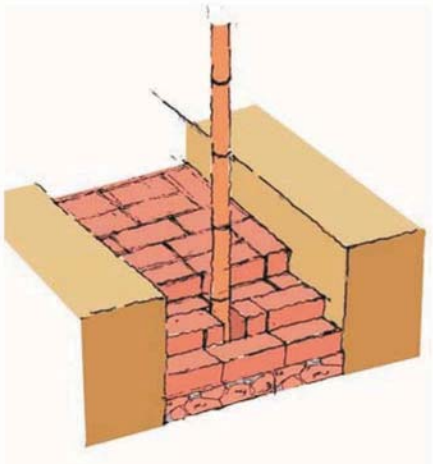
Phase 3: Raised Plinth

- Details
- DRR measures for reinforcement

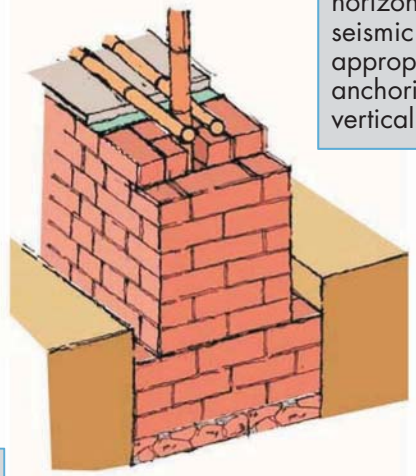
Foundations and plinth are suggested to be in fired bricks and cement mud as DRR flood resistant



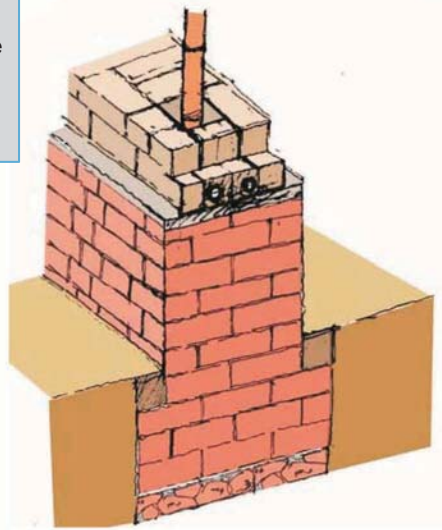




The masonry may be reinforced by vertical poles and horizontal band. The poles have to be well anchored with the foundations



Reinforcement with horizontal band as seismic DRR. Ensure appropriate anchoring with the vertical frame



ADOBE BRICK SHELTER

PHASES 3	SUPERSTRUCTURE
Walls Core materials and techniques	- Adobe brick construction should not be built less than 13.5" thick, in order to provide resistance and distribution of the load from roof to ground. - To reduce the weaknesses, it is important for good execution to start building the walls from the corners, and get the bond correct, since weak corners make the shelter vulnerable. - Lime and cement should be added to the mud mortar to increase the bonding capacity and the waterproofing
Notes and recommen-dations	- In order to improve the durability fired bricks may be used for the external face of walls only upto the sill level, and the abode brick for the internal. The thickness will be minimum 13.5". - Another solution may be to use fired bricks walls (full wall) upto the sill level and above with the adobe. This increases the bearing capacity and water resistance. - If only adobe bricks are available, in order to improve the stability and durability of the shelter, the thickness may be increased to 18" at the base of walls, till sill level. - Cement-lime-sand mortar is preferred to the mud mortar, although the walls have to be plastered.
DRR for earthquake resistance Joint and binding Reinforced bands	- Suitable interlocking of adobe brick should be provided to ensure stability and durability of walls and provide earthquake resistance. - In order to reinforce the corners, the wall rows may be overlapped and projected at the corners, this provides a buttress. Increasing the thickness at the corners also provides buttresses - It is also recommended to use fired bricks as columns for the corners and openings of an adobe structure. Steel bars may be used as vertical reinforcements at the corners and junctions

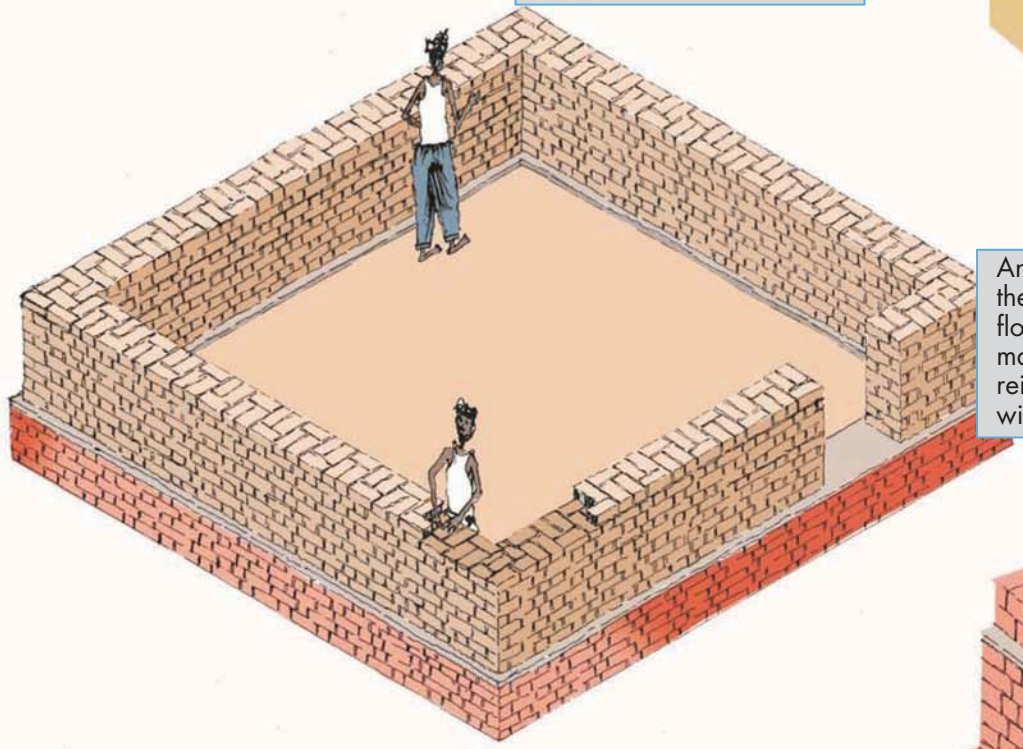
IASC Inter Agency Standing Committee PAKISTAN FLOODS SHELTER CLUSTER

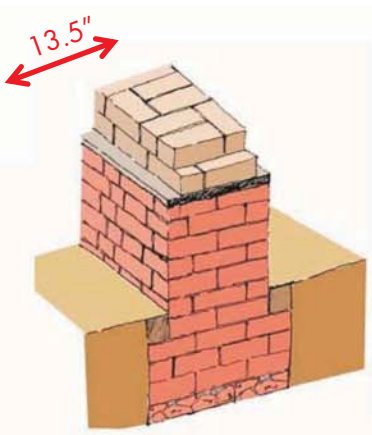
ADOBE BRICK SHELTER

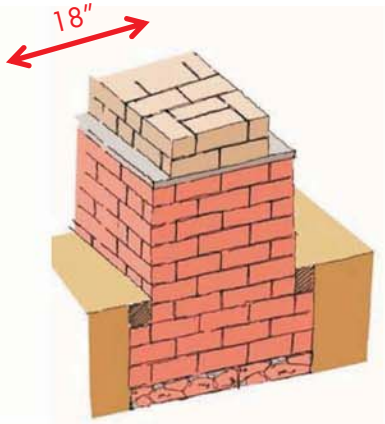
Phase 4: Elevation

- Sill level
- Reinforcement

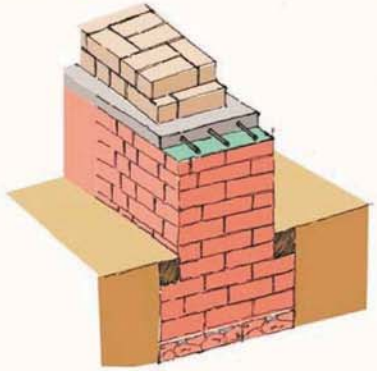
Adobe walls should not be less than 13.5" thick. Increasing the thickness to 18"at the base till the sill level, improving the stability as DRR against the earthquake

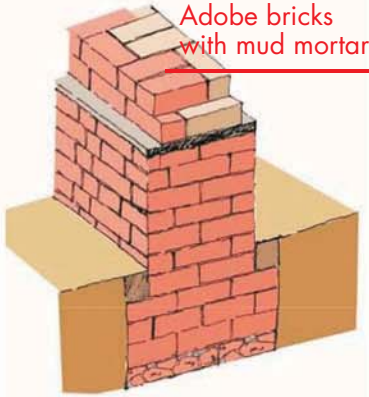


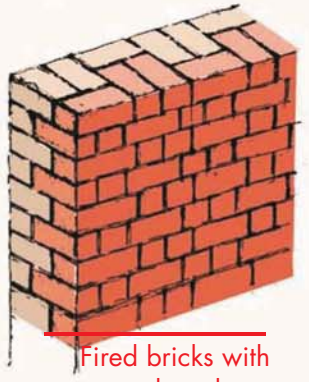




Another DRR against the earthquake is the floor level band that may be executed with reinforced concrete, with 3 bars # 4.







As DRR measures against the flood it is a good practice to use fired brick with cement/sand mortar for the external side of walls, at least till the sill level.

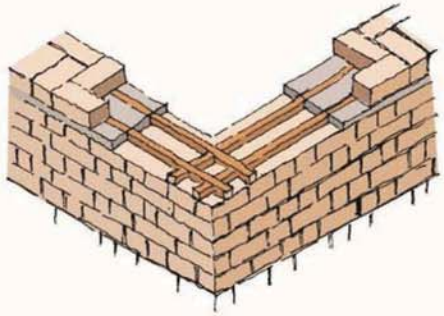
ADOBE BRICK SHELTER

PHASES 4	SUPERSTRUCTURE
DRR flood resistance (plaster as protective and expendable surface)	- The Adobe has poor water resistance thus the external walls have to be protected. - The adobe shelter has to be completely plastered externally, while internally at least till the sill level. - A protective layer is compulsory for the external walls and suggested for the internal as well. - A protective layer has to be applied at least till 3' above the ground level (better sill level). - The protective layer may be a eco-friendly one as lime–mud mixture, or animal dung mixed with mud, or in alternative a film of bitumen mixed with kerosene oil. - Bitumen with stabilized mud mortar is an effective treatment, it makes the wall waterproof and fire resistant. It should be prepared by mixing bitumen with kerosene oil (5:1)and mud (1.5 kg of bitumen for 30 kg of mud) - It is suggested to use lime/cement plaster till sill level for waterproofing (applied on the bitumen film). - Above the sill level the use of lime-mud plaster (1 : 3 mixture) may improve the water resistance to the inner of the upper structure - The coats have to be 2- 3 applied by curing and in sequence till the roof level
Maintenance	- Re-plaster the raised plinth with lime/mud/cement mortar at least once a year before the monsoon season, and whenever necessary (worn-out plaster) - Re-apply the protective film (mixture with lime, or animal dung, or bitumen) at least once a year before the monsoon season or when worn-out - In case of reinforced band: verify that the bars are not exposed and corroded, paint them with red oxidant varnish

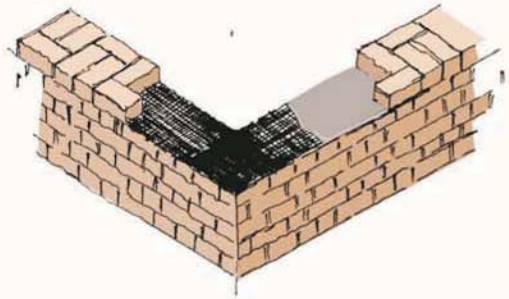
ADOBE BRICK SHELTER

Phase 4: Elevation

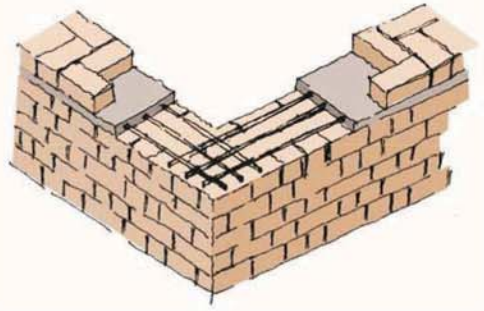
- DRR measures
  - Reinforcement at corners
  - Plastering



Timbers or bamboos are an option. They should be inserted every 2.5', overlapped at the corner



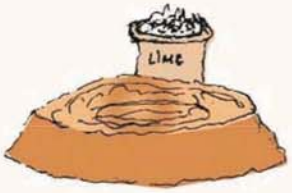
Wire mesh is also an option, if protected by a cement casting. This reinforcement should be also provided at least every 3'



Reinforced concrete corners may be a good option if the bars are well placed and protected by the cement. They should be provided every 3'

Plastering the walls externally is compulsory, the internal plaster is also a good practice as DRR in order to protect the adobe from the erosion caused by the stagnant water.

Waterproof measures may be provided by applying a lime-mud mix (1:3) plaster at least till the sill level. There should be 2-3 coats.



Adding lime or cement to the mud mortar gives waterproofing characteristic. It is suggested to use this improved mortar at least till the sill level, which is also generally the flood level

Bitumen mixed with kerosene and stabilized mud plaster may be a valid option.

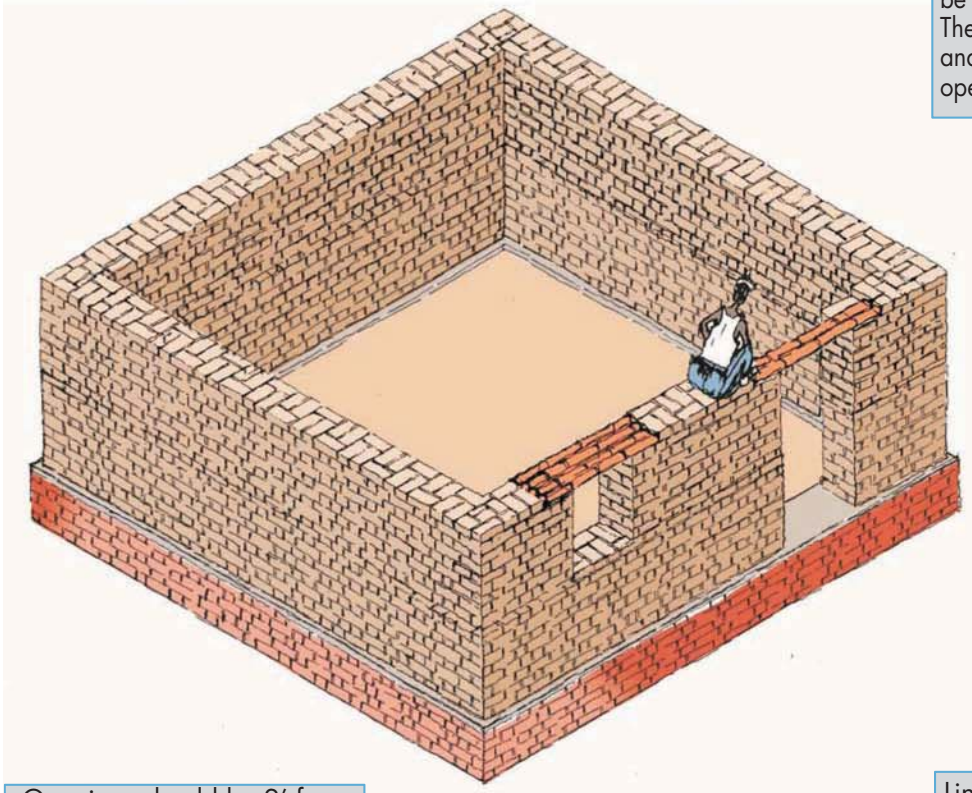
ADOBE BRICK SHELTER

PHASES 4	SUPERSTRUCTURE
Opening door window	- Openings within the wall space should not take up an area greater than 50% of the wall. - Openings should be higher than wider - Windows and doors should be kept a minimum of 2 ft from corners and from each other and open outwards. - The doors should open outwards for fire safety purpose

ADOBE BRICK SHELTER

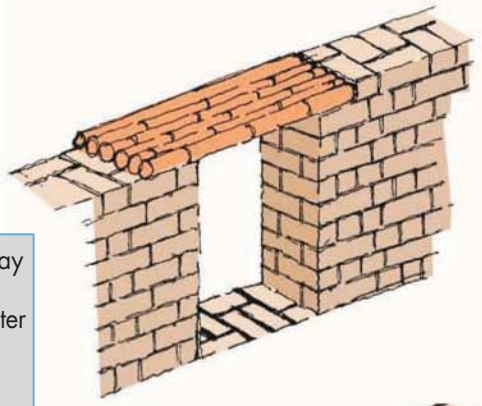
Phase 4: Elevation

- Lintel level
- Opening
- Details and options of lintels

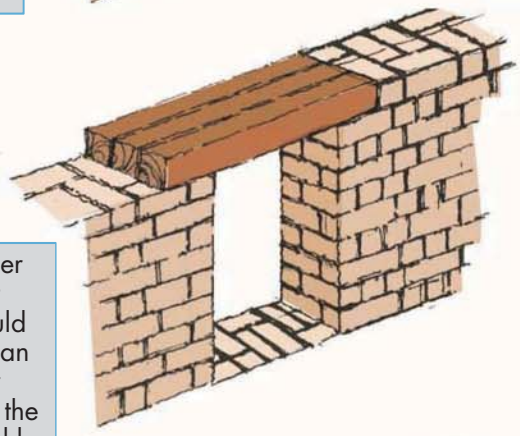


Openings should be 2' from the corners, always higher than wider. Never be over than the 50% of the wall.

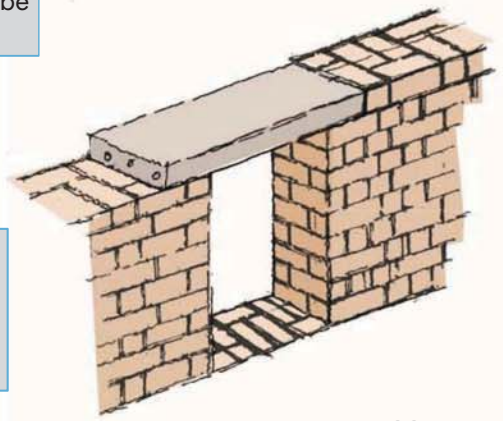
Lintels should be designed according to the loads overhead.



Bamboos tied together may be an option.
They should be 2" diameter and 6" longer than the opening for each side.



Timber is another option for short span, they should be 6" longer than the opening for each side, and the thickness should be 2"



Lintel may be executed with 3 steel bars # 2 and cement.
Pre-cast concrete may be an option.

ADOBE BRICK SHELTER

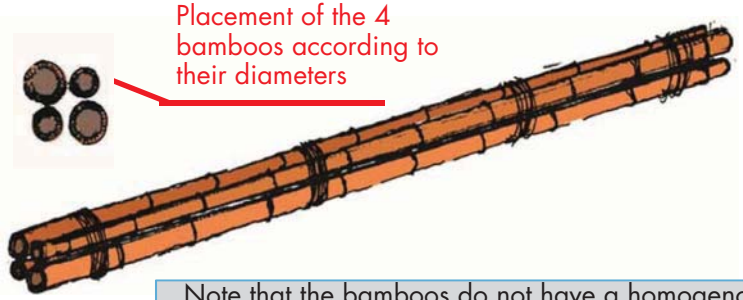
PHASES 4	SUPERSTRUCTURE
Lintels	- In order to bear and distribute the load of the wall above the openings, lintels should be installed. - Lintels should be minimum 2" thick and 6" longer than the opening on each side. - Lintels should be designed based on the load being carried overhead - For short spans timber plate or tied bamboos (2-3) may be an option, which sounds more appropriate to the adobe structure. - The pre-cast concrete lintel may be a good option - The lintel may be executed with bricks system using n.2 steels #3 and cement mortar.
Ventilation	- The ventilation is very important mainly during the summer that is very hot in several areas. - Two windows may ensure ventilation. Alternatively one or two ventilators, executed on the opposite side of the window (generally on the back wall) may ensure good ventilation. - The dimensions depend on the size of the shelter, it may be one of 2' x 1' or two 1'x1' - In some areas, where the summer is very hot, it may be suggested to increase the height of the shelter to improve the internal ventilation. In this case the entire structure of the shelter has to be re-calculated (note this will increase the cost of the shelter)

ADOBE BRICK SHELTER

Phase 5: Roof

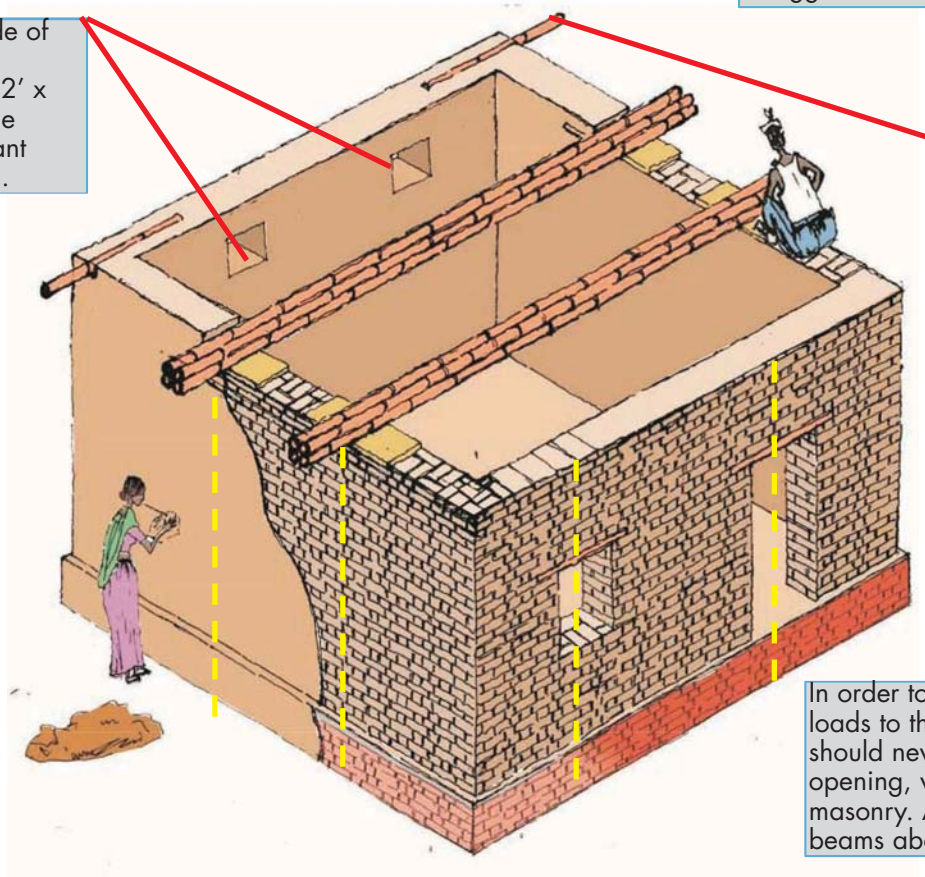
- Roofing structure

3 or 4 bamboos tied together or other lightweight roof may be used as beams for mud shelters. The minimum requirement is two beams, Bearing pads underneath the main beams are compulsory



Note that the bamboos do not have a homogenous diameter, thus they should be assembled together with a rotation of 180°, if necessary, alternating bigger diameter with smaller.

Two openings on the opposite side of the window and door can ensure internal ventilation. They may be 2' x 1' depending on the volume of the shelter. Ventilation is very important mainly during the summer season.



Eaves or overhang of the roof of 15" may prevent rainwater from running down wasting the mud plaster

In order to ensure the correct transfer of loads to the bearing walls, the beams should never be placed in line with opening, which are the weak portion of the masonry. An option may be to place the beams above the walls without openings.

PHASES 5	ROOF
Generic guidance	- Roof design should allow for live and dead loads. Live loads are applied loads such as rain, wind, snow or usage for grain or livestock. Dead loads are those including the makeup of the roof structure such as beams, straw, mud, cement etc. - A bamboo or other lightweight roof can be used for all construction methodologies, while steel girder roof or similar heavy roof requires a strong bearing structure, therefore it is only suitable for fired brick, concrete block, engineered steel frame shelters - A thick mud layer will add a lot of load to the roof and may cause severe damaging strain to the roof structure and loadbearing walls. - Timber elements may in some cases be larger loads than steel or other alternatives. - Bamboo and timber are susceptible to termites. Adequate treatment should be provided to timber and bamboo materials - Timber, bamboo or straw roofs are not suitable for indoor cooking or heating fires. - A conical or four-sided pitched roof is preferable in areas where wind loads are a consideration, particularly cyclone vulnerable areas. - Gable ends or flat surfaces may be more stressed due to resistance to the wind force - The pitch of a roof will vary based on the wind conditions in the area, however a maximum pitch is advised of 30° for simple pitched roofs. - A mono-pitched roof may have a pitch of upto 10° to allow adequate drainage of rainwater. - In the flat roof a minimum slope should be 3/8" per foot

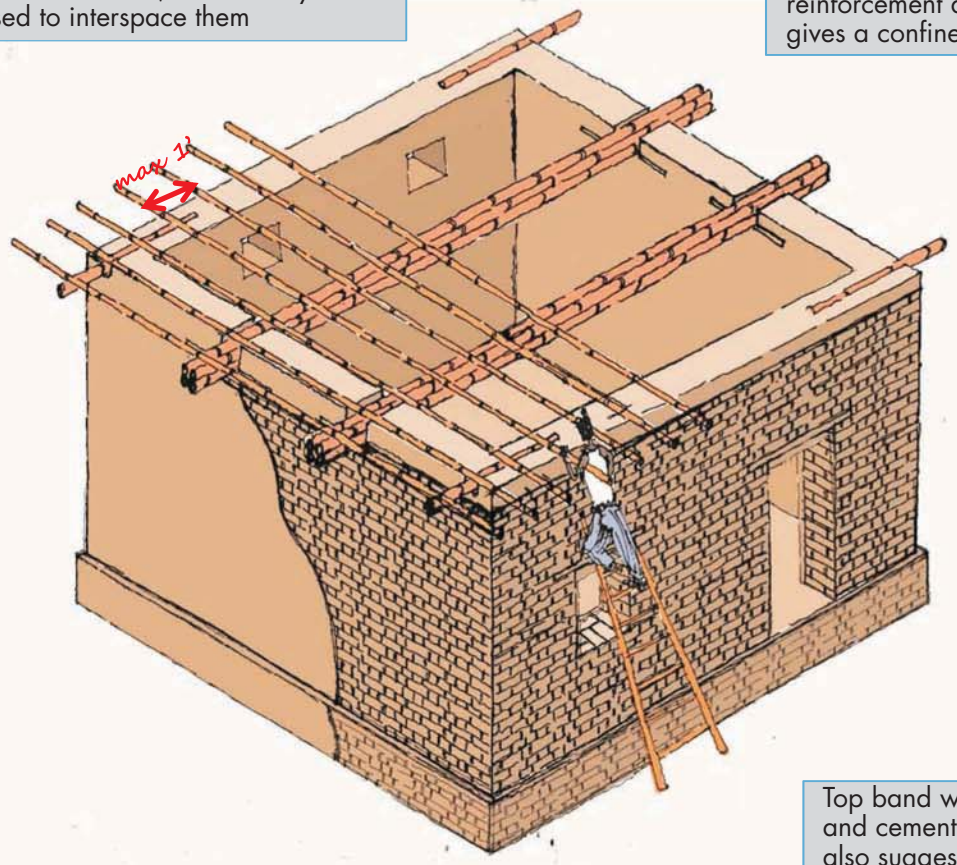
ADOBE BRICK SHELTER

Phase 5: Roof

- Roofing structure and options

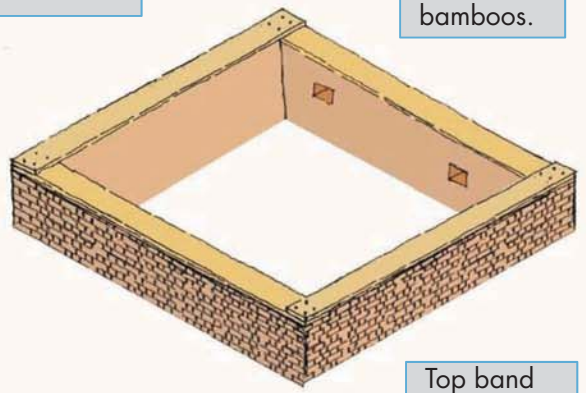
The continuous band underneath the beams ensure a better transfer of loads and is a seismic DRR.

The secondary structure of purlins may be done with bamboos of minor diameter i.e. 2". The distance between the purlins should be maximum 1', a brick may be used to interspace them

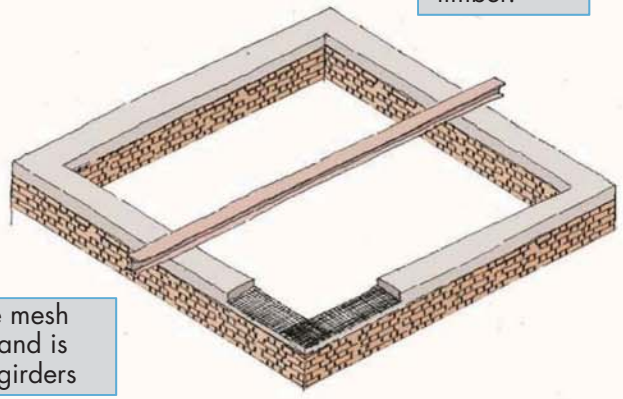


Overlapping the elements of the reinforcement at the corners, gives a confined action

Top band with bamboos.



Top band with timber.



Top band with wire mesh and cement. This band is also suggested for girders

ADOBE BRICK SHELTER

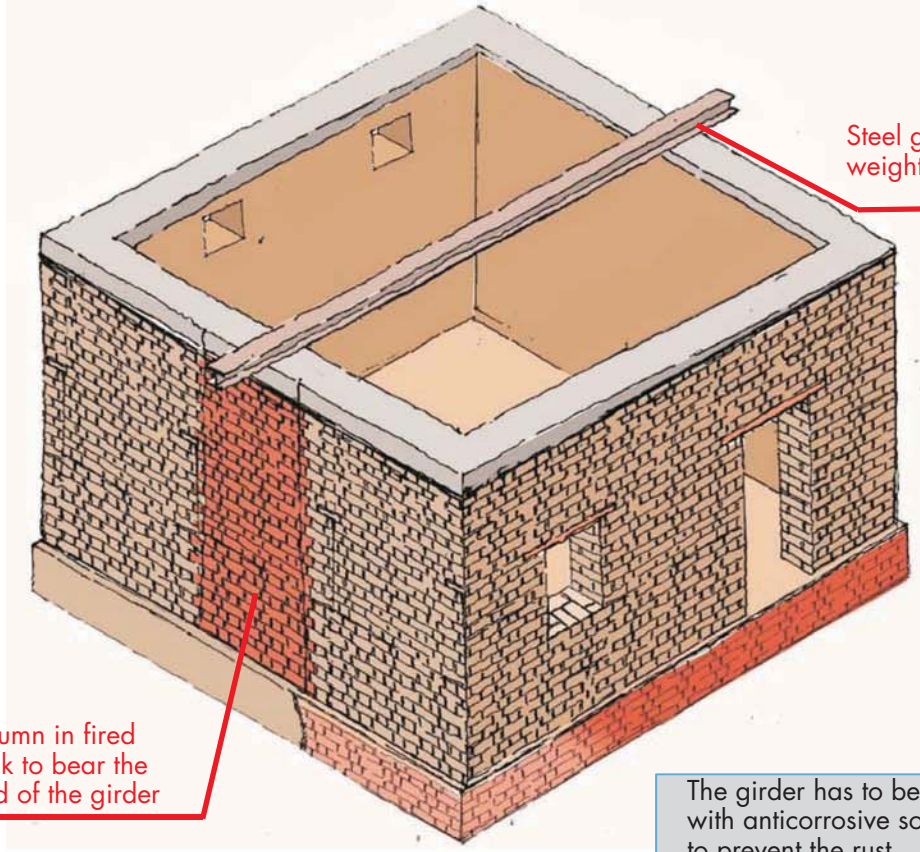
PHASES 5	ROOF
Main structure	- A bamboo or other light weight roof can be used for all construction methodologies. - As main beams three-four bamboos tied together may work. The number of main bamboos beams should be two. - Timber of adequate section and weight may be an option; a bearing pad should be placed underneath. - Steel girder might be another option, in such case a bearing plate has to be inserted underneath the girder in order to distribute its load - The secondary structure of purlin may be made by well sized bamboos. The distance between bamboos should not be more than 1' (1 brick), their length has to be enough to overlap the thickness of walls - Above the bamboos a mat of chick, straw, thatch and plastic sheet is generally used. Straw and plastic sheet have to be incorporated in the top of the walls by the final plastering. - Bamboos, timber and straw should be treated against termites. - T-iron and tiles are strongly not advisable for adobe.
Note and recommen-dations DRR for earthquake resistance	- All loadbearing elements of the roof structure, columns, beams and joints have to be placed not above the door or window openings. Any openings provide weaknesses in the walls, because it reduces the portion of bearing walls. Thus placing the loadbearing elements right above the openings may cause failure in the walls with cracks and even collapse of the portion. - All elements of the roof structure should be tied to each other. All joints or beams in the roof structure need to be individually tied to purlins. The roof must also be securely tied to the wall structure. Well fastening ensures a good resistance to the strong wind and is a kind of DRR against earthquake - Roofs have different load distribution arrangements, according to the concentration of loads underneath the beams. Thus in order to distribute the roof loads equally a top plate/band or ring beam should be provided at the top of the walls. It should be continuously encircling the walls, this provides a way of fastening the walls together at the top to prevent pushing outward forces of the roof in case of horizontal seismic forces. - The pitched roof with two gables placing plates/bands at the top of the wall (without gables) distributes the load and constrains the pushing forces of the rafters. - It is suggested to assemble trusses instead of rafters, since the horizontal bottom chord ties the inclined top chords constraining their pushing outward forces.

ADOBE BRICK SHELTER

Phase 5: Roof

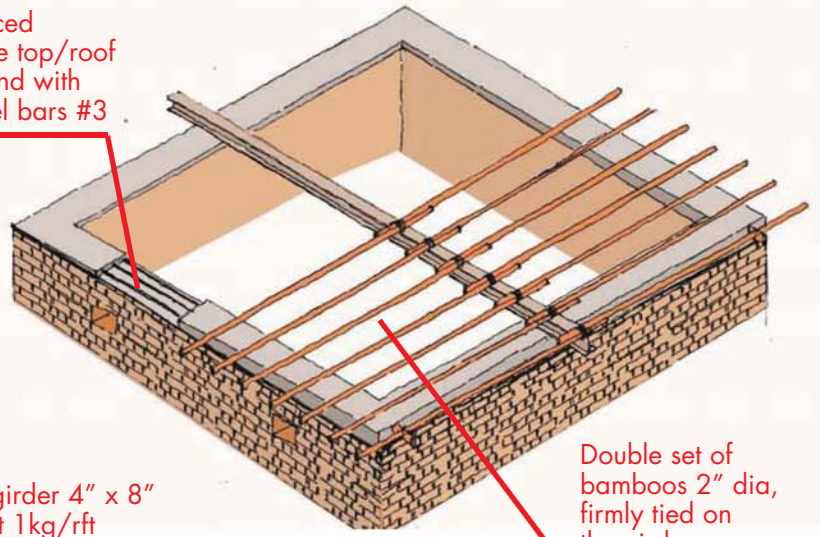
- Roofing structure and options

Although it is not recommended, another solution preferred by the beneficiaries is to use girders as main structure for the roof. The reasons why girder are preferred are because it is perceived as highly resistant material, it is a durable material in case of collapse, it is not affected by termites and other insects.



Column in fired brick to bear the load of the girder

Steel girder 4" x 8" weight 1kg/rft

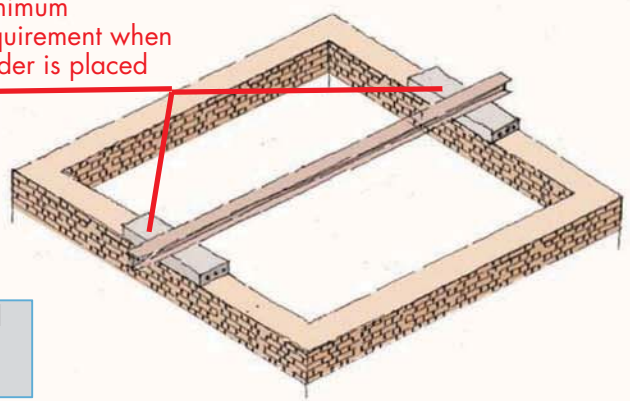


Reinforced concrete top/roof ring band with 3-4 steel bars #3

Double set of bamboos 2" dia, firmly tied on the girder

Due to its higher weight it is compulsory to execute the roof ring band in reinforced concrete . A valid alternative is to build a column in fired brick with a reinforced concrete pad to bear the load of the girder. The secondary structure of purlins may consist of a double set of bamboos, this also allows to select their right size .

Bearing pads as minimum requirement when girder is placed



The girder has to be treated with anticorrosive solution to prevent the rust.

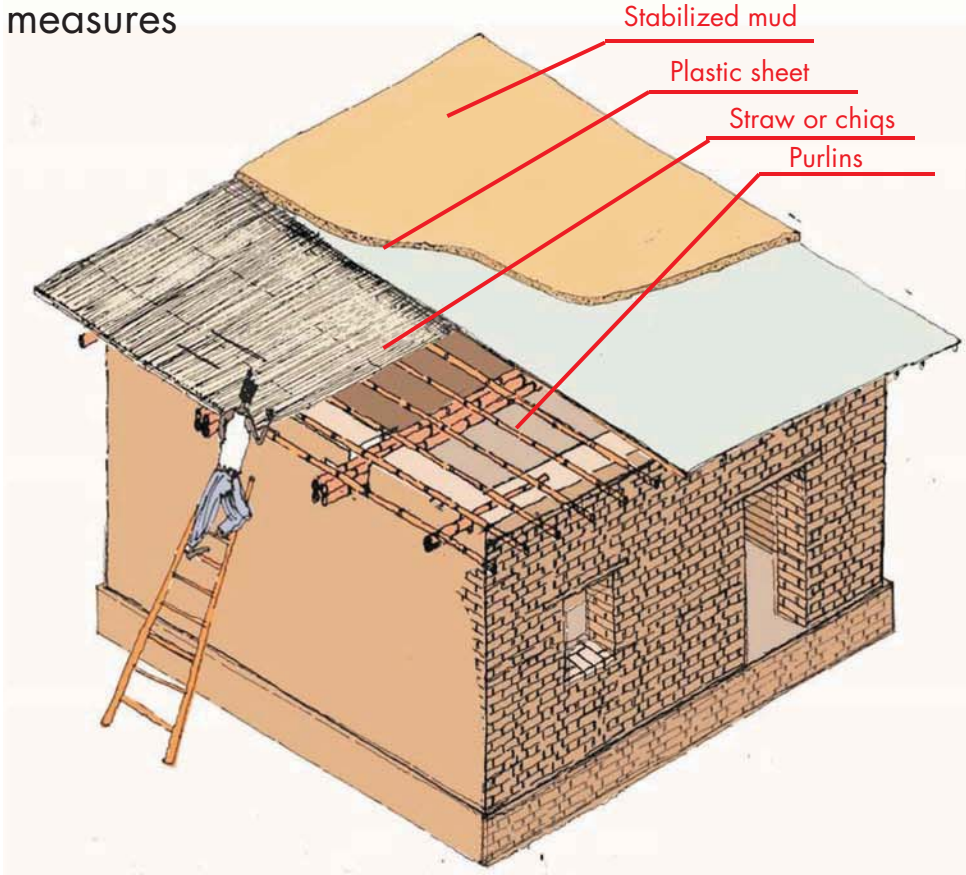
ADOBE BRICK SHELTER

PHASES 5	ROOF
Covering package Generic guidance	- Roof topping can be made with many different materials as long as the items are lightweight, strong, durable, secured, waterproof, insulating and maintainable. - Any material that soak water or melt should be avoided - A common practice is the use of a thatch or other structural system, plastic sheeting with a mud plaster layer, protected with a final waterproofing layer. - Lime plaster or a bitumen mixture may provide a water-resistant finish to the roof that should be reapplied prior and after annual rains.
Covering package Specific guidance	- Above the semi structural mat of straw or thatch, a polythene sheet, a layer of stabilized mud have to be applied in 2-3 coats, the thickness may be 3" maximum. The mud layer may make the structure heavy. - The last coat should be a waterproofing. Lime /mud plaster may improve the water resistance. - Bitumen mixed with stabilized mud mortar is an effective treatment, it is waterproofing and fire resistant. It should be prepared by mixing (5:1) bitumen with kerosene oil and mud (1.5 kg of bitumen for 30 kg of mud). - Also the animal dump, mixed with mud, may be a kind of waterproofing as an eco-friendly option - In case of flat roof, the coats of plaster have to be incorporated at the top of the walls and the parapet, protecting the matting of plastic sheet and straw and the structure of roof (as a kind of waterproofing capping). This is a DRR that will avoid the rain water to penetrate in the connection of roof/walls.

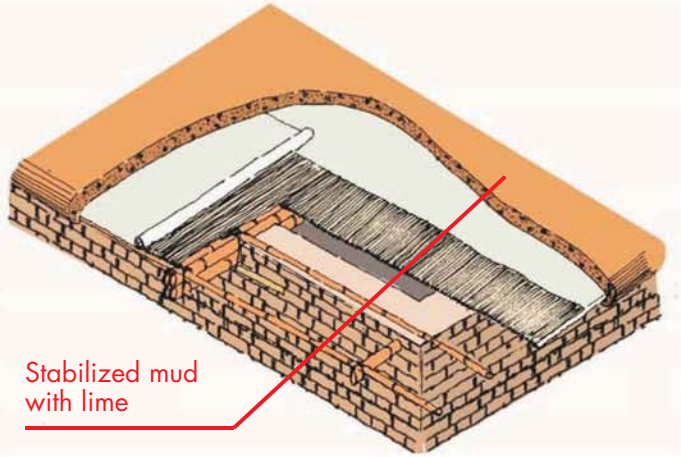
ADOBE BRICK SHELTER

Phase 5: Roof

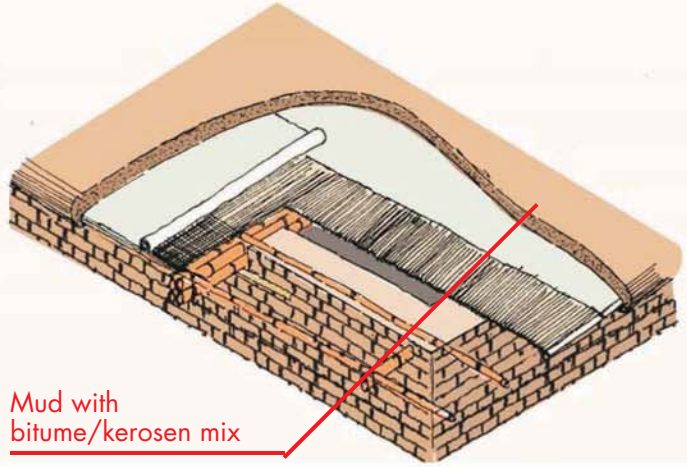
- Roofing structure and options
- Roofing cover
- DRR measures



Covering package may be executed with straws or chiqs, polythene sheet and 2-3 coats of mud. The maximum thickness of the mud should be 3" in order to avoid heavy loads on the beams and the walls



The covering package with straw, plastic sheet and 2-3 coats of mud. The last layer has to ensure waterproofing to the roof, thus it may be with stabilized mud with lime.
The thickness should be 3" maximum.



Another option for the last waterproofing layer may be adding bitumen mixed with kerosene to the mud. The thickness may be less than 3".
Animal dump may also be an ecofriendly option.

PHASES 5	ROOF
DRR waterproofing and drainage	- An overhang of the roof, or eaves, of 15" minimum will prevent rainwater from running down on mud or plaster of the walls and soaking into the structure and the plinth. This will aid the structures resistance. - For flat roof it is important to have a right slope to allow the rain water to wash away quickly, the stagnancy upon the roof will allows the rain water to soak the top layers and penetrate in the core of walls. - Where there is a parapet it is compulsory to provide 1 or 2 waterspouts, the slopes have to be arranged accordingly (minimum 1%). - The waterspouts should be minimum 2.5”and project minimum 8”. - The waterspouts have to be well sealed with bitumen without any discontinuity in order to prevent rain water to penetrate in the structure of roof and walls above. - Another option may be CGI spout in “U” shape. - The use of gutters to catch rain water may be considered; obviously the slope has to be adequate in case of flat roof

ADOBE BRICK SHELTER

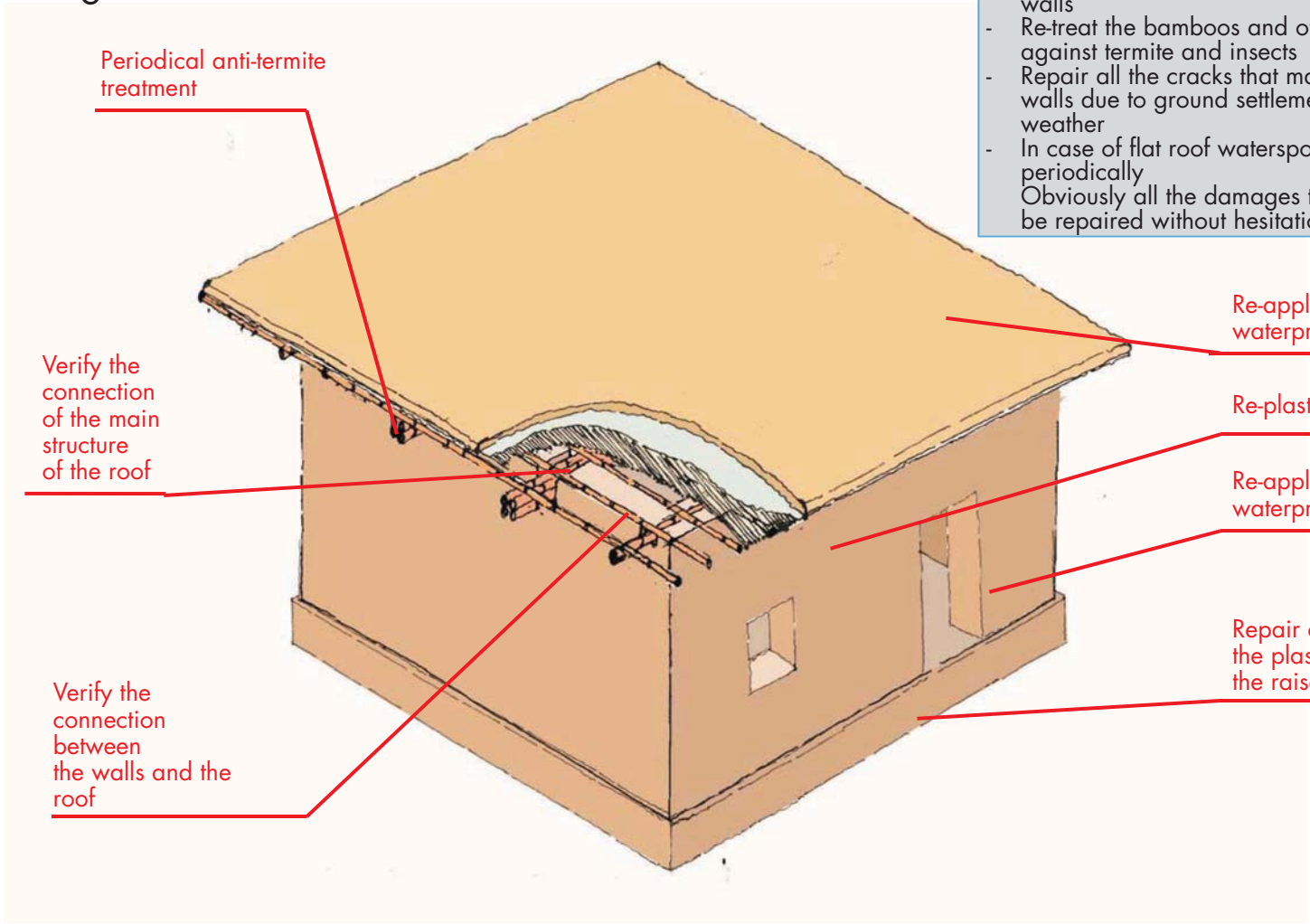
Maintenance :

- DRR
- Waterproofing plaster
- Roofing cover

Maintenance of the structure and DRR ensures a longer and safer life of the shelter. The main treatment has to be applied periodically, i.e. yearly, are:

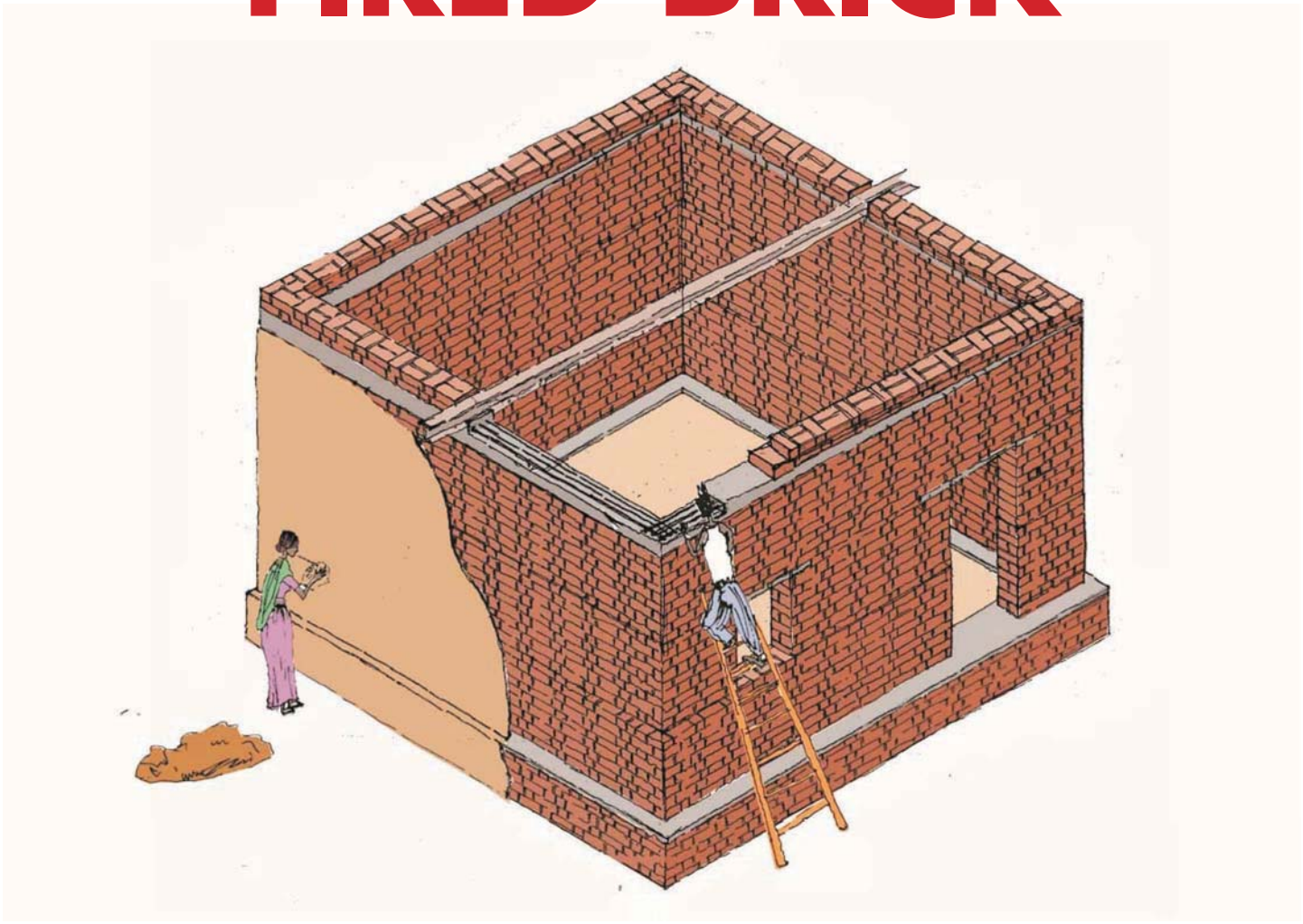
- Re-plastering before the raining season
- Verify and re-apply the waterproof layer of bitumen of stabilized mud till the SL
- Verify and reply the waterproof layer of the roof
- Control the connection of the main structure of the walls
- Re-treat the bamboos and other wooden elements against termite and insects
- Repair all the cracks that may have appeared on the walls due to ground settlement and or to the dry weather
- In case of flat roof waterspouts should be cleaned periodically

Obviously all the damages that might occur should be repaired without hesitation



PHASES 5	ROOF
Maintenance	- Re-plaster the roof with lime mud or bitumen mud mortar at least once a year or whenever necessary - Periodic cleaning of the waterspouts - Re-apply the film of bitumen yearly before the monsoon season - Verify the good connection of the element of the structures (beams and purlin) - Re-treat the bamboos and wooden elements against termite once an year or whenever necessary - Inform the owners regarding periodic termite treatment, annual re-plastering of the roof and periodic cleaning of the waterspouts

ONE ROOM SHELTER
FIRED BRICK



FIRED BRICK MASONRY SHELTER

Brick masonry houses are constructed with fired bricks and generally mud mortar with the external pointing or plastering with cement/sand plaster, in order to protect the mud mortar joints as DRR. However it is strongly suggested to use the cement/sand mortar instead of the mud one, as further DRR. Since the pointing/plastering is not always executed with the consequence that the mud mortar exposed to the weather factors, will be easily eroded.

The foundation and the raised plinth have to be compulsorily in fired brick masonry and cement sand mortar as DRR.

The thickness of the walls has to be 9" minimum; increasing the thickness improves the stability and the DRR against earthquake.

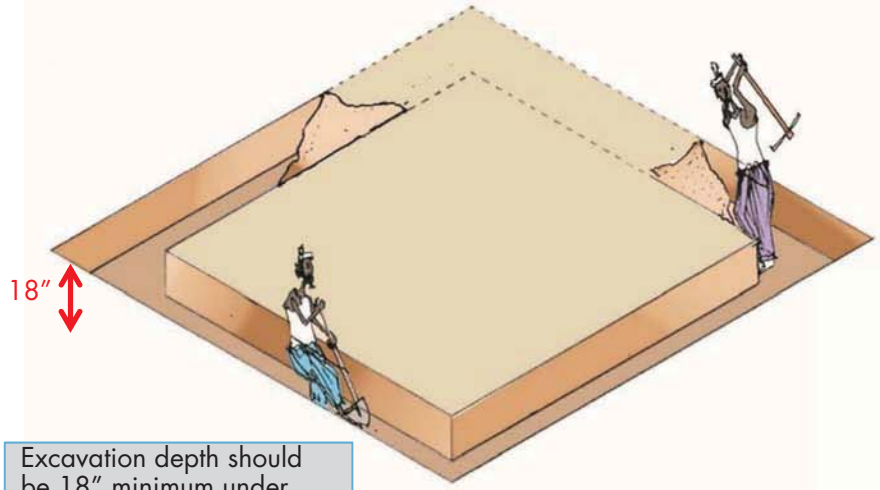
A better DRR measure against floods is plastering the external walls completely to ensure protection against rainflash; beside the full plastering is a way to constrain the masonry thus increasing the resistant against the seismic action. Plastering the roof with cement sand is also recommended, this has to be applied ensuring continuity between the roof application and the plastering of the walls.

DRR for the earthquake resistance may be a reinforcement with a vertical frame in reinforced concrete columns at the corner and opening, and reinforced bands at floor, sill, lintel and roof level. This technique is named confined brick masonry. The roof band is always suggested.

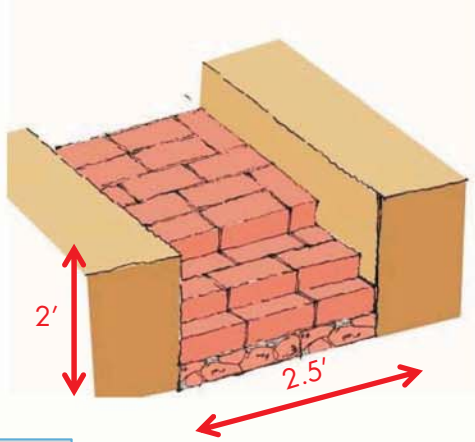
FIRED BRICK SHELTER

Phase 1: Excavation
- Excavation

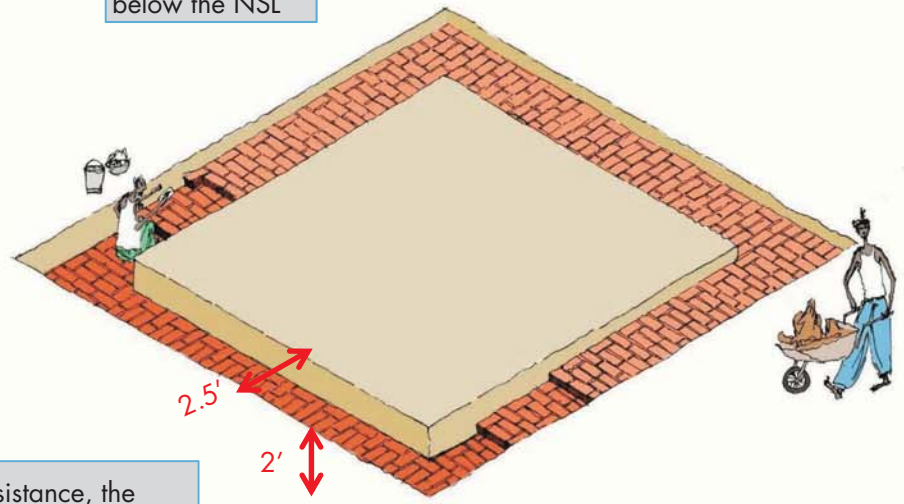
Phase 2: Foundation
- Bearing foundation
- Foundations



Excavation depth should be 18″ minimum under compacted soil. Up to 2′ - 3′ when not compacted



Foundation with 2.5′ foot, founded 2′ below the NSL



In order to give waterproofing resistance, the use of cement /sand (1:4) mortar is mandatory for the foundations. Lime may be added (1:1:6)

FIRED BRICK SHELTER

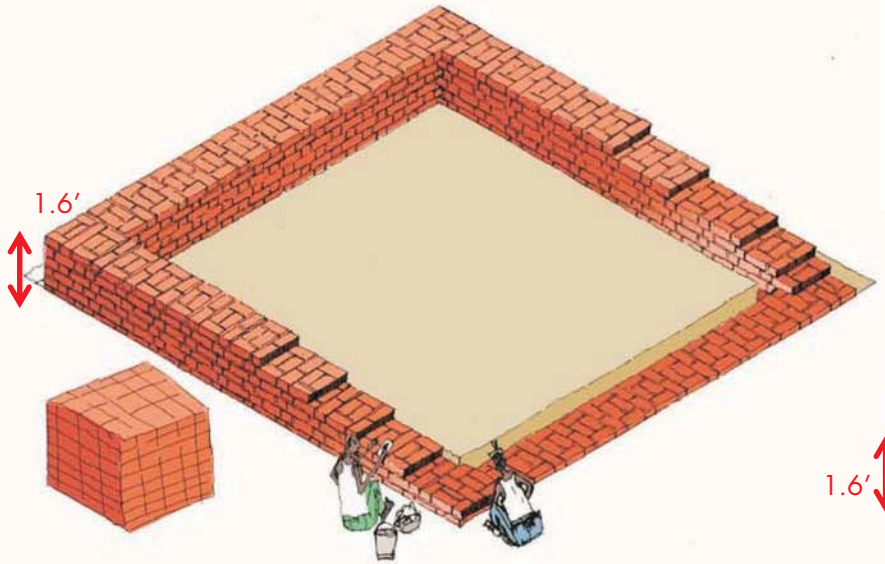
PHASES 1 and 2	BEARING FOUNDATIONS AND FOUNDATIONS
Generic Guidance	- Foundations and platforms specification, depth and height, depend on the site characteristics (soil, elevation), super structure, materials and loads Thus their depth and width have to be designed on a case to case basis. - The excavation depth may be more than 2'- 3' in not compacted soils. - Generally the width of the platform should be almost one third for each side=1.6-2 times the thickness of the walls. - Increasing the width of walls at the base will improve resilience and help keep longer the flood water away from the base of the walls which will extend or prevent the time of disintegration (depending on the time of stagnancy) - The foundations need to have a sealed barrier at the base to prevent the water to penetrate into the structure both from the ground (dampness) and from stagnancy. - Reinforce the walls at ground level by adding concrete plaster/pointing layer or mud/lime
Specific Guidance	- Excavation depth minimum 24" below undisturbed ground or compacted soil. - The wall structure or columns (reinforced masonry) should extend to the same depth of 24" to reach the solid layer and ensure stability - Minimum dimension for the foundations are 2'wide footings founded 2' below the natural surface level (NSL)
Notes and recommen-dations	- Brick masonry has heavy load and require a concrete, stone or brick foundation to distribute the load to the ground and thus ensure stability of the wall - Appropriate anchoring details for the foundation should be considered - The plinth can be plastered with cement/sand/lime for improve the waterproofing - Burnt brick may be a better option for foundation due to their waterproofing characteristics - In order to improve the stability of the trench, a layer of cement/soil may be poured under foundation. The suggested mixture (stabilized soil) is sand(27%) soil (70 %) cement (3 %); the thickness should be 6" minimum.

FIRED BRICK SHELTER

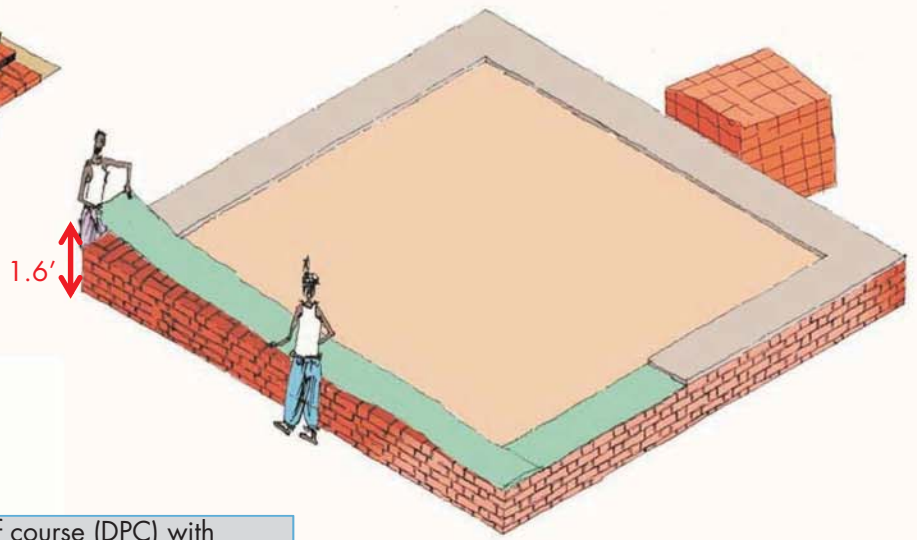
Phase 3: Raised Plinth

- Plinth
- DPC
- DRR measures

Foundations and raised plinth have to be built with cement/sand mortar (1:4). Pointing the plinth is mandatory.



Floor level should be raised at least 1.6' up to 3' in flood affected areas



Damp proof course (DPC) with plastic sheet on the top of the plinth, a layer of cement improves the waterproofing characteristic

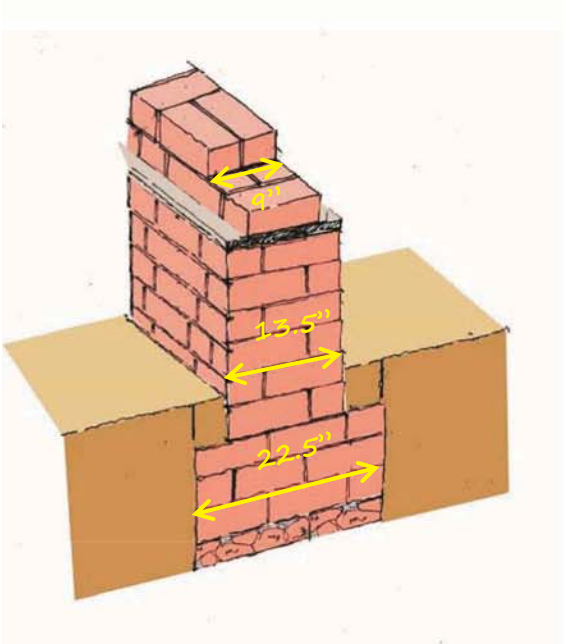
FIRED BRICK SHELTER

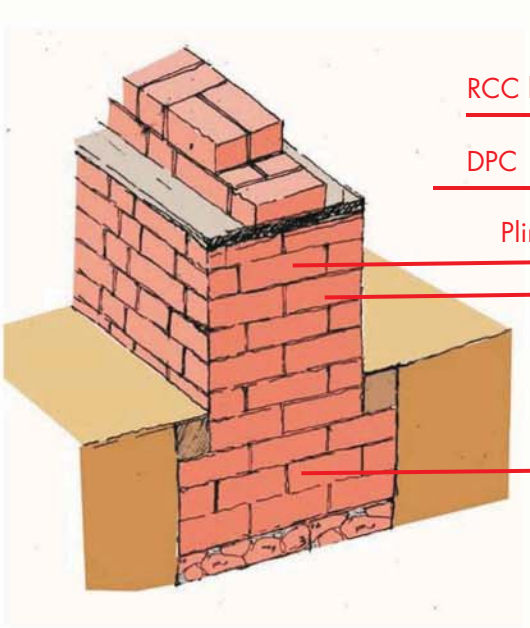
PHASES 3	RAISED PLINTH FLOOR
Generic Guidance	- The floor level should be raised to at least 1.6'up to 3' above the Natural Surface Level (NSL) adopting a continuous plint. - General recommendation is to further protect the foundations below floor level by raising an earth platform 3' wide at the top and tapering to NSL over 6'. (i.e 1 in 2 slope minimum.) The top of this platform should be 6" below floor level. - A damp proof course (DPC) at plinth level is compulsory in order to prevent moisture rising into the walls. A DPC is either a thin layer of concrete at plinth level with plastic on one surface or simply a strong plastic layer
DRR improvements (Flood and earthquake)	- The plinth may be with fired bricks or in concrete, cement/sand mortar. - The plinth can be plastered with cement/sand/lime to improve the waterproofing - At the top of the plinth a reinforce band with 2-4 bars can ensure the earthquake resistance, in case of concrete plinth it may be reinforced with 4 bars
Maintenance	- Re-plaster the raised plinth with lime/mud/cement mortar at least once a year, before the monson season, and whenever necessary - In case of reinforced band: verify that the bars are not exposed and corroded, paint them with red oxidant varnish

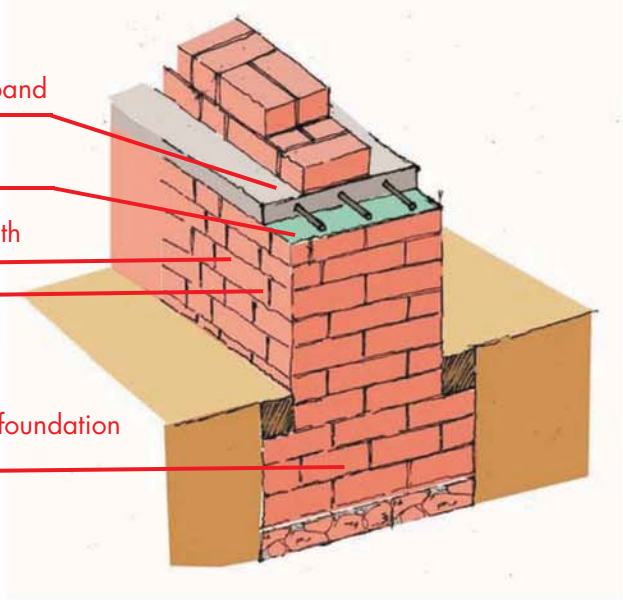
FIRED BRICK SHELTER

Phase 3: Raised Plinth

- DRR reinforcement







The minimum requirement for the thickness is 9", i.e. one brick length. Plinth and foundation should be enlarged at least 13.5" and 22.5" respectively.

Increasing the thickness provides stability and durability. This is suggested mainly for the foundation and plinth.

DPC over the raised plinth prevent the soil humidity. A continuous reinforced band over the plinth at floor level is considered as DRR against earthquake.

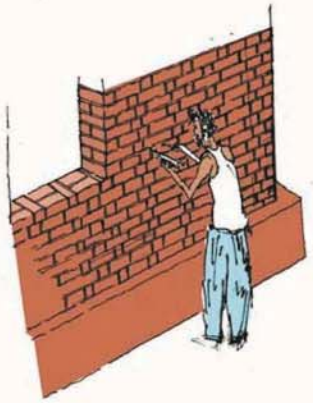
FIRED BRICK SHELTER

PHASES 4	SUPERSTRUCTURE
Walls Core materials and techniques	- Fired brick walls may differ in size depending on structural design. - The minimum requirement is 9", i.e. the length of a brick - Increasing the thickness provide stability, durability and waterproofing, it may be 13.5" i.e. 1.5 brick's length. - Alternate the displacement of each brick row to ensure the interlocking - Construct from corners to center - Ensure good connection from plinth to walls and interlock bricks at corners - Reinforce long walls at centre - Avoid too wide vertical joints, and too thick bedding joints - Hollow block walls should be reinforced using steel or similar materials - Cement or lime and sand based mortar should be used for bonding. - For general purpose use cement mortar (but the mix can be harsh) 1 Cement: 4 Fine Sand - Use Cement Lime Mortar for Block and Bricklaying, plasters and Renders: 1 Cement: 1 Lime: 6 Sand - Lime Mortar for Block and Bricklaying: 1 Lime: 3 Sand
Notes and recommen-dations	- All junctions of the wall - at base, top and corners - need to be tied, either through interlocking or reinforcement elements like timber or steel. - Care should be taken to ensure that salt in the sand is of very low levels, as salt will damage the mortar - It is not advisable to build more the 3 shelters in line, since long walls have a negative seismic response

FIRED BRICK SHELTER

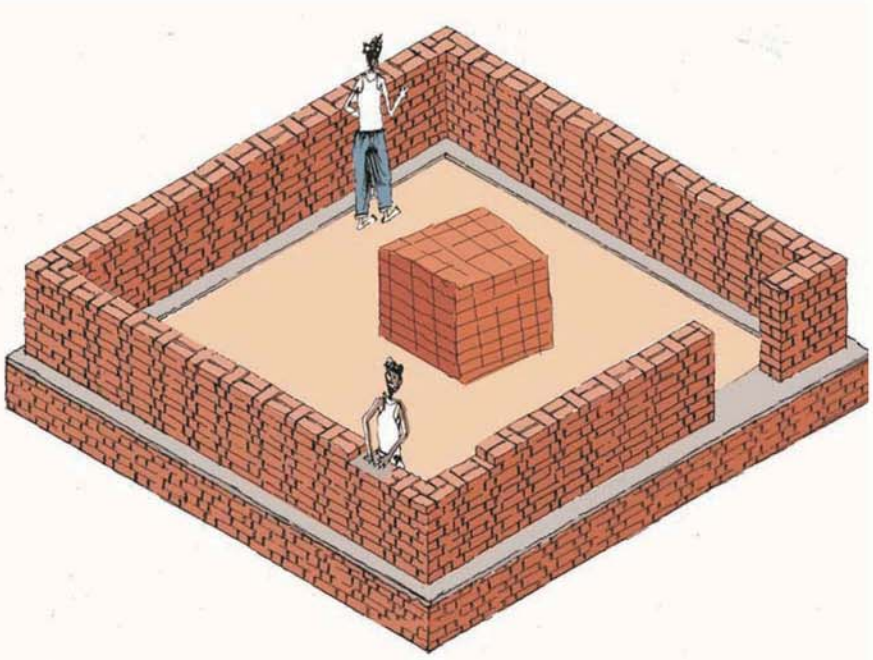
Phase 4: Elevation

- Sill level
- DRR measures



Pointing is an option, in case of good quality of bricks and cement mortar. Pointing has to be done with cement/sand mortar till the sill level (it is mandatory) and up to the roof level is preferably.

The external plastering is always a good practice, since it protects the masonry from rain, wind and stagnant water, prolonging its durability. Plastering is mandatory for mud/lime mortar execution



It is suggested cement/lime/plaster at least till the sill level. Plastering the whole walls is preferable. Adding lime may be an option. There should be 2 coats.

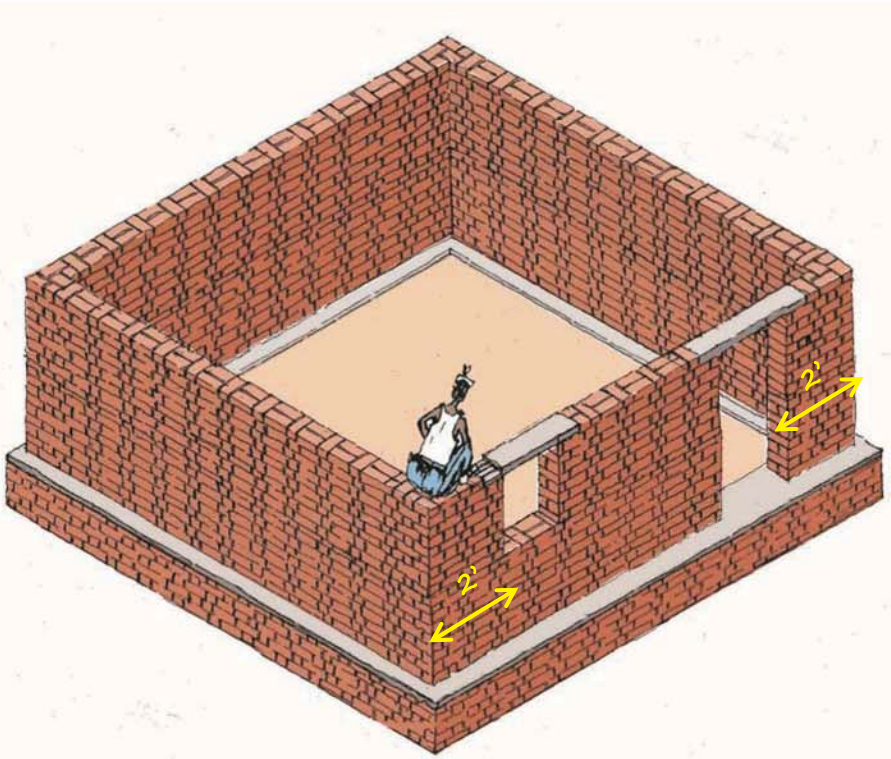
FIRED BRICK SHELTER

PHASES 4	SUPERSTRUCTURE
DRR flood resistance (Plaster as protective and expendable surface)	- The external plastering is always a good practice, since it protects the masonry from rain, wind and stagnant water , prolonging its durability. - It is suggested to use cement/lime/plaster at least till the sill level. - Pointing is an option from the sill level up to the roof. - Plastering the whole walls is preferable. - Plastering is mandatory for mud/lime mortar execution. - Pointing is suggested anyway in case of good quality of bricks, cement mortar and good execution of the masonry.
Maintenance	- Re-plaster the raised plinth with lime/mud/cement mortar at least once a year before the monsoon season, and whenever necessary (worn-out plaster) - Re-plaster the external walls at least once a year before the monsoon season, and whenever necessary - In case of reinforced band, verify that the bars are not exposed and corroded, paint them with red oxidant varnish

IASC Inter Agency Standing Committee PAKISTAN FLOODS SHELTER CLUSTER

FIRED BRICK SHELTER

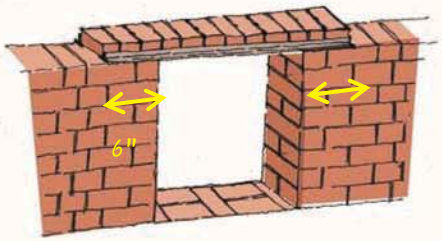
Pha
- Lint
- Det



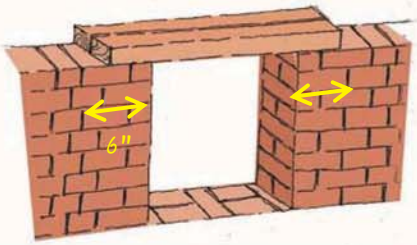
Openings should be 2' from the corners, always higher than wider. Never be over than the 50% of the wall.

Lintels should be 6" longer than the opening for each side; the thickness should be 2" at least. Wider opening may need longer and thicker lintel

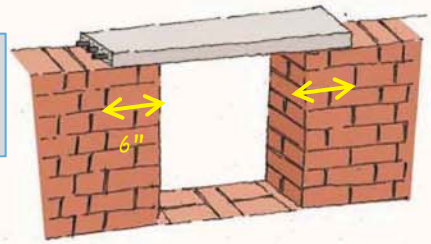
Lintels may be executed with 2 T irons and bricks in between with cement mortar.



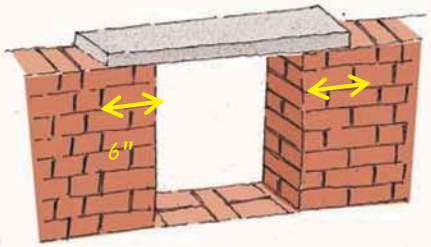
Timber is another option for short span



Lintel may be executed with 3 steel bars # 2 and cement.



A pre-cast concrete lintel is a good option



FIRED BRICK SHELTER

PHASES 4	SUPERSTRUCTURE
Opening door window	- Openings within the wall space should not take up an area greater than 50% of the wall. - Openings should be higher than wider - Windows and doors should be kept a minimum of 2 ft from corners and from each other and open outwards. - The doors should open outwards for fire safety purpose
Lintels	- In order to bear and distribute the load of the wall above the openings, lintels should be installed. - Lintels should be minimum 2" thick and 6" longer than the opening on each side. - Lintels should be designed based on the load being carried overhead - For short spans timber plate or tied bamboos (2-3) may be an option, which sounds more appropriate to the adobe structure. - The pre-cast concrete lintel may be a good option - The lintel may be executed with bricks system using n.2 steels #3 and cement mortar.
Ventilation	- The ventilation is very important mainly during the summer which is very hot in several areas. - Two windows may ensure ventilation. Alternatively one or two ventilators, executed on the opposite side of the window (generally on the back wall) may ensure good ventilation. - The dimensions depend on the size of the shelter, it may be one of 2' x 1' or two 1'x1' - In some areas, where the summer is very hot, it may be suggested to increase the height of the shelter to improve the internal ventilation. In this case the entire structure of the shelter has to be re-calculated (note this will increase the cost of the shelter)

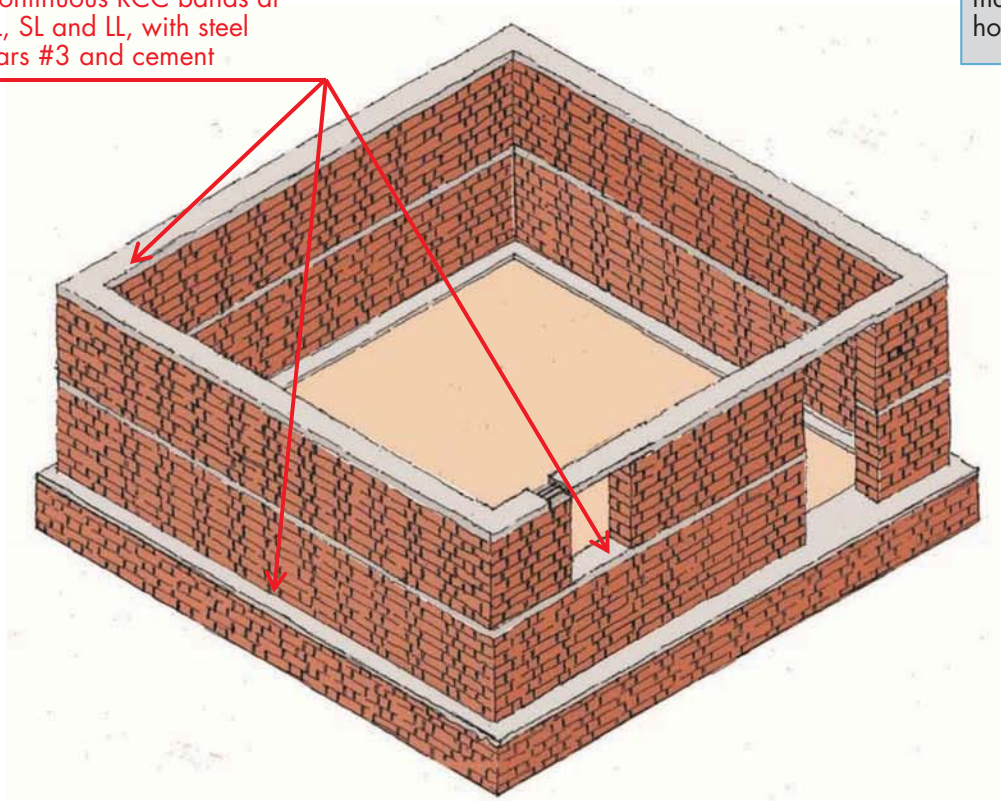
FIRED BRICK SHELTER

Phase 4: Elevation

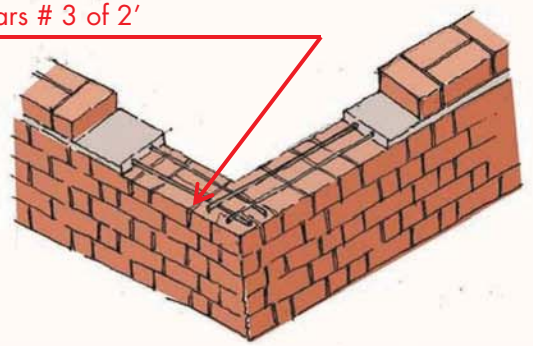
- DRR: reinforcing bands

To strengthen the structure reinforced bands may be executed at different levels i.e. Floor Level (FL) Sill Level (SL), Lintel Level (LL) and the top ring band at Roof Level (RL). They are considered as DRR. There should be RCC bands executed with steel bar # 3 for the SL and LL and # 4 for the FL and RL, the action of the bands is to confine the masonry improving the resistacnce against the horizontal forces of earthquakes.

Continuous RCC bands at FL, SL and LL, with steel bars #3 and cement



Reinforcement of the corner with "L" insert with 2 steel bars # 3 of 2'



Other less expensive option is to reinforce the corner only. The reinforcement should be executed every 2,5', with 2 steel bar # 3 and concrete.
The function of corner reinforcements is to avoid the separation of the walls due to horizontal forces of earthquakes or increased loads.

FIRED BRICK SHELTER

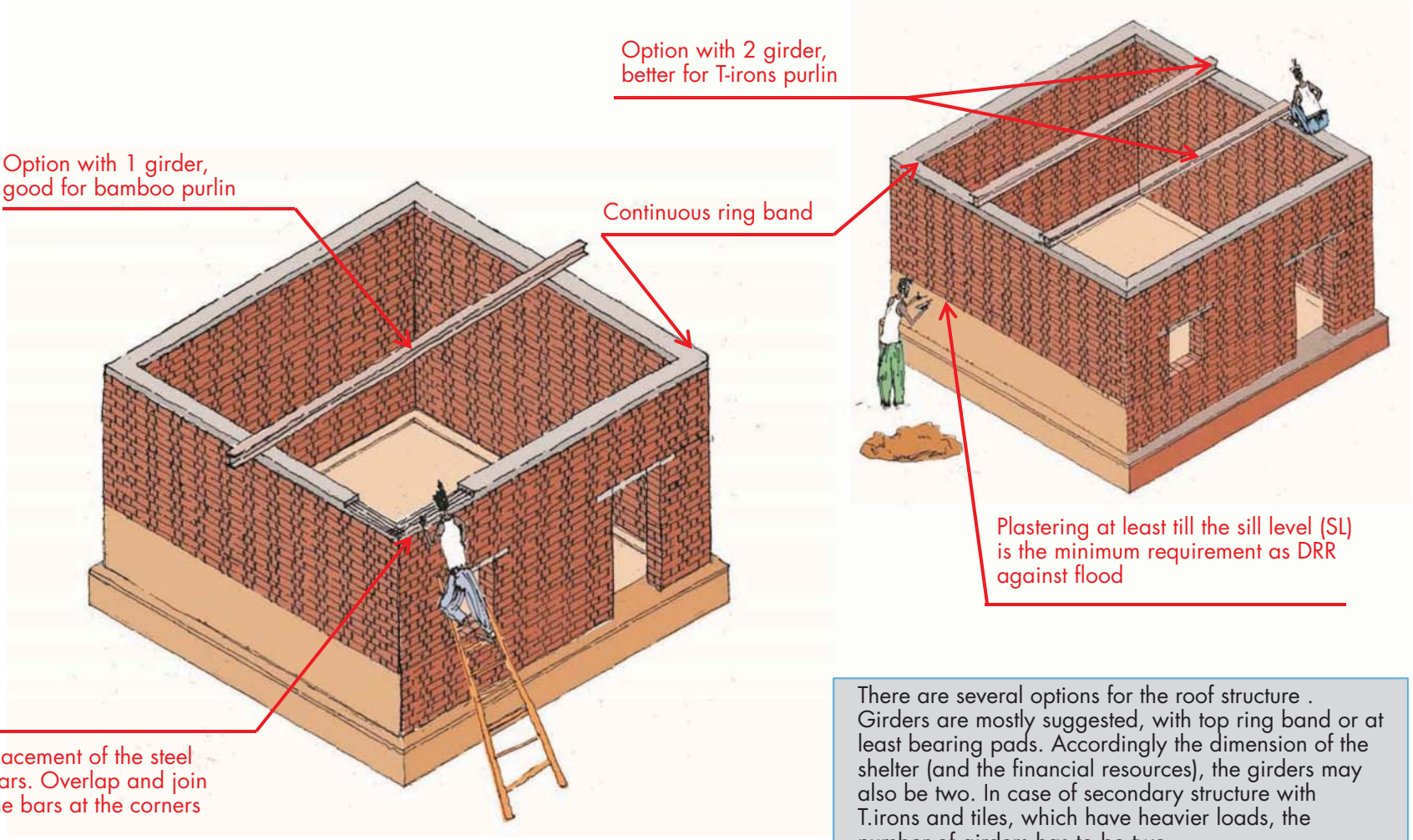
PHASES 4	SUPERSTRUCTURE
DRR for earthquake resistance Joint and binding Reinforced bands	- Thickness and good execution considered as DRR themselves. - Reinforced band at floor level, sill level, lintel level and roof level are DRR measures against earthquakes. - The bands have to be continuous, interlocking the bars at corners. - The number of bars may be 2-4 depending on the height of the band. - The floor and top bands are suggested to be 3"-4" with 4 bars#4, while the ones at sill and lintel may be 2" with 2 bars#3. - The top band should be provided in any case as a basic DRR against earthquake. - Vertical reinforcements with steel bars collaborate to the stability and seismic resistance of the shelter. - The vertical bars have to be interlocked with the horizontal ones. - Columns in reinforced concrete, along with reinforced horizontal bands improve the seismic resistance. - This kind of structure, named "CONFINED MASONRY" is more suitable in seismic areas, but obviously it is expensive.

FIRED BRICK SHELTER

Phase 4: Elevation

- Roof level
- Continuous roof band

The top ring band should always be executed because of its confining action as DRR against earthquakes. It has to be executed as RCC with 3 – 4 steel bars # 4 and pouring concrete (cement –gravel- sand 1:2:4). The bars have to be overlapped and joined at the corners . However the minimum requirement consists of inserting concrete bearing pads underneath the girders at least.



There are several options for the roof structure . Girders are mostly suggested, with top ring band or at least bearing pads. Accordingly the dimension of the shelter (and the financial resources), the girders may also be two. In case of secondary structure with T.irons and tiles, which have heavier loads, the number of girders has to be two.

FIRED BRICK SHELTER

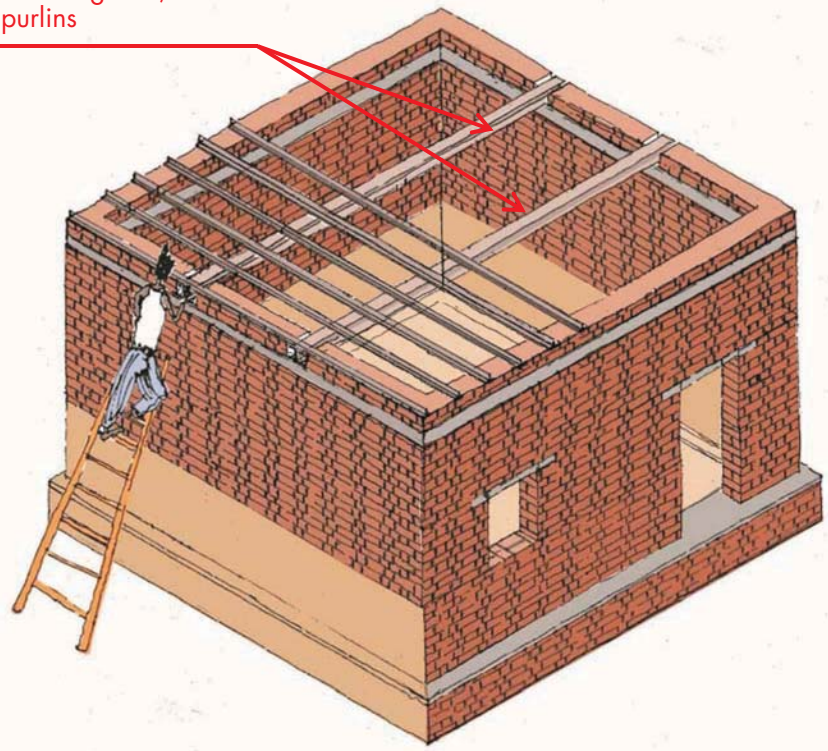
PHASES 5	ROOF
Generic guidance	- Roof design should allow for live and dead loads. Live loads are applied loads such as rain, wind, snow or usage for grain or livestock. Dead loads are those including the makeup of the roof structure such as beams, straw, mud, cement etc. - A bamboo or other lightweight roof can be used for all construction methodologies, while steel girder roof or similar heavy roof requires a strong bearing structure. Therefore it is only suitable for fired brick, concrete block, engineered steel frame shelters - A thick mud layer will add a lot of load to the roof and may cause severe, damaging strain to the roof structure and loadbearing walls. - Timber elements may in some cases be larger loads than steel or other alternatives. - Bamboo and timber are susceptible to termites. Adequate treatment should be provided to timber and bamboo materials - Timber, bamboo or straw roofs are not suitable for indoor cooking or heating fires. - A conical or four-sided pitched roof is preferable in areas where wind loads are a consideration, particularly cyclone vulnerable areas. - Gable ends or flat surfaces may be more stressed due to resistance to the wind force - The pitch of a roof will vary based on the wind conditions in the area, however a maximum pitch is advised of 30° for simple pitched roofs. - A mono-pitched roof may have a pitch of up to 10° to allow adequate drainage of rainwater. - In the flat roof there should be a minimum slope of 3/8" per foot.

FIRED BRICK SHELTER

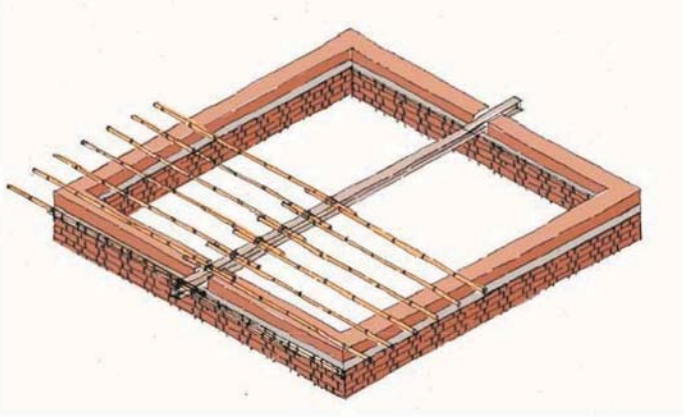
Phase 5: Roof

- Roof level
- Main structure and options

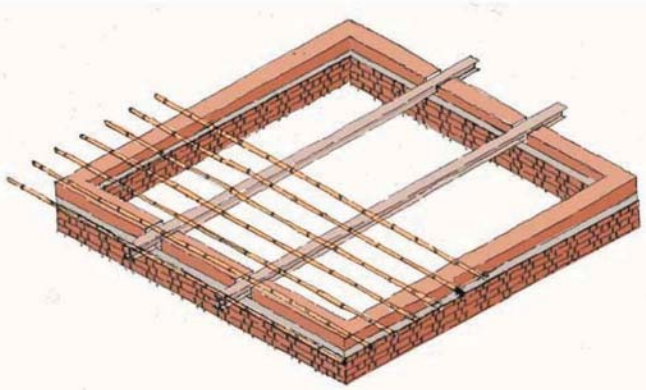
Option with 2 girder, and T-irons purlins



There are several options for the roof structure . Girders are mostly suggested, with top ring band or at least bearing pads. According to the dimension of the shelter (and the financial resources) the girders may also be two. They have to be two in case of secondary structure with T.irons and tiles, for the heavier loads.



Option with 1 girder, good for bamboo purlins, with eaves



Option with 2 girder, good for bamboo purlins, without eaves

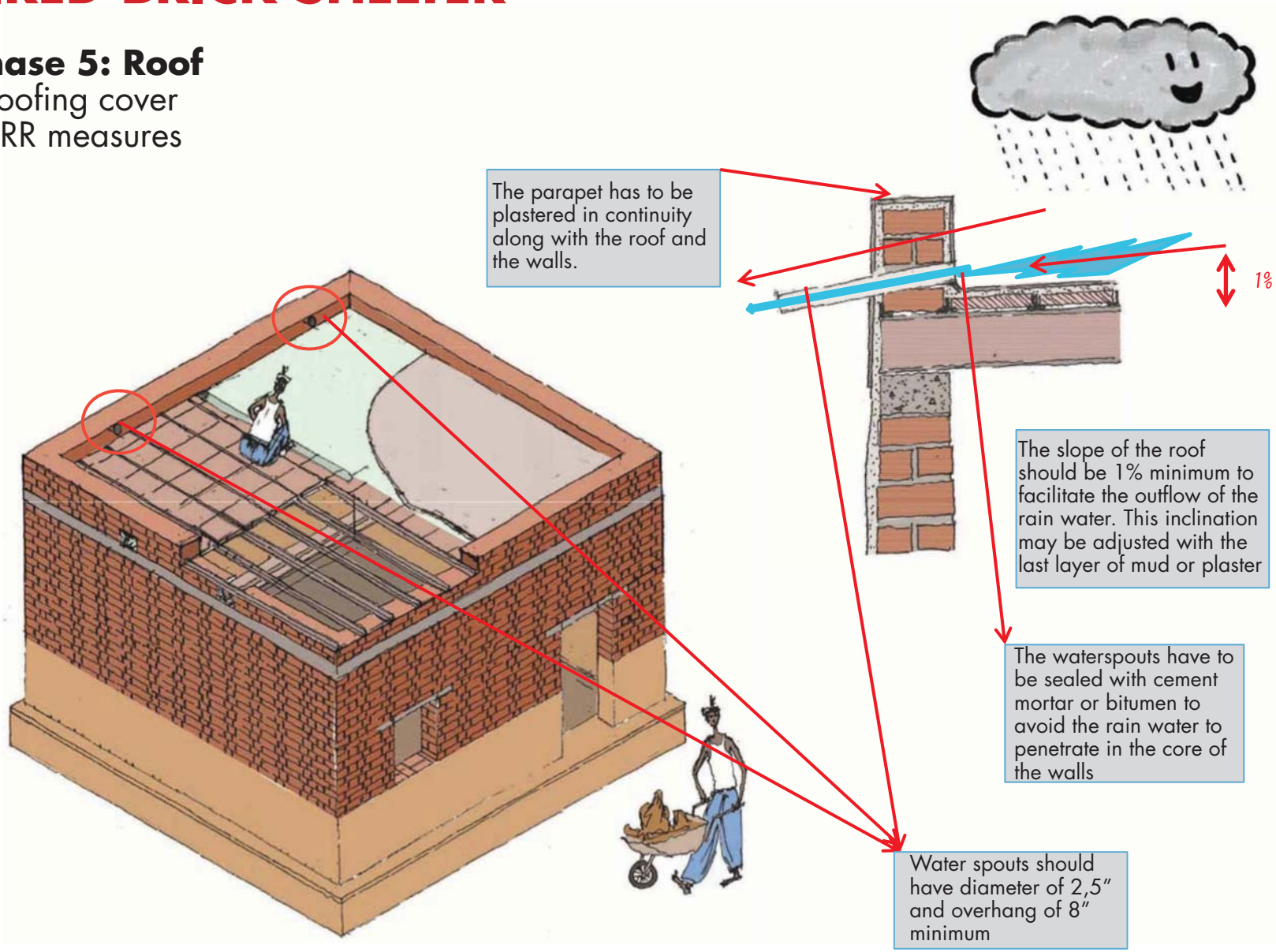
FIRED BRICK SHELTER

PHASES 5	ROOF
Main structure	- This structure is supposed to be more resistant, thus the solution of the bamboos beam is not suitable. - Timbers of adequate size and steel girders are suitable options. - The girder "I" beam size should depend on the number (1 or 2), loads of the roof and thickness of walls - Suggested sizes are 4"x6" or 4"x8", also 5.5"x2.5" may be used. - Bearing plate, or pad, has to be inserted underneath the girder in order to distribute its load. - A steel plate of 12"x8"x0.5", or a concrete tile or wooden board may be on option. Anti-oxide treatment is suggested for the iron/steel elements. - The secondary structure of purlin may be made of well sized bamboos. - The distance between bamboos should be not more than 1' (1 brick), their length has to be enough to overlap the thickness of walls - Above the bamboos, a mat of chick, straw, thatch and plastic sheet is generally used. Straw and plastic sheet have to be incorporated in the top of the walls by the final plastering. Bamboos, timber and straw should be treated against termites. - An alternative to the "I" girder may be a concrete precast beam. - An alternative to the bamboos and straw are the "T" beams (T-iron) and tiles of cement or burned clay.
Note and recommen-dations DRR for earthquake resistance	- All loadbearing elements of the roof structure, columns, beams and joints have to be placed not above door or window openings. Any openings provide weaknesses in the walls, because it reduces the portion of bearing walls. Thus placing the loadbearing elements right above the openings may cause failure in the walls with cracks and even collapse of the portion. - All elements of the roof structure should be tied to each other. All joints or beams in the roof structure need to be individually tied to purlins. The roof must also be securely tied to the wall structure. Well fastening ensures a good resistance to the strong wind and is a kind of DRR against earthquake. - Roofs have different load distribution arrangements because of the concentration of loads underneath the beams. Thus in order to distribute the roof loads equally a top plate/band or ring beam should be provided at the top of the walls. It should be continuously encircling the walls. This provides a way of fastening the walls together at the top to prevent pushing outward forces of the roof and in case of horizontal seismic forces. - In case of pitched roof with two gables, placing plates/bands at the top of the wall (without gables) will distribute the loads and constrains the pushing forces of the rafters. - It is suggested to assemble trusses instead of rafters, since the horizontal bottom chord ties the inclined top chords constraining their pushing outward forces.

FIRED BRICK SHELTER

Phase 5: Roof

- Roofing cover
- DRR measures



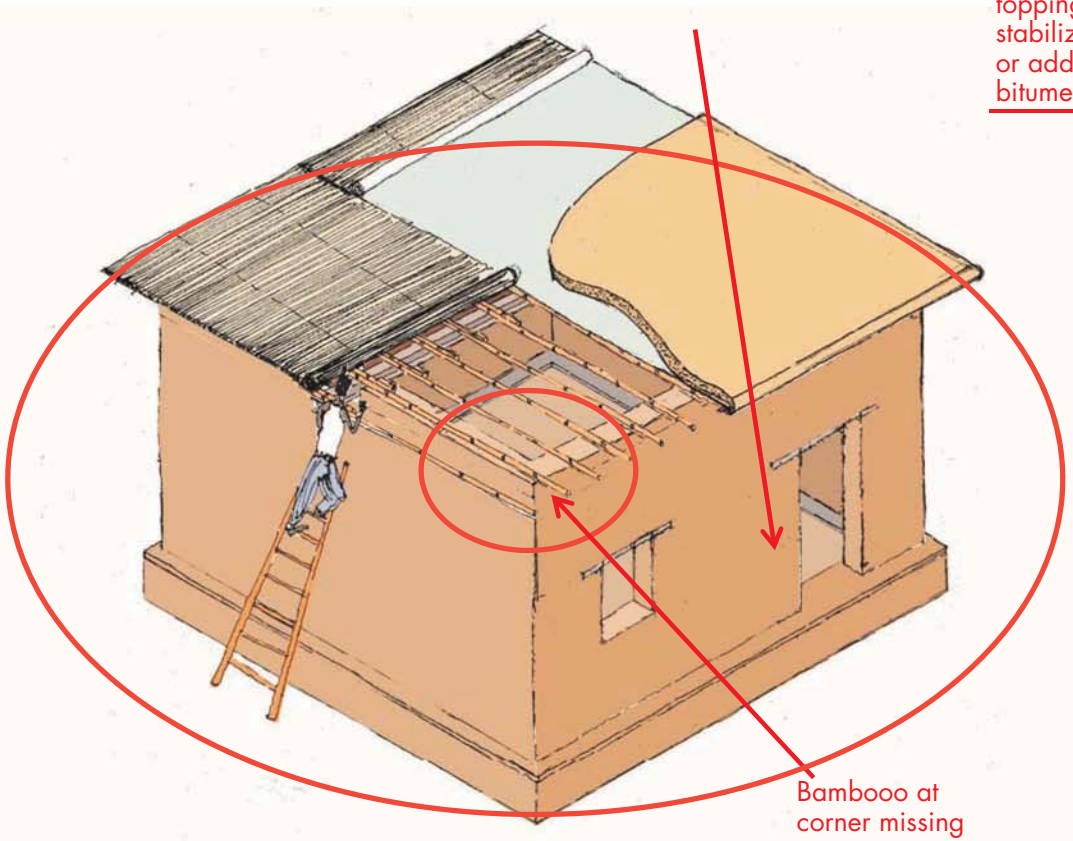
FIRED BRICK SHELTER

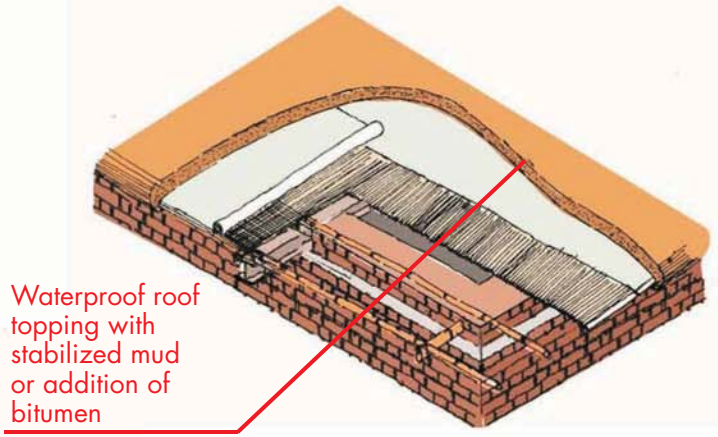
PHASES 5	ROOF
Covering package Generic guidance	- Roof topping can be made with many different materials as long as the items are lightweight, strong, durable, secured, waterproof, insulating and maintainable. - Any material that soak water or melt should be avoided - A common practice is the use of a thatch or other structural system, plastic sheeting with a mud plaster layer, protected with a final waterproofing layer. - Lime plaster or a bitumen mixture may provide a water-resistant finish to the roof that should be reapplied prior and after annual rains.
Covering package Specific guidance	- Above the semi structural mat of straw or thatch, a polythene sheet, a layer of stabilized mud have to be applied in 2-3 coats, the thickness may be 3" maximum. The mud layer may make the structure heavy. - The last coat should be a waterproofing. Lime /mud plaster may improve the water resistance. - Bitumen mixed with stabilized mud mortar is an effective treatment, it is waterproofing and fire resistant. It should be prepared by mixing (5:1) bitumen with kerosene oil and mud (1.5 kg of bitumen for 30 kg of mud). - The animal dump , mixed with mud may also be a kind of waterproofing as an ecofriendly option - In case of flat roof, the coats of plaster have to be incorporated at the top of the walls and the parapet, protecting the matting of plastic sheet and straw and the structure of roof (as a kind of waterproofing capping). This is a DRR that will avoid the rain water to penetrate in the connection roof/walls.

FIRED BRICK SHELTER

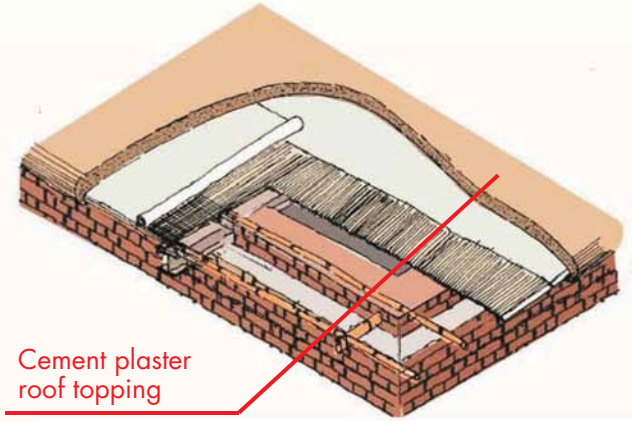
Phase 5: Roof

- Roofing cover
- DRR measures





The covering package with straw, plastic sheet and 2-3 coats of stabilized mud with lime or bitumen/kerosen mix. The last layer has to ensure waterproofing to the roof, thus it may be with stabilized mud with lime. The thickness should be 3" maximum.



The last waterproofing layer may be of cement/sand plaster. The thickness may be less than 3". It is important to apply the plaster with continuity

FIRED BRICK SHELTER

PHASES 5	ROOF
DRR waterproofing and drainage	- An overhang of the roof, or eaves, of 15" minimum will prevent rainwater from running down on mud or plaster of the walls and soaking into the structure and the plinth. This will aid the structures' resistance - For flat roof it is important to have a right slope to allow the rain water to wash away quickly, the stagnancy upon the roof will allow the rain water to soak the top layers and penetrate in the core of the walls. - Where there is a parapet it is compulsory to provide 1 or 2 waterspouts, the slopes have to be arranged accordingly (minimum 1%). - The waterspouts should be minimum 2.5"and project minimum 8". - The waterspouts have to be well sealed with bitumen without any discontinuity in order to prevent rain water to penetrate in the structure of roof and walls. - Another option may be CGI spout in "U" shape. - The use of gutters to catch rain water may be considered; obviously the slope has to be adequate in case of flat roof.
Maintanance	- Re-plaster the roof with lime mud or bitumen mud mortar at least once a year or whenever necessary - Periodic cleaning of the waterspouts - Re-apply the film of bitumen yearly before the monsoon season - Verify the good connection of the element of the structures (beams and purlin) - Re-treat the bamboos and wooden elements against termite once a year or whenever necessary - Inform the owners regarding periodic termite treatment , annual replastering of the roof and periodic cleaning of the waterspouts

FIRED BRICK SHELTER

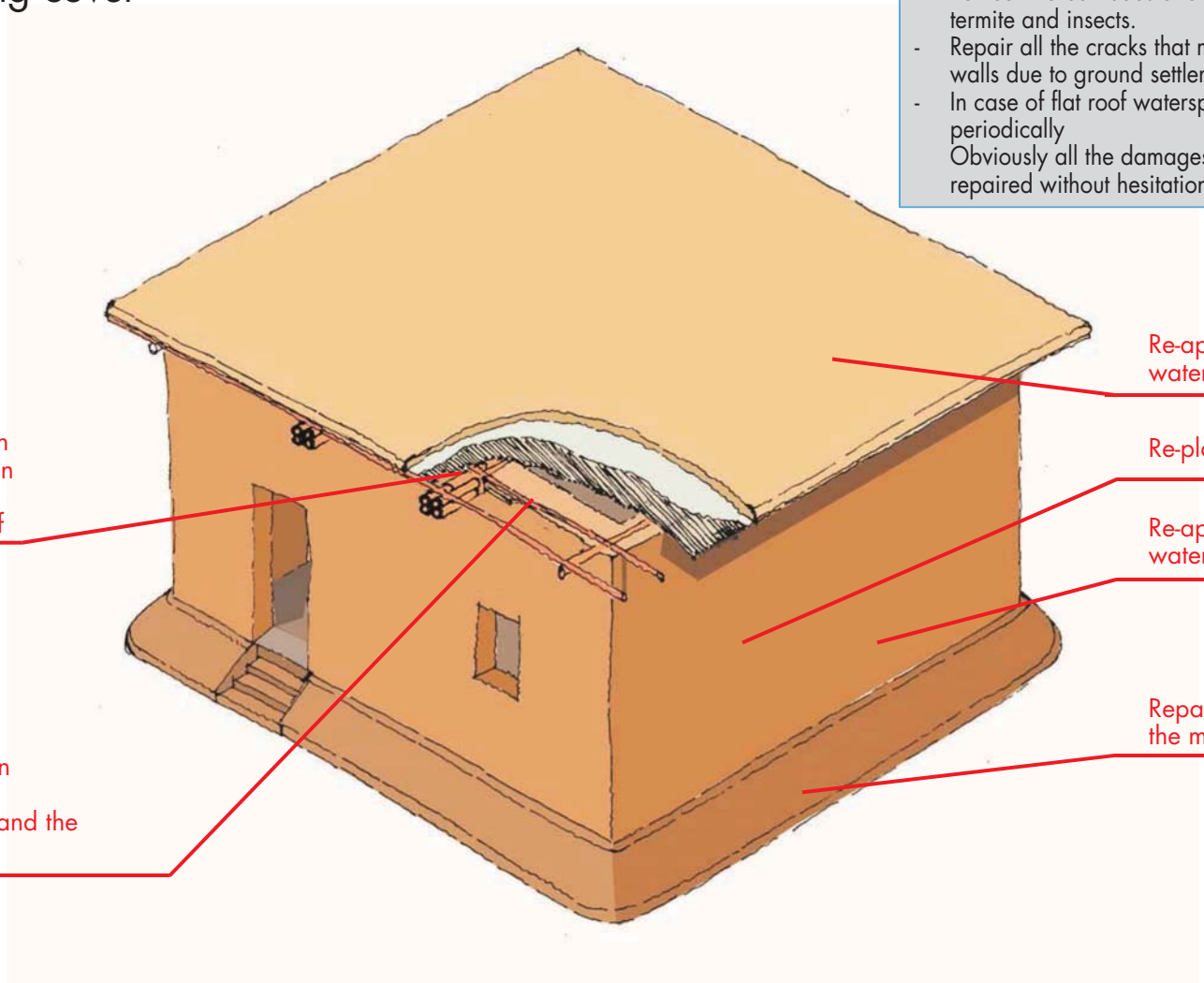
Maintenance :

- DRR
- Waterproofing plaster
- Roofing cover

Maintenance of the structure and DRR ensures a longer and safer life of the shelter. the main treatments to be applied periodically, i.e. yearly, are:

- Re-plastering before the raining season
- Verify and re-apply the waterproof layer of bitumen of stabilized mud till the SL
- Verify and reply the waterproof layer of the roof
- Control the connection of the main structure of the walls
- Re-treat the bamboos and other wooden elements against termite and insects.
- Repair all the cracks that may have appeared on the walls due to ground settlement and or to the dry weather
- In case of flat roof waterspouts should be cleaned periodically

Obviously all the damages that might occur should be repaired without hesitation.



HANDS was founded by Prof. A. G. Billoo (Sitara-e-Imtiaz) in 1979. HANDS has evolved in 34 years as one of the largest Non Profit Organization of the country with integrated development model. HANDS has a network of 31 offices across the country and has access to more than 16.2 million population of nearly 20,274 villages / settlements in 29 districts of Pakistan. HANDS strength is 18 volunteers Board Members, 12 Districts Patrons, more than 1700 full time staff. They are backed by thousand of community based volunteers of more than 5000 medium & small size organization.

HANDS is certified by Pakistan Centre for Philanthropy (PCP) and tax exempted by Income tax department of government of Pakistan. HANDS has qualified the Institutional Management Certification Program (IMCP) of USAID for management standards. HANDS is accredited with European Union. HANDS also possess membership with Humanitarian Accountability Partnership (HAP). HANDS is also member of International Union of Conservation of Nature (IUCN)

HANDS international recently established its office in London, United Kingdom. HANDS International UK is registered as non Government Organization in Companies act 2006 of England and Wales.

HANDS Pakistan Head Office

140-C, Block II, PECHS, Karachi.

Tel: (021) 34532804, 34527698 Fax: (021) 34559252

Email: info@hands.org.pk, info@handsinternational.org.uk

Web: www.hands.org.pk, www.handsinternational.org.uk

https://vimeo.com/user15449840

facebook.com/HANDSPakistanOrg

handspakistan.wordpress.com

flickr.com/photos/handspakistan

twitter.com/handspakistan

HANDS Suggestions and Complaint Cell: complaint@hands.org.pk Tel: (021) 34532804, 34527698 Mobile: 0345-8227501, 0334-2634403