

CONSTRUCTION MANUAL FOR STABILIZED COMPRESSED EARTH BLOCKS

SCEB MANUAL



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC

skat Swiss Resource Centre and
Consultancies for Development

PROECCO PROmoting EMPloyment through
CLImate Responsive CONstruction

00

TABLES OF CONTENTS

0.0	Introduction	7
.....		
1.0	Foundation	8
.....		
2.0	Base Wall	9
	Materials	9
	Height	10
	Capillary Barrier	11
.....		
3.0	Wall-Block Work	12
3.1	Block coursing	13
	Block coursing example	14
	Horizontal Coursing principles	15
	Vertical Coursing principles	18
3.2	Bonding patterns	19
	Main block sizes	19
	Straight walls	21

L-Shape	22
T-Shape	23
X-Shape	25
Pillars	27
Butresses	28
3.3 Implementation	30
Mortar	30
Block laying	32
Pointing	35
4.0 Openings	36
4.1 Dimensions	37
4.2 Lintels	38
4.3 Sill wall	40
4.4 Joineries	41
5.0 Ring-Beam	45
Cast in situ concrete	65
U-shape bricks	47
6.0 Roof/Wall bond	48
6.1 Roof anchorage	49
External roof anchorage	49

Hidden anchorage	50
6.2 Gable wall	52
6.3 Terminating wall in CEB	53

INTRODUCTION

Beyond the fact that CSEB blocks are assembled onto walls using standard bricklaying and masonry techniques, building in compressed stabilised earth blocks sends the designer and builder directly back to the rules of «good practice» for designing and building with earth.

These essential rules respond to two categories of problems to solve :

- **Structural problems:** respect the principles of good compressive strength and, the poor tensile and shearing strength of earth as a building material. In respecting these principles, it is essential to choose between appropriate structural designs and construction details;
- **Problems of water and humidity.** Certain fundamental principles have to be respected: protecting the top and the base of the Walls («a good hat and good shoes»), allowing the earth building material to breathe and incorporating suitable details into the design principles.



01

FOUNDATION

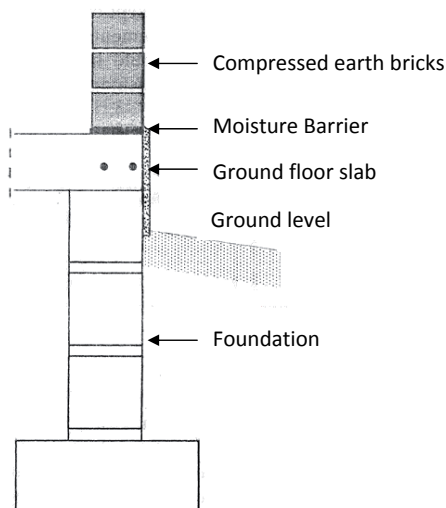
REMINDER: The foundations permit equal distribution of the weight of walls and roof into the ground. They should be strong, resistant to compression, and should ensure total wall stability.

Standards for CSEB foundations are similar to those for brick walls. The basic principle of building with earth is to keep the wall out of contact with the ground, in order to protect the walls from water and damp action.

Therefore, waterproof materials (concrete, stone, burnt bricks or sandcrete block masonry, highly stabilized compacted soil or compressed bricks for dry and well-drained sites) should be used to stop capillarity and other water infiltrations.

The following should be taken into consideration for a good foundation design :

- **Drainage :** A properly designed peripheral drainage that will keep the soil dry around the foundation;
- **Gradient :** A gradient, outside the building, to divert rain waters into a gutter some distance from the wall. Pervious materials must be used for it to allow good evaporation of moisture in the soil;
- **Moisture Barrier :** A good damp proof course (bitumen, water repellent cement) in order to prevent moisture to soak slowly from the foundation into the earth wall.



02

BASE WALL

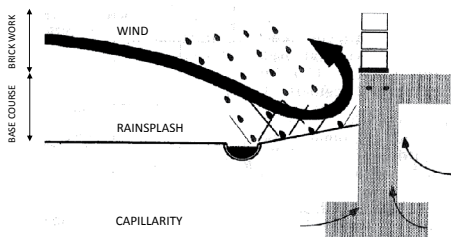
MATERIALS

The materials used for the base should be able to carry the weight of the building and resist humidity. Such materials include :

- stones;
- fi red bricks;
- hollow concrete blocks.

If the above materials are not accessible, highly stabilized earth blocks can be used if they are well protected against any contact with water and moisture, and if the surrounding is dry, well drained and protected from infiltrating water. (Ex : 8% cement stabilized CEB).

The role of the base wall is to protect the rest of the wall from humidity.



HEIGHT

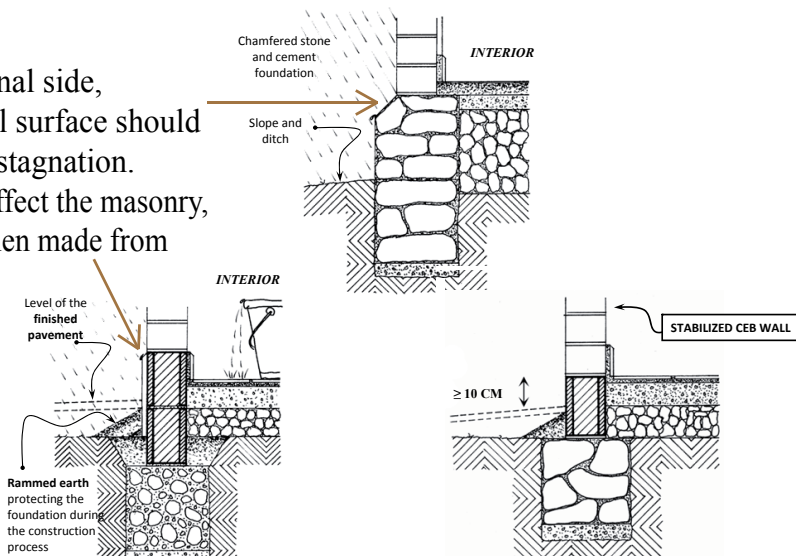
The base of the wall should be high enough to avoid the eroding effect of splashing water and capillary action on brickwork.

Whatever the nature of foundation is, the base wall must be raised up sufficiently :

- To about 20cm (8") minimum above the natural ground level if there is presence of a capillary barrier;
- To about 40 cm (1'4") if there isn't any capillary barrier, as the function of the base wall is to allow the humidity to evaporate before reaching the earth wall, more vulnerable. A layer of hollow concrete blocks offers a good protection for a CEB wall;

Even when highly stabilized, CEB'S suffer from slow decay processes, due to the repeated action of water erosion.

On the external side, no horizontal surface should allow water stagnation. This would affect the masonry, especially when made from earth



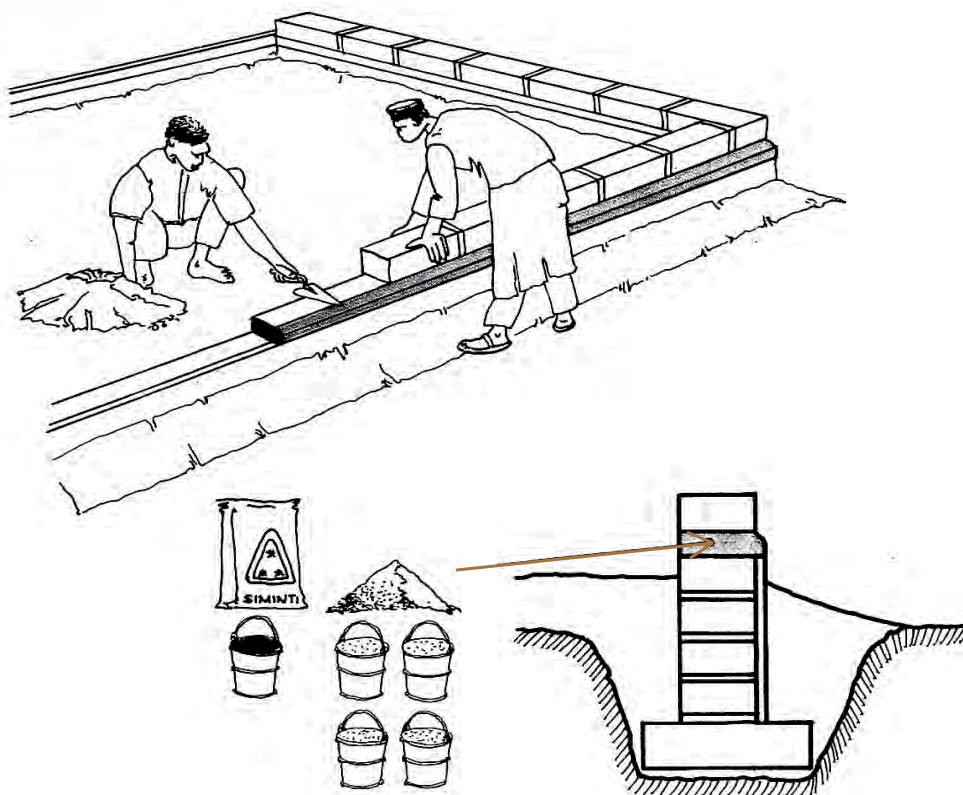
CAPILLARY BARRIER

Anyway, capillary barrier (cement plastering, coal tar plastering, use of plastic sheets, etc.) should be provided in base wall to prevent dampness rising easily into the building.

To be effective, the capillary barrier is laid down on top of the basement wall, generally on the course above the ground level, otherwise water can rise by capillary action through the soil towards the wall.

Apply plastering or the waterproof film all-round the building, on every wall (external and internal), and always at the same level, on the same course.

Whichever capillary barrier is used, apply it all around the building, on all the walls, one course above the internal slab.



03

WALL-BLOCK WORK

Earth block work permits to construct thin or thick walls, serving as support or partition.

The earth works well in compression but resists badly to the forces of traction (opposing forces), bending or shearing.

The dimensions of the earth walls must follow some rules :

- The relation thickness / height of the wall must be lower than 1/10. Beyond of that the wall loses its stability;
- The maximal distance between sidewalls or vertical joints on a same wall is 5 meters (16'8"). If long walls are needed, they should be divided into smaller sections, providing expansion joints and buttresses;

03

03.1 - BLOCK COURSING

It is essential to design the coursing pattern before building to ensure good cohesion of the wall and prevent structural faults.

Poor coursing can result in uneven settlement and cracking. Stability is achieved with good bonds at corners junction and separating walls that help tie them together.

It is necessary to respect 3 rules :

- The width of the mortar joints, both horizontal and vertical, should be even and a maximum of 1 to 1.5 cm;
- The minimum overlap between two bricks should be $\frac{1}{4}$ of the length of a full brick (No vertical straight joints in the wall);
- Only use whole bricks, $\frac{3}{4}$ and $\frac{1}{2}$ bricks for the construction of walls.

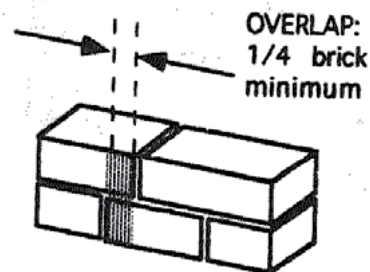
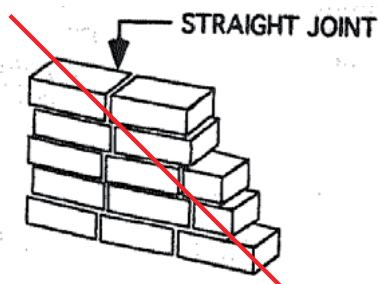
For most of the walls, 2 different courses are sufficient, alternatively from a layer to the other.

In this case, the bricks of the layers 1, 3, 5... are always in same position.

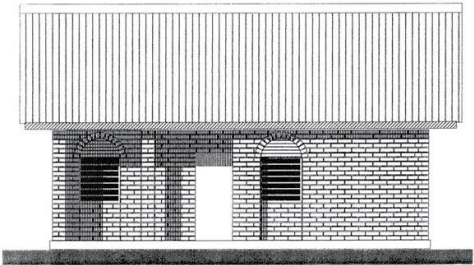
The bricks of the layers 2, 4, 6... are also in same position.

Advantages of block coursing :

- The plan is easier to read;
- Bricks will not be wasted due to excessive cutting on site;
- Bonding patterns are easy to implement;
- The speed of laying bricks is increased.



BLOCK COURSING SAMPLES



1st layer plan :
all blocks are visible

Butress reinforcing the walls end

Butress + dilatation joint (if length
of wall > 5 meters)

Butresses reinforcing the walls end

Straight joint for crack control
between the wall and the sill wall

Butress reinforcing the corner

Infilling wall below window sill

L= 3 BTC

L= 13 BTC

Dimension in number of Blocks

2nd layer plan :
the second layer must
be drawn as well to
ensure all bonding rules
are respected

End of walls supporting door frames
must be reinforced (door slams)

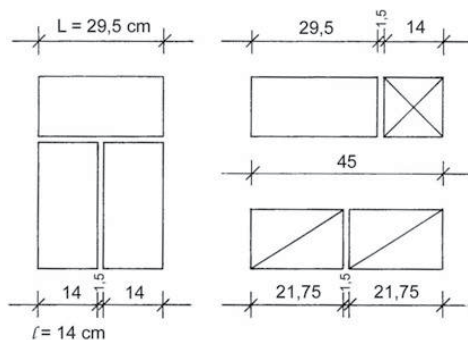
HORIZONTAL COURSING PRINCIPLES

The masonry is well dimensioned when the elements (wall, openings) are dimensioned according to the size of the brick, and when all the mortar joints are.

All the bricks are drawn to check the bonding. All dimensions are calculated according to the size of the "brick + mortar joint".

Example, for the 29,5 x 14 x 9 CEB :

- The thickness of the joint is :
 $L - 2 \ell = 1,5 \text{ cm}$
- The length of the $\frac{3}{4}$ brick is :
 $(L + \ell) / 2 = 21,75 \text{ cm}$

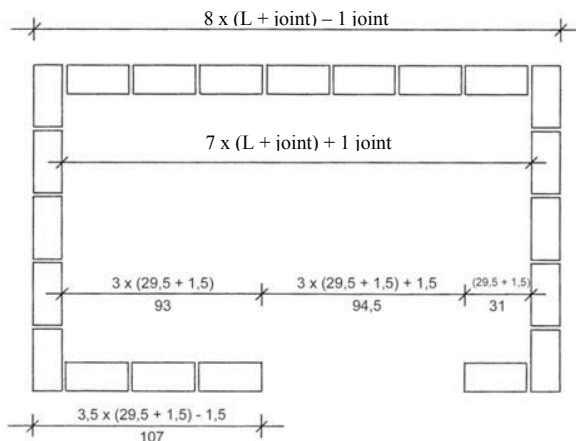


Basic calculation rules :

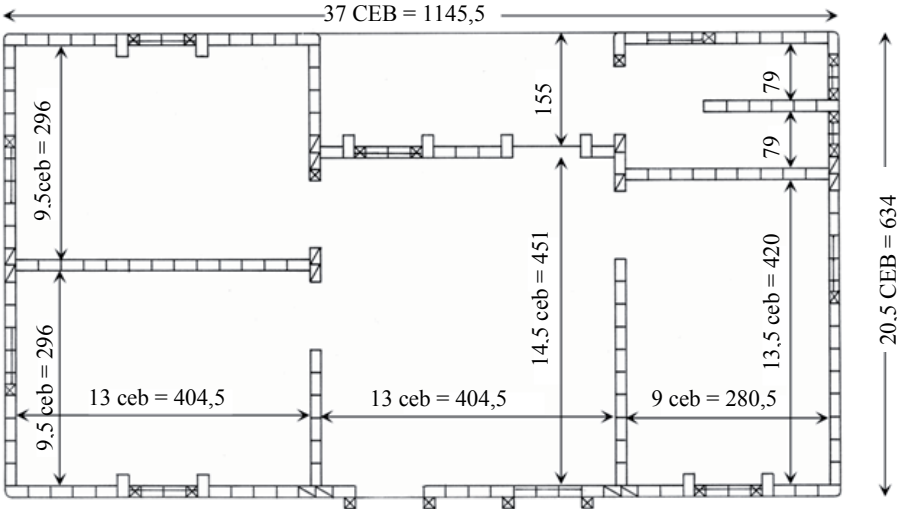
- External dimensions :
(-) 1 joint.
- Internal dimensions :
(+) 1 joint.

Example,
for the 29,5 x 14 x 9 CEB :

Working size
= Length + joint
= $29,5 + 1,5 = 31 \text{ cm}$

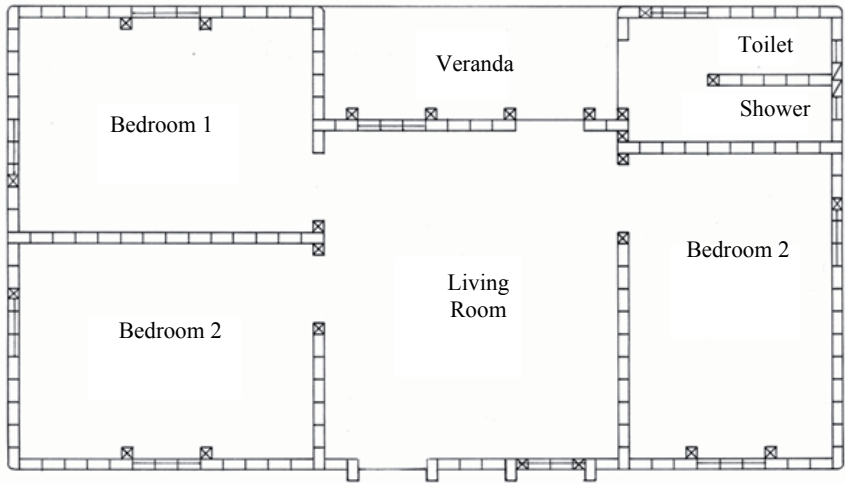


Plan example – plan with ceb of 29,5x14x9



1st layer

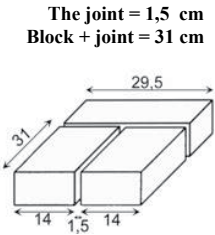
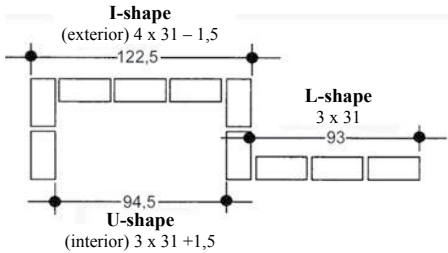
- Doorway : 3 CEB = 94,5 cm
- Window : 3 CEB = 94,5 cm
- 2,5 CEB = 79 cm
- 1 CEB = 32,5 cm



2nd layer

To make construction with CEB easier, it is recommended to design your building according to the sizes of brick. Also, for dimensioning the walls it is possible to use conversion tables.

Example of a conversion table for CEB of 29,5 x 14 x 9 cm :



Number of blocks	I-shape	L-shape	U-shape
0,5	14	15,5	17
1	29,5	31	32,5
1,5	45	46,5	48
2	60,5	62	63,5
2,5	76	77,5	79
3	91,5	93	94,5
3,5	107	108,5	110
4	122,5	124	125,5
4,5	138	139,5	141
5	153,5	155	156,5
5,5	169	170,5	172
6	184,5	186	187,5
6,5	200	201,5	203
7	215,5	217	218,5
7,5	231	232,5	234
8	246,5	248	249,5
8,5	262	263,5	265
9	277,5	279	280,5
9,5	293	294,5	296
10	308,5	310	311,5
10,5	324	325,5	327
11	339,5	341	342,5
11,5	355	356,5	358
12	370,5	372	373,5
12,5	386	387,5	389
13	401,5	403	404,5
13,5	417	418,5	420
14	432,5	434	435,5
14,5	448	449,5	451
15	463,5	465	466,5
15,5	479	480,5	482
16	494,5	496	497,5
16,5	510	511,5	513
17	525,5	527	528,5
17,5	541	542,5	544
18	556,5	558	559,5
18,5	572	573,5	575
19	587,5	589	590,5
19,5	603	604,5	606
20	618,5	620	621,5

Number of blocks	I-shape	L-shape	U-shape
20,5	634	635,5	637
21	649,5	651	652,5
21,5	665	666,5	668
22	680,5	682	683,5
22,5	696	697,5	699
23	711,5	713	714,5
23,5	727	728,5	730
24	742,5	744	745,5
24,5	758	759,5	761
25	773,5	775	776,5
25,5	789	790,5	792
26	804,5	806	807,5
26,5	820	821,5	823
27	835,5	837	838,5
27,5	851	852,5	854
28	866,5	868	869,5
28,5	882	883,5	885
29	897,5	899	900,5
29,5	913	914,5	916
30	928,5	930	931,5
30,5	944	945,5	947
31	959,5	961	962,5
31,5	975	976,5	978
32	990,5	992	993,5
32,5	1006	1007,5	1009
33	1021,5	1023	1024,5
33,5	1037	1038,5	1040
34	1052,5	1054	1055,5
34,5	1068	1069,5	1071
35	1083,5	1085	1086,5
35,5	1099	1100,5	1102
36	1114,5	1116	1117,5
36,5	1130	1131,5	1133
37	1145,5	1147	1148,5
37,5	1161	1162,5	1164
38	1176,5	1178	1179,5
38,5	1192	1193,5	1195
39	1207,5	1209	1210,5
39,5	1223	1224,5	1226
40	1238,5	1240	1241,5

(Dimensions are given in centimeters)

VERTICAL COURSING PRINCIPLES

The height of a layer is equal to the height of the brick + the thickness of the mortar joint.

Traditionally, this height corresponds approximately to 1/3th of the brick length.

This allows creating vertical patterns on the wall surface without cutting the bricks.

Example : CEB = $29,5 \times 14 \times 9$ cm.

The height of the layer can be calculated in such a way that different brick types can fit together. This is particularly useful when building on sloping ground.

Example : $20 \times 20 \times 9$ cm earth brick.

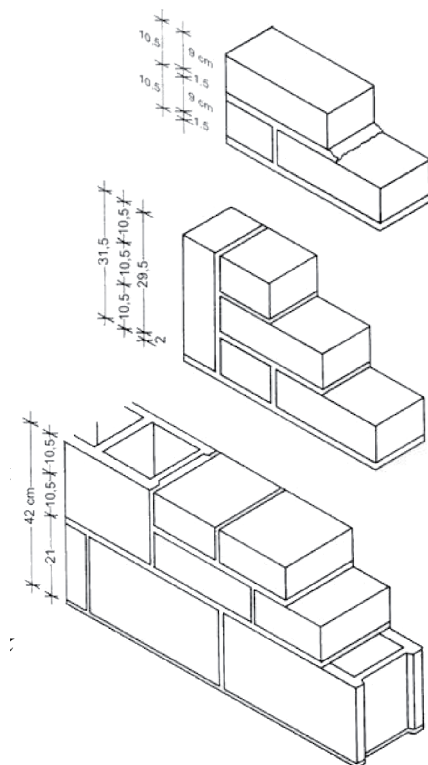
On a 20 cm thick hollow cement block $40 \times 20 \times 20$ cm.

It is important to maintain the same height of the

brick courses for the entire construction. In this way the brick course number acts as a check and a control during site work.

Example : Layer n°21 = Lintel level.

Height under lintels = $20 \times 10,5 = 210$ cm.



03

03.2 - BONDING PATTERNS

MAIN BLOCK SIZES

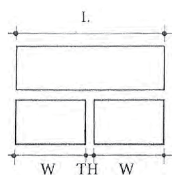
Use modular bricks with a constant size :

L = Length

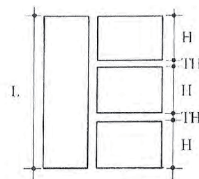
W = Width

H = Height

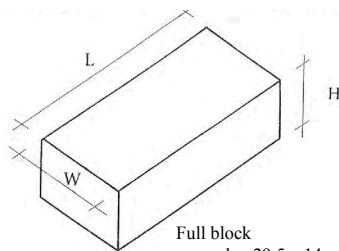
TH = Thickness of the joints



$$L = 2W + TH$$
$$W = (L - TH) / 2$$



$$L = 3H + 2TH$$
$$H = (L - 2TH) / 3$$

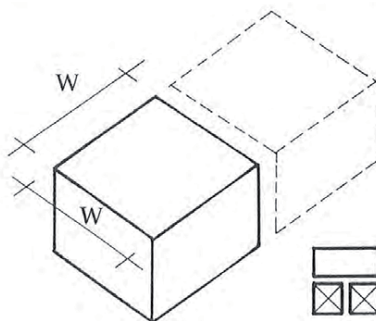


Full block
example : 29,5 x 14 x 9 cm

HALF BLOLCK

example : 14 x 14 x 9 cm.

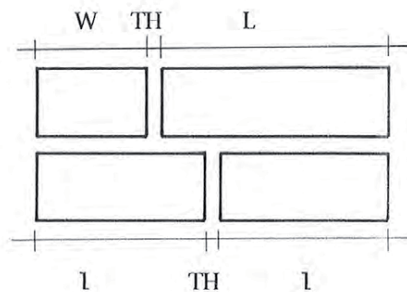
> square block : $L = W$



THREE QUARTER BLOLCK

example : 21,75 x 14 x 9 cm.

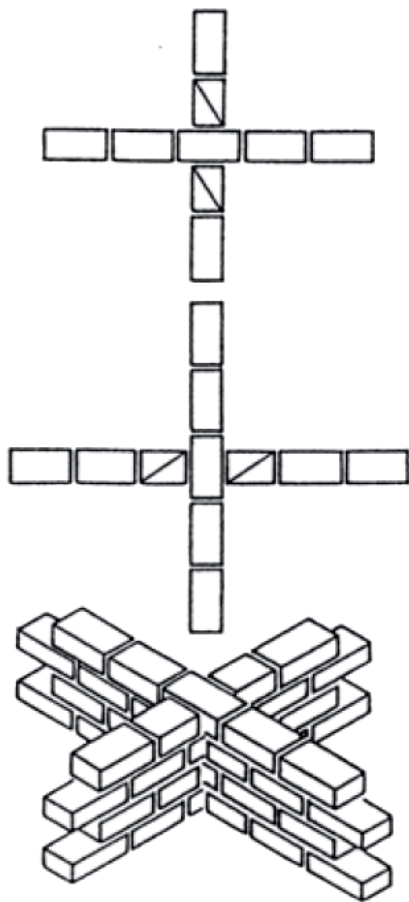
> square block : $L = W$



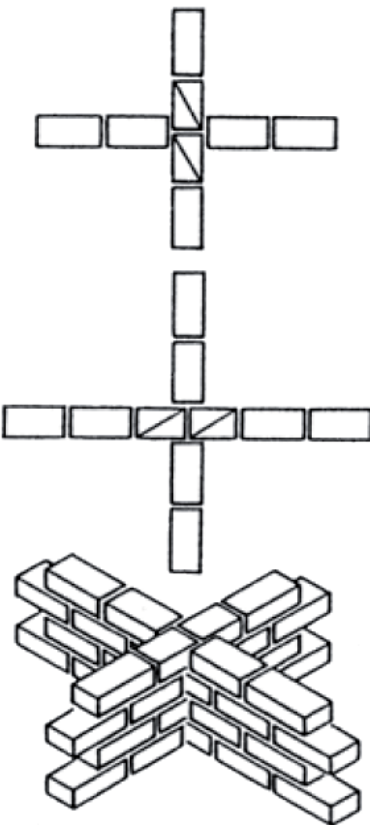
$$2l + TH = L + W + TH$$

$$l = (L + W) / 2$$

HALF BRICK WALL THICKNESS



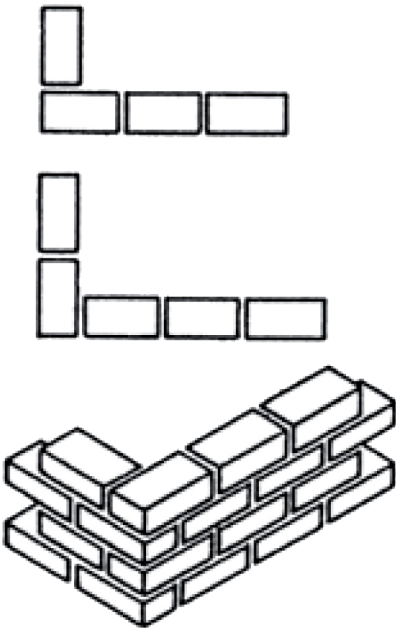
option 1



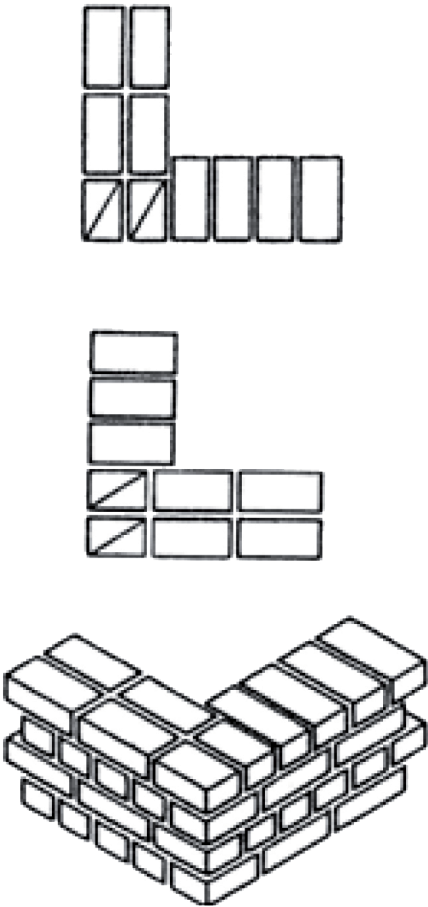
option 2

L-SHAPE

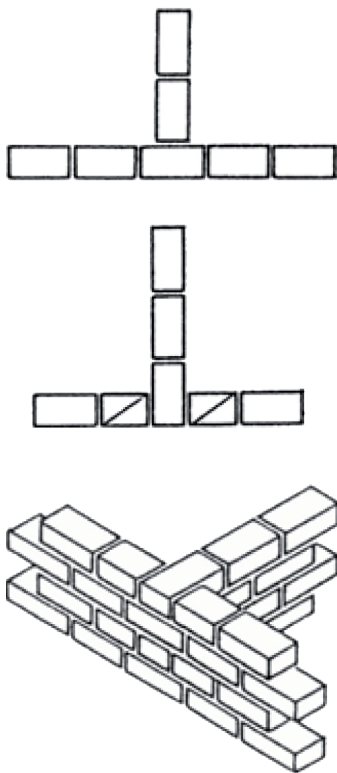
HALF BRICK WALL THICKNESS



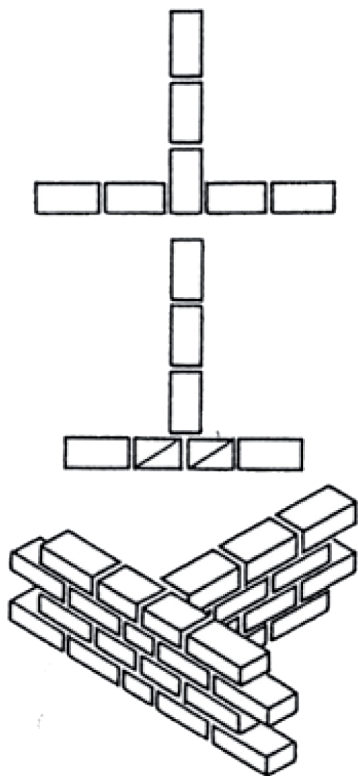
ONE BRICK WALL THICKNESS



HALF BRICK WALL THICKNESS

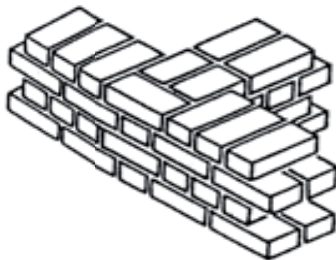
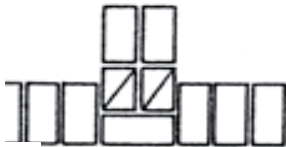
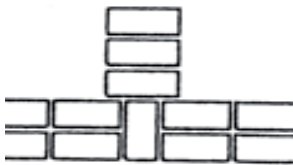


option 1

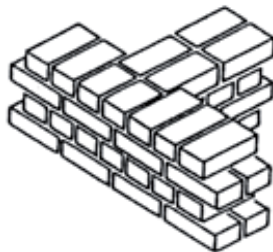
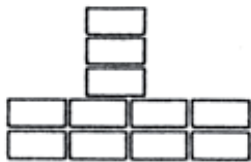
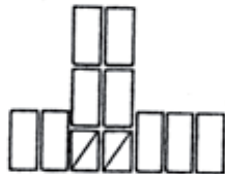


option 2

FULL BRICK WALL THICKNESS

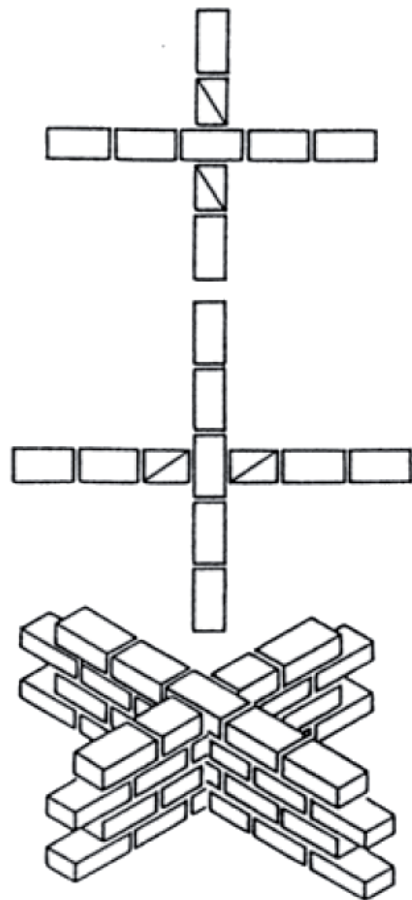


option 1

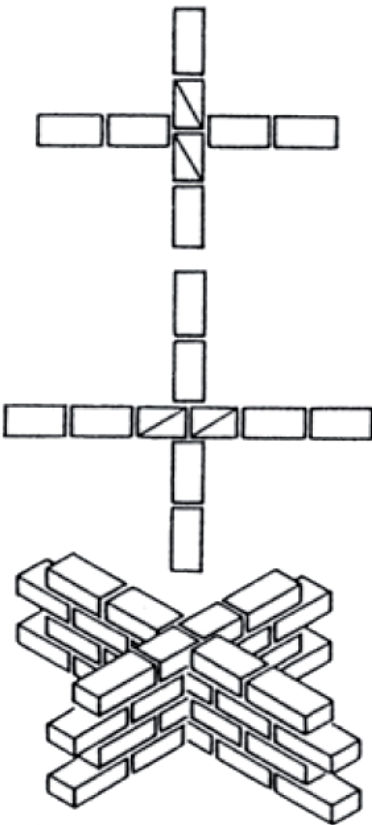


option 2

HALF BRICK WALL THICKNESS

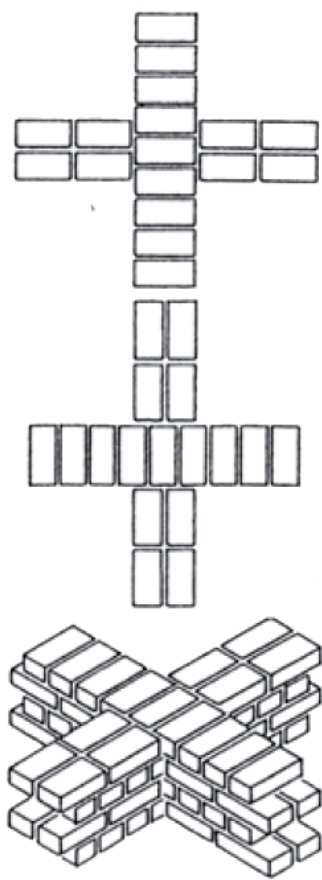


option 1

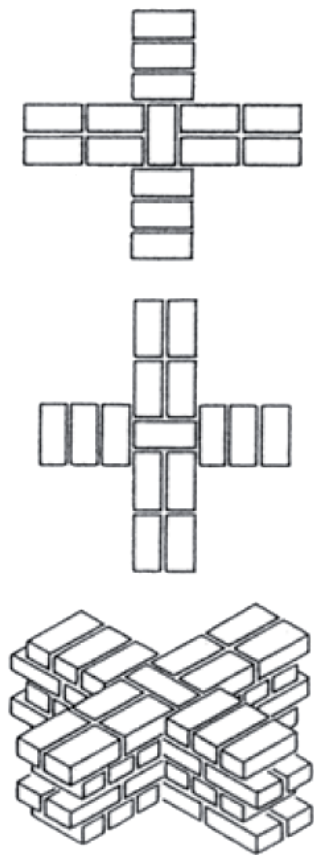


option 2

FULL BRICK WALL THICKNESS



option 1



option 2

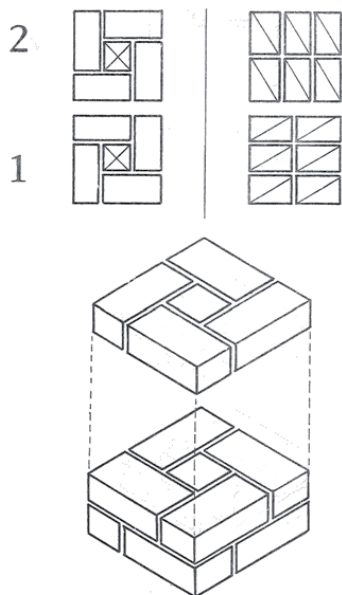
PILLARS (example with 29,5 x 14 x 9 cm blocks)

Bonding patterns for small section pillars (30 x 30 cm or 30 x 45 cm) generally require full blocks and use a rotating pattern or reversed symmetrical patterns.

Bonding patterns for large section pillars (45 x 45 cm or 60 x 60 cm) use the three-quarter block in classic designs. Simplified patterns can require only the use of a full block.

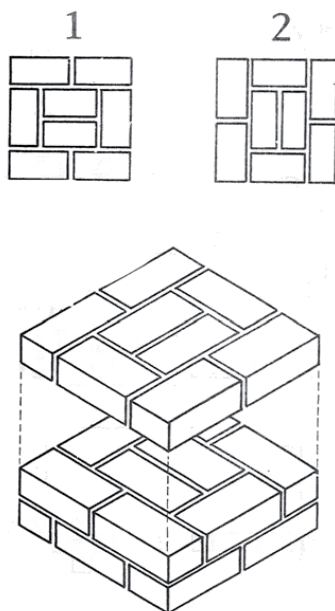
1,5 FULL BRICK X 1,5 FULL BRICK

Simplified bonding pattern for a 45 x 45 cm pillar



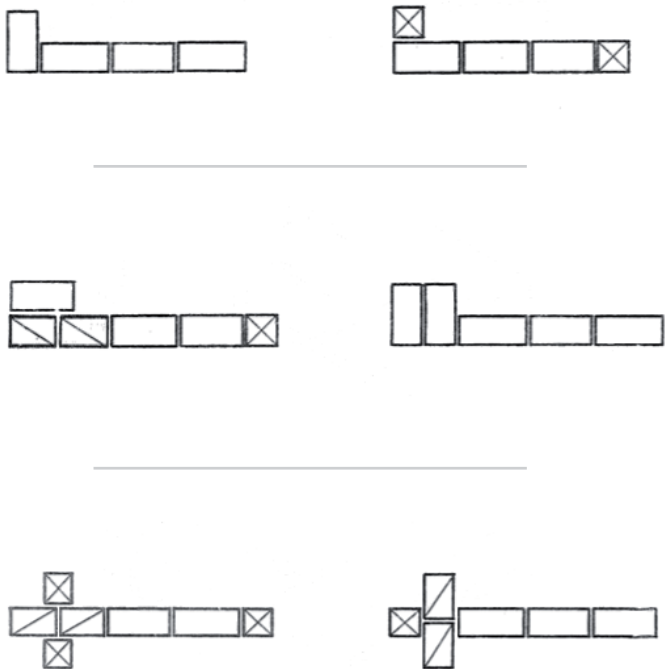
2 FULL BRICK X 2 FULL BRICK

Simplified bonding pattern for a 60 x 60 cm pillar



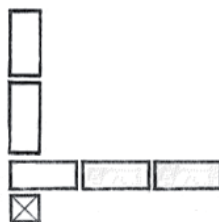
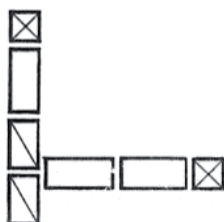
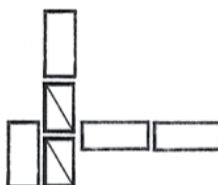
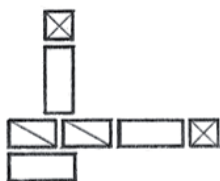
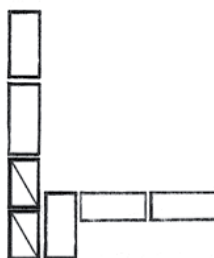
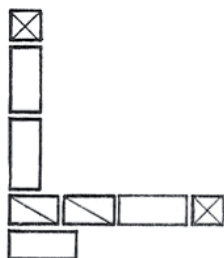
BUTRESSES

Straight walls :
To ensure good stability and support pointed loads, buttresses can be used for fine walls.



BUTRESSES

Corners:



03

03.3 - IMPLEMENTATION

MORTAR

A good mortar should have good mechanical strength and should have the same compressive strength and resistance to erosion as the compressed earth blocks.

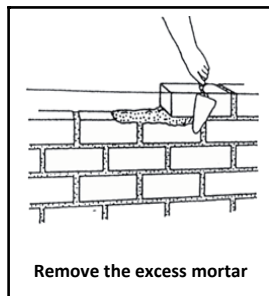
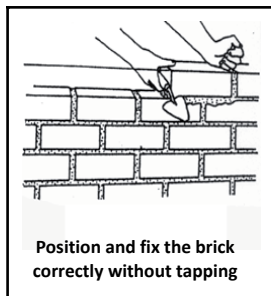
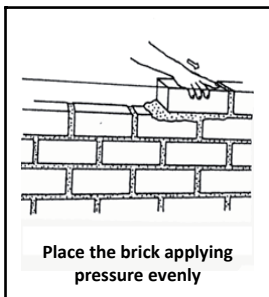
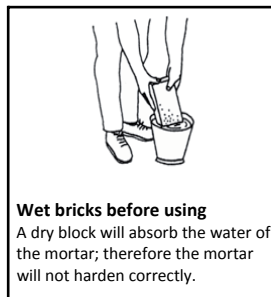
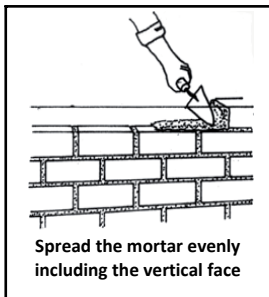
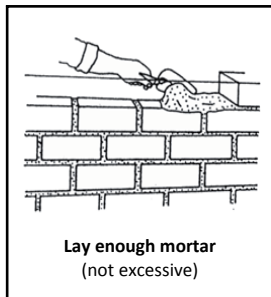
Mortar used for stabilized CSEB masonry will be made of stabilized soil. Characteristics of the mortar have to be as close as CSEB Characteristics.

The mixing water of the mortar should be clean.

The surface to which it is to be applied should be prepared and clean.

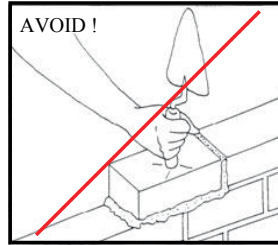
MORTAR

- Before laying the first course, it is recommended to set it without mortar, in order to verify correctly the joining between bricks before continuing the construction:
- Control the horizontal and vertical levels at every course, with spirit levels and lines;
- Do not rise up more than 5 layers of bricks per day; this may have some effect on the settling of the mortar and affect the stability of the walls.

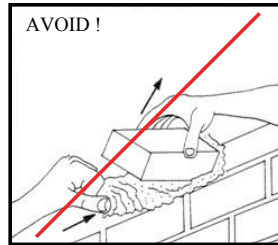


BLOCK LAYING

Do not strike the brick with a hard tool to put it in place. If there is too much mortar or if the mortar is too hard to push the brick down by hand, remove the brick and reduce the mortar.

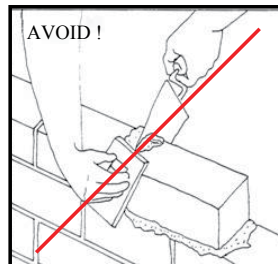


Do not lift the brick and push some mortar under it to fill the gaps, it is better to replace the mortar completely in enough quantities



Do not fill the vertical joints after laying the bricks :

- Waste of time;
- Risk smearing the bricks;
- Risk of partial filling;

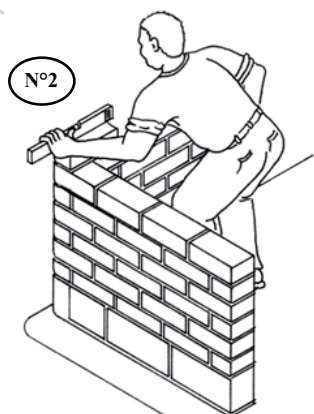


Do not repoint after the mortar has dried : it is a waste of time, materials and money to scrape dried mortar, clean it , refill and then repoint it.

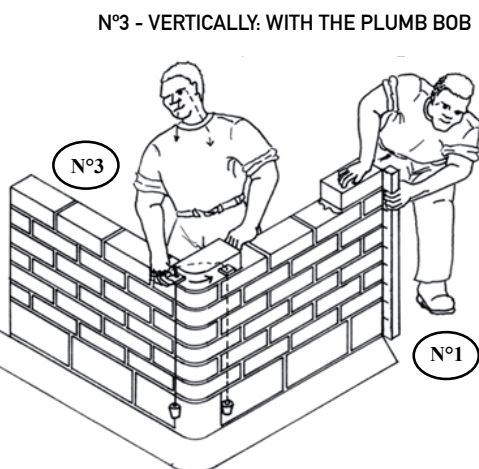
It is recommended that the laying of the blocks and the pointing is done by the same workman one after another, that is when the mortar is still workable.

MANSONRY WITH DIFFERENT GUIDES

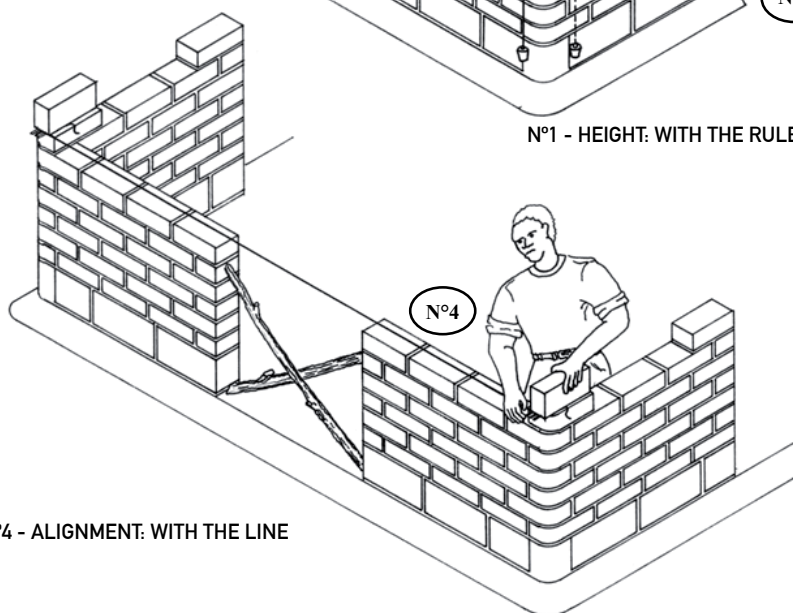
For each layer, start by laying the corner block, and check:



N°2 - HORIZONTALLY: WITH THE LEVEL



N°3 - VERTICALLY: WITH THE PLUMB BOB

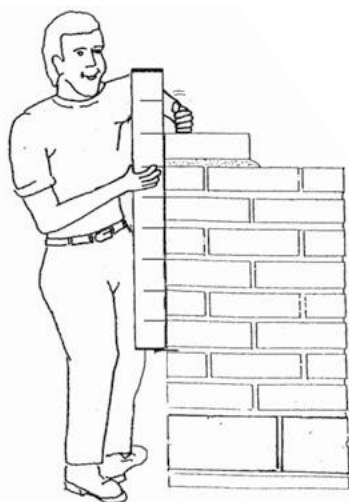
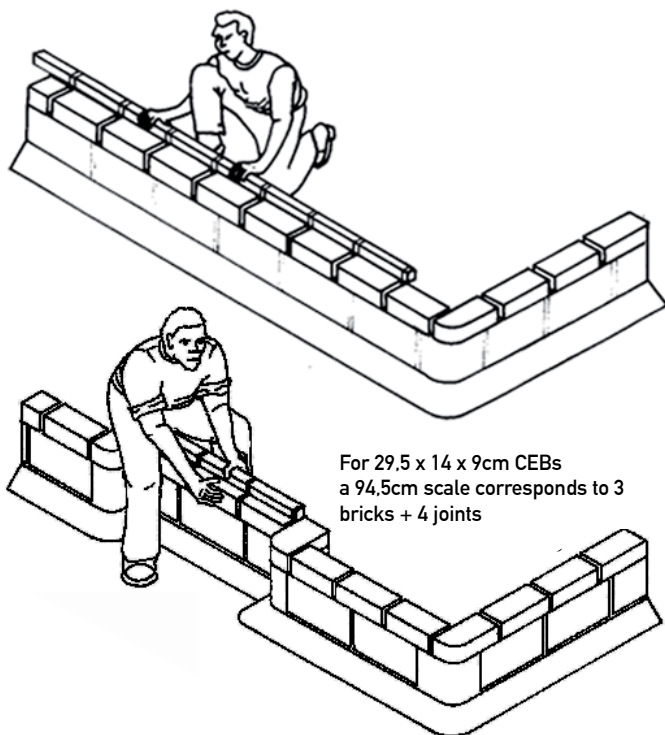


N°1 - HEIGHT: WITH THE RULE

N°4 - ALIGNMENT: WITH THE LINE

MASONRY WITH GUIDE SCALES.

A metallic or wooden graduated scale, showing the size of the brick + joints helps to check the position of the brick and spacing for openings.



This scale 94,5cm long. The lenght corresponds to 9 layers of 10,5cm each (block + joint)

The scale also serves as a guiding tool to check that the wall remains straight

A nail helps to keep the scale a the right height

03

03.3 - BLOCK LAYING

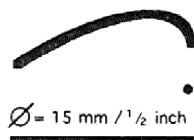
POINTING

Stabilized blocks create a brick wall that if properly stabilized can be left exposed with no outer plaster finish. However, special care should be given for the pointing to give a neat finish to the mortar joints.

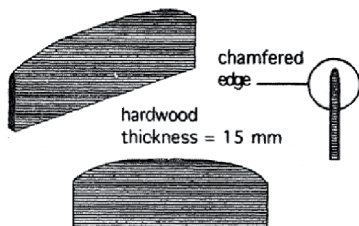
- Don't repoint after the mortar has dried; it is a waste of time, materials and money to scrape dried mortar, clean it, refill and then repoint it;
 - The pointing is done after partial drying of the mortar. It is therefore recommended that the laying of the blocks and the pointing is done by the same workman one after another, that is when the mortar is still workable;
 - After pointing, clean the joint with a wet sponge.
- Appropriate tools for pointing :



spoon



bended iron rod



pointing wood

04

OPENINGS

The openings (windows, doors...) represent a weak point in the structure of the building.

It is often from the openings that appear many cracks. Therefore it is necessary to look after their solidity. Care should be taken with the structural bonding of frame openings with CSEB walls in order to limit cracking which could lead to water infiltration and therefore a process of erosion.

04

04.1 - DIMENSIONS

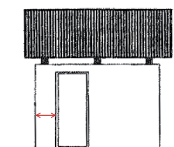
It is necessary to respect some rules in the construction of openings :

- Do not make openings too close one from another (minimum 1 meter) (3'4");
- Do not place the openings less than 1 meter from an angle of the building;
- Well anchor the lintel in the wall: support it on a minimum of 20 cm (8") inside the wall on each side of the opening.

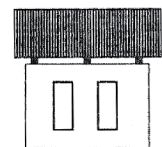
It is necessary to avoid :

- Too large openings (more than 1.20 meters) (4');
- Too many openings on a same wall or openings badly equilibrated in the wall.

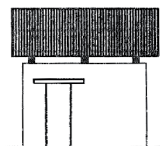
CORRECT PRACTICE



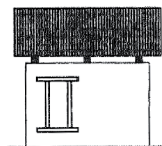
Openings are placed at least 1 meter far from the corner



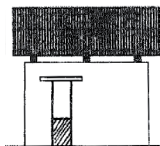
Regular distribution



Good overlap of the lintel on the jambs (min 25 cm)



Strengthening of the jambs and sills



Straight joints in the wall under the window

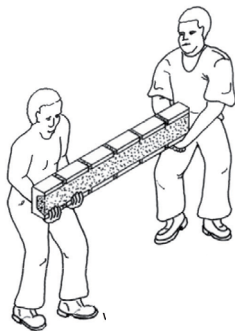
04

04.2 - LINTELS

Lintels are placed over openings to carry wall and roof loads.

Can be used :

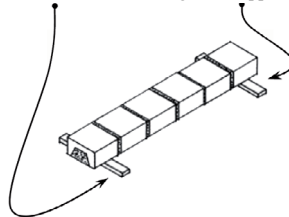
- Wood lintels / concrete lintels : as in traditional masonry, lintels can be made of wood, steel, stone or concrete, made on site or prefabricated;
- Arches : the lintel can also be replaced by an arch in earth blocks, in order to keep a structural homogeneity of the wall and to avoid the use of wood;
- Prefabricated CEB lintel : because bricks have little tensile strength, they can't be used for straight lintels on their own. They must be used with other materials such as steel and cement. Frog bricks (U-shape brick) can be used to precast reinforced concrete lintels. The length of these lintels shouldn't be more than 4 + 2 bricks, 4 bricks being the width of the opening.



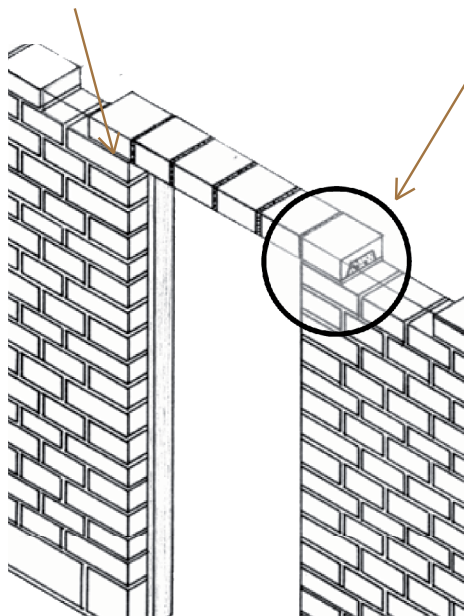
Transport :
Do not hold the bricks when lifting up, but hold the concrete part
The concrete should always rest either at the bottom or on the side.

Stocking:

- The rods are placed at the bottom
- The lintel is resting on 2 supports



Make sure that no mortar is trapped between the frame and the lintel



WARNING !

Leave a 5 mm gap between the frame and the lintel to allow the lintel to go down when the masonry will settle down.
(Shrinkage due to settling of the mortar and loading)

04

04.3 - SILL WALL

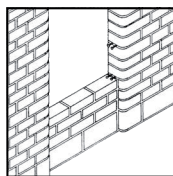
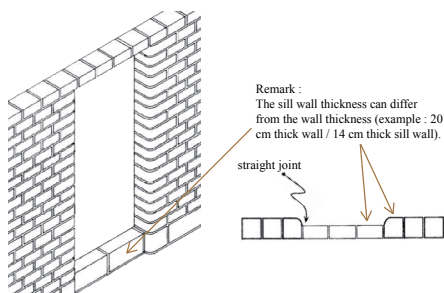
The sill is very solicited by the loads transmitted from the lintel by the sides of the opening.

To avoid the cracks under the sill, it is possible to create straight joints under the opening either during the construction or after the construction, while jointing or pointing with a tool.

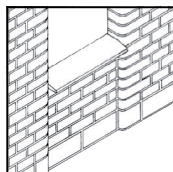
It is also possible to increase the length of the sill or put some reinforcement underneath.

Building the sill wall at the end offers 2 advantages :

- Easy circulation of materials and equipment on site, as all windows serve as doors;
- The possibility to create 2 straight joints and therefore avoids cracks between the main wall and the sill wall.



100 mm nails are used. To connect the sill wall to the main wall every 3 layer.



The window sill is sealed with a cement mortar.

04

04.4 - JOINERIES

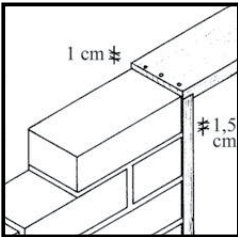
The vibrations and shocks resulting from the manipulation of the doors and windows can cause some cracks in the walls.

It is therefore necessary to anchor well the joineries in the masonry.

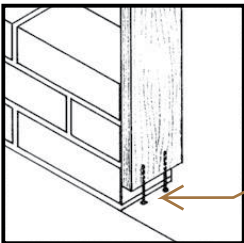
There are several possible solutions for the anchorage :

- Put in place the door and window frames before building up the walls, and fix them with nails or wire at the level of a mortar joint;
- Put in place in the same way the frames before constructing the walls, but fix them in the masonry with special U shape blocks permitting to sink concrete for a better anchorage.

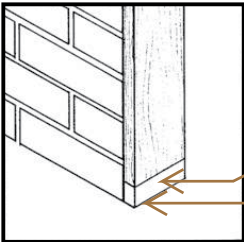
PUT IN DOOR AND WINDOW FRAMES BEFORE
BUILDING UP THE WALLS



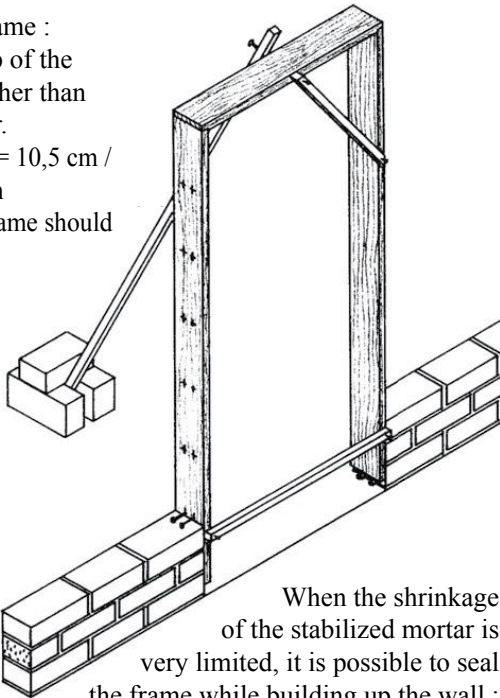
Position of the frame :
Make sure the top of the
frame is 1 cm higher than
the last bricklayer.
Example : 1 layer = 10,5 cm /
20 layers = 210 cm
> The top of the frame should
be at 211 cm.



At the base :
The wood is not
in contact with
the ground.

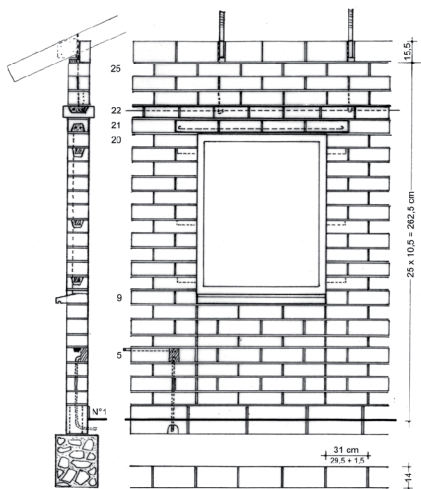


Cement
Finished ground level



When the shrinkage
of the stabilized mortar is
very limited, it is possible to seal
the frame while building up the wall :
2 nails every 3 layers, inserted in the mortar joints.

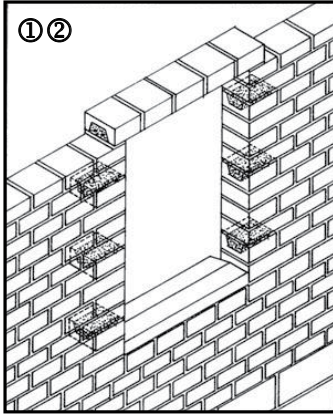
PUT IN THE SAME WAY THE FRAMES BEFORE
CONSTRUCTING THE WALLS



Example : Section and elevation on an opening of a half brick thick CEB wall (CEB U-shape lintel, CEB U-shape anchoring, independent sill wall)

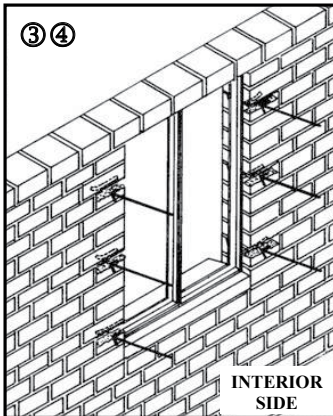


Sealing frames during brick work. Align the position of anchoring and U-shape blocks



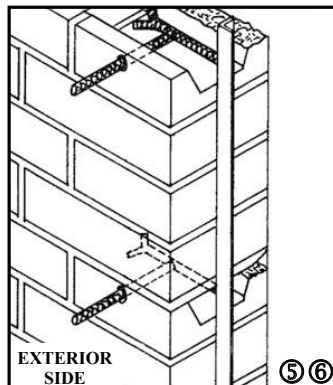
During the block work :

- 1) Place 3 U-shape half-blocks on each side of the opening.
- 2) Fill them with wet sand, and continue to lay bricks above.



After the block work :

- 3) Gently break the U-shape blocks, on the inner side, and remove the sand.
- 4) Put in place the joinerie and introduce the anchorings.



In case of safety grills :

- 5) Drill a hole on the exterior side, and pull out the rods for fixing the protection grill.
- 6) Fill the holes with cement mortar.

05

RING-BEAM

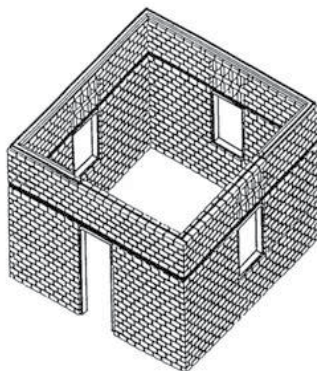
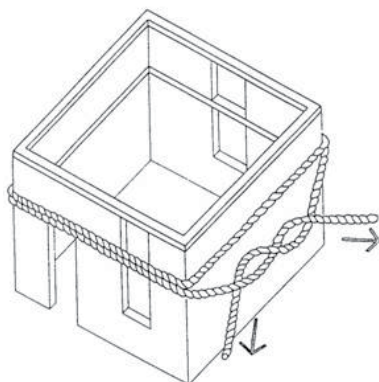
A reinforced concrete or wood bond beam is built at the top of a CEB wall to tie all of the walls together, level the walls, provide an anchor point for the roof or the next story, or act as continuous lintel for the openings.

The main role of the ring beam is to link the walls, to tighten the building in all directions.

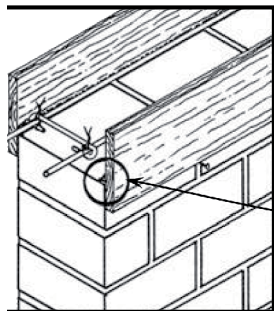
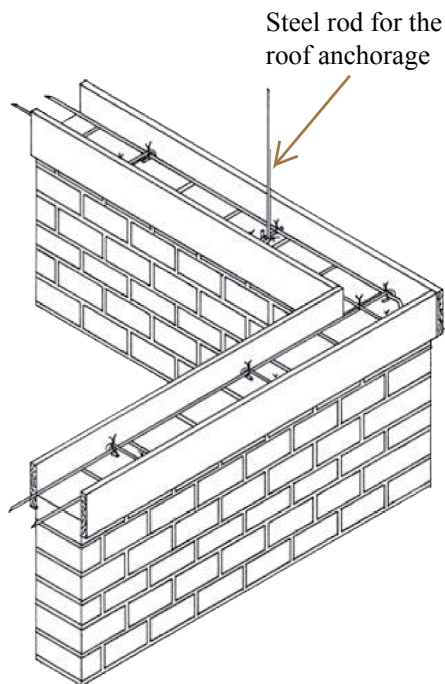
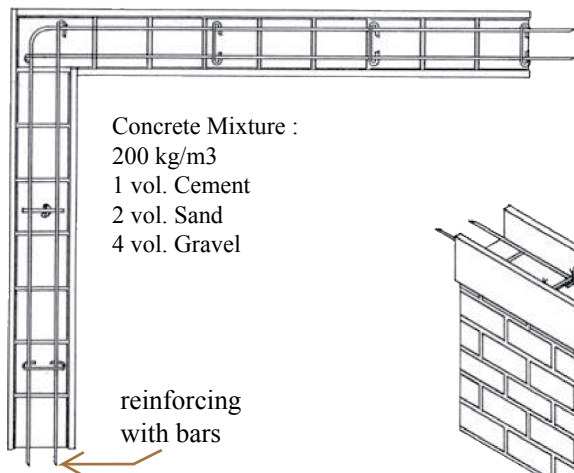
To assure its function, and to resist the strengths of traction, the ring beam must be rigid and unalterable.

Important :

The ring beam is positioned under the last layers of blocks. Therefore, the ring beam is loaded with the top layers of blocks, and avoids any movement of pieces of walls (the height of the wall over the ring beam should be of 3 layers minimum).



CAST IN SITU CONCRETE



Warning !

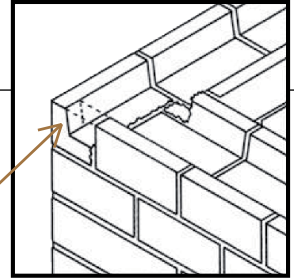
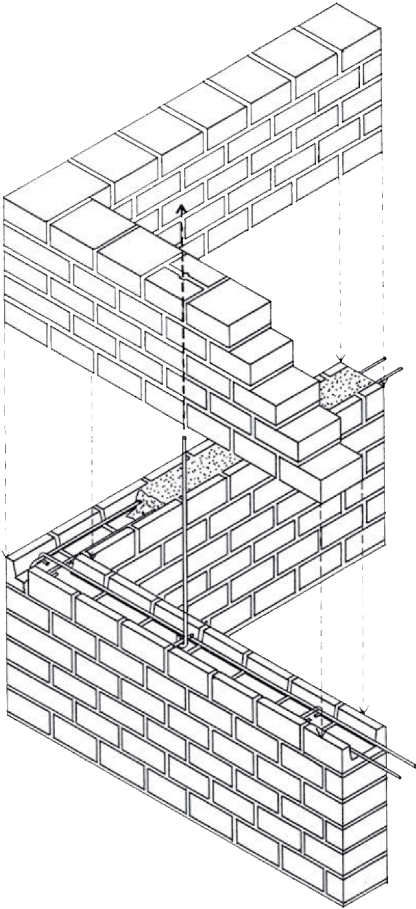
The concrete should not smear the walls !

To avoid smearing the walls, fill up the edges of the form-work with a soil mortar.

U-SHAPE BICKS, USED AS LOST FRAMEWORK

Advantages of U-shape bricks :

- Quantity of concrete is reduced;
- Walls remain clean;
- No formwork is needed saving time and materials (wood);
- Brick laying can continue immediately after pouring the concrete.



In the corners :

- gently break the U-shape blocks,
- fill up the cavity with a soil mortar.



06

ROOF / WALL BOND

Strong winds can pull out the roof and disunite the walls. To reduce the risks of distortion and uprising of the roof, it is necessary to bond the roof to the wall.

The selected anchorage solutions should be very strong and well dimensioned.

Anchoring the roof to the exterior walls, and also possibly to interior walls, is necessary. Preferably, anchor to the ring beam (in wood, steel, or concrete) rather than to isolated supports.

06

06.1 - ROOF ANCHORAGE

EXTERNAL ROOF ANCHORAGE

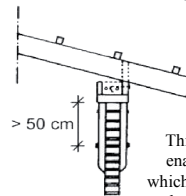
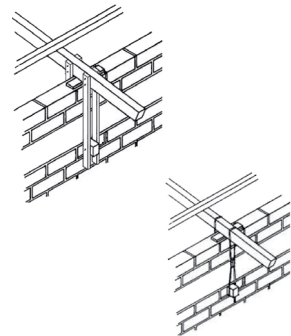
Low Ring Beam :

The roof truss is fixed to the timber section built in under the ring beam with 4 battens.

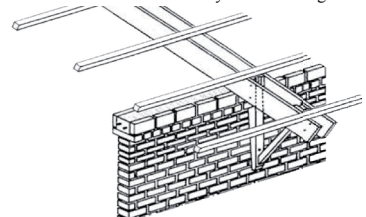
The anchorage can also be achieved by using steel cables that connect the roof truss to the timber section built in under the ring beam.

High Ring beam :

The ring beam that's placed at the top of the wall is too light to hold the roof. The anchorage has to be done at a lower level of the wall with two "sandwich" boards.



This anchorage system enables to attach struts which are needed to support heavy roof overhangs.



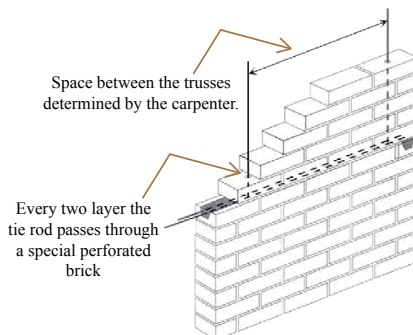
HIDDEN ANCHORAGE

To anchor the roof to the ring beam, iron rods (1/4") should be cast in the ring beam and brought up to the trusses. The height of the wall over the ring beam should be of 3 layers minimum. This connection can be done by passing iron rods :

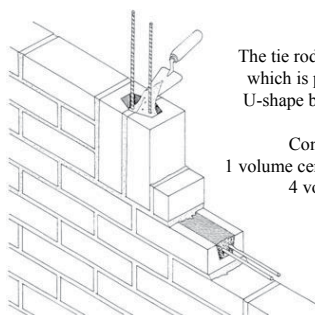
- through special perforated CSEB-blocks;
- through vertical U-shape frog bricks filled with concrete;
- with cast concrete only.



Through special perforated CSEB-blocks



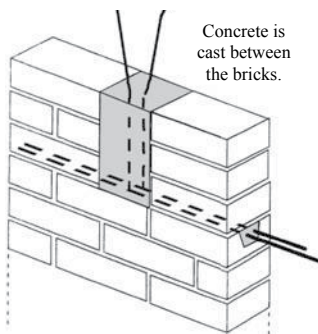
Through vertical U-shape frog bricks filled with concrete



The tie rods are cast in concrete which is poured between two U-shape blocks laid vertically.

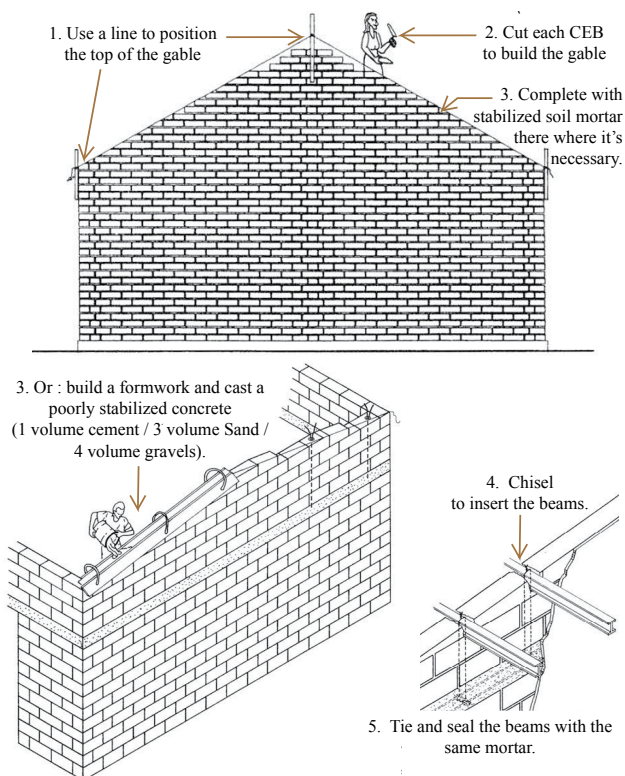
Concrete dosage :
1 volume cement / 2 volume Sand /
4 volume gravels.

With cast concrete only



06

06.2 - GABLE WALL

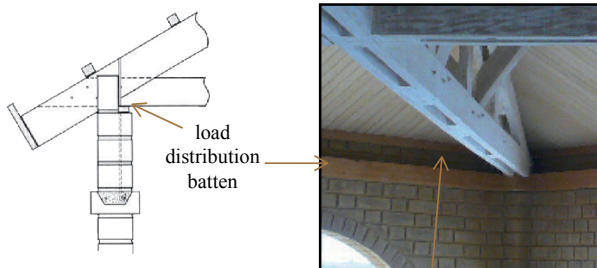


06

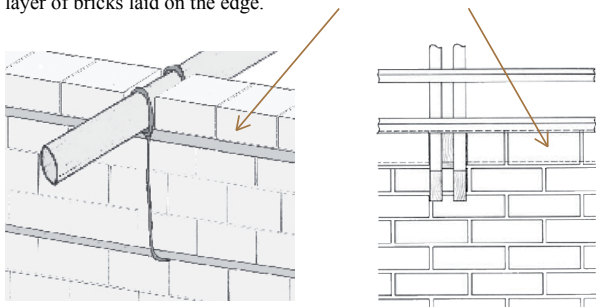
06.3 - TERMINATING WALL IN CEB

The batten distributing the load of the trusses is positioned on the inner side of the wall and also serves as a support for the suspended ceiling.

TERMINATING WALL



On the external side, the empty space between the trusses is filled by a layer of bricks laid on the edge.



Skat Consulting Rwanda
KG 5 Ave, No 40. Kigali, Rwanda
phone: +250 (0)78 838 57 90 (office)
www.madeingreatlakes.com

Skat Swiss Resource Centre
and Consultancies for Development
PROECCO Promoting Employment through
Climate Responsive Construction

Skat Consulting Ltd. (Head Office)
Vadianstrasse 42 CH-9000 St.Gallen Switzerland
phone: +41 (0)71 228 54 54
web: <http://www.skat.ch>