2022 Southeast Afghanistan Earthquake,

Build Back Safer Practical Training Program

Kabul, Afghanistan
October 10, 2022

miyamoto.

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Authorship and Acknowledgments

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Héctor Esteban, D.S.A. terre
Earth Construction Expert

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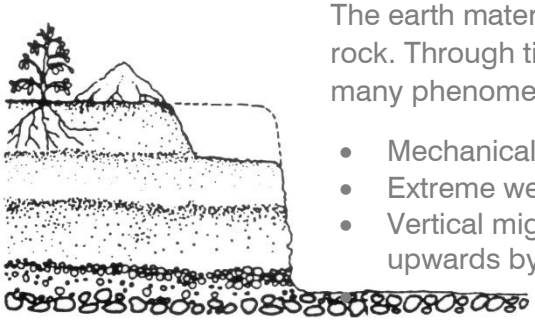
1. Soil classification and states of hydration

1.1.1 Origin:



The earth material comes from the disintegration of the mother rock. Through time, this rock undergoes transformations caused by many phenomena:

- Mechanical erosion (volcano, agriculture, wind...).
- Extreme weather conditions: heat, frost
- Vertical migrations of some components, downwards by rain, upwards by evaporation.

1.1.2 Components:

Inert			Active
 Stones 200 – 20 mm. ▪ They come from the erosion of the mother rock. ▪ Their resistance to shocks allows them to be used directly as masonry blocks.	 Gravels 20 – 2 mm  Sands 2 – 0.02 mm. ▪ Result of the erosion of stones. ▪ They form the skeleton of clay cement. ▪	 Silts 0.02 – 0.002 mm ▪ It is a sand invisible to the eye because its diameter is so small. ▪ With water, the grains of silts stick together. ▪ Low cohesion.	 Clay Ø < 0,002 mm ▪ They give cohesion to all the components of the soil. ▪ Their cohesive strength is reversible with water.

There are several types of soil according to the importance in quantity of one of the components:

GRAVELLY SOIL - SANDY SOIL - SILTY SOIL - CLAYEY SOIL

1.1.3 States of hydration:

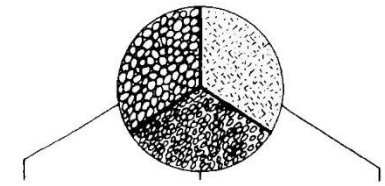
The more water the soil absorbs, the more its consistency changes. There are 4 basic states:

DRY - HUMID - PLASTIC - LIQUID.

- For each state, the soil in its entirety can be worked in a very specific way:
  - DRY: cuts - digs - pulverizes.
  - HUMID: compacts and compresses slowly
  - PLASTIC: can be shaped, moulded, demoulded
  - LIQUID: flows - sprays – paints

2. Fundamental soil properties for pakhsa and khama kashta

2.1.1 Texture:



It is the granular composition of a soil.

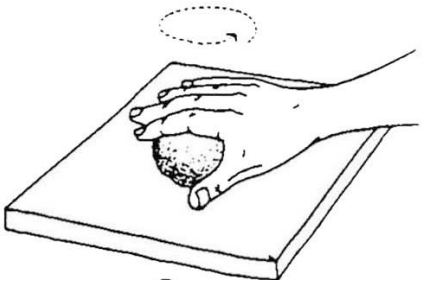
Each grain fraction has its own characteristics that can influence the structure of the whole soil.

Example: 10% of clay is enough to give plasticity and cohesion to the whole soil material.

2.1.2 Plasticity:

In its plastic state, the earth can be shaped without breaking or cracking.

This property is fundamental in the shaping of objects, bricks, full walls or plastering.



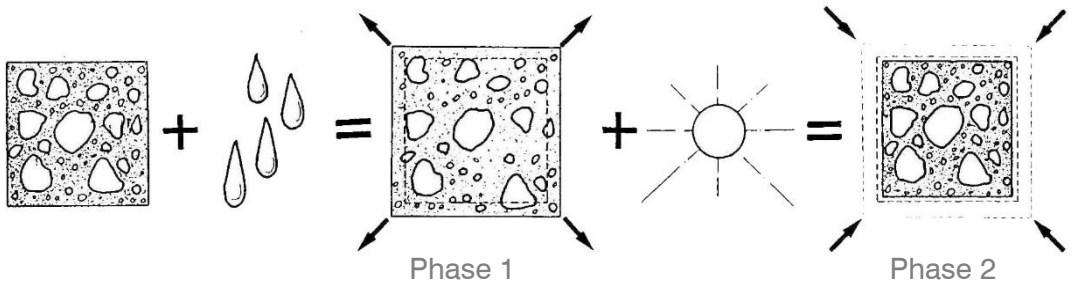
2.1.3 Cohesion:

I when the components of the soil remain associated.

The cohesion process works in two phases:

Phase 1: The soil absorbs water, from 20 to 30% depending on the type of soil. The clays start to swell. This process requires time.

Phase 2: The soil dries. The clays decrease in volume by attracting to them the other components. These other components are fully bonded at the dry state.

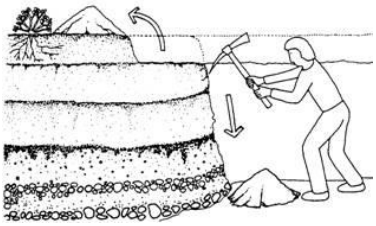


3. Field tests

Without laboratory tests and with significant experience, field tests are sufficient.

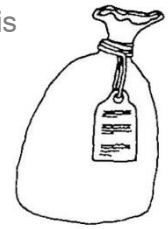
3.1 Sight and Touch - Smell - Hand washing

3.1.1 Sample collection



The top organic layer is discarded.

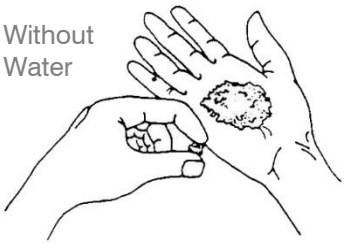
The sample is taken from the lower layers above the rock



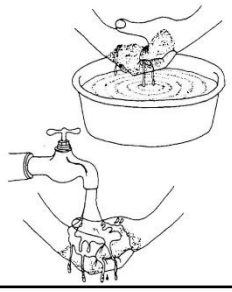
For each sample note:

- location
- depth

3.1.2 Touch and smell

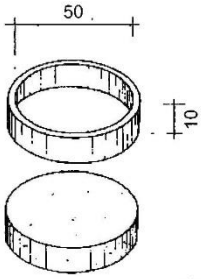
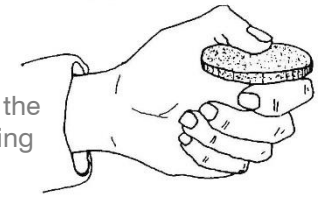
Objective	Procedure	Questions to be noted	Important points
Identify the composition of the soil. Identify the presence of organic matter.	Without Water  With Water 	In addition to the sample, an observation of the entire area should be made: existing earthen structures, soil used for roads, size of the different soil layers, etc. • By sight: Gravel and thick sands are identified. • By touch: Fine sands are identified. It remains a mass composed of clays and silts. • By smell: If with water, the soil smells like humus (musty smell), it is organic soil	▪ Release of an odor (with water): ***ORGANIC soil*** ▪ Rough, crumbly, not very sticky (with water): ***SANDY soil*** ▪ fine, easy to pulverize, sticky (with water): ***SILTY soil***

3.1.3 Hand washing

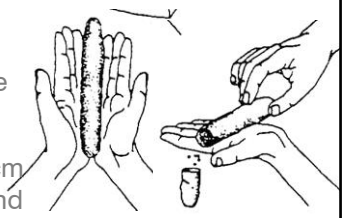
Confirms whether it is a clayey or silty soil.		Spread the liquid soil on your hands, then rinse them GENTLY with water. If it is difficult to remove, the soil is more likely to be clayey.	Difficult to crush, slow to melt in water, very sticky and fine: ***CLAYEY soil***

3.2 Biscuit – Cigar – Bottle

3.2.1 Biscuit test

Objective	Procedure	Results	Important points
-Test the dry strength. -Determine the percentage of fine particle shrinkage.	Remove the gravels from the sample and bring the soil to a plastic state. Mould 2 tablets with a piece of PVC tube or similar.  <u>After drying</u>: Observe the possible shrinkage phenomena.  Evaluate the resistance of the soil by breaking and crushing between the thumb and the index	No shrinkage, easy to reduce to powder: ***SANDY soil***  Shrinkage, easy to reduce to powder: ***SILTY soil***  High shrinkage, very difficult to powder: ***CLAYEY soil*** 	Prepare the clay in a plastic state, and let it settle for an hour before moulding the two tablets. This gives the clay time to react with the water. Less than 1 mm shrinkage and difficult to powder: <u>Good soil.</u>

3.2.2 Cigar test

Determine the cohesion of the soil. Check if the amount of clay in the soil is appropriate for making bricks	Remove particles larger than 5 mm. Prepare the sample in the plastic state. Make a 3-4 cm thick cigar and gently push it out of the support 	Measure the length of broken part: - Between 5 and 8 cm has already the balance of clay and sand for <u>good soil</u>	Bring the soil to a plastic state, and let it settle for an hour before making the cigar. This gives the clay time to react with the water.

3.2.3 Bottle test

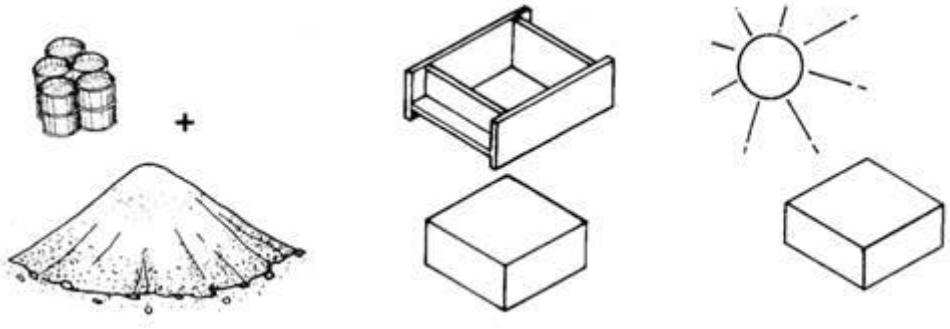
Measuring the relation between the different soil components	In a transparent bottle, fill 1/4 of soil and 3/4 of water. Shake vigorously. Then let settle until the water is clean. 	Note the proportions of the different components: - Gravel and sand at the bottom - Silt and clay at	This test is used to measure the proportion of sand and gravel.

4. Khama-khashta

4.1 Introduction

The production of khama khashta is based on the principle of moulding a prepared earth in a plastic state and drying it naturally on the ground.

The amount of water required is about one third of the volume of the dry earth.

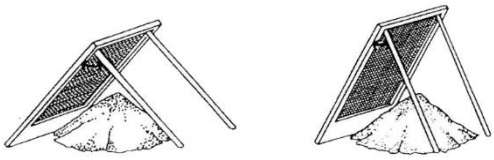


4.2 Sieving the soil

Sieving the soil is important to ensure the correct soil composition when removing:

- Organic substances.
- Gravels bigger than 20 mm.
- Clods of soil

4.2.1 Sieving by inclined system

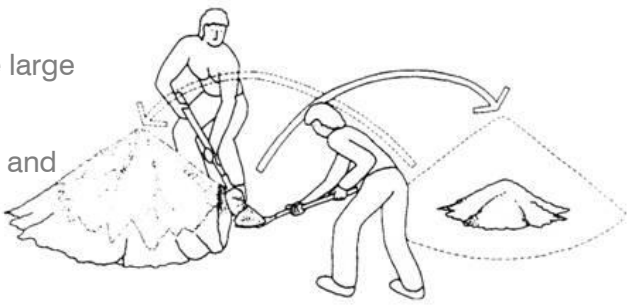


The inclination of the sieve changes the diameter of the sieved soil. The more vertical the sieve, the finer the grain.

4.2.2 Sieving by moving the pile

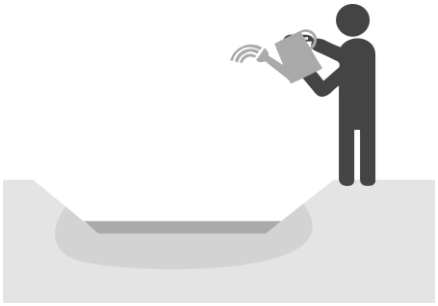
By emptying the shovel well to the top, the large clods and gravels roll to the periphery.

Two people are needed to crush the clods and remove gravel larger than 20 mm.



4.3 Plastic soil mixture

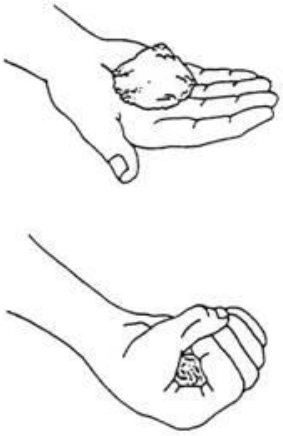
In the dry areas, on hard and homogeneous soil, after removing the top soil, it is advisable to flood the excavation so that the water can soften the soil and facilitate the manual extraction.



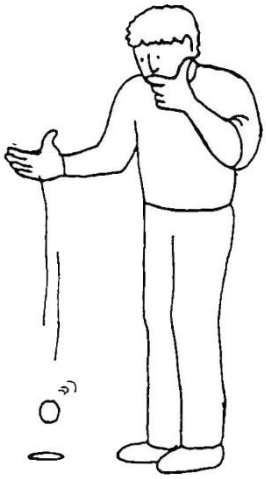
<u>With the feet</u>
This is one of the most common ways of mixing in small-scale production. 4 m3 man/day

<u>Animals</u>
Work carried out by animals walking on the working surface.

4.4 Optimum water content test



Mould a ball of plastic soil in your hand.

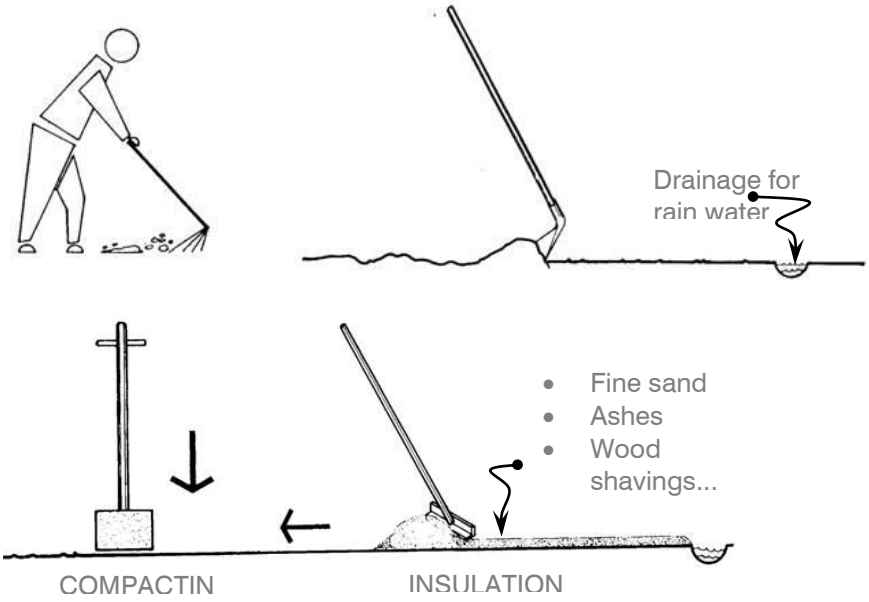


Drop it from elbow height.

The ball does not break: <u>optimal mix</u>

If it crumbles or breaks into several pieces, there is <u>not enough water</u>

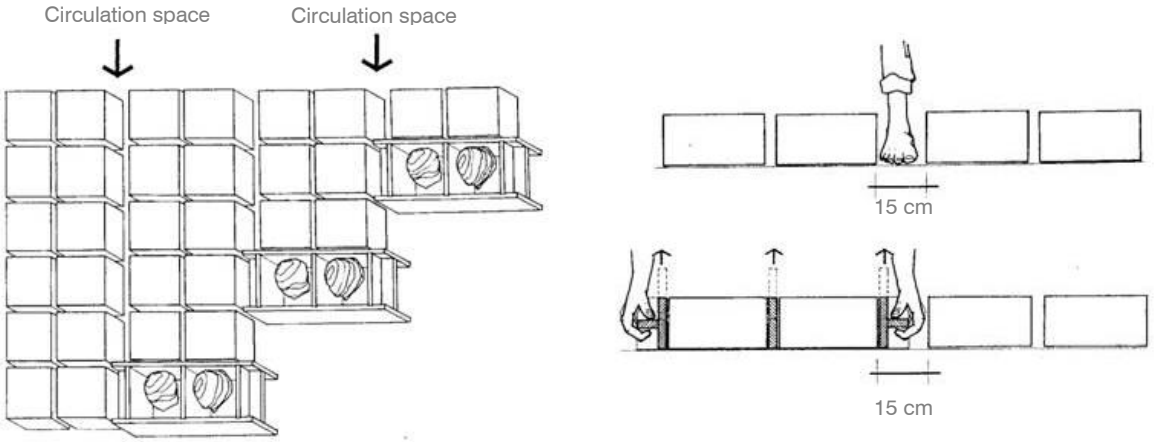
4.5 Preparation of the drying area



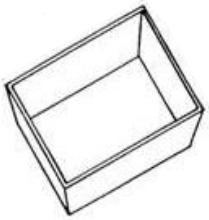
4.6 Moulding and demoulding

It is recommended to:

- Mould after the soil / water mixture has settled for at <u>least one night.</u>
- Provide every meter a space for circulation to cover the bricks in case of rain.
- Respect the alignments to manage the space and the counting of bricks



4.7 Tools



Mould cleaning tray

Leveling ruler to remove excess on the mould. If not available, it can be done by hand

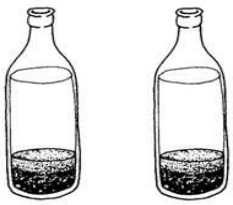
Sponge or brush to moisten bricks and moulds

4.8 Control tests

4.8.1 Soil control

When extracting:

- Check each week that the new soil is identical to the one selected at the beginning.
- Perform a "bottle test" (settling of the soil in water after shaking).
- Compare the repartition of the different layers with those of the reference bottle.



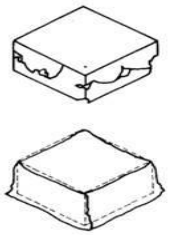
Reference Sample

CONTROL:

When the 2 bottles do not look the same, re-test the new soil to verify its properties.

4.8.2 Shape control

When demoulding: No voids are accepted at the edges.
The base size must not increase more than 5%.



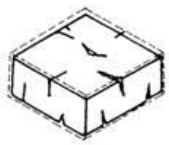
CONTROL:

Better compacting in the corners of the mould.

Reduce the amount of water in the mix.

4.8.3 Shrinkage control

After demoulding: Rapid appearance of cracks on the surface.
After drying: No cracks larger than 5 cm No voids are accepted at the edges.
The base size must not increase more than 5%.



CONTROL:

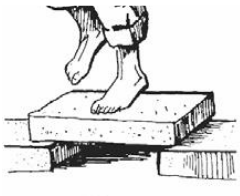
Protect from the sun.

Add sand

4.8.4 Strength control

After complete drying:

Randomly select 3 bricks from the daily stock.
Each of the 3 bricks must withstand the weight of a man (+- 80kg) for one minute.



CONTROL:

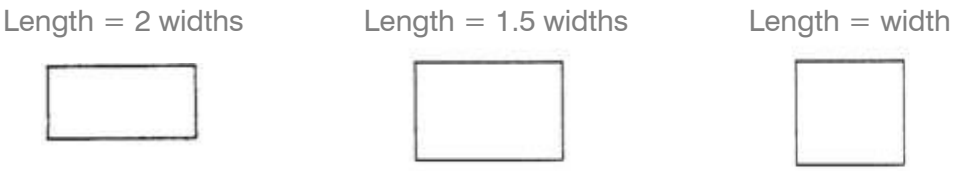
Check the cohesion of the soil: if it is too sandy change the quarry

4.9 Basic principles for brick-coursing

4.9.1 Brick dimensions

The dimensions of the bricks are very variable and respond to both tradition and construction criteria.

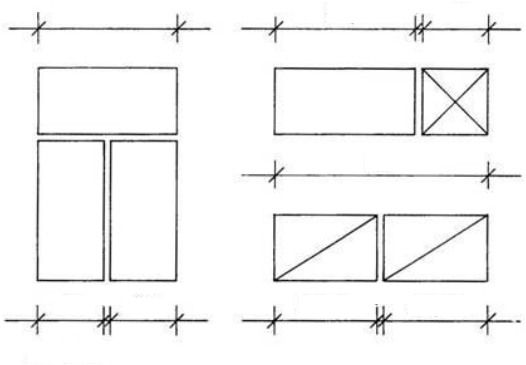
As for the overall dimensions of the walls of the khama khashta, the thicknesses can vary between 30 cm and 1 m.



4.9.2 Brick coursing

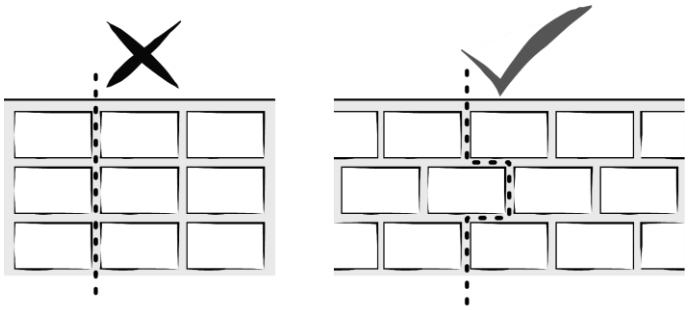
This is the way in which the bricks are assembled and linked together, in all directions (horizontal, vertical, thickness of the wall).

It helps to have a whole number of bricks with all vertical joints of the same thickness.



4.9.3 Brick overlapping

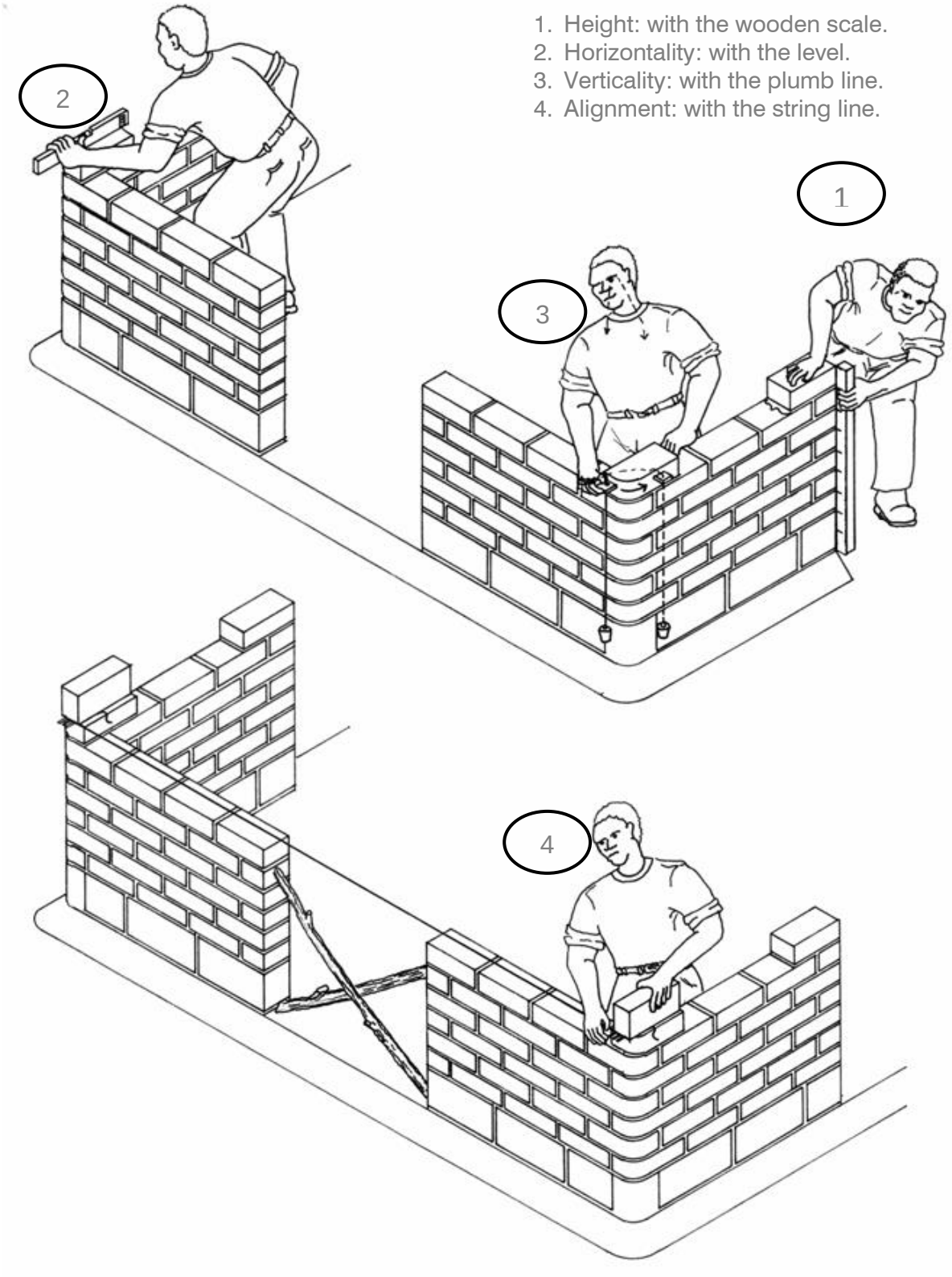
Good brick-coursing ensure the strength and stability of walls.
A properly built wall does not crack easily and is more resistant to ground movements.



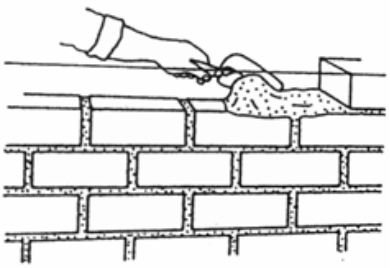
4.9.4 Control techniques

At each brick layer, start by placing the corner bricks and checking:

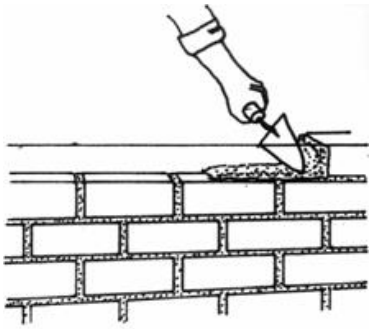
1. Height: with the wooden scale.
2. Horizontality: with the level.
3. Verticality: with the plumb line.
4. Alignment: with the string line.



4.9.5 Laying bricks with mortar

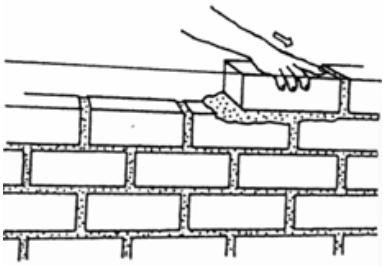


Apply the right amount of mortar

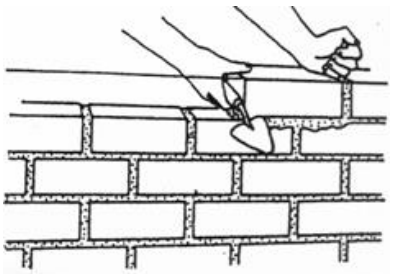


Spread the mortar, also on the vertical side

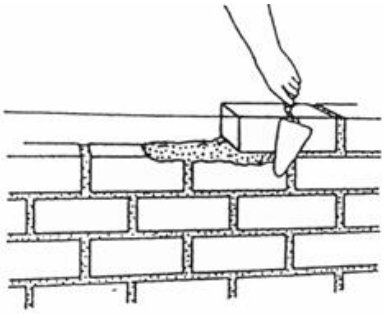
GENTLY moisten the bricks with a sponge or brush before laying them



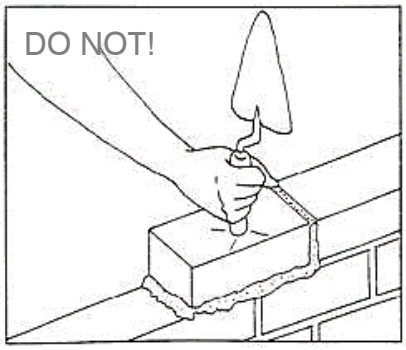
Place the brick by pushing



Make sure the block is well placed without typing it

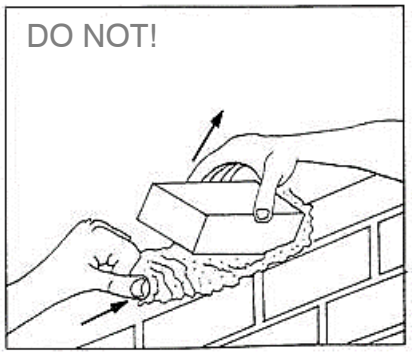


Remove excess mortar



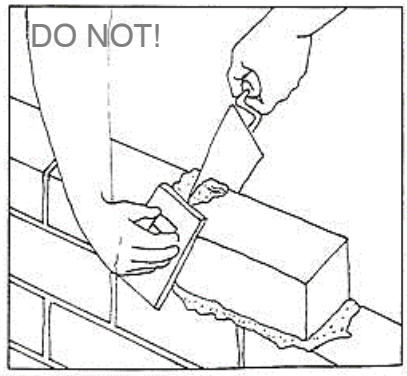
Do not hit the block with a hard object to bring it into the correct position.

If the mortar is too thick and hard to push in with your hands, it is better to change the mortar layer.



Do not lift the block to push mortar in once it has been placed.

It is better to remove the brick and put a new layer of mortar.

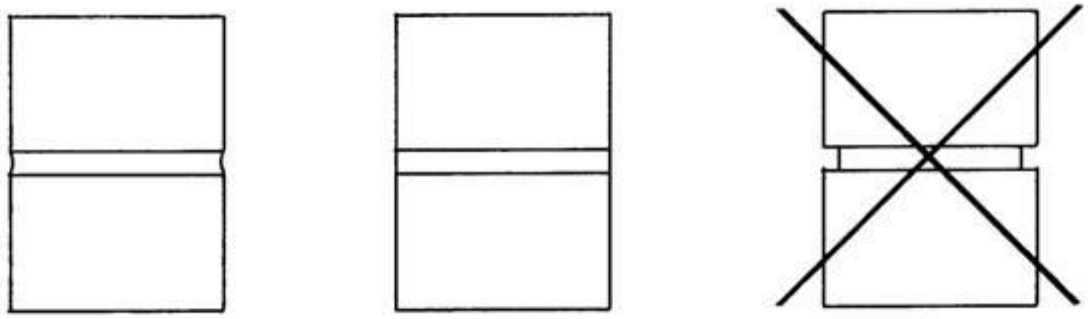


Do not fill in the vertical joints after laying the bricks:

- Loss of time.
- Risk of dirtying the blocks.
- Risk of partial infilling.

Flush or slightly rounded joints offer good resistance of the wall to the weather.

Avoid joints that are too deep, which weaken the edge of the bricks in the presence of water and lead to moisture.



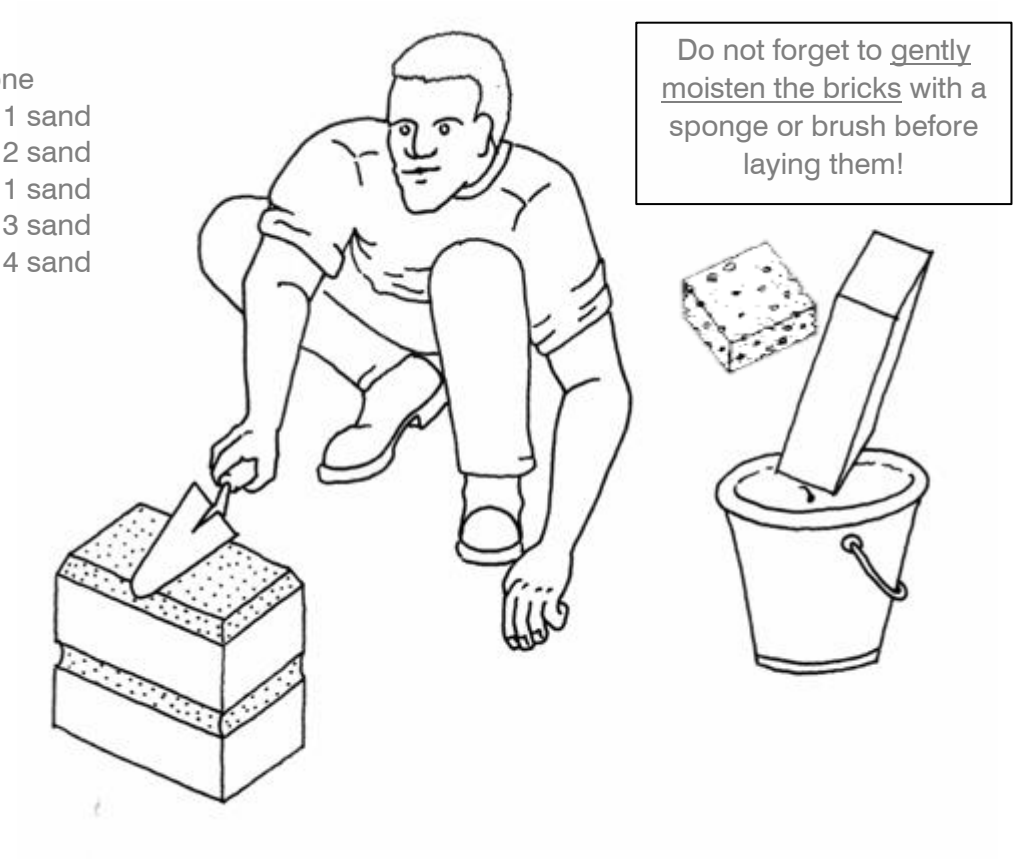
4.9.6 Testing the soil mortar

Objective: This test will help to determine the best dosage between soil and sand.

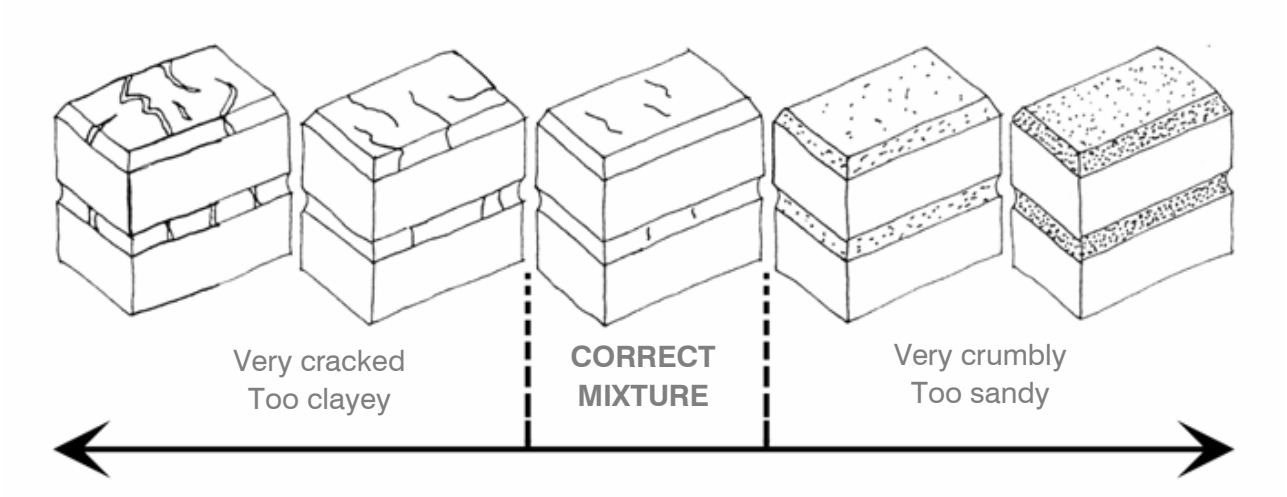
Procedure: Prepare on 2 khama khashta bricks a mortar mix and repeat the procedure with more sand each time.

Example:

- soil alone
- 4 soil / 1 sand
- 3 soil / 2 sand
- 1 soil / 1 sand
- 1 soil / 3 sand
- 1 soil / 4 sand



Result: Choose the hardest and least cracked mortar, which ensures the best adhesion between 2 blocks.



5. Pakhsa

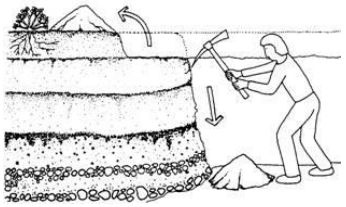
Pakhsa is a type of stacked raw earth construction used in a plastic state to build a wall directly. Its composition is the same as that of khama khashta bricks, however for pakhsa big stones are allowed.

The soil found in south east Afghanistan with rich and homogeneous quantity of aggregates limits the shrinkage of the clay.

5.1 Building process

1. Extraction of the soil from the area.

Top soil is not suitable for construction and needs to be removed

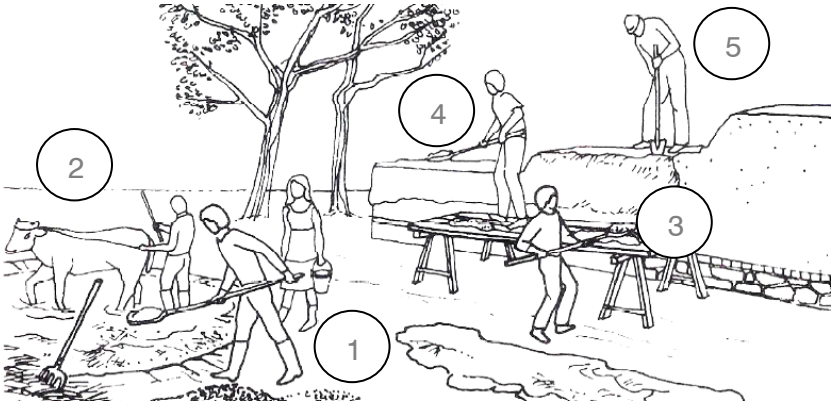


2. In the dry areas, on hard and homogeneous soil, it is advisable to flood the excavation so that the water can soften the soil and facilitate the manual extraction.

3. After the soil is well mixed, slabs of this plastic soil are used. The mason slaps them onto the stone foundations. The most classic size of the slabs is 20 to 30 cm on each side by 5 to 10 cm in height (the size varies depending on each area)

4. Lifts of 40 to 60 cm depending on the area are made with the plastic slabs

5. After one course is sufficiently dry, a consecutive course is laid on top and the excess is trimmed to achieve a flat surface.



5.2 Control tests

5.2.1 Shape control

When placing the soil slabs:

No voids are accepted

Big stones can compromise structure stability

CONTROL:

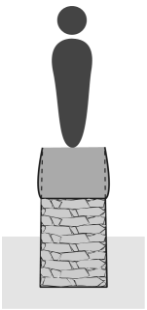
The slabs can be slammed, turned over or smoothed by compressing to ensure good cohesion of the lift.

Avoid placing big stones together

When starting a new lift:

A drying time is necessary between the two lifts so that the lower one has reached a sufficient cohesion to support the upper one

Drying time varies greatly, depends on the type of soil used, its water content, the thickness of the wall and the weather.



CONTROL:

Before starting a new lift, check if the lift settle when applying the mason's weight.

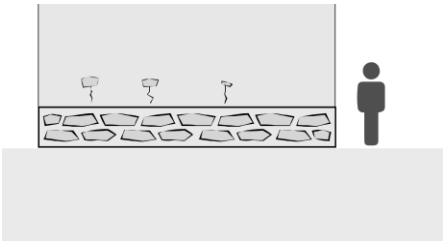
If the lift settles, wait for it to dry

5.2.2 Crack control

When starting a new lift:

It is common to see cracks when the lifts start to dry, normally these cracks doesn't compromise stability of the wall at the short term

To reduce the long-term maintenance of the building, it is recommended that cracks are repaired



CONTROL:

When starting a new lift, look for new cracks and place stones over them to prevent the crack from continuing to grow in the wall.

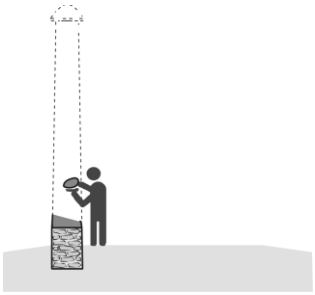
5.3 Water control and strength

Pakhsa drying time varies greatly depending on:

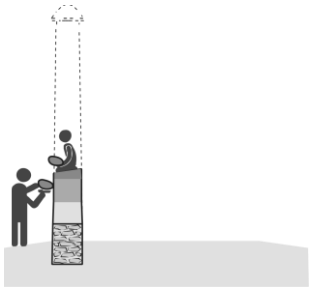
- The type of soil
- The water content
- The thickness of the wall
- The weather

During the construction of pakhsa walls, several stages of strength can be identified depending on the amount of water in the wall:

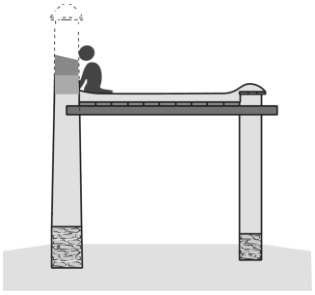
1. During its execution pakhsa is in a plastic state. It supports its own weight and briefly the weight of the mason who is putting it in place, thus compressing the material. No other load is applied to it.



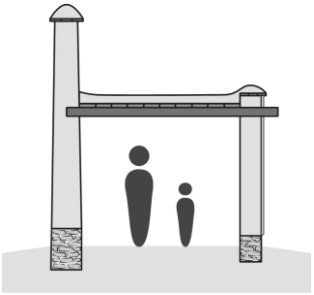
2. After an initial drying period, the drying pakhsa is firm enough to support the mason's weight, at this moment the next lift can be carried out



3. The pakhsa still humid on its core, however it has settled, densified and lost enough water. This can be identified by sight and touch. At this moment the wall can support the loads that will be applied to it during the life of the structure



4. When pakhsa is completely dry, the material finishes its shrinkage and its strength increases. After one year it is recommended to do the plastering.

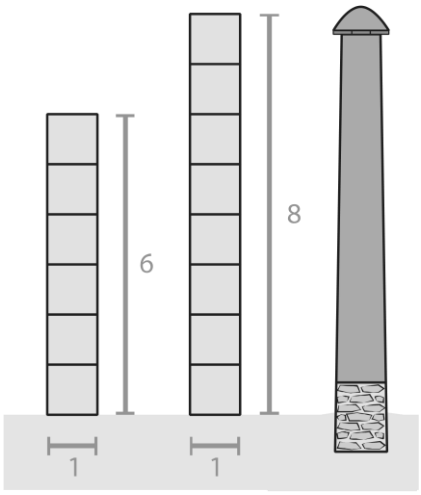


6. Height versus thickness of walls

6.1.1 Introduction

To guarantee a good stability of the walls, a good wall height to width ratio should be followed.

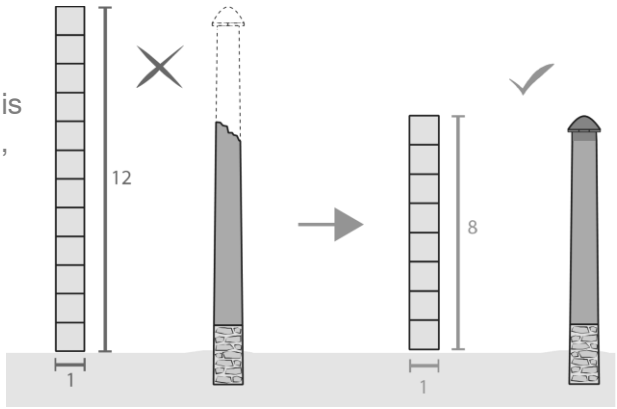
The best height versus thickness of the wall is to make it between 6 to 8 times as tall as it is thick



6.1.1 Actions to take

A wall that exceeds the recommended ratios is prone to collapse during an earthquake. If so, the wall must not be rebuild at its original height.

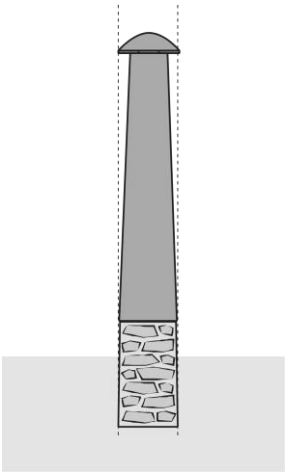
The remaining wall should be levelled out, crumbled and loose parts must be removed and a proper capping must be added.



6.1.2 Tapered walls

To improve the stability of the walls in case of earthquake, the width of the wall decreases as it is being built.

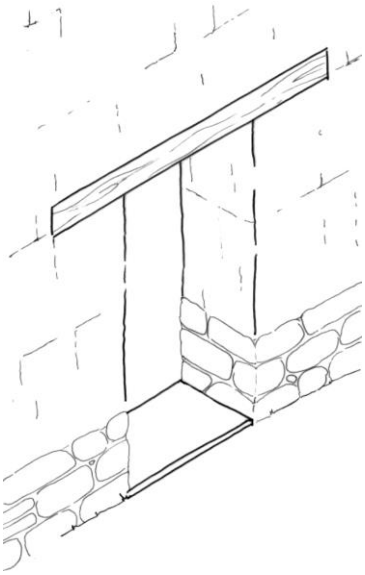
To this effect, each new lift is made one centimeter thinner on each side than the previous one.



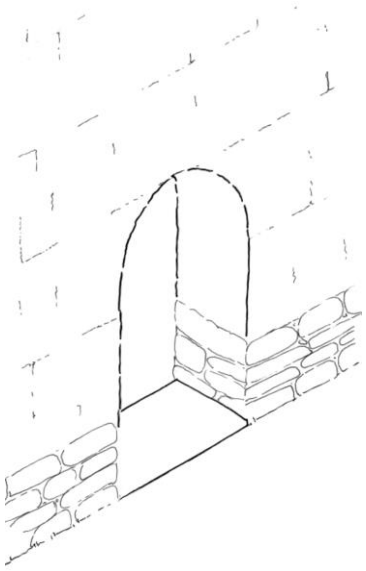
7. Wall openings

When creating an opening (door, window), the opening can be achieved by means of:

- A lintel made of materials that work in bending, such as wood,
- An arch made of materials that work under compression such as soil (pakhsa) or stone



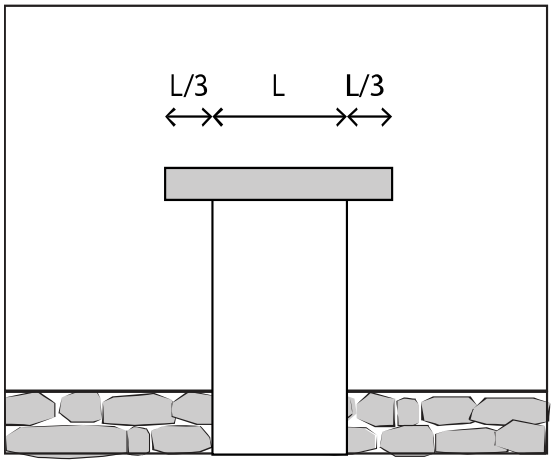
Wooden lintel



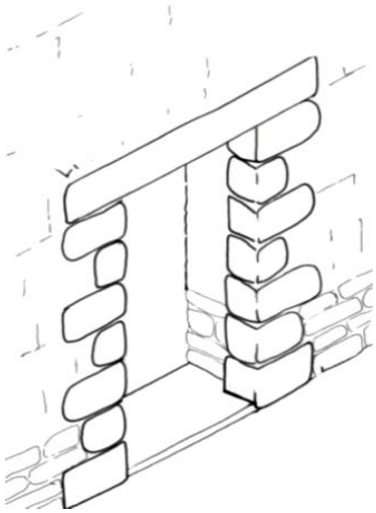
Arch carved into a pakhsa wall

The load of the elements supported by this crossing is then transferred:

- To the supporting elements of the opening via
- Masonry or wooden jambs



1/3 of the length of the opening is recommended to be embedded in the wall.



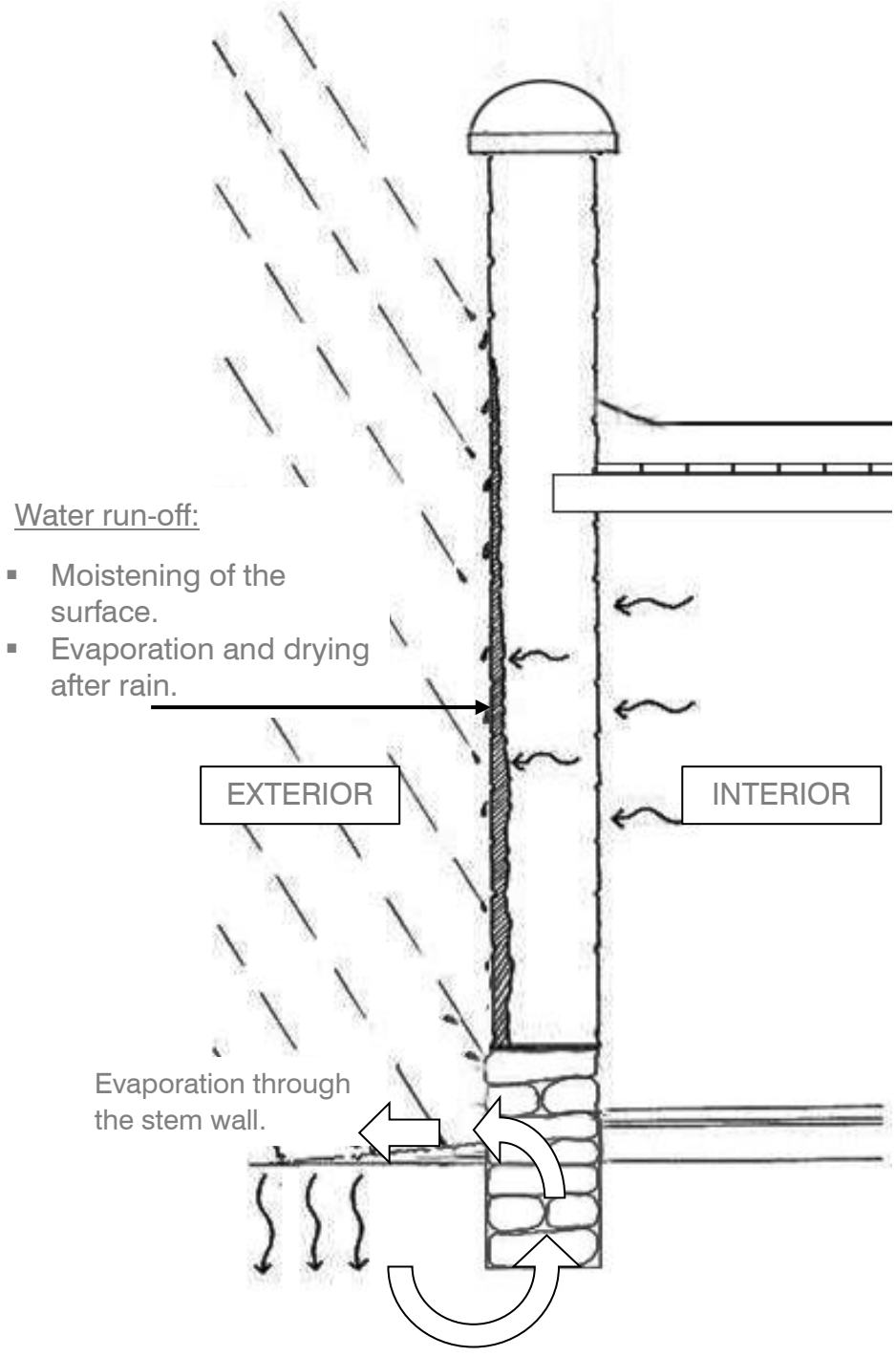
Masonry vertical support

8. Plastering

8.1.1 Introduction

A good quality earth wall can withstand normal rainfall with normal maintenance. However, to extend the lifetime of the walls, plastering is recommended.

Pakhsa and khama khashta walls self-regulate the passage of moisture inward and outward to remain stable. Soil-based plasters allow this regulation of humidity. Plasters that are completely waterproofing, like cement plastering, should be avoided



8.1.2 Testing plaster

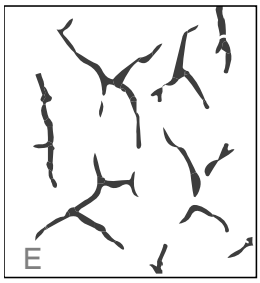
Plastering is useful to give correct maintenance to damaged or worn surfaces over time,

Preparing a good mix is very important order to have a plaster that spreads and sticks well to support when applying, and very important, without cracking to much once it's dry

It is recommended to have a soil sieved to 5 mm and mixed with short chopped straw.

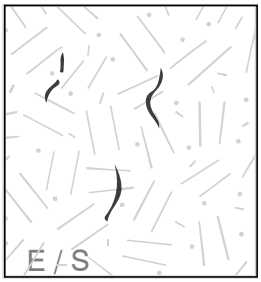
1. Make several plaster samples on the surface to plaster, or on minimum 30 cm x 30 cm panel
2. Identification of the mixture on each panel.
3. Wait for complete drying.

Choose the mixture that cracks very slightly (example):

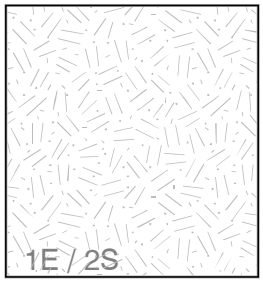


(Soil only)

(2 Soil / 1 Straw)



(Soil / Straw)

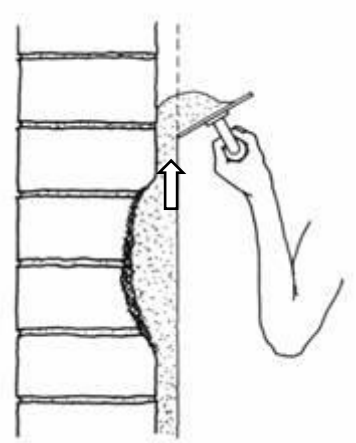


(1 Soil / 2 Straw)

The best mix:

- Good résistance to friction
- Minor cracks (3 cm)

8.1.3 Applying plaster



1. Plastering is useful to give correct maintenance to damaged or worn surfaces over time.
2. Remove dust and gently moisten the surface
3. Apply the plaster from bottom to top using a plasterer.

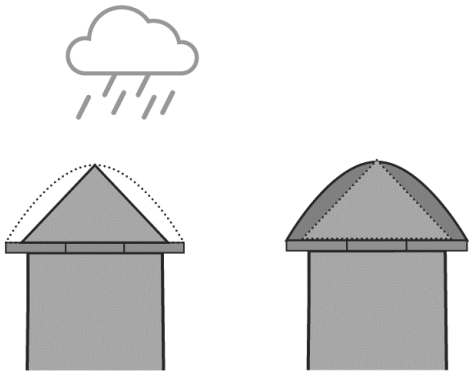
For thick layers (≥ 4 cm) or to fill cavities:

- Apply a thin layer as a base.
-

9. Capping

Capping is very important to preserve a wall in good shape and stable. It avoids water stagnation that will eventually lead to water leaking on the wall, main cause of degradation of pakhsa and khama khashta walls.

The capping must be reshaped (same soil composition) with a smooth form that goes till the edges of the existing seat



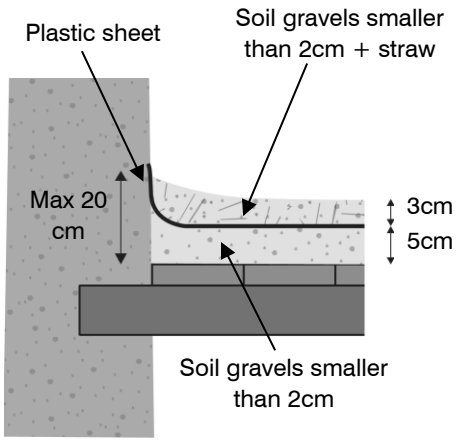
10. Roof soil cover

It is very important to periodically do maintenance on the soil cover of the roof that will assure:

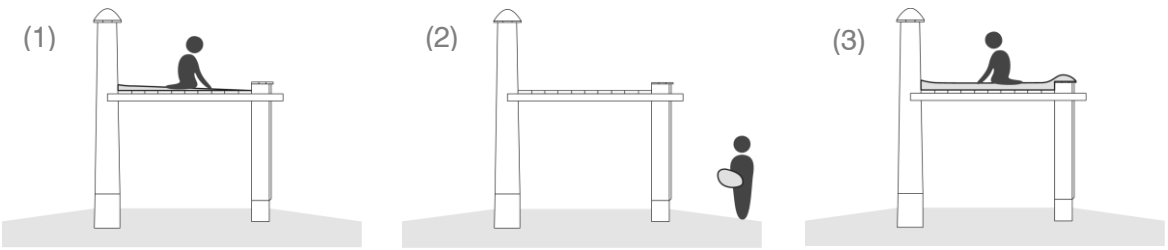
- water proofing
- and thermal storage during winter

However it is very important to avoid overloading of the roof.

It is a common practice to have 8 cm thick roof soils in the thinner section. However, when increasing the section for a wood drainage it is important to not exceed the 20 cm of thickness.



1. Before adding a new layer, remove the previous soil layer
2. Work well the soil and avoid using the top layer soil
3. Add the new layer of soil, with a good draining system



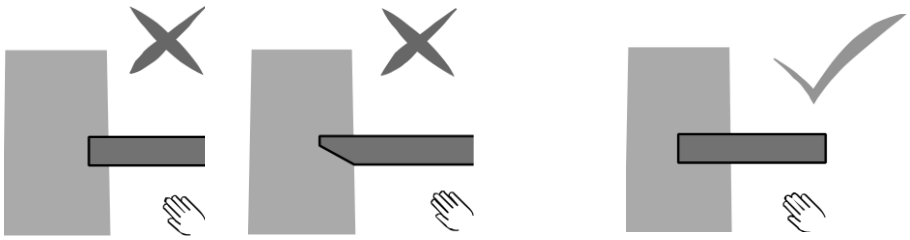
11. Beam-to-wall connections

Any beam-to-wall connection must have free movement in the event of an earthquake. Beams should not be firmly attached to the embedded wall connection

11.1.1 Pakhsa compound walls

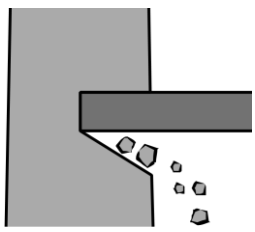
The beams must be sufficiently embedded in the compound wall so that they cannot be pulled out in the event of an earthquake

It is important that the beam gets at least halfway into the compound wall

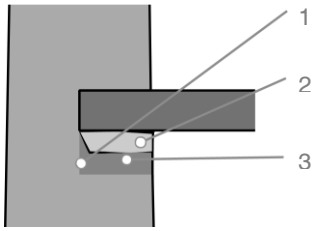


When the connection in the wall has become fragile, the following actions can be taken:

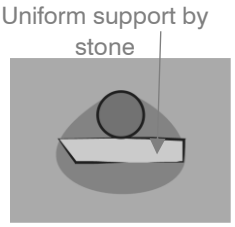
1. Remove some soil to level the hole
2. Use a stone or piece of wood to support the beam from below
3. Refill the rest of the hole under the stone or wood with new soil



Side view



Side view

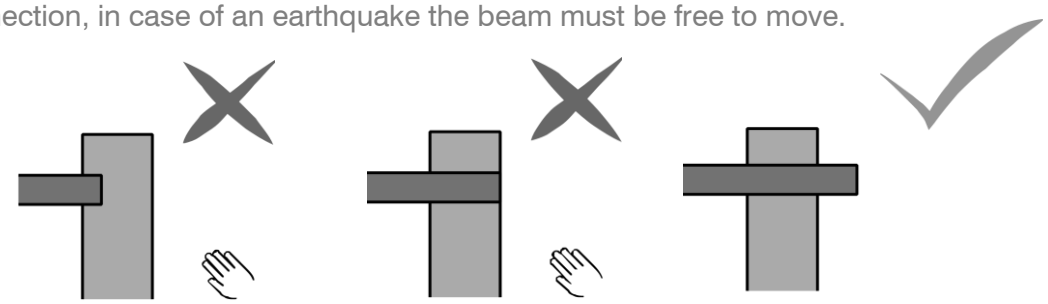


Front view

11.1.2 Interior walls

Pakhsa and khama khashta walls

The beam must pass through and out of the inner wall, without any element stiffening the connection, in case of an earthquake the beam must be free to move.



Stone walls

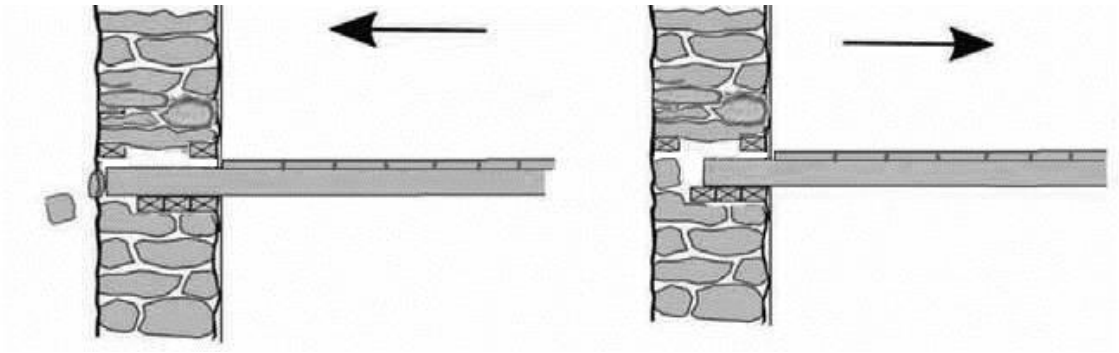
The beam should be placed in the masonry above and below a wooden element that:

- distributes the beam's load evenly throughout the wall;
- Function as a "sliding platform", allowing the horizontal displacement of the beam, during an earthquake, without crumbling the stones of the wall.

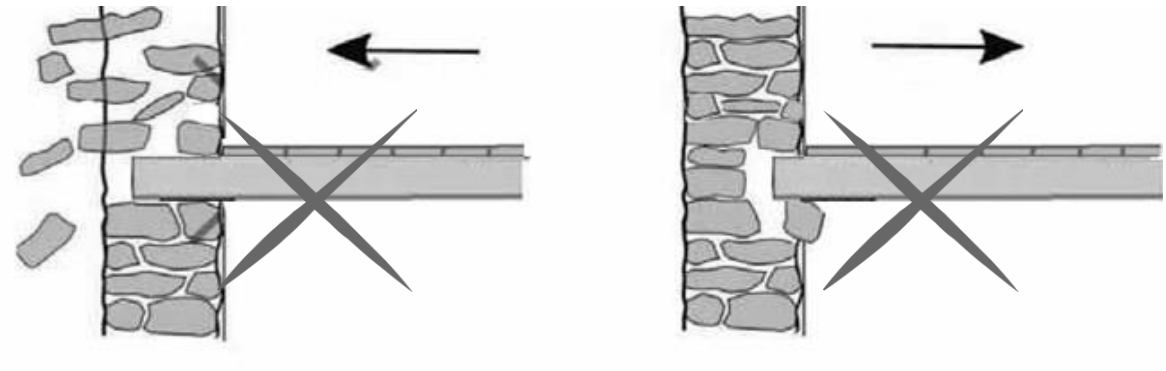
For this last feature, it is essential to leave an approximately 5 cm gap between the beam and the masonry (on both sides, as well as on the upper face).

The beam should go in about 3/4 of the wall's thickness, to prevent from coming out, with the inward horizontal movements.

The remaining 1/4 should be filled with stone masonry. It is very likely that the outward horizontal movements will cause the falling of these few stones, but this would not jeopardize the stability of the wall.



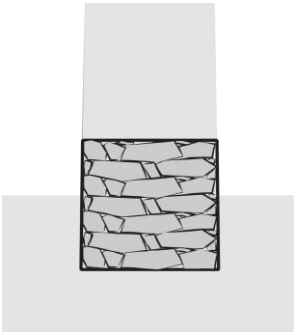
If, on the other hand, the beam is confined in the stone masonry, its horizontal displacement may cause heavy damage to the masonry and even cause collapsing of the upper part of the wall.



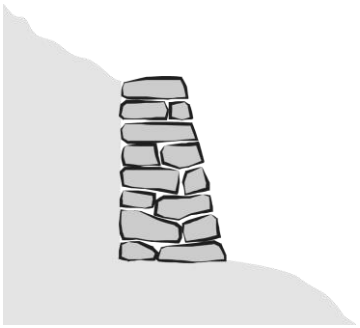
12. Stonework

12.1.1 Introduction

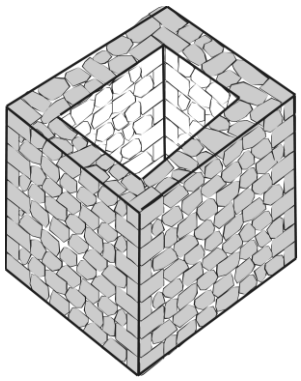
Stonework is very useful for foundations and stem walls, retaining walls and housing walls.



Foundation and stem wall



Retaining wall

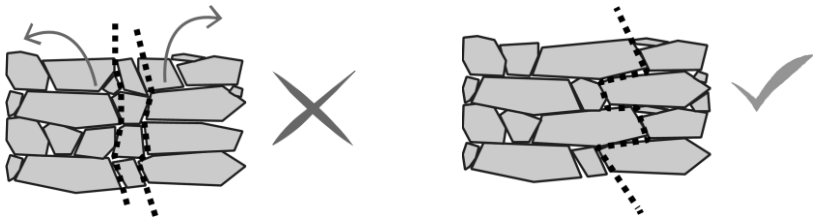


Housing walls

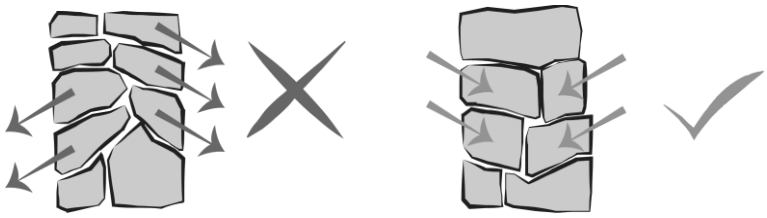
12.1.2 Stonework principles

Ensure good overlapping of the stones and keep gaps in between stones to a minimum

Find stones that fit well together and fill the gaps with small stones

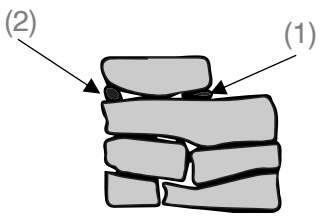


The stone should lean slightly towards the center of the wall so they do not fall out

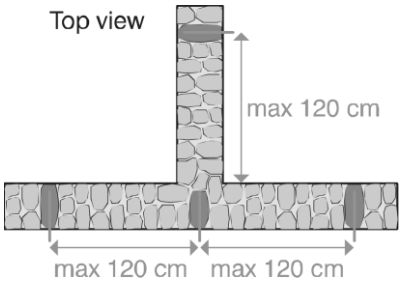


The aesthetic aspect is not the most important for the choice of the stone placing. The stones should be placed to be the most difficult to be removed.

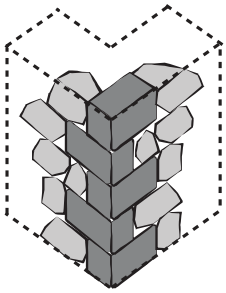
The blocking stone (1) must be inside the wall so that it cannot be removed or fall. The outside stone (2) is putted after, but even if removed, the big stone must remain in place.



When large stones are available, regularly use these to bind the foundation together by placing them through (max every 120 cm)



- Particular attention should be given to the laying of the corners.
- Big stones should be used as often as possible, at every course.
- The corner stones must be crossed so that no vertical continuity can exist in joints.

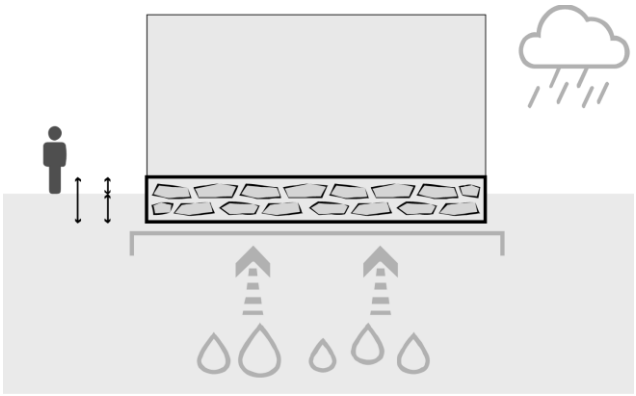


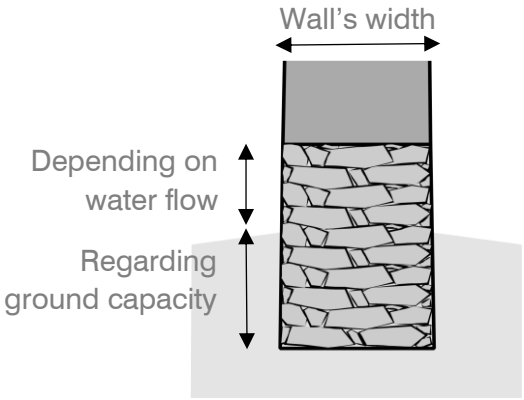
12.1.3 Foundation and stem wall

When building with soil, stonework is very important because in addition of providing support to the wall with its corresponding loads, it avoids rising humidity towards the walls.

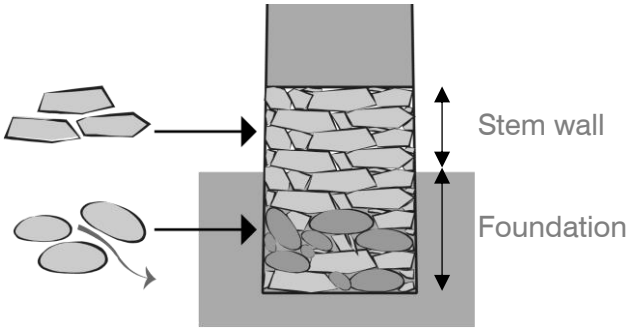
Heights of the stem wall vary according to the amount of water flow in the area.

Depth of the foundations always in relation to the ground capacity





Rounded stones are not stable in dry wall construction, however, if there are not enough cornerstones, round stones can be used on foundation, to save cornerstones for stem wall

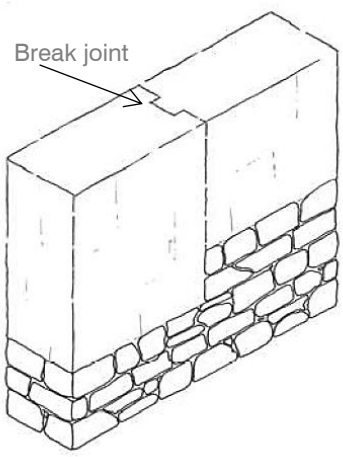


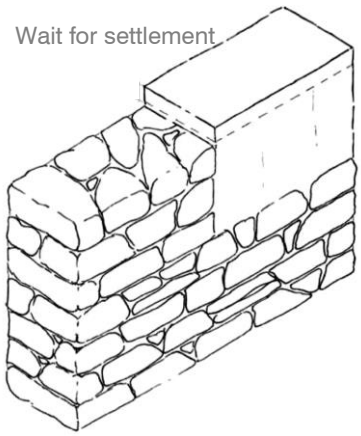
Stepped stem wall on pakhsa wall

As it dries, the pakhsa settles and therefore has a vertical movement.
If the surface on which the wall rests is not stable and horizontal (stepped stem wall), differential settlement can lead to cracking.

In order to prevent this risk, it is recommended to limit differential settlement within the same pakhsa element.
The settlement of a pakhsa lift is on average 2%. It varies according to the composition of the soil and the water content of the mixture.

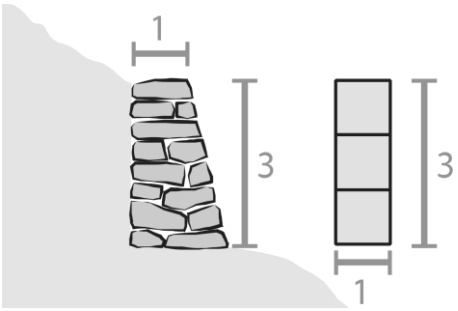
To limit or avoid differential settlement, it is possible to:
- Provide a vertical separation (break joint) between the walls at each change in height
- Level the wall with the cob and let it settle before continuing to build the wall.





12.1.4 Retaining wall

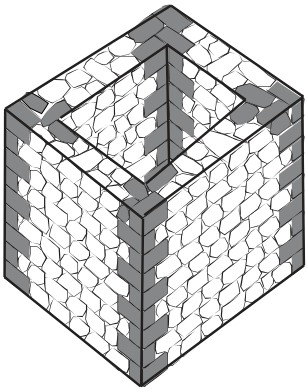
The ratio for a stone retention wall is 1:3, as counted from the top, narrower side.



12.1.5 Stone walls

The ratio for stone walls is 1:3 or 1:5, if a top timber structure is used.

It is important to cross-lay the corners with big stones for stability.

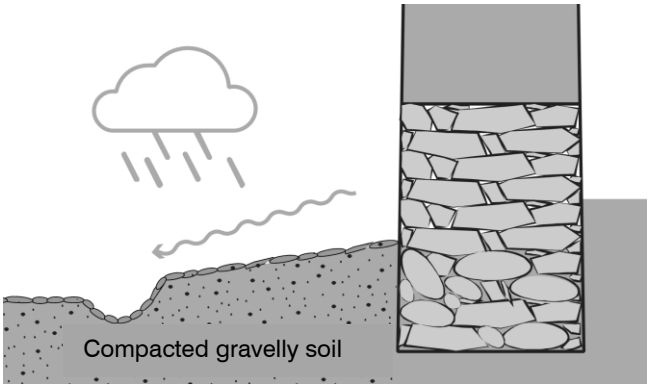


12.1.6 Draining

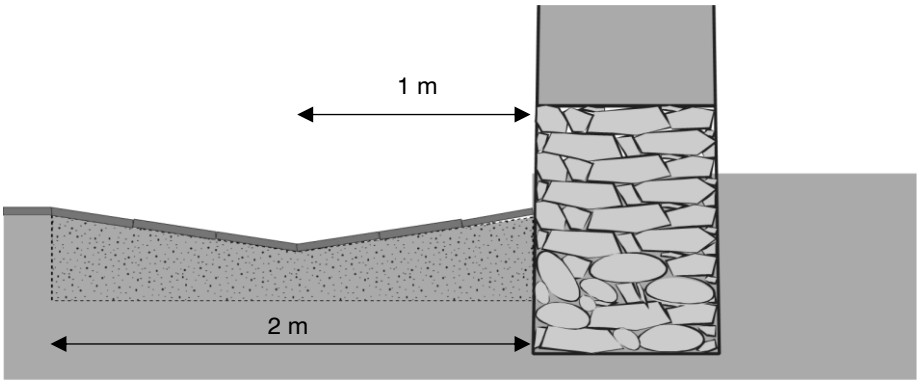
It is recommended that drainage be provided in the immediate vicinity of the walls.

The surface can be made of flat stones, round stones, gravels, or compacted soil.

These small assembled elements allow the evaporation of moisture.

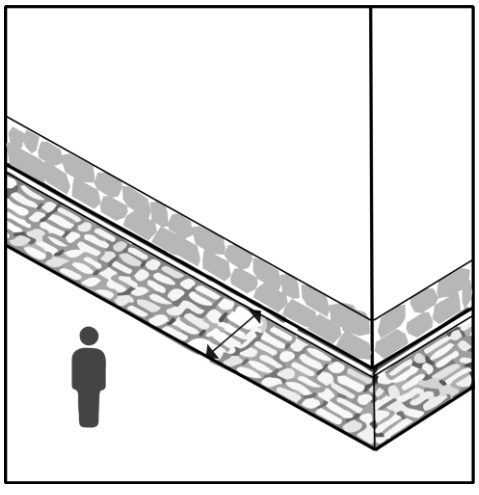


The drainage needs to be wide enough so that the bottom line of the gutter is as far away from the wall and its foundations as possible.

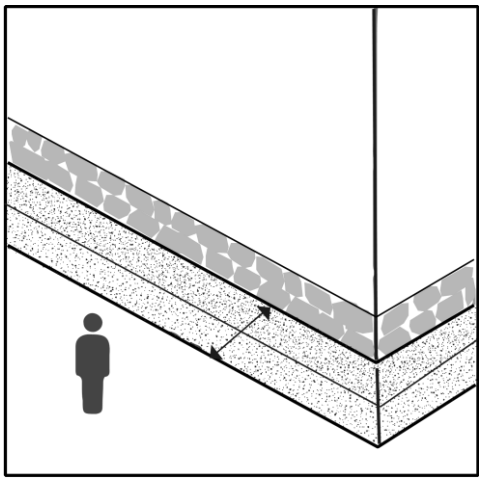


Alternatively, a gravel bed can be laid around the perimeter of the building to act as a drainage system for run-off water.

Always with the bottom line as far as possible from the foundations.



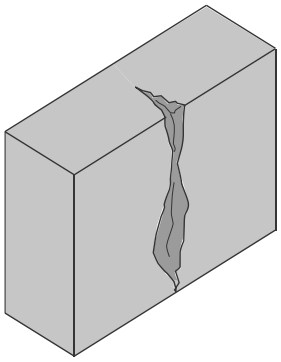
Flat stone drainage



Gravel bed drainage

13. Repairs

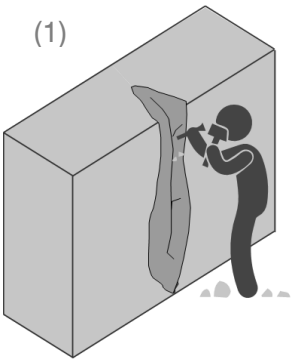
13.1.1 Cracks and severe erosion



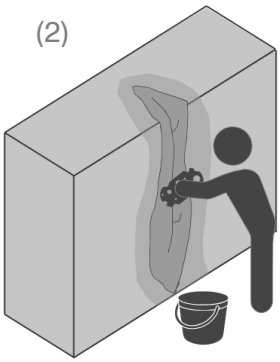
1. Carve the crack to take off unstable elements and get a bigger contact surface
2. Gently hydrate the existing wall
3. Add, depending on the level of erosion or crack gap:
   - Mortar made from the same soil,
   - Or khama kashta bricks

*Make sure of not leaving any gap with the mortar, compress with a soft material like wood

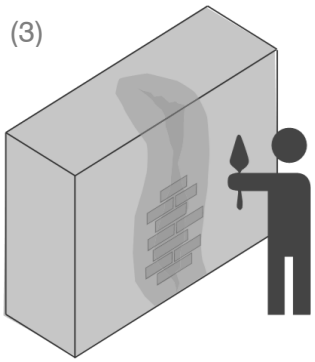
(1)



(2)



(3)

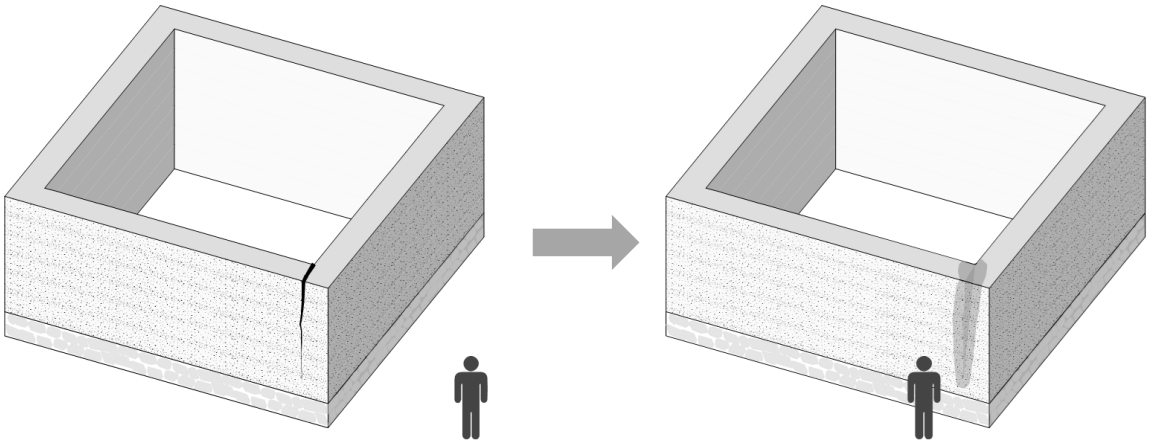


13.1.2 Vertical cracks

A vertical crack in walls connection indicates that both walls had an independent movement during the earthquake. This is possible when the connection between both walls was flexible and not stiff, flexible connections are a good construction practice in this case.

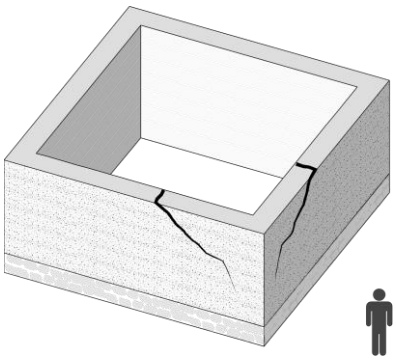
Vertical cracks can be repaired when there the walls are vertical and not out of plumb or with offset elements.

Repairing this cracks is important to ensure waterproofing and winterization. To do so follow the steps explained bellow.



13.1.3 Diagonal cracks

Diagonal crack in walls indicates that there was stiff connection between walls avoiding free movement. This may compromise the stability of the walls.

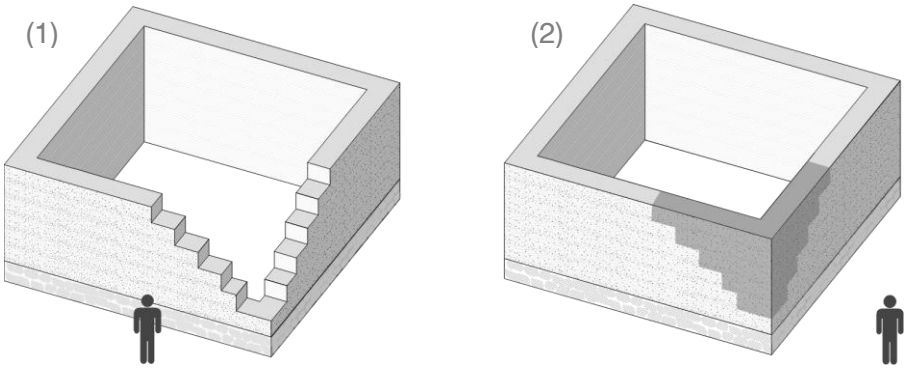


- When a wall has out-of-plum or offset elements is better to take them away and rebuild if necessary.

*Stay safe, take off all of the elements that could fall around the wall.

1. Take off the compromised wall parts following the crack and the pakhsa lift or khama khashta courses
2. Rebuild the missing parts

*It is important to gently hydrate the connection surfaces

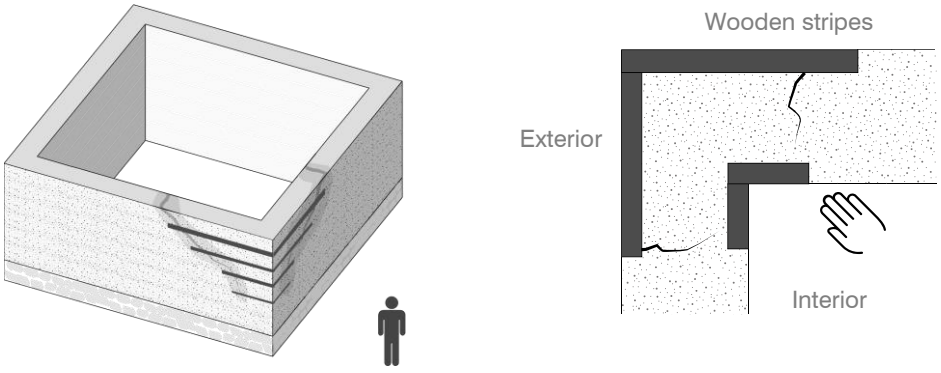


- When the wall is vertical and its elements are stable enough, minor repairs may be done:

*Stay safe, take off all of the elements that could fall around the wall.

1. Repair the cracks
2. Carve on both sides of the wall the thickness of wooden stripes
3. Gently moisten the surface
4. Insert the wooden stripe with soil mortar in both sides of the wall
5. Fill-in the empty spaces

*The size of the wooden stripe depends on the wide of the crack
*The wooden stripes need to be on both sides of the wall



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