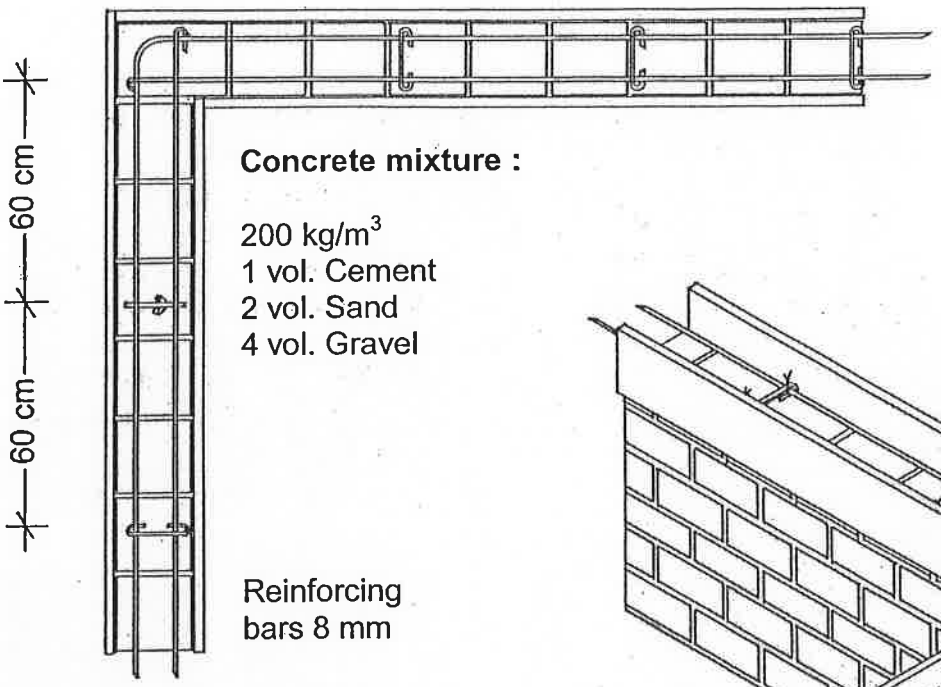
Part VI: Ring Beams and Roof Anchorage

This chapter concerns ring beams and the anchorage of roofs that are very important aspects of construction. They play a vital structural role and cannot be neglected or underestimated. This chapter illustrates various construction systems for ring beams. This includes ring beams cast in concrete, ring beams cast in special U shaped bricks and also the use of normal bricks for casting ring beams. Ring beams using well seasoned wooden planks are also illustrated.
Concerning roof anchorage, various methods, details and the importance of these are shown.

RING BEAMS

CONCRETE RING BEAM

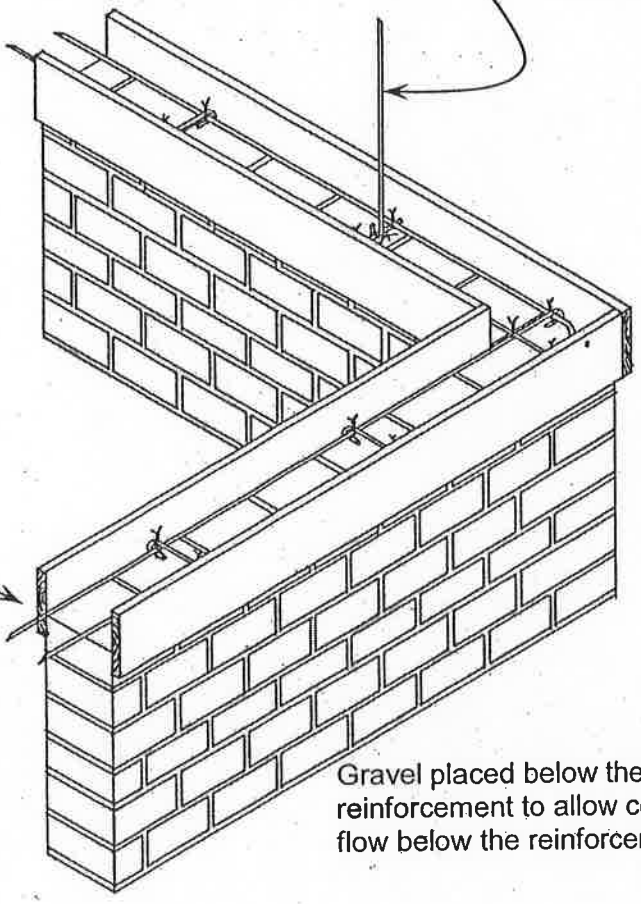


Concrete mixture :

200 kg/m^3
1 vol. Cement
2 vol. Sand
4 vol. Gravel

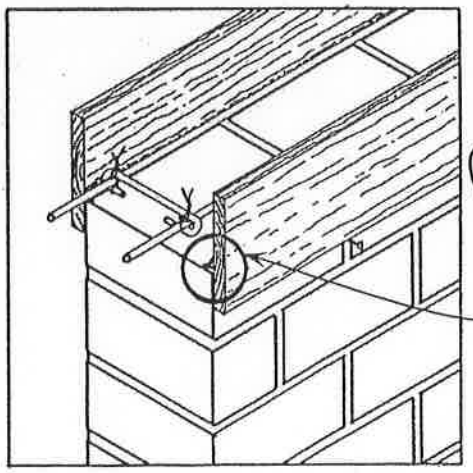
Reinforcing bars 8 mm

Steel rod for the roof anchorage

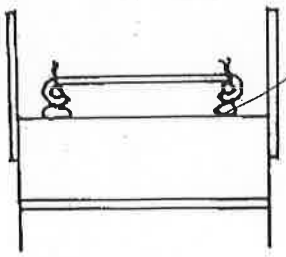


WARNING !
The concrete should not **smear the walls !**

Gravel placed below the reinforcement to allow concrete to flow below the reinforcement

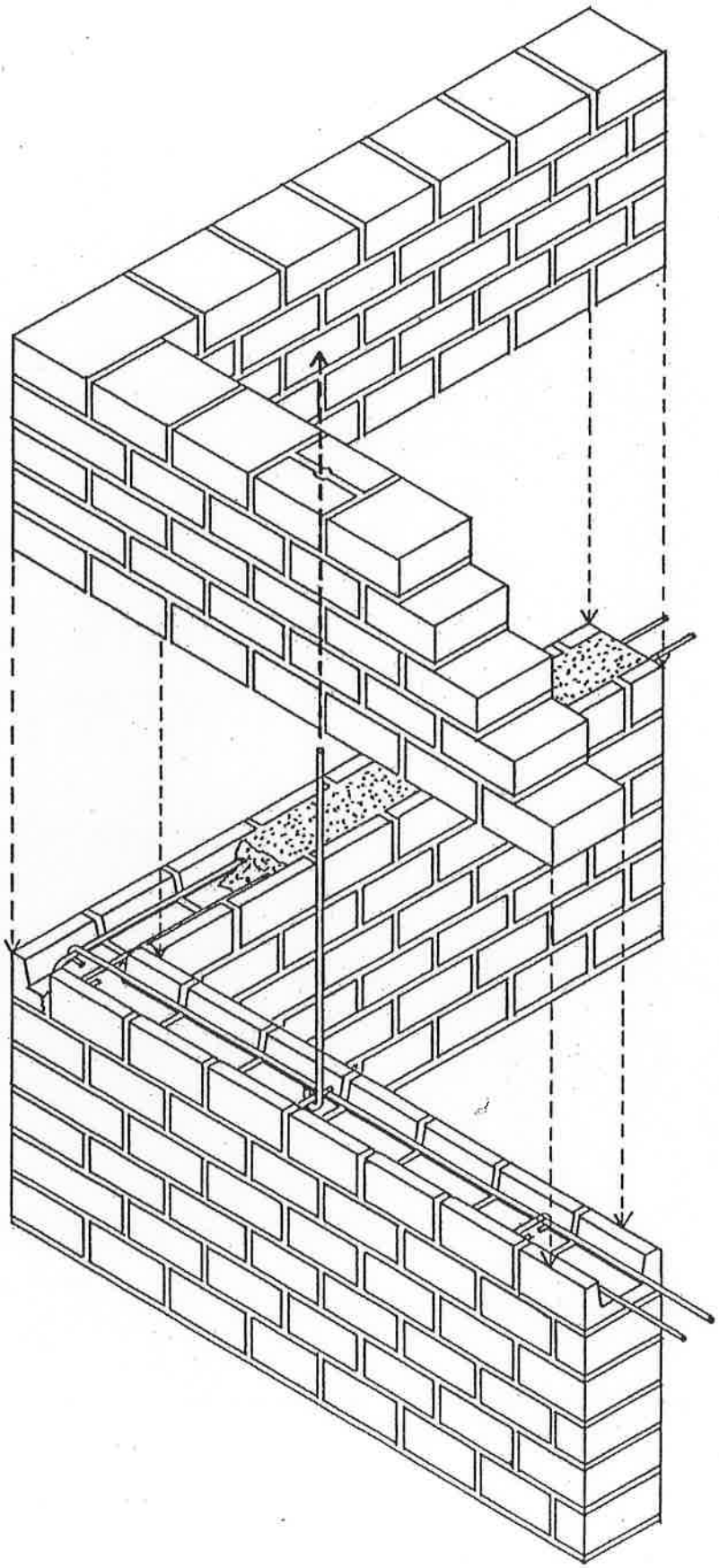


To avoid smearing the walls,
fill the edges of the formwork with a soil mortar.



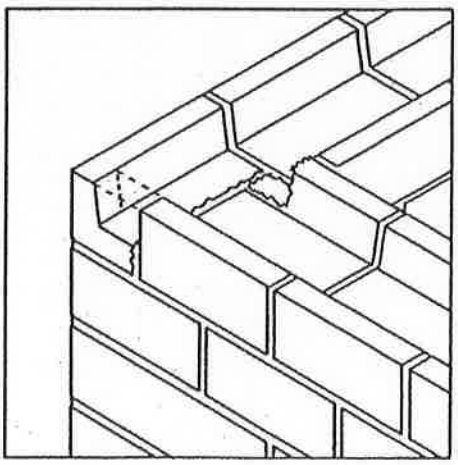
Ensure that the reinforcement does not touch the bricks and is raised on some kind of support.

USING U-SHAPE BRICKS



Advantages of U-shape bricks:

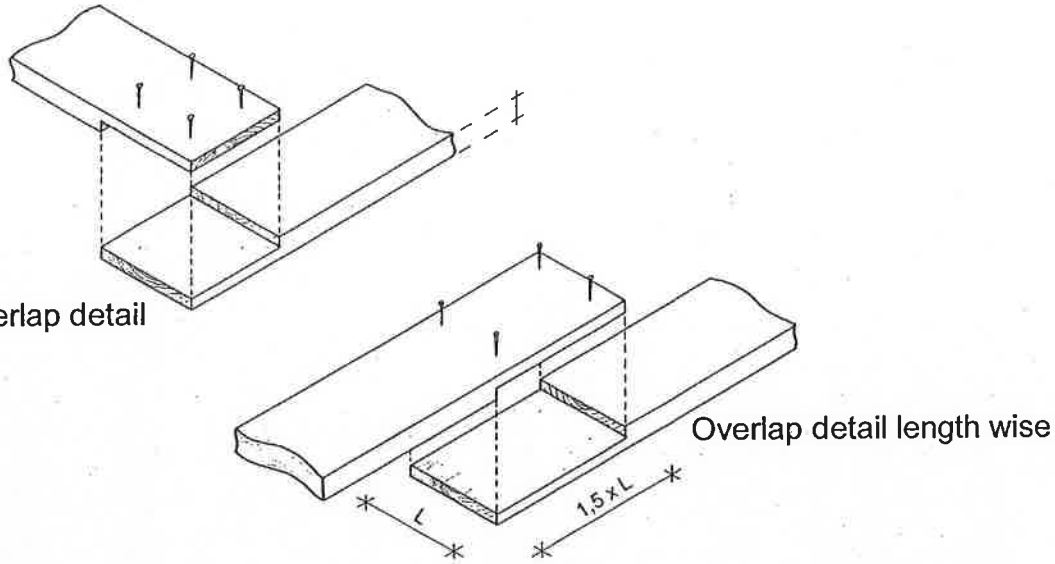
- Quantity of concrete is reduced.
- Walls remain clean.
- No formwork is needed, saving time and materials (wood).
- Brick laying can continue immediately after pouring the concrete.



- In the corners, gently break the U-shape blocks.
- Fill up the cavity with a soil mortar.

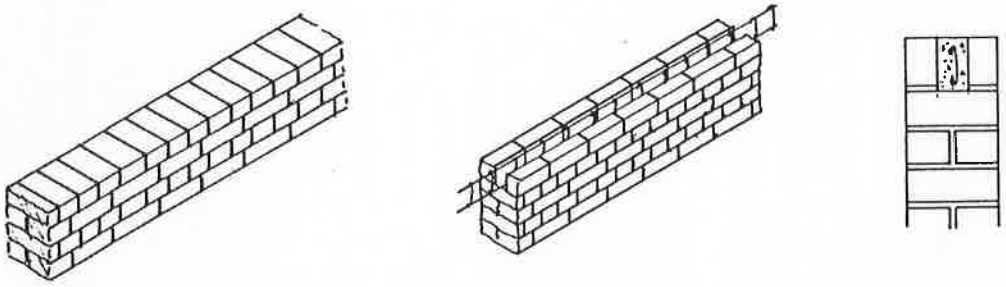
RING BEAMS

Well seasoned planks can be used as ring



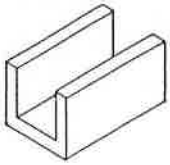
Ring Beams using materials other than reinforced concrete work equally well. The corners should be strengthened.

USING BRICKS AS A PERMANENT FORM

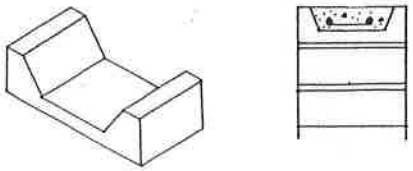


Advantages of the permanent form:

No formwork is needed, saving time and materials (wood).
Quantity of concrete is reduced.
Walls remain clean.
Brick laying can continue immediately after the concrete has been poured..



Ring beams can be made with bricks made specially for such purposes.



ROOF ANCHORAGE

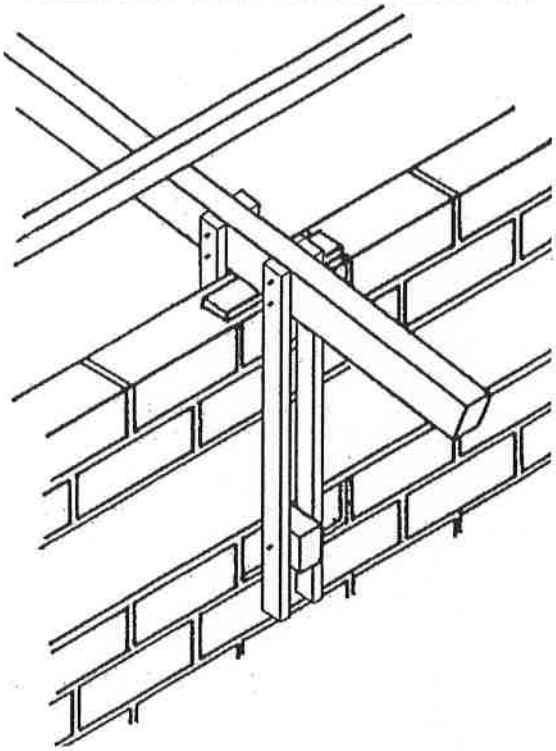
EXTERNAL ANCHORAGE

Strong winds can lift up the roof and disconnect it from the walls.

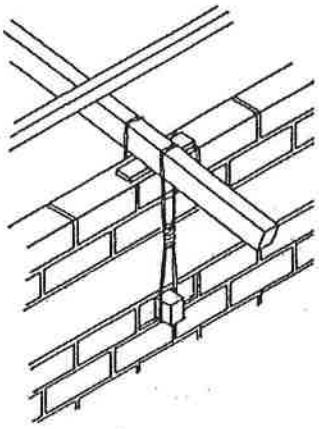
The roof anchorage helps to « ***anchor*** » the roof to the masonry.

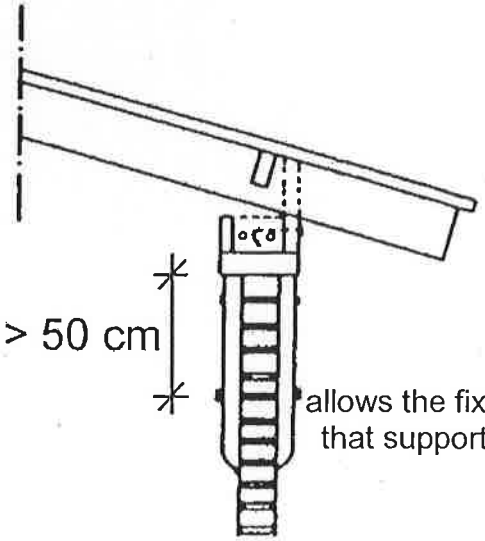
1. Low ring beam :

4 battens are fixed to a piece of timber placed under the ring beam.

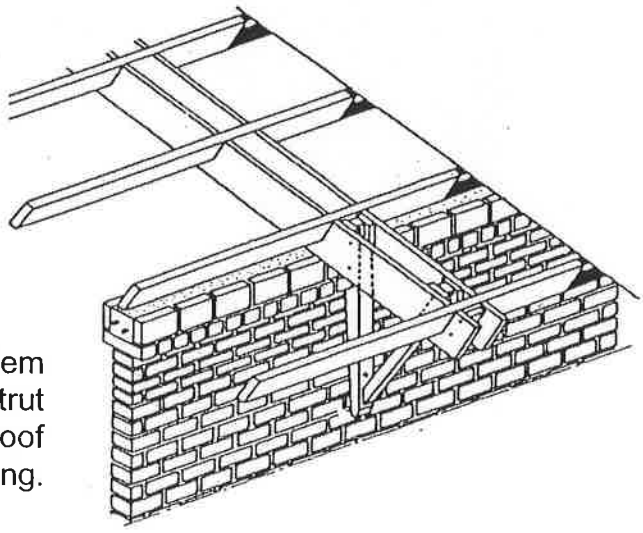


The anchorage can also be done using a steel rod which connects the rafters to a piece of timber placed under the ring beam.





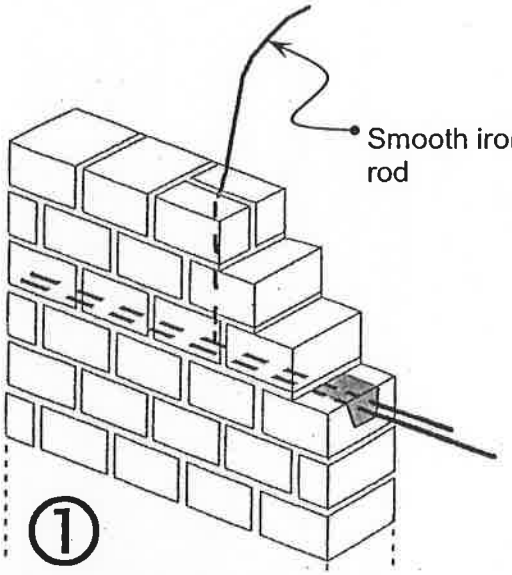
This system allows the fixing of the strut that supports a heavy roof overhang.



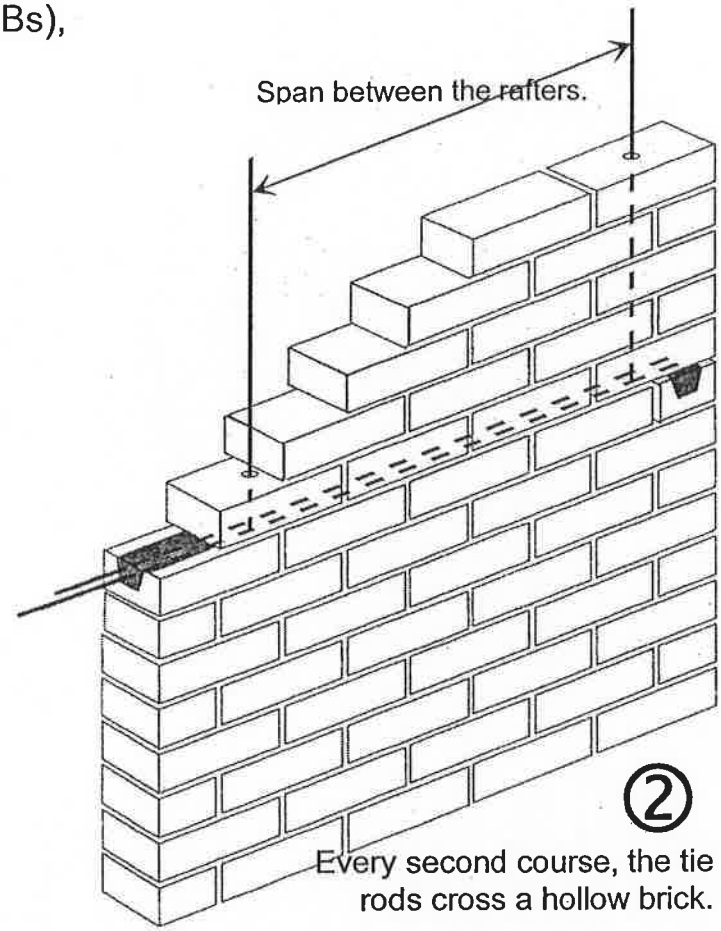
ROOF ANCHORAGE

INTERNAL ANCHORAGE

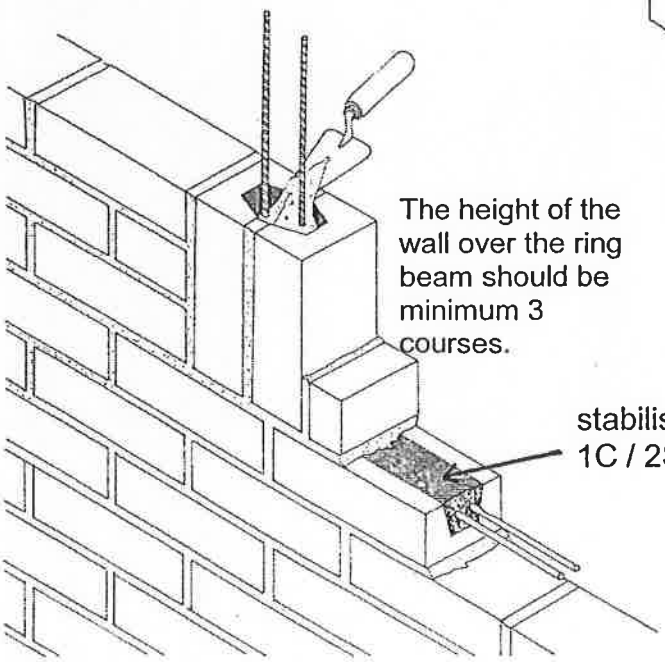
For hollow bricks it is easy to insert a tie rod between the ring beam and the top of the wall.
For plain bricks (fired bricks, CEBs), 4 solutions can be used:



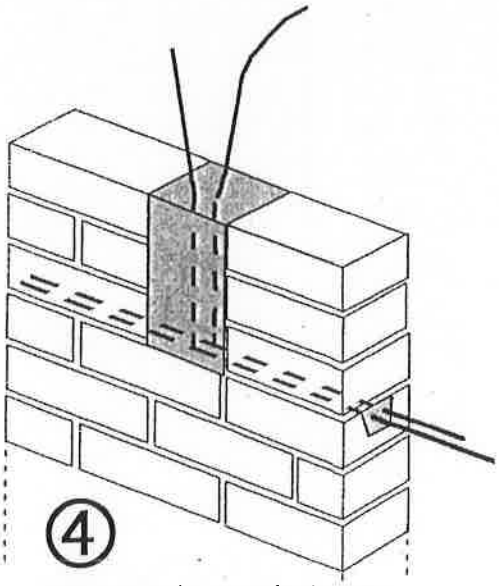
① The tie rod is inserted in the mortar.



② Every second course, the tie rods cross a hollow brick.



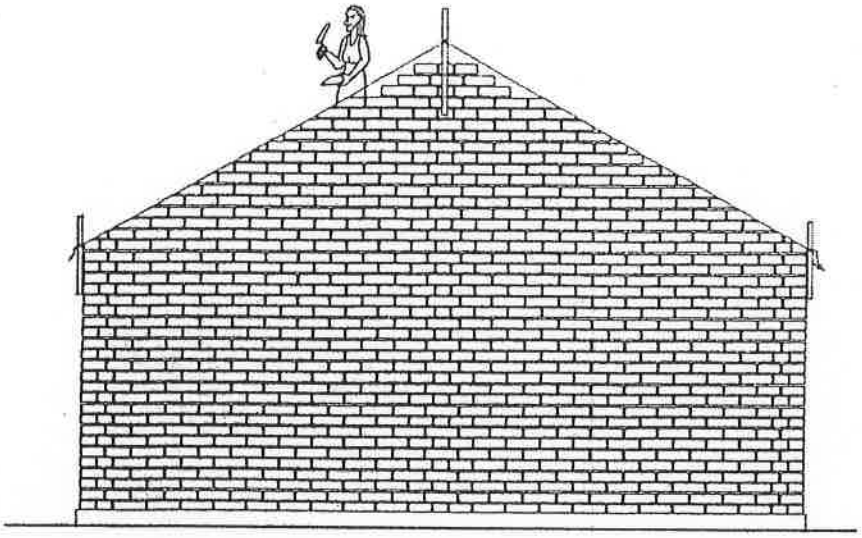
③ The tie rods are cast in concrete which is poured between two U-shape blocks laid vertically.



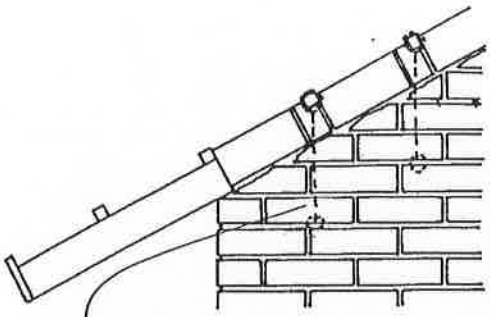
④ Concrete is cast between the bricks.

ROOF ANCHORAGE

CEB/BRICK GABLE/TILED ROOF

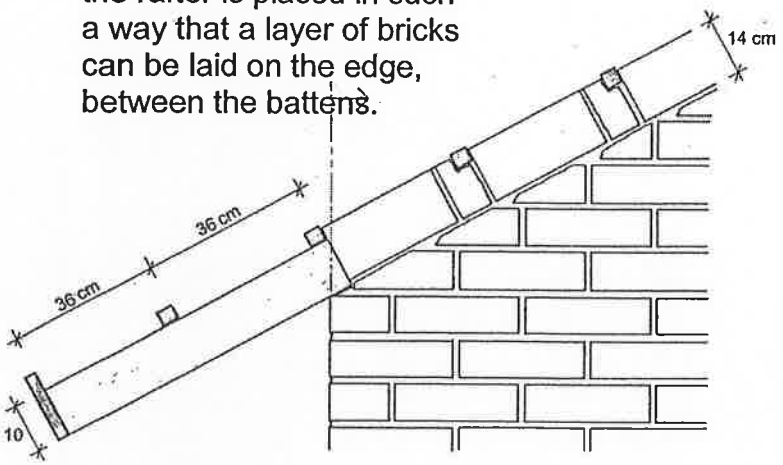


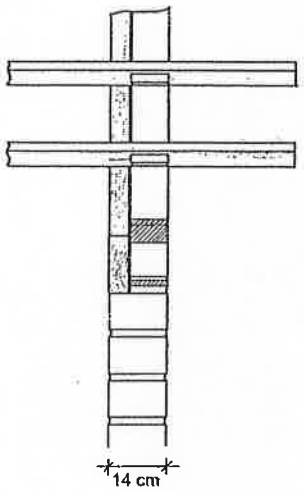
1. Use a line to position the top of the gable.
2. cut each brick to build the gable and use a stabilised soil mortar to finish off.

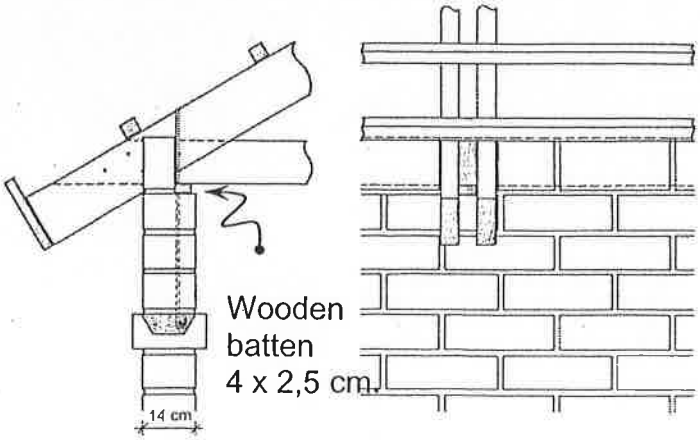


Anchoring the battens is important

3. On the 14 cm gable wall, the rafter is placed in such a way that a layer of bricks can be laid on the edge, between the battens.





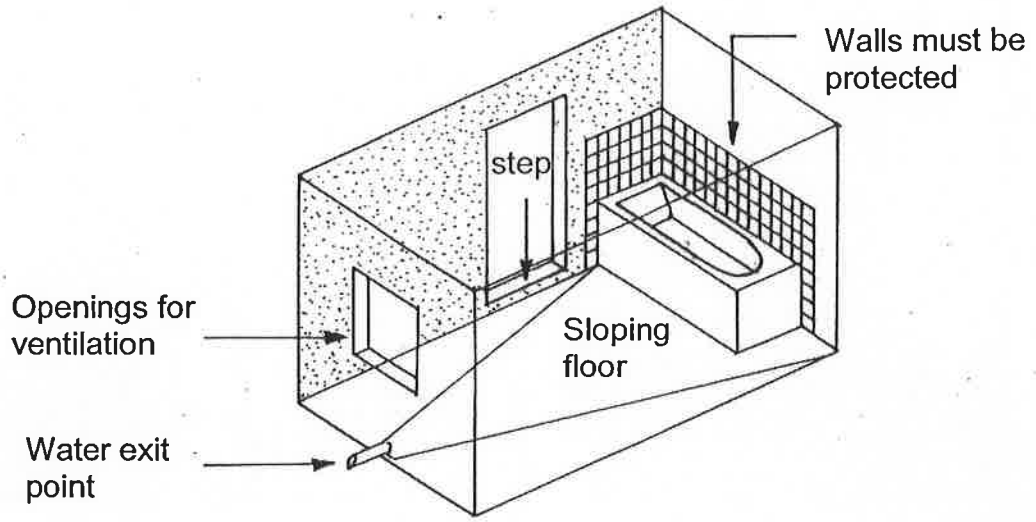


The wooden batten distributing the load is positioned on the inside to serve as a support for the suspended ceiling.
On the external face, the wall ends in a layer of bricks laid on the edge.

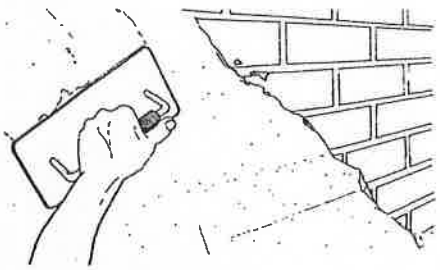
Part VII: Finishings & Fittings

This chapter covers finishings and various fittings. These are delicate aspects of any construction and have a very important aesthetic role, but also an equally important functional and structural role.
The basic rules to be followed for serviced rooms are illustrated. The need for well designed and equally well executed plumbing works is stressed.
Electrical fittings have become more complicated with the demand for concealed wiring. Various details concerning what should and what should not be done are illustrated.
Incorrectly or excessively applied plaster can cause problems in a well constructed structure. This has been illustrated with actual examples from the field.
Distempers, their functions and methods of preparation are also covered.

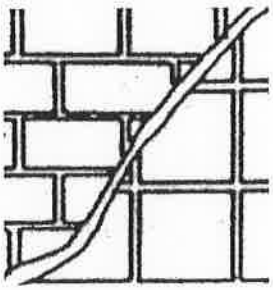
PROTECTION FROM WATER



A well applied cement render can protect the wall from water.



Ceramic tiles should be laid on a cemented surface.

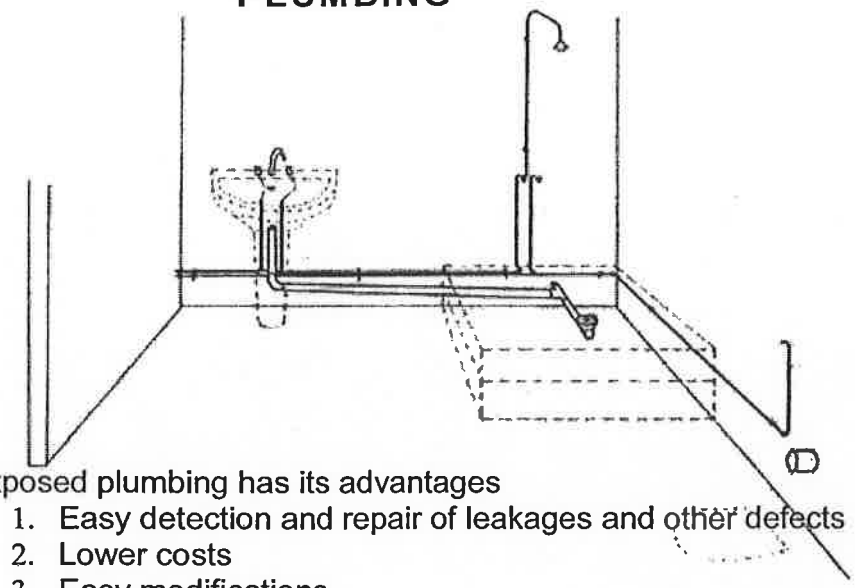


The walls that are likely to be exposed to water regularly like bathroom walls around bathing areas and basins, in washing rooms, or around the kitchen sink, should be protected.

Some General Tips

- **A well-built floor sloping towards a water exit point is very important.** A slope of 3cm/m ensures good drainage.
- The water exit point should be well located. It should have a trap and the mouth must be covered with netting to ensure that insects or rodents do not enter the premises. The mouth should be cleaned regularly
- A step or stone slab at the door ensures that no water overflows into the neighbouring rooms.
- Good ventilation (a window) is important to allow evaporation and avoid condensation.
- The wall must be protected with a cement render and ceramic tiles. **The tiling should extend up to the height where water splashes onto the wall.** The walls around the bathing area need to be protected to a height of 2.1 metres.

PLUMBING

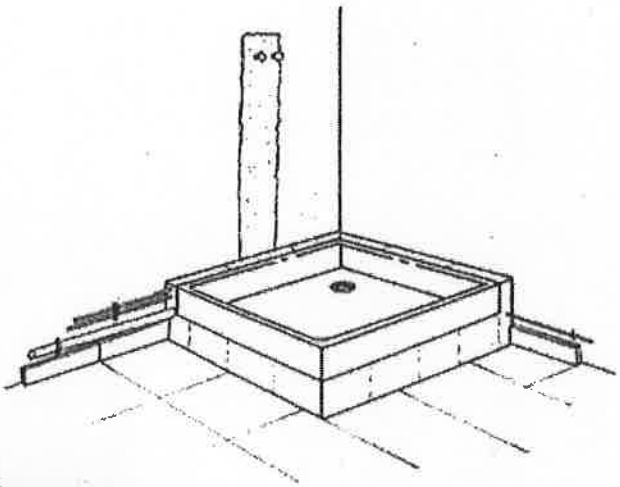


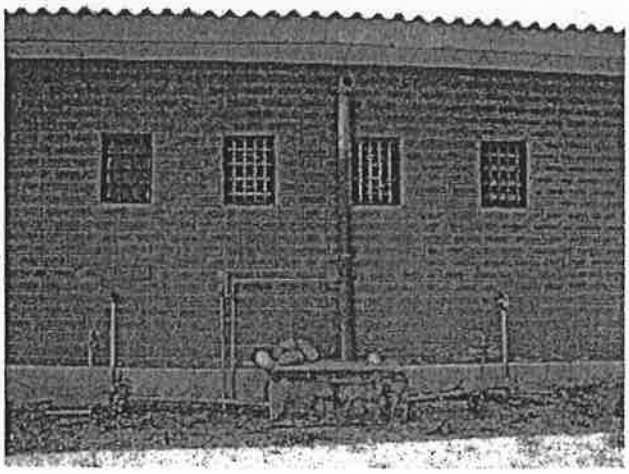
Exposed plumbing has its advantages

1. Easy detection and repair of leakages and other defects
2. Lower costs
3. Easy modifications

The load of horizontal pipes fixed onto the walls weakens thin walls and should be avoided.

Showers, bath and sinks must be at least 10 cm from the floor (to allow space for the U-bend) and 7 cm from the wall (to allow space for pipes).

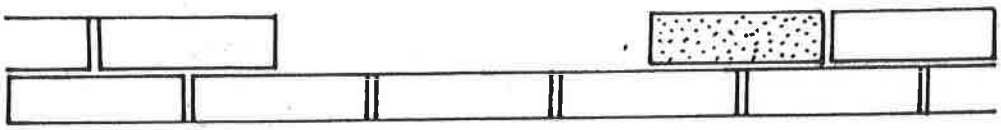




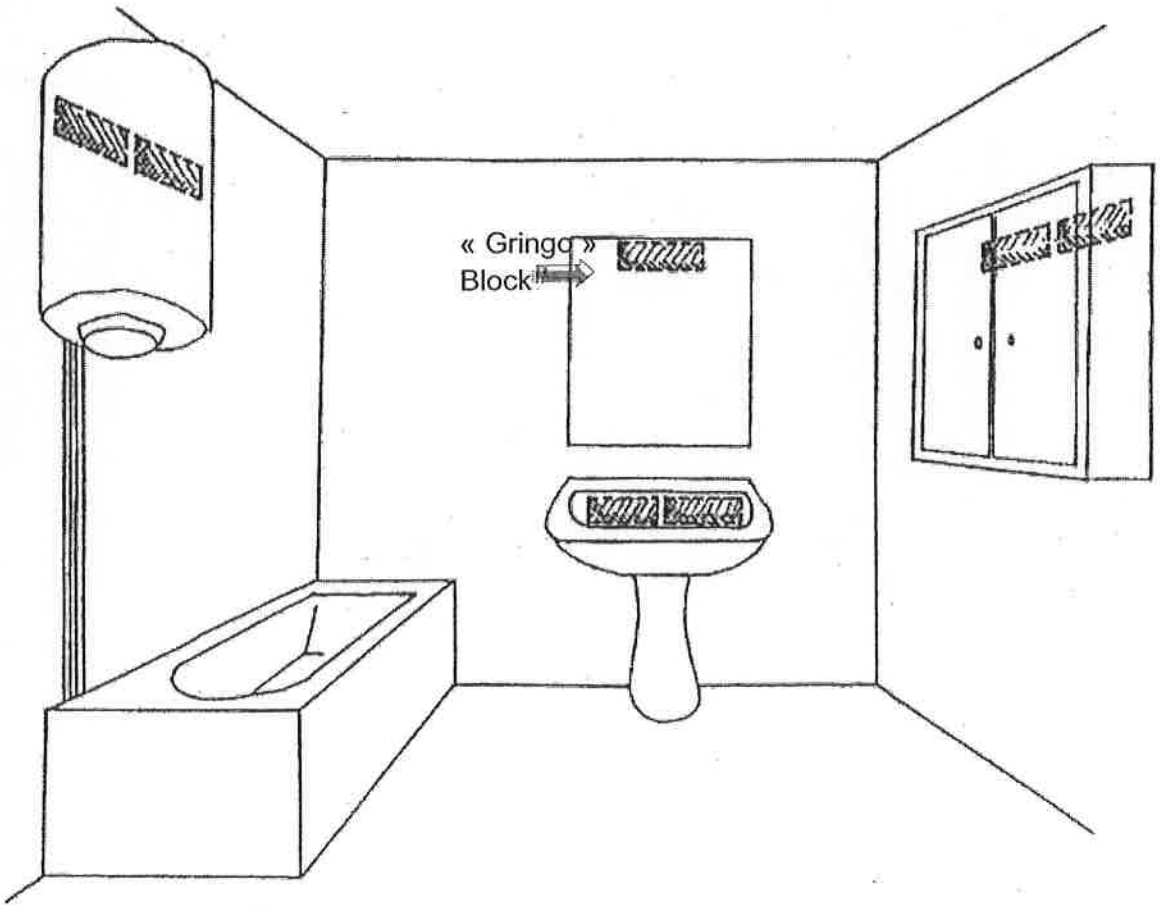
Exposed Plumbing on the external wall in a CEB house at Jos.

Badly designed plumbing as seen in this photograph can disfigure well built exposed brick walls

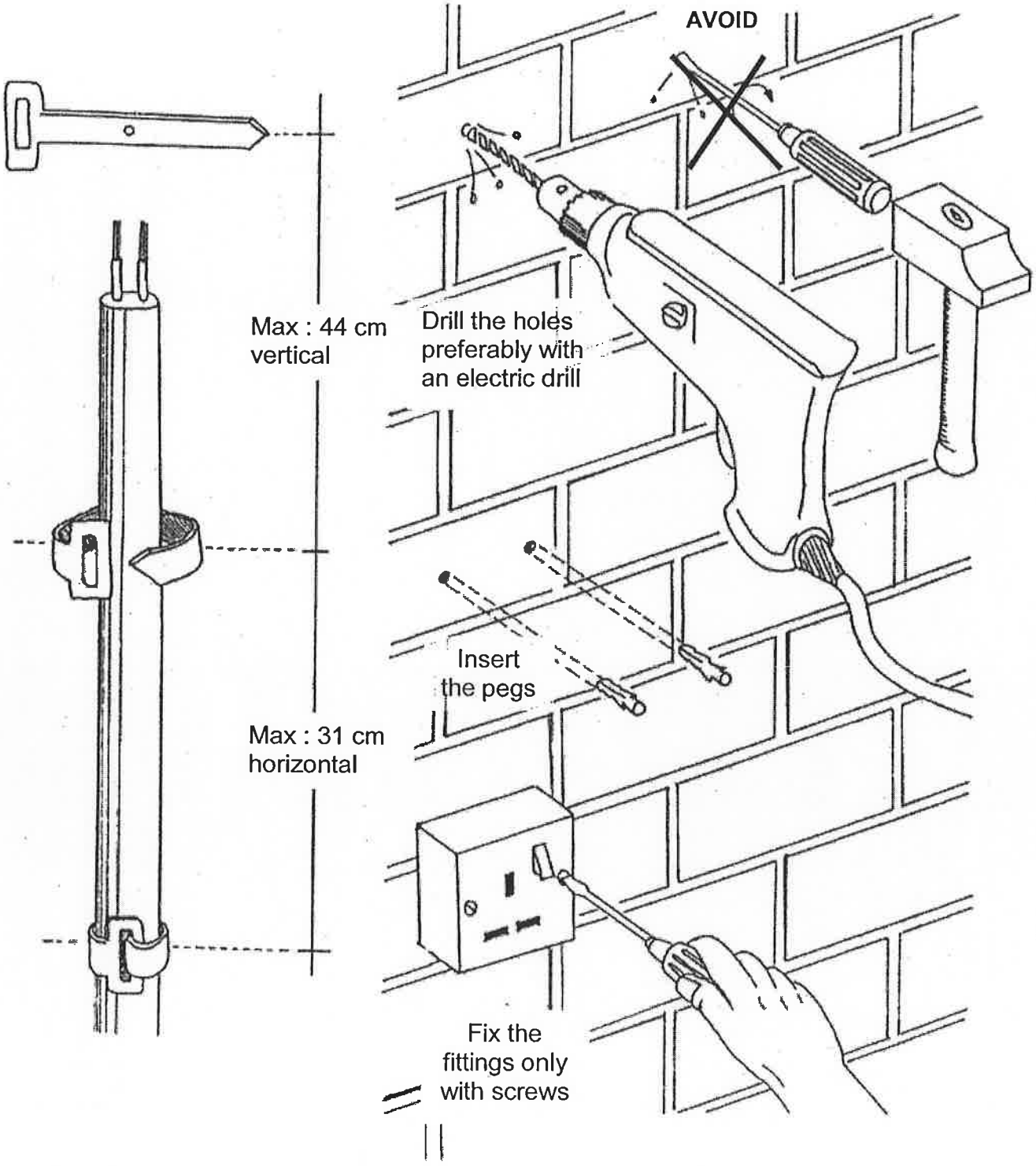
FIXING LOADS ONTO WALLS



A concrete brick cast in the same size as that of the bricks used for masonry and laid in the wall serves for drilling holes for the fixing of heavy loads onto the walls. It is called a "Gringo".
The prevalent practice of using timber bricks poses problems.



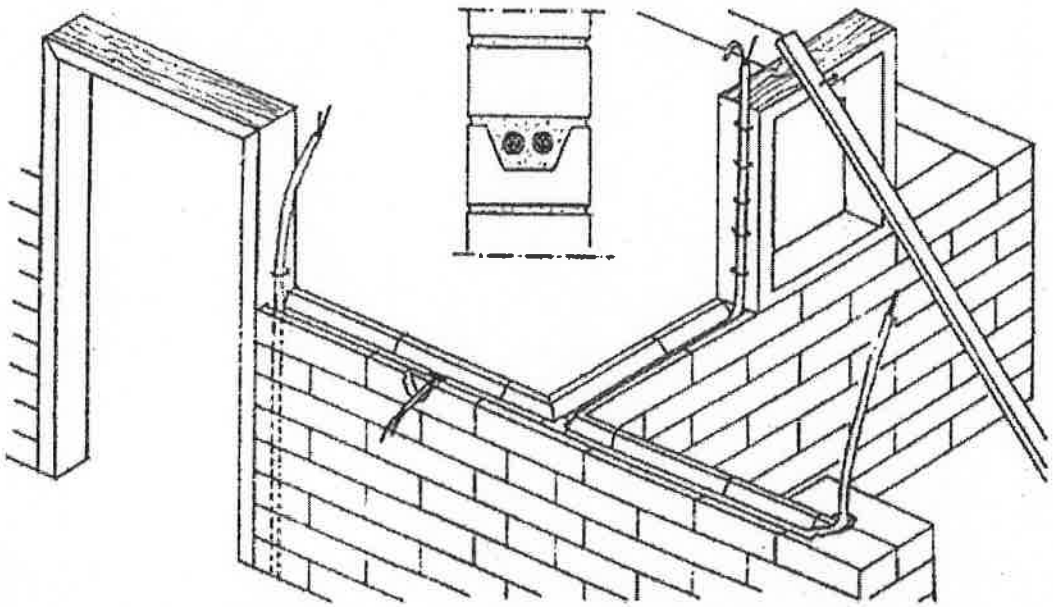
VISIBLE FITTINGS



CONCEALED WIRING IN A THIN CEB WALL

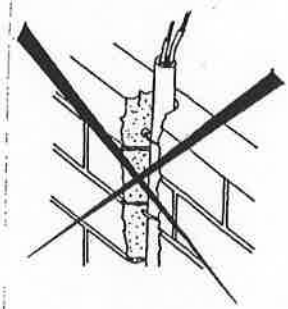
Electricity wires can be cast into the wall during the construction process:

- ***Horizontally*** ⇨ by using U-shape bricks
- ***Vertically*** ⇨ by placing them along door or window frames
  ⇨ by using hollow bricks

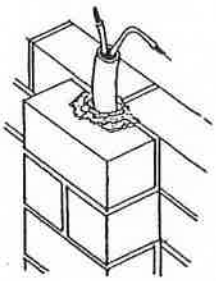


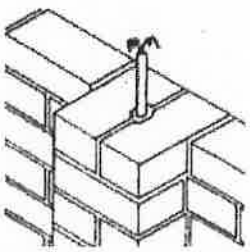
Concealed wiring in thin walls is best avoided

Chasing the walls for electrical cables should without exception be avoided, especially in thin walls.

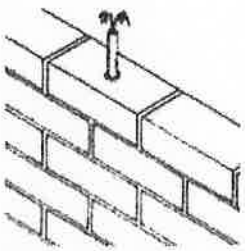


Exposed wiring in corners is a practical and intelligent solution.

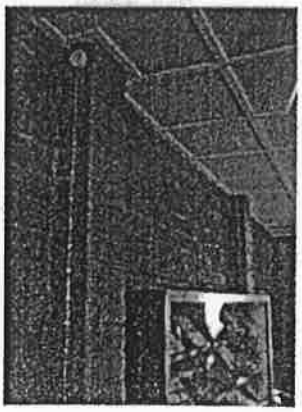




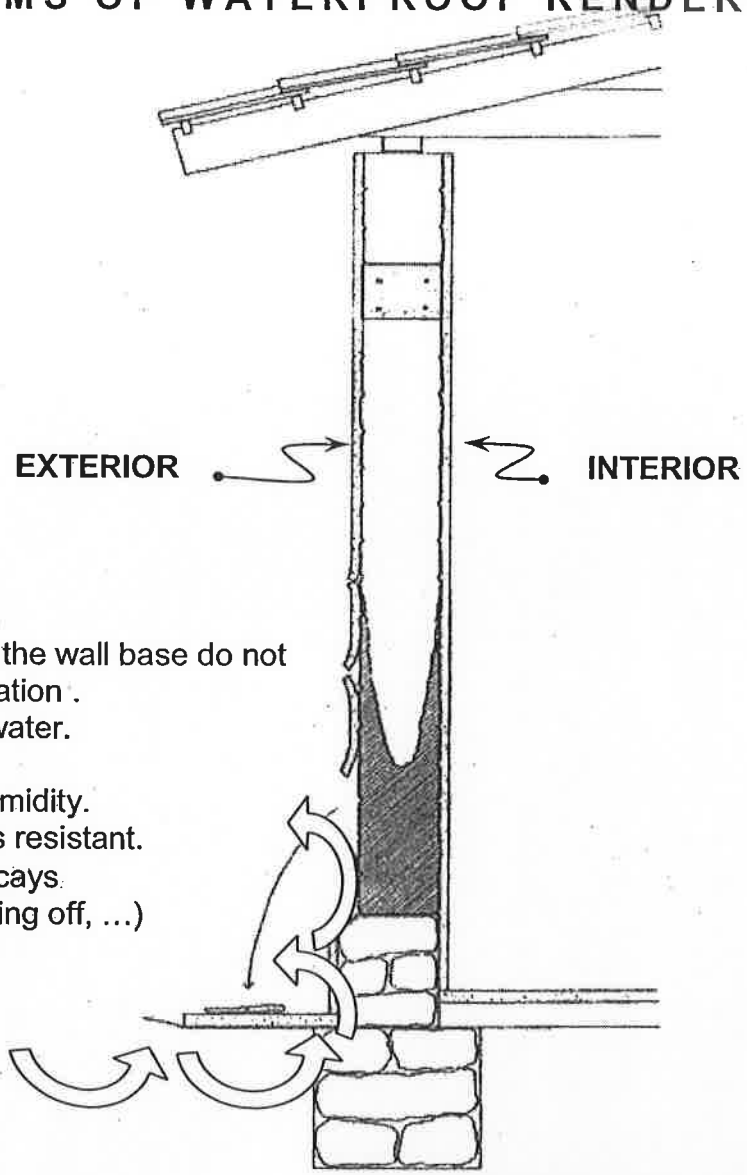
Exposed wiring with wiring that runs through the false ceiling.



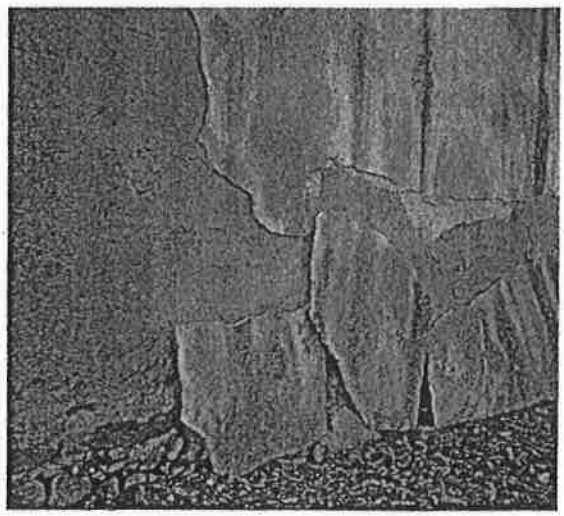
Detail of concealed wiring: fixing the switch box.



PROBLEMS OF WATERPROOF RENDERING



- The pavement and the wall base do not allow water evaporation .
  The wall absorbs water.
- Accumulation of humidity.
  The wall is less resistant.
  ⇒ The plaster decays
  (cracking, peeling off, ...)



Moisture being trapped at the wall base due to highly waterproofed surface finishes that do not allow the evaporation of moisture, thus endangering the wall.

DISTEMPERING

DISTEMPERING (FOR COMPRESSED EARTH BRICKS)

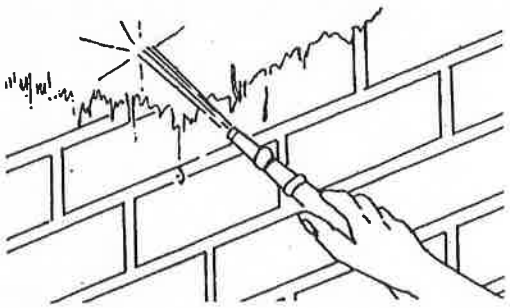
The distemper can be a mix of soil, cement and water. It takes a colour similar to that of the bricks and can be used to finish the wall especially when the masonry is not very neat. It does not offer the same protection as plaster but is easier and cheaper to do and can be

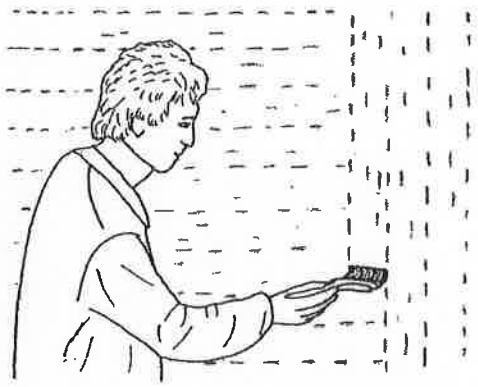
Preparation of distemper

1. Mix the soil with water and stir well, until the soil is well suspended.
2. Leave the bucket for a short time to allow heavy particles to settle.
3. Pour the liquid into another container taking care to avoid the heavy settled particles. (The finer the soil particles the better the distemper)
4. Mix small quantities of cement in batches into this liquid mix stirring well until the desired volume is reached.

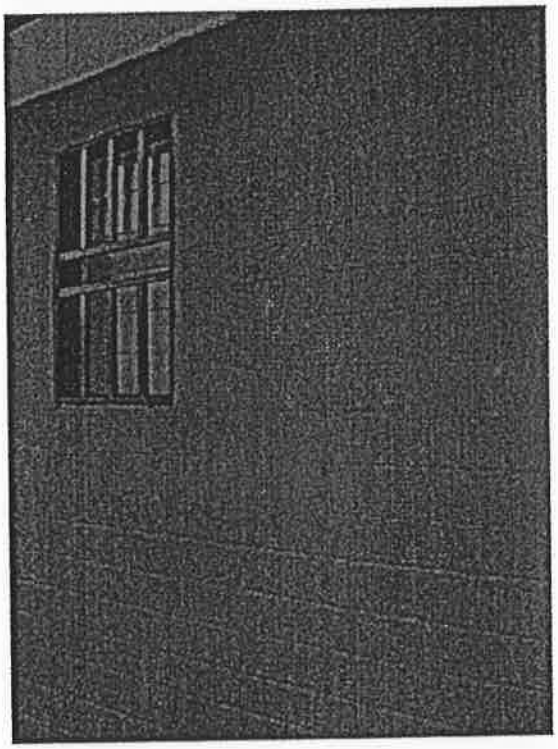
The proportion of soil to cement can vary. The proportion of cement is between 20 and 30%.

The distemper is ready and is to be used immediately





Distempering should be done on a well moistened wall after the water has been absorbed.
Apply the first coat of distemper with a wide brush in vertical and horizontal coats.
Allow the first coat to set.
Moisten the first coat to apply the 2nd coat in a similar fashion.



Distempered wall of a CEB building in Jos, Nigeria.

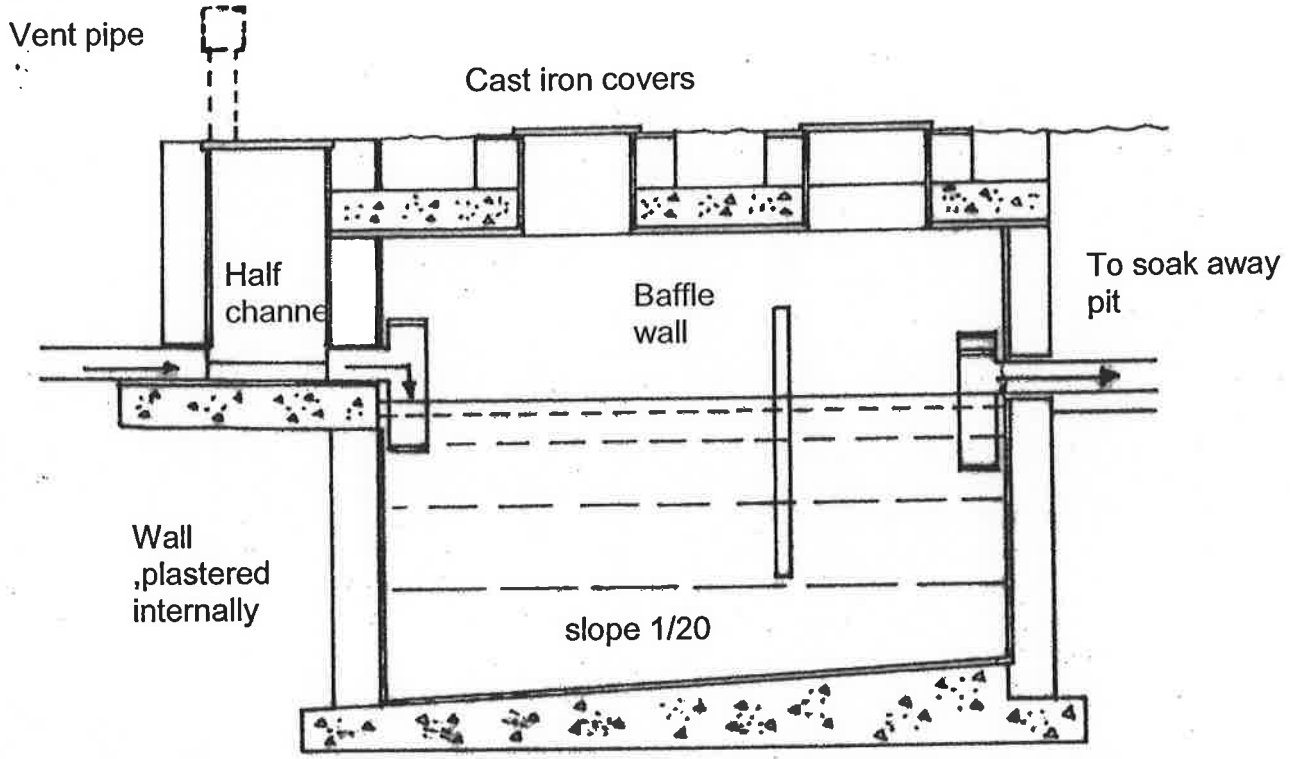
DISTEMPERS for Fired Clay Brick Walls

The same principals apply for distempering fired clay brick walls.
The distemper is often cement based and there is a range of colours from which to choose.

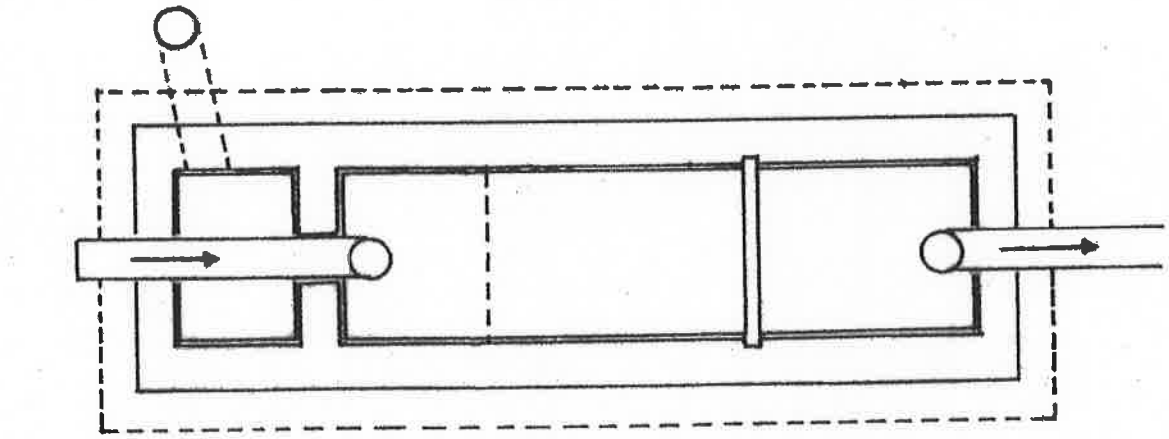
Part VIII: Specific Works

No construction site is complete without masonry works such as the septic tank, external pavements and boundary walls. These are illustrated in this chapter. Various important details concerning each of these masonry works are illustrated. .

A Typical Septic Tank



Section



Plan

Soak away: This is a pit dug in permeable soil so that the water fed to it is absorbed by the soil. Generally the soakaway is filled with large broken stones and may be covered with a concrete slab so as to seal it from other soil or to prevent debris. It is important to locate the soak away in a position where the water will seep away, to prevent a waterlogged area within close proximity to the building. Stagnant water breeds mosquitoes and this must be avoided at all costs.

OUTSIDE PAVEMENT

OBJECTIVE :

The outside pavement of a house should serve to:

- Protect the wall base and the foundation against water infiltration which could cause severe damage to the structure and weaken the building.
- Drain and divert all the rain water collected by the roof.

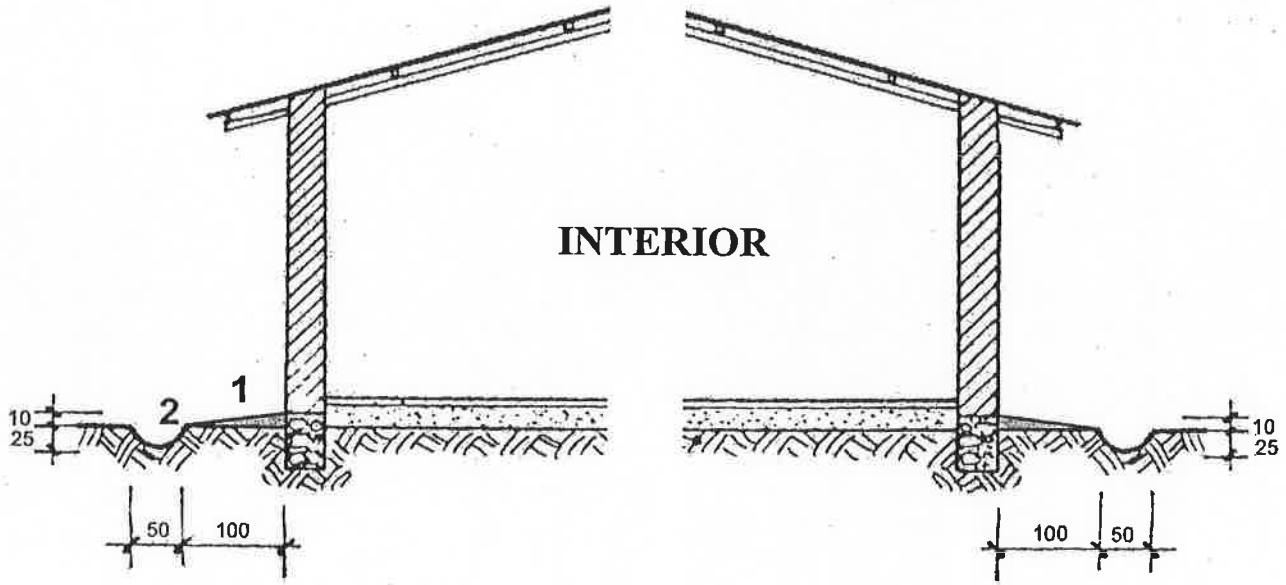
PRINCIPLE :

Working on the periphery of the building consists in :

1. Creating a slope to divert water.
2. Creating a channel at the end of this slope to evacuate the water.
   The slope of this channel is designed according to the surrounding environment. It should carry the water to the lowest point, far away from the building.

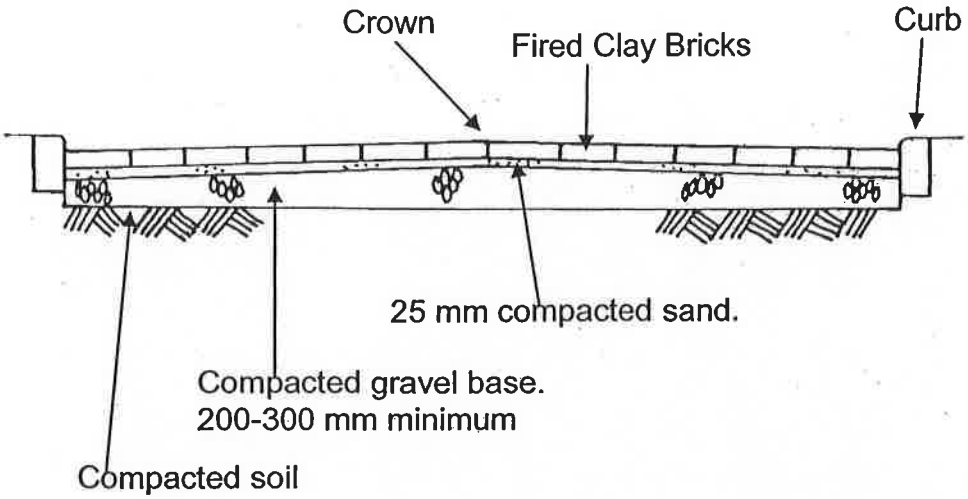
IMPORTANT:

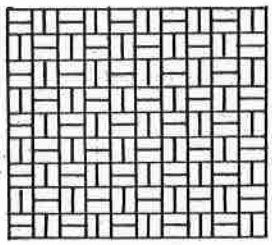
*This system should remain **permeable** in order to allow for the evaporation of absorbed humidity, and keep the foundations dry.*



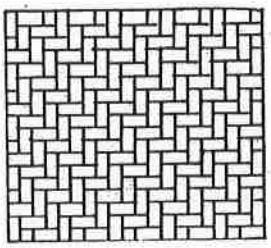
WARNING:

This drainage system requires periodic maintenance, especially before the rainy seasons
Check the slope.

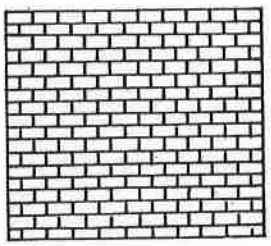




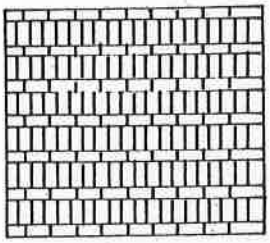
Basket Weave



Herring Bone

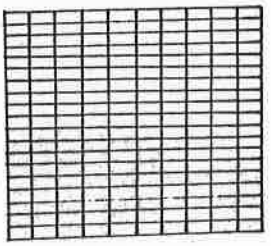


Running Bond

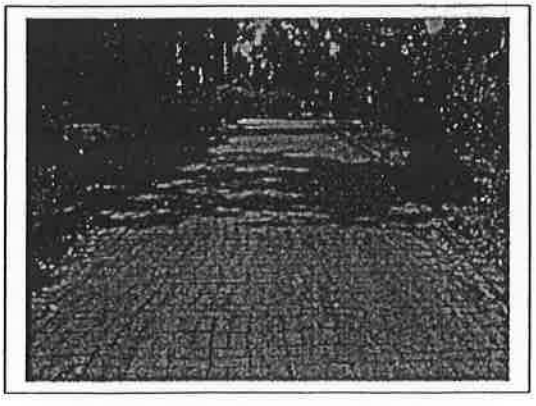


Running and stack bond mixed

Various interesting patterns using ordinary bricks can be devised.

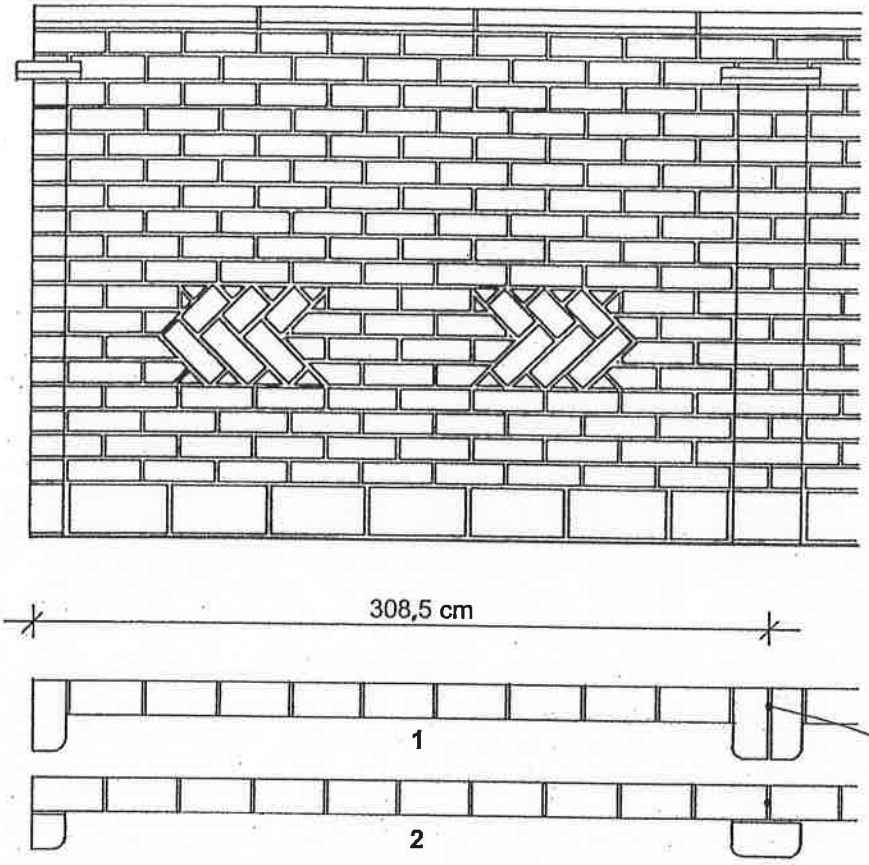


Stack Bond

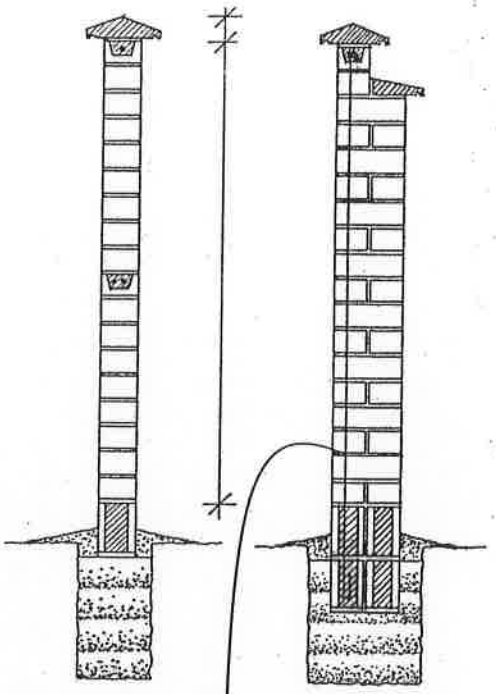


Brick Paving at Jos. All driveways have been laid in brick and are satisfactorily stable.

BOUNDARY WALL



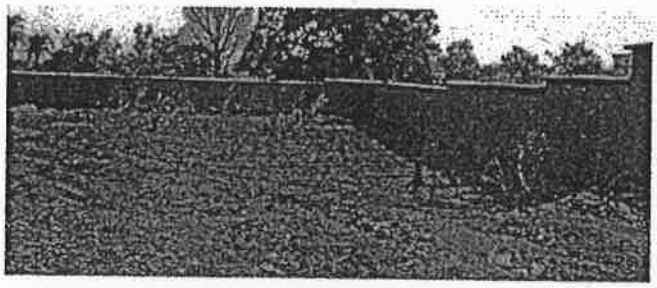
Plan with expansion joints at buttresses.



Section through wall

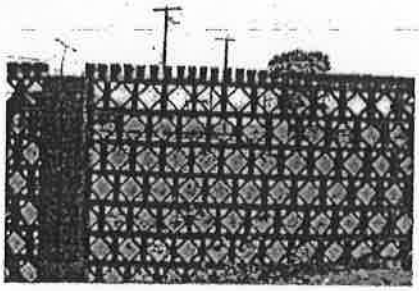
Section through buttress with detail for fixing the coping

A 6mm/8mm steel cable connecting the foundation to the coping. This ensures the fixing of the coping.



Boundary wall in CEB, stepped to match natural contours and with a concrete coping. (CFTD Jos)

Boundary wall in fired clay bricks, Jos.

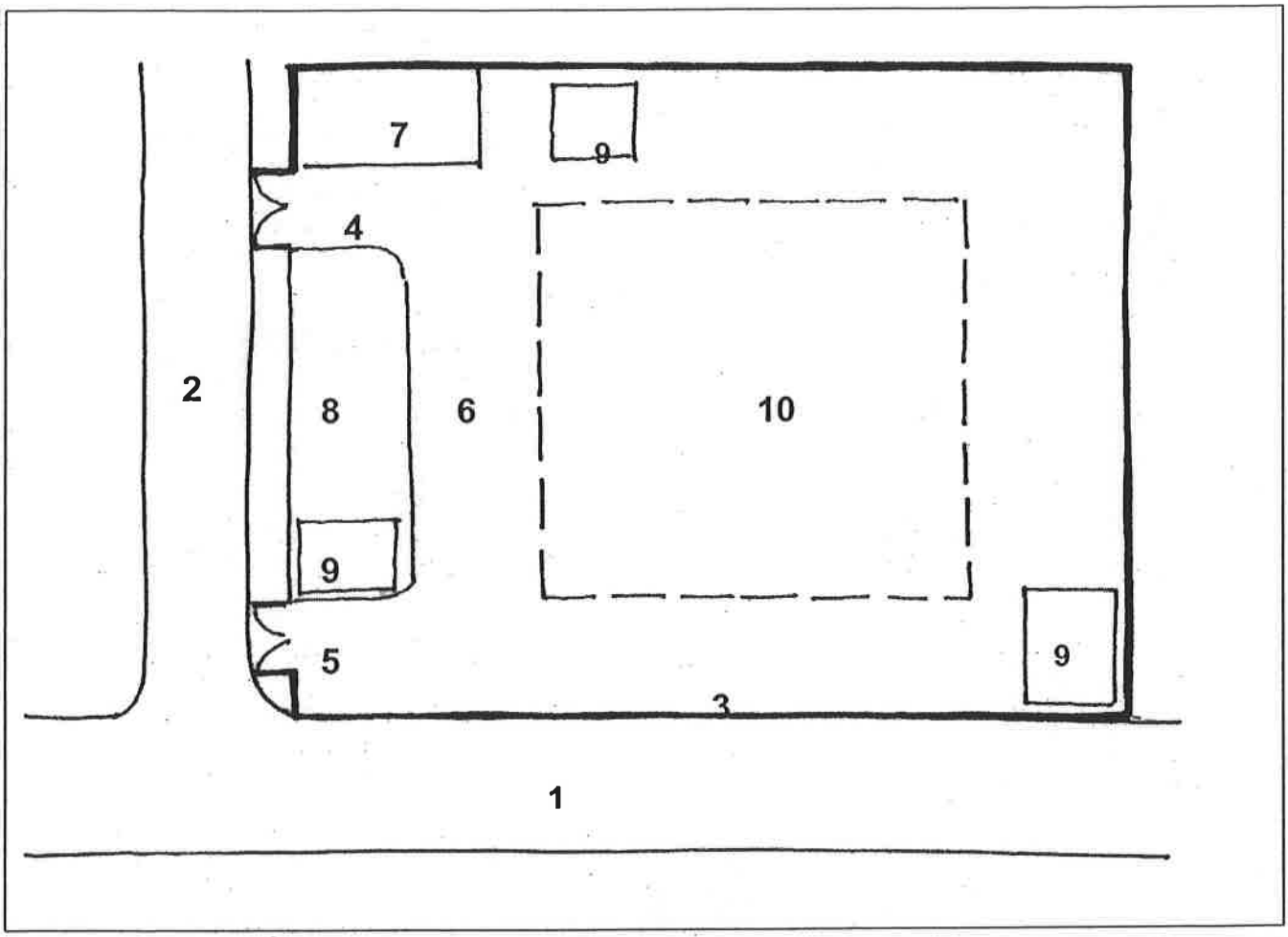


Decorative fired clay bricks, Jos.

Part IX: Site Organisation & Safety

Overall site organisation, scaffolding and safety aspects are not given due importance on sites. A well organised site, safe and well mounted scaffolding greatly improve the performance of a site. A high safety standard is of utmost importance and should be strictly enforced.
These aspects have been covered in this chapter. The aim is for the reader to appreciate their importance and also the advantages to be gained by implementing them.

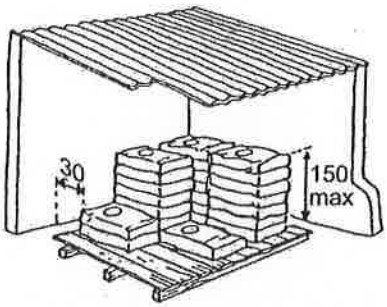
EXAMPLE OF GOOD SITE ORGANISATION

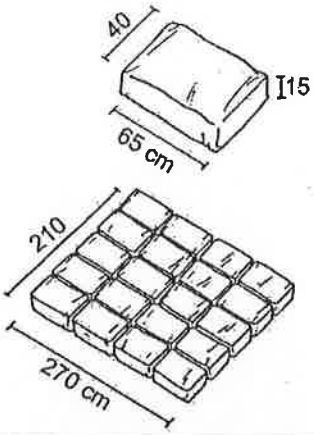


1: Main Road Do not locate any openings or stock any building materials on the main road.
2: Secondary Road All access to the site should be located via the secondary road. Care should be taken at all times not to block this road.
3 Boundary Wall This secures the site and also helps to organise the work. The boundary wall should be constructed taking into account access to the site during construction
4 Entry A separate entry and exit allow undisturbed flow of trucks and building materials.
5 Exit
6 Internal Road provides an internal traffic road for vehicles to circulate easily,.
7 Watchman's Cabin and Material Store Living quarters with basic accommodation amenities for the site watchman will ensure his continuous presence. Remember that the watchman plays a very important role on construction sites.
8 Main Stacking Area A stacking area that has access from the road itself will leave the site free of vehicles and simplify the unloading of trucks. It should be used for materials like gravel and sand.
9 Secondary Stacking Areas Create smaller stacking areas (depending on the site requirements) to facilitate easy access to building materials during construction.
10 Construction site The site where construction is to take place should be kept completely free of building materials. Leave a clear passage around this area for easy movement and for work.
Water Tank Even if the site has a water connection or a well, a tank is useful. It should ideally be installed to allow it to be filled by a tanker vehicule and also close to the site work.

SITE ORGANISATION

STOCKING

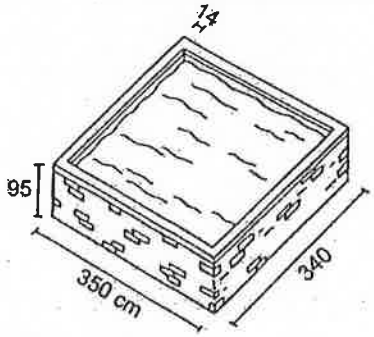




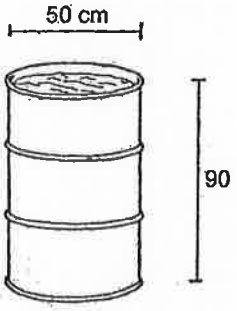
▪ CEMENT :

Bags of cement are kept in a locked place. They must be placed on a raised platform, and protected from the ground and at a distance from the walls to protect them from moisture.

Rearrange the bags every 3 weeks, especially during the rainy season.



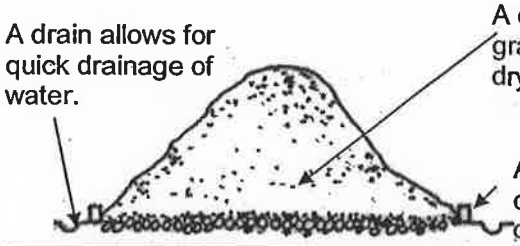
8,5 m^3 water tank.
14cm brick wall with cement plaster.



200 lts barrel

▪ WATER:

Try to assure a **piped water connection** on site before starting site work.
A **well** on site would be the next best option. Even with a water connection, a well would be an excellent back-up.
Barrels are cheap and can be moved. They are always useful to have on site.
The **masonry water tank** is a low cost and sure way to store water.

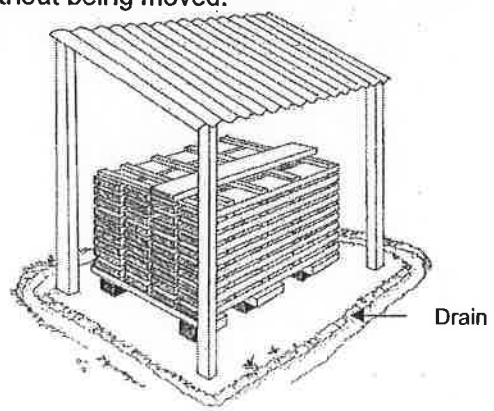


▪ SAND / SOIL:

Beware of heavy rains on muddy sites. A cover and drains will protect the sand or soil.

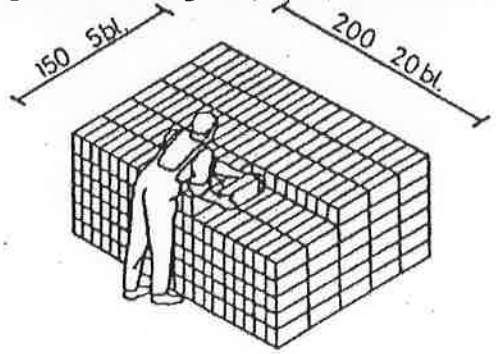
▪ WOOD:

Flat and well ventilated, wood planks can dry without being moved.



▪ BRICKS AND BLOCKS:

Must be stocked on a flat surface.
This must be close to the building to reduce handling, but far enough to avoid collisions and dirt.



SAFETY ON THE JOB

Safety on the job is a must. Unsafe and unprofessional practices can cause injuries and can result in lost work time and money. Do not take short cuts. Do not break safety rules.

DO NOT ECONOMIZE ON SAFETY EQUIPMENT

PERSONAL PROTECTION:

- Wear a helmet, and make everybody on site wear a helmet.
- Wear hard-sole steel-toed safety boots. If not available, wear at least local hard-sole shoes (tire-sole).

Helmets and shoes are not cheap and many people are not used to them, but they are worth wearing.

- Remove all rings and jewellery so they don't interfere with your work.
- **Do not wear long flowing clothes at the site. They might get tangled in equipment and cause an accident.**
- Wash all exposed parts of the body with clean water especially when working with cement, which can seriously affect the skin.
- Always have a well stocked first aid box on site. Check it regularly to be sure that it is in order.

SECURING THE SITE

Securing the site should be the first thing to do on beginning site work. It has several advantages:

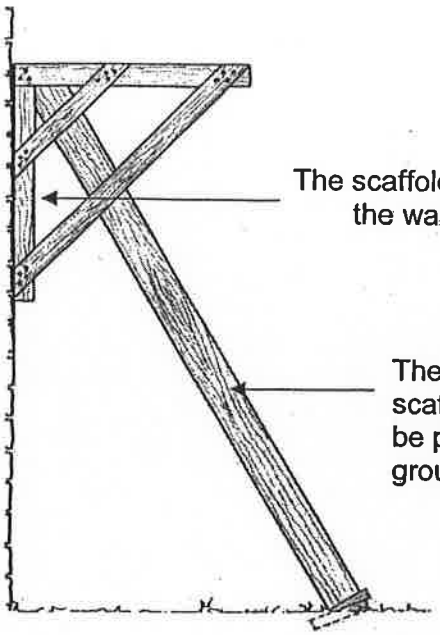
- **Safety**: it prevents the entry of unauthorised persons, reducing the risk of accidents.
- **Protects against robbery**.
- **Site organisation**: deliveries, storage and site work itself are better organised.

The best way to secure the site is to build the definitive boundary wall first with its gate and gatehouse. This provides an effective barrier at no additional cost and the use of the gatehouse to store equipment in a safe and protected place.

If this is not possible, used zinc or local mat (zanna) can provide a minimum level of protection at low cost.

SCAFFOLDING LAID AGAINST THE WALL

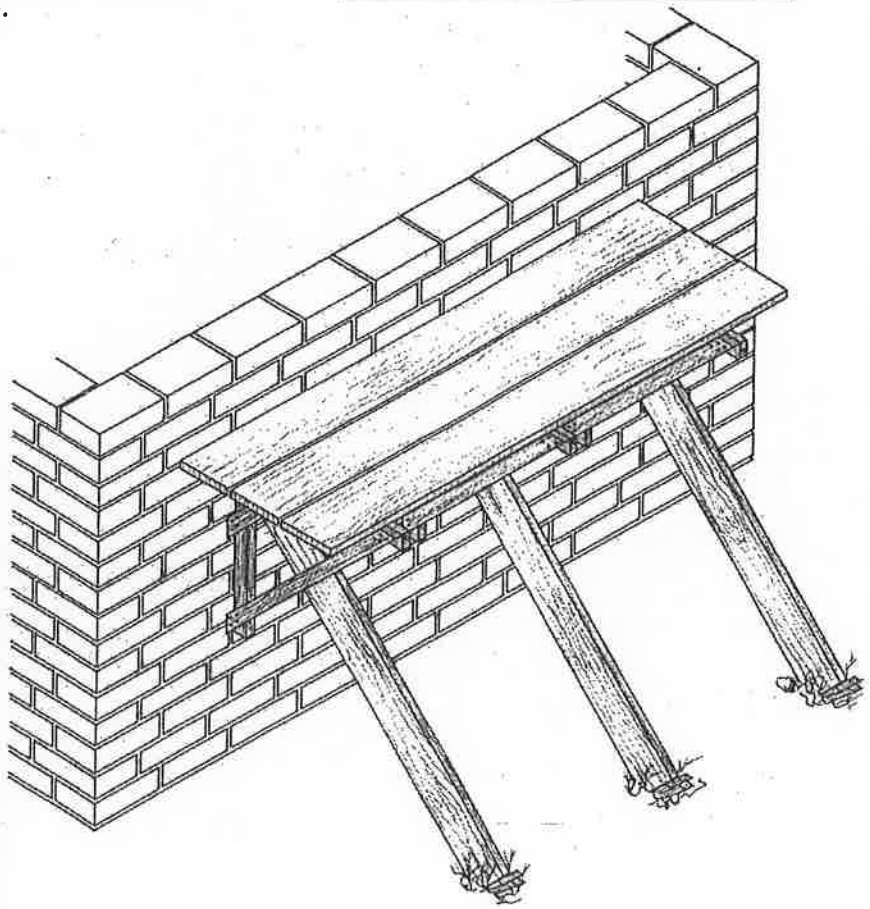
To be used on thick stable walls only.

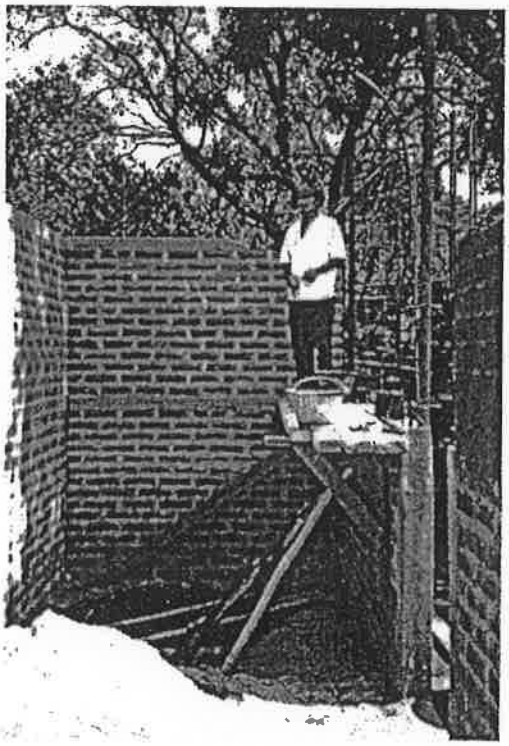


The scaffolding is not fixed into the wall but against it.

The strut supports the scaffolding and should be properly fixed in the ground.

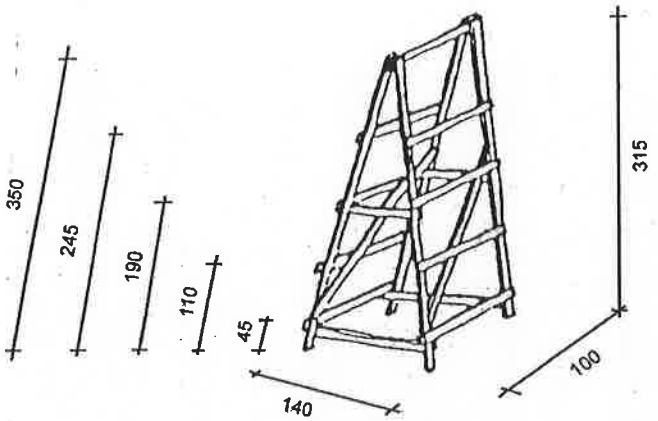
Security angle
Between 30° minimum and 45° maximum

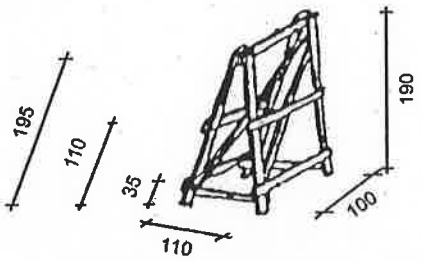


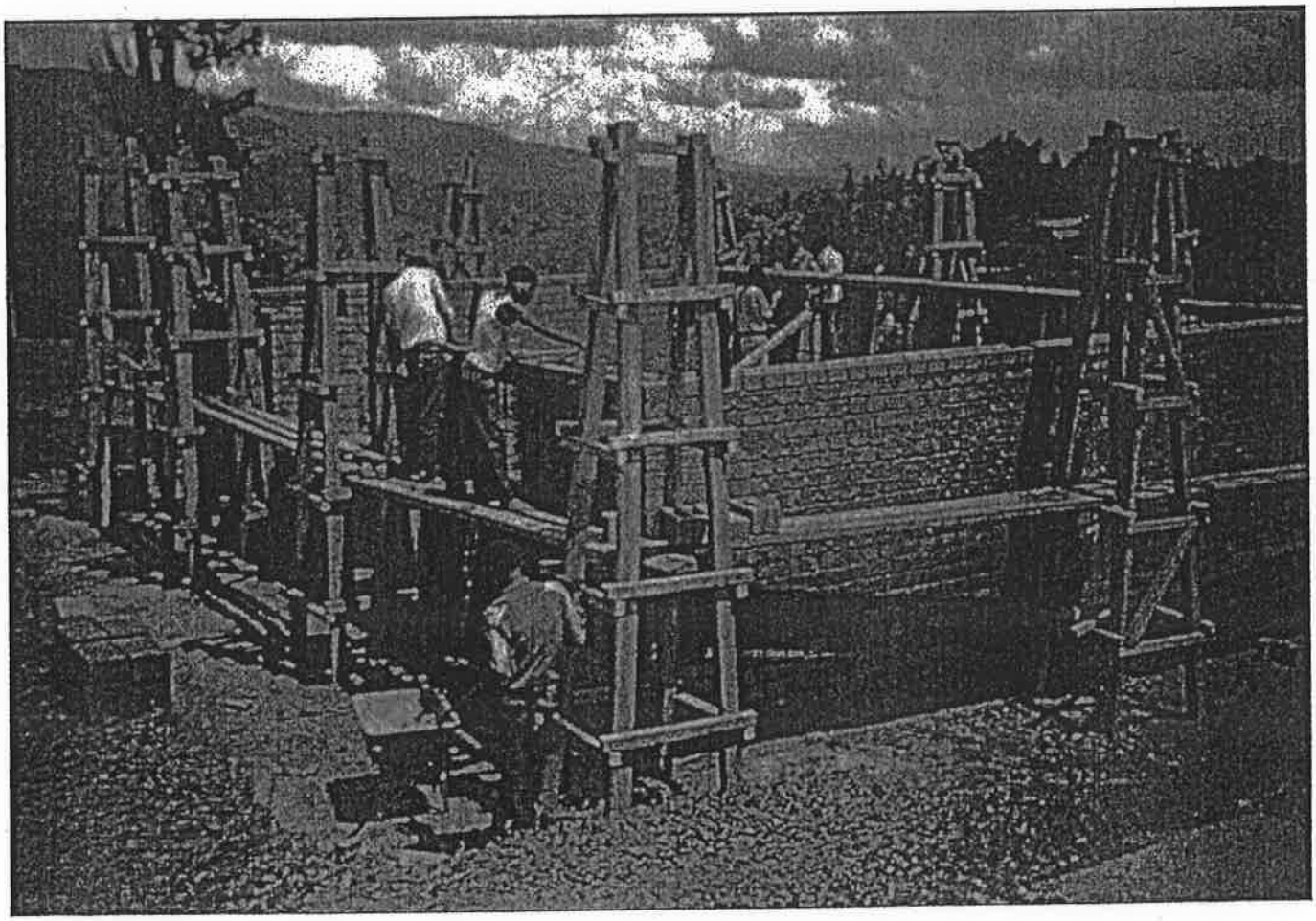


Note that the scaffolding has been fixed at the level of the ring beam.

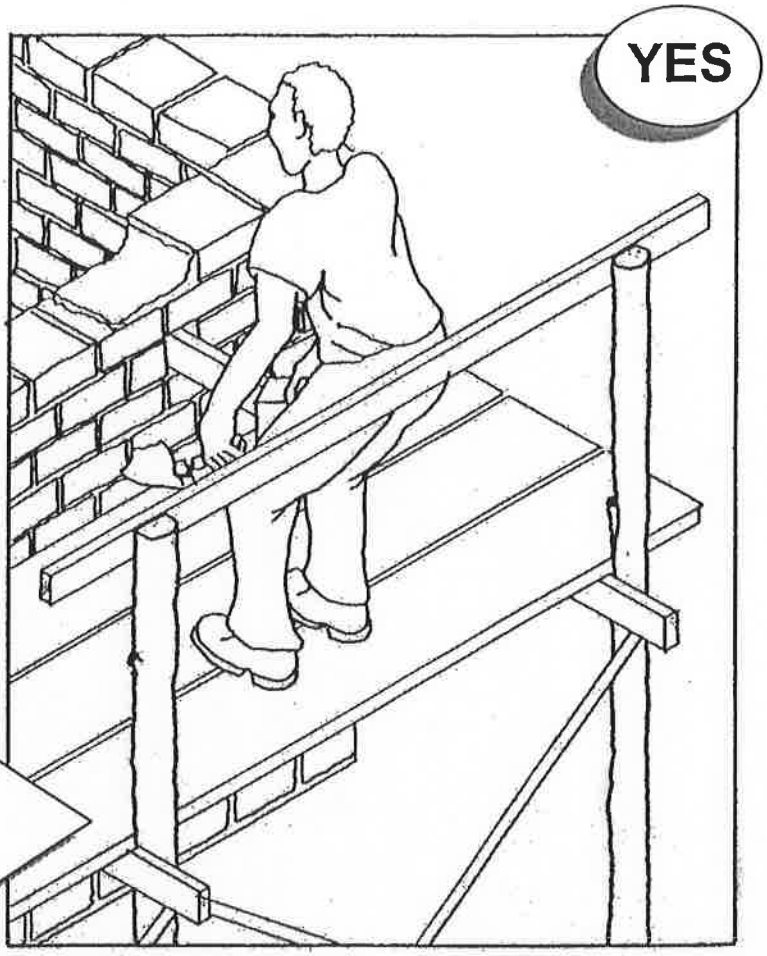
MOBILE SCAFFOLDING



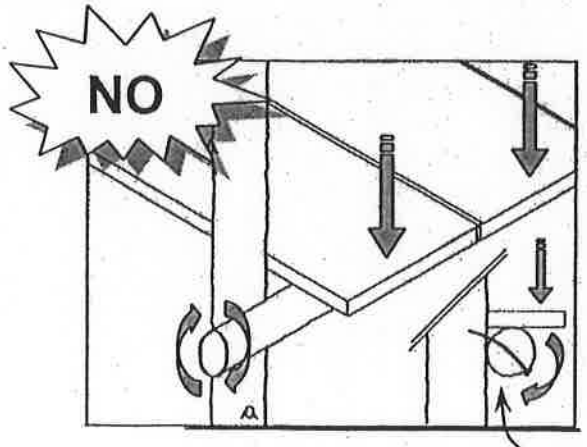




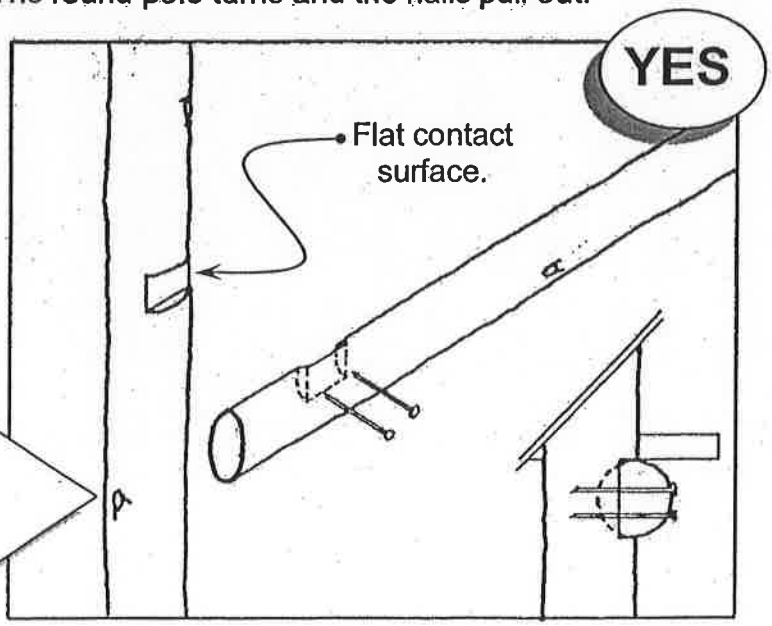
SCAFFOLDING SAFETY



The barrier rail must be nailed **On the inside**



The round pole turns and the nails pull out.



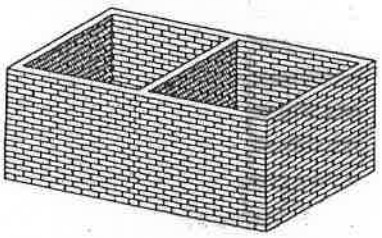
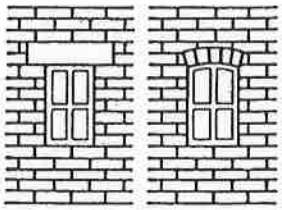
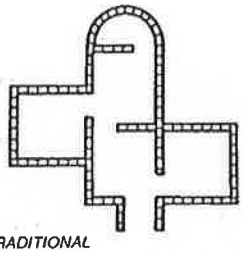
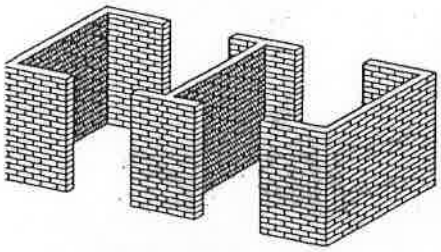
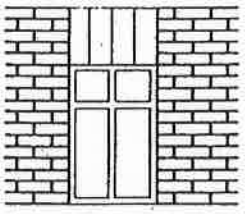
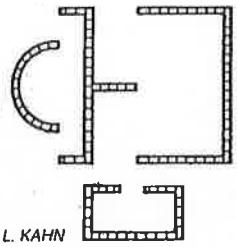
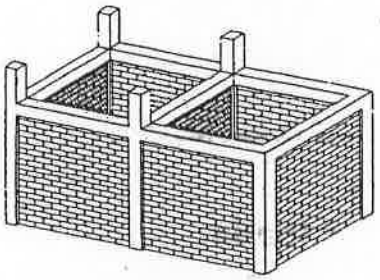
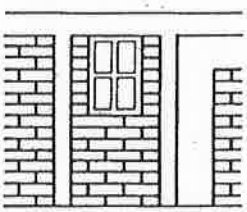
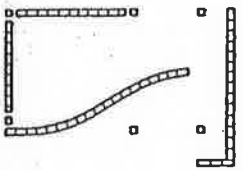
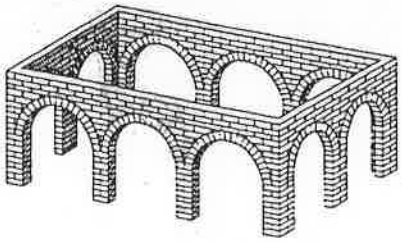
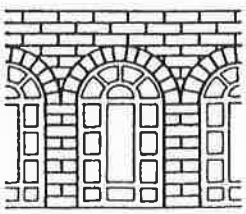
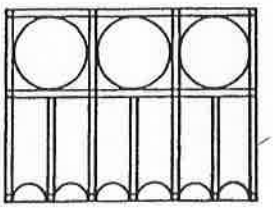
Round poles must be **chiselled** before being nailed together.

Part X: Construction principles

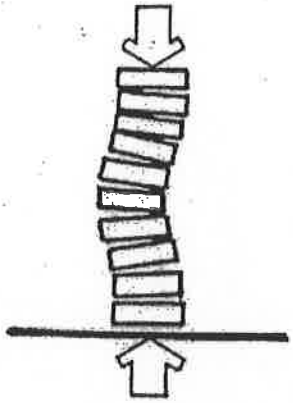
This chapter highlights certain aspects that play an important role in masonry construction. It gives methods that would help the reader design and construct high quality masonry structures. Basic structural types in masonry walls are discussed. Structural stresses in walls, the basics of wall construction, modular coordination in brick masonry and the basics of quantity estimation are also covered.

WALL AND STRUCTURAL TYPES

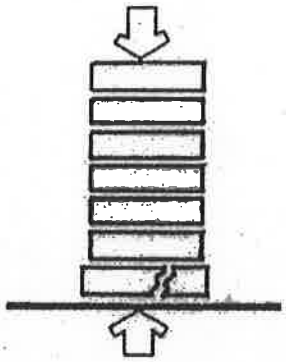
STRUCTURAL CONCEPTS

WALLS	OPENINGS	PLAN RESOURCES
THE PLACING OF BASIC ELEMENTS ONE ON TOP OF THE OTHER USING A BONDING PATTERN RECONSTITUTES A HOMOGENOUS MASS. FOUR TYPES OF STRUCTURE CAN BE CONSIDERED.	*THERE ARE TWO WAYS OF PROCEEDING: WITHIN THE MASS OF THE INFILL MATERIAL. OR USING AN EXISTING GAP BETWEEN TWO MASONRY STRUCTURES.*	
BUILDING CONSISTING OF PERIPHERAL WALLS AND CONTINUOUS PARTITIONS: MONOLITHIC ENVELOPE.		
MONOLITHIC ENVELOPE	*WITHIN THE MASS OF THE WALL*	*THE SPACE IS CONTINUOUS (WORK ON THE ENVELOPE*
		
		TRADITIONAL
BUILDING CONSISTING OF INDEPENDENT. SELF-STABLE BLOCKS		
WALLS WITH BUTTRESSES AND ANGLES	*FILLING IN AN EXISTING GAP BETWEEN TWO SELF-STABLE BLOCKS*	*THE SPACE IS CONTAINED (WORK ON THE BOUNDARIES)*
		
LOADBEARING FRAME + MASONRY INFILL		*L. KAHN*
INFILL OF POST/BEAM FRAME (concrete, wood, steel)	*WITHIN THE MASONRY INFILL BETWEEN CONCRETE FRAME POSTS*	*THE SPACE IS SCREENED (WORK ON THE ENVELOPE)*
		
BRICK LOADBEARING FRAME + INFILL		*LE CORBUSIER*
POST AND ARCH FRAME	*AS ABOVE WITH A FRAME OF ARCHES, VAULTS AND DOMES*	*THE SPACE IS SCREENED (WORK ON THE ENVELOPE)*
		
		HASSAN FATHY

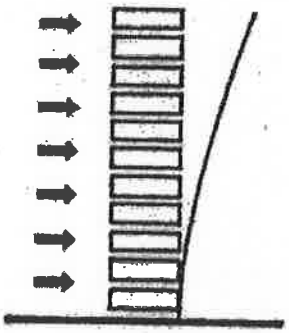
STRUCTURAL STRESS



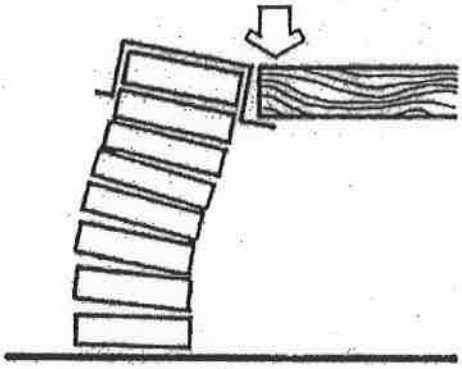
Buckling



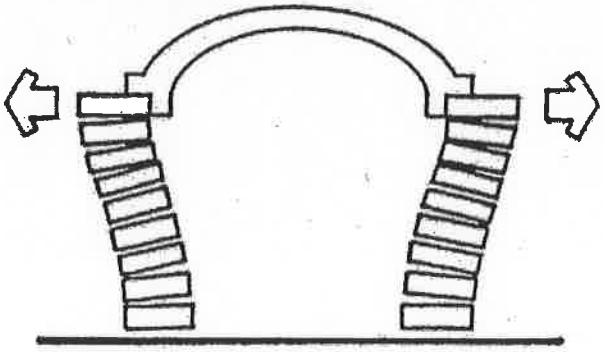
Crushing



Uniform pressure of the wind



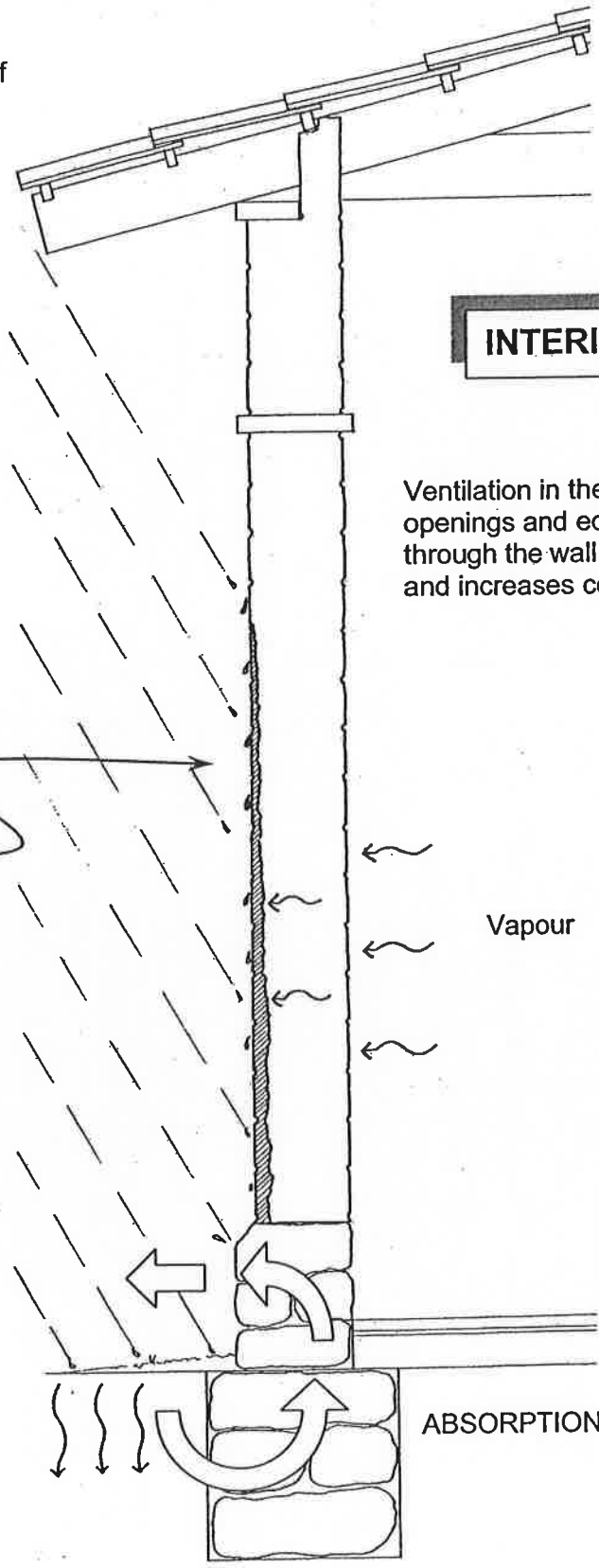
Vertical eccentric loads



Horizontal eccentric loads

WALLS GENERALS

Depending on local weather conditions a well designed roof protects the house from rains.



Ventilation in the form of openings and equally importantly through the wall reduces humidity and increases comfort.

Running rain water:
- Wetting of the surface.
- Evaporation and drying after the rain.

Vapour

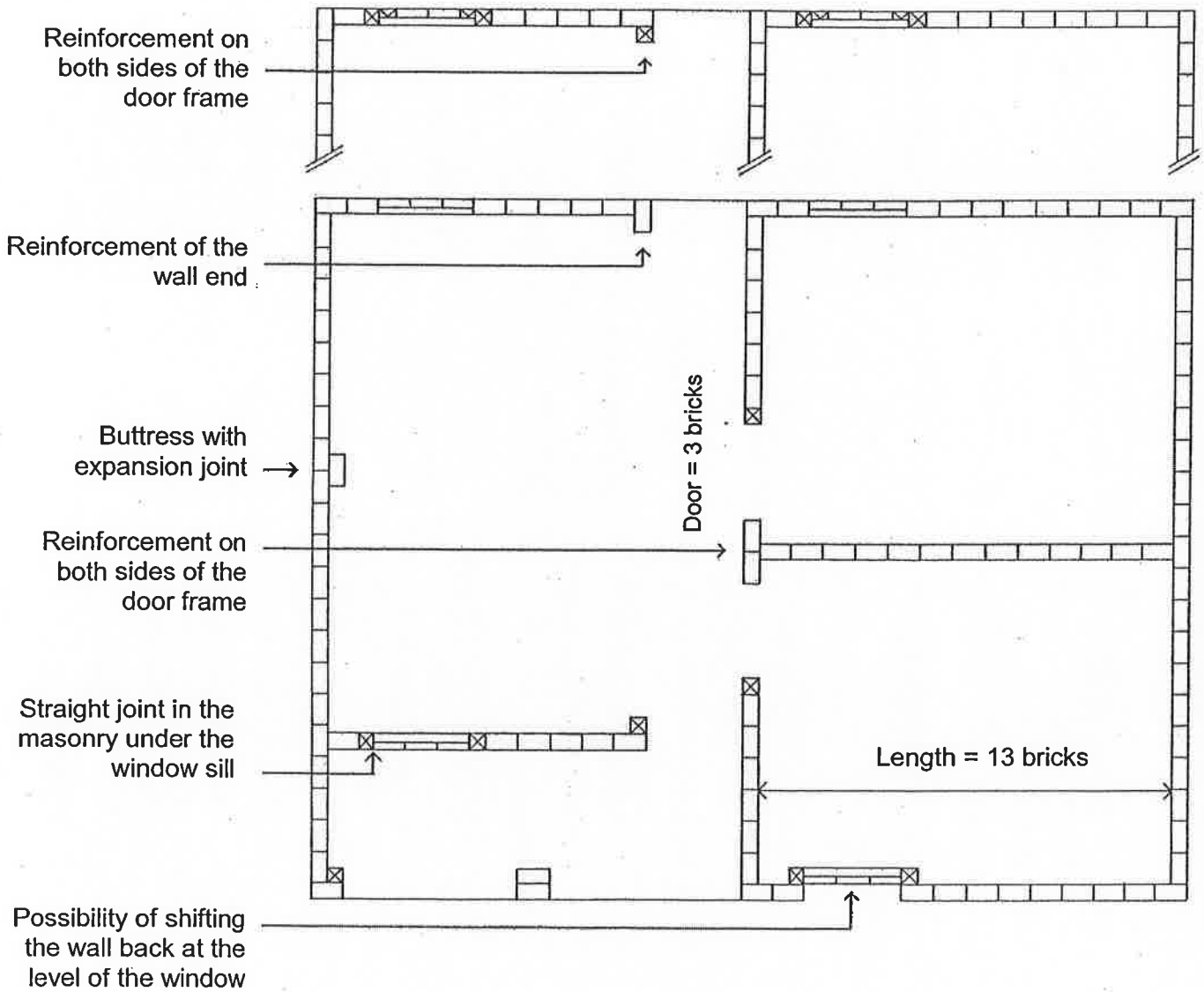
EVAPORATION THROUGH THE BASE.

A surface drain ensures that water does not accumulate at the wall base.

ABSORPTION

CONSTRUCTION PRINCIPLES FOR THIN LOAD BEARING WALLS

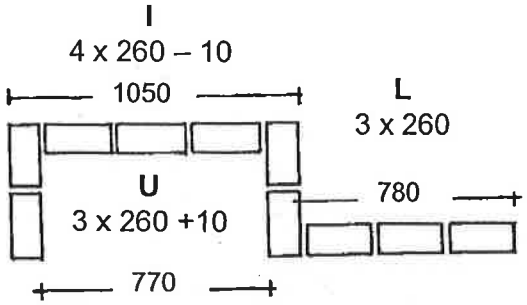
Special care should be taken when constructing with thin walls. The various details illustrated below should be put in practice.



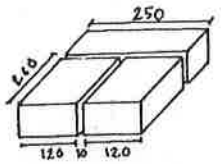
PLAN

The plan layout showing the bonding pattern should be drawn for the first two courses. This allows proper detailing and easy execution.
As illustrated, all openings and wall lengths should be in multiples of bricks.

CONVERSION TABLE FOR FCB (250 X 120)



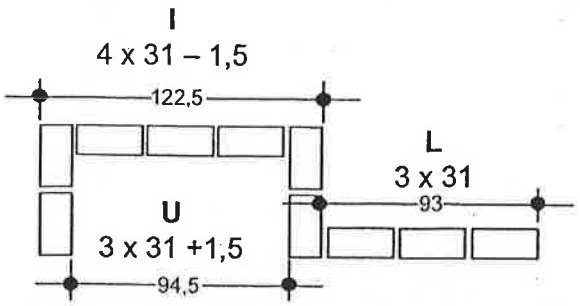
mortar joint = 10 mm
brick + joint = 260 mm



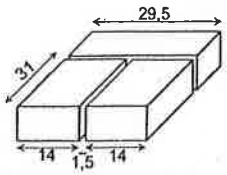
Number of blocks	I shape	L shape	U shape
0.5	120	130	140
1	250	260	270
1.5	380	390	400
2	510	520	530
2.5	640	650	660
3	770	780	790
3.5	900	910	920
4	1030	1040	1050
4.5	1160	1170	1180
5	1290	1300	1310
5.5	1420	1430	1440
6	1550	1560	1570
6.5	1680	1690	1700
7	1810	1820	1830
7.5	1940	1950	1960
8	2070	2080	2090
8.5	2200	2210	2220
9	2330	2340	2350
9.5	2460	2470	2480
10	2590	2600	2610
10.5	2720	2730	2740
11	2850	2860	2870
11.5	2980	2990	3000
12	3110	3120	3130
12.5	3240	3250	3260
13	3370	3380	3390
13.5	3500	3510	3520
14	3630	3640	3650
14.5	3760	3770	3780
15	3890	3900	3910
15.5	4020	4030	4040
16	4150	4160	4170
16.5	4280	4290	4300
17	4410	4420	4430
17.5	4540	4550	4560
18	4670	4680	4690
18.5	4800	4810	4820
19	4930	4940	4950
19.5	5160	5170	5180
20	5290	5300	5310

Number of blocks	I shape	L shape	U shape
20.5	5420	5430	5440
21	5550	5560	5570
21.5	5680	5690	5700
22	5810	5820	5830
22.5	5940	5950	5960
23	6070	6080	6090
23.5	6200	6210	6220
24	6330	6310	6320
24.5	6460	6470	6480
25	6590	6600	6610
25.5	6720	6730	6740
26	6850	6860	6870
26.5	6980	6990	7000
27	7120	7130	7140
27.5	7250	7260	7270
28	7380	7390	7400
28.5	7510	7520	7530
29	7640	7650	7660
29.5	7770	7780	7790
30	7900	7910	7920
30.5	8030	8040	8050
31	8160	8170	8180
31.5	8290	8300	8310
32	8420	8430	8450
32.5	8550	8560	8570
33	8680	8690	8700
33.5	8810	8820	8830
34	8940	8950	8960
34.5	9070	9080	9090
35	9200	9210	9220
35.5	9330	9340	9350
36	9460	9470	9480
36.5	9590	9600	9610
37	9720	9730	9740
37.5	9850	9860	9870
38	9980	9990	10000
38.5	10110	10120	10130
39	10240	10250	10260
39.5	10370	10380	10390
40	10500	10510	10520

CONVERSION TABLE FOR CEB (295 X 140)



mortar joint = 1,5 c
brick + joint = 31 c



Number of bricks	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

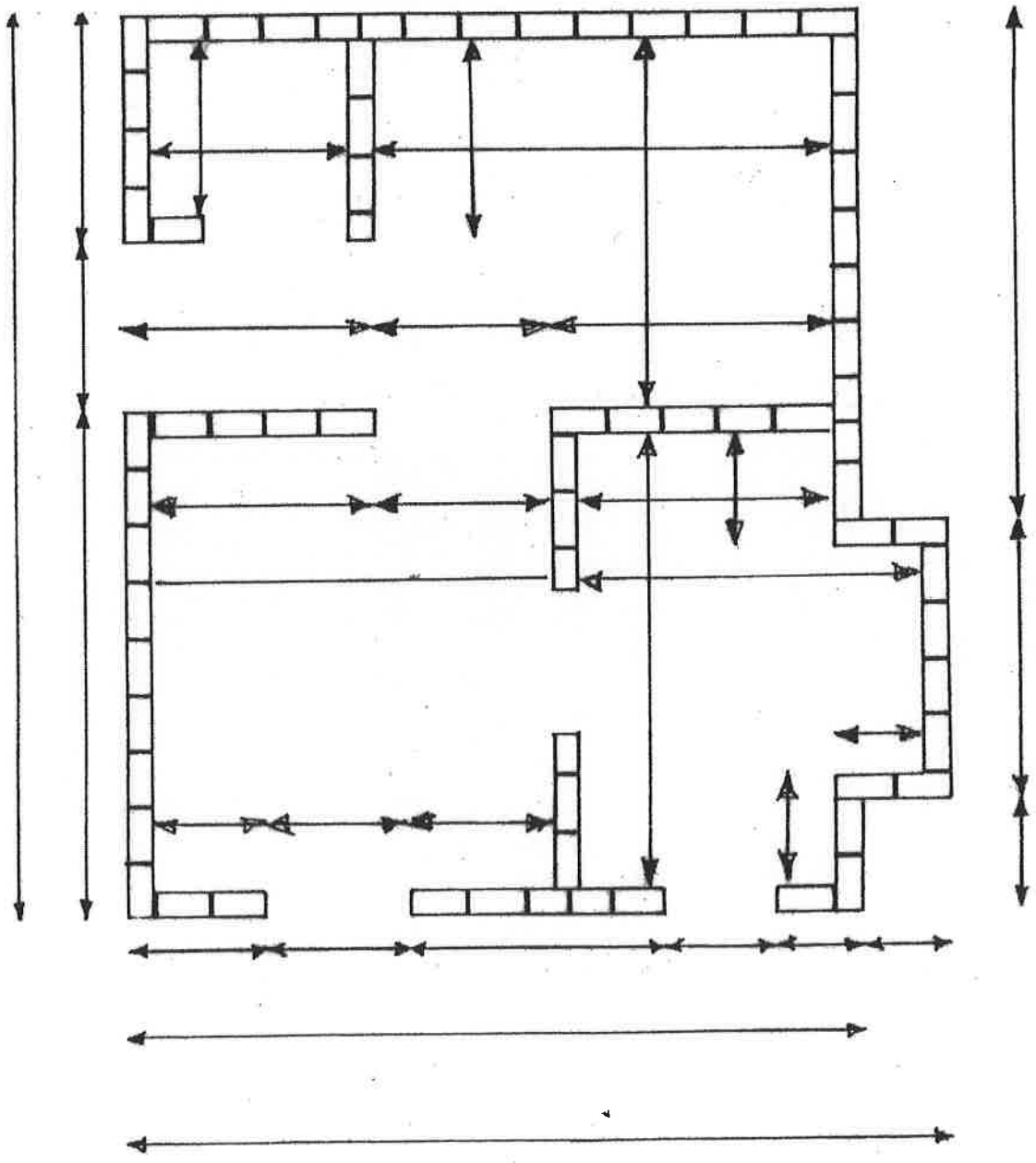
Number of bricks	I shape	L shape	U shape
20.5	634	635.5	637
21	649.5	651	652.5
21.5	665	666.5	668
22	680.5	682	683.5
22.5	696	697.5	699
23	711.5	713	714.5
23.5	727	728.5	730
24	742.5	744	745.5
24.5	758	759.5	761
25	773.5	775	776.5
25.5	789	790.5	792
26	804.5	806	807.5
26.5	820	821.5	823
27	835.5	837	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

MODULAR COORDINATION EXERCISE

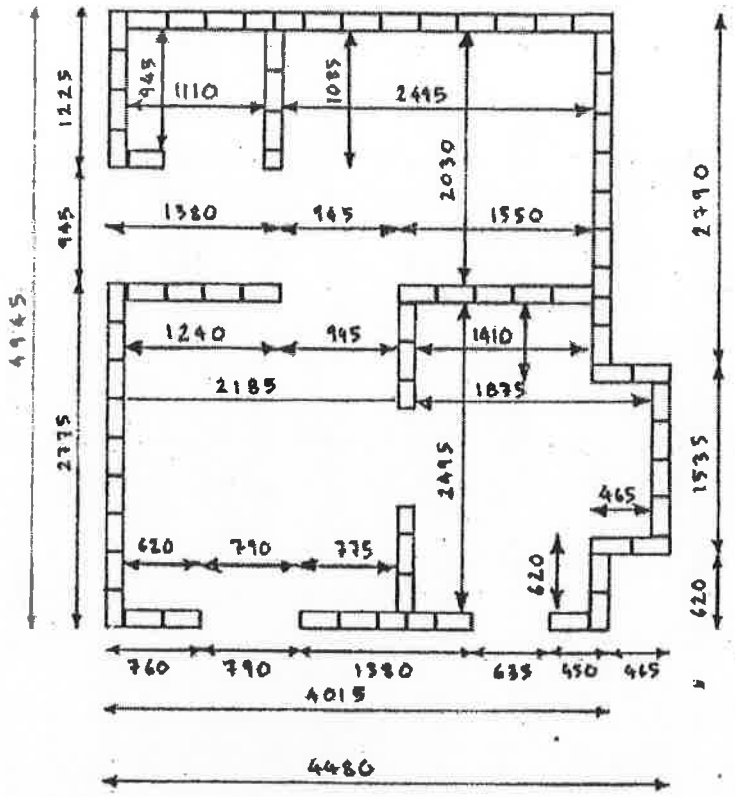
Objective: To understand better the relationship between the dimensions of the bricks, that of the walls and the advantage of modular coordination before starting construction.

Method

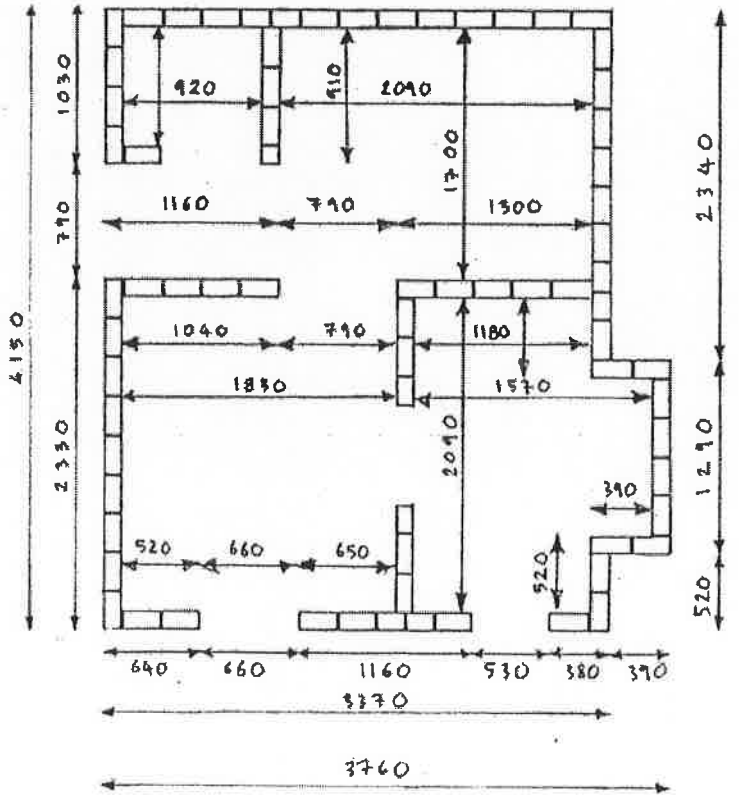
- Mark the dimensions on the drawing with 5 mm accuracy, knowing that Compressed earth bricks are 295 x 140 x 90 with mortar joints of 15 mm and that the Fired Clay Bricks are 250 x 120 x 60 with mortar joints of 10 mm.
- The drawing should be corrected if need be according to the brick sizes.
- Use the table given earlier to work out dimensions



Solution for Compressed Earth Bricks (295 x 140 x 90)



Solution for Fired Clay Bricks (250 x 120 x 60)



ESTIMATION OF QUANTITIES

IMPORTANCE OF ESTIMATING QUANTITIES:

We are not dealing here with cost estimation. The costs of material vary too greatly to allow this to be accurate.

Estimation of quantities allows a first estimation of the quantities of material required for the building.

Estimation of quantities allows:

- Better cost estimation. Therefore better estimation of profits and less risk of losing money.
- Delivery planning, preventing shortage of material on site and delay.

WHAT IS TO BE ESTIMATED:

Everything that is used as building material is to be estimated. Every component of every element of the building is to be detailed. Here we will only deal with masonry materials.

- Bricks
- Mortar (its components: cement, soil, sand)
- Iron (if used for reinforcement)
- Concrete blocks and stones (if used for foundations)

WASTE: This will depend on the quality of the bricks, and on the care of the bricklayers, on handling and transport. As a starting principal:

- For bricks and blocks: 15% wastage
- For mortar: 30% wastage

HOW TO ESTIMATE QUANTITIES:

There are various **rules of thumb** that may not be the most accurate, but that have come from site experience and can be very useful.

EXAMPLE:

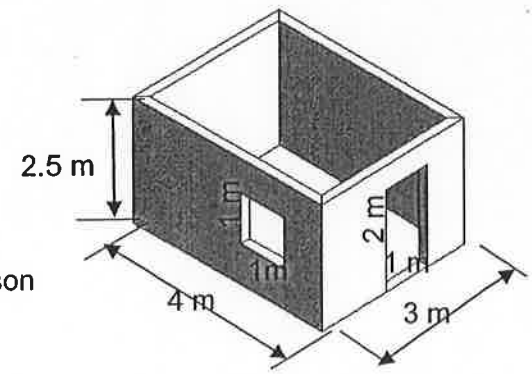
Area of walls: (4+3+4+3) x 2.5 = 35 m^2
Area of openings: 1x1 + 1x2= 3 m^2
Area of brickwork: Walls – openings = 35 – 3 = 32 m^2
With the area of a brick we can calculate the total number of bricks
Add 10% wastage
We have the total number of bricks

Another method

Bricks in one course **x** number of courses
The wastage is considered equal to that of the window areas
We have the total number of bricks

For mortar quantities

90 bricks need one bag of cement.
Hence number of bags
We know the mortar mix, we can work out the sand requirements
One mason + helper can lay 200 bricks a day, hence number of mason days



Various rules of thumb based on actual site experience exist. They serve as reliable starting tools but do not replace accurate quantity estimations based on correct, detailed architectural drawings. Quantities play a very important role in construction. They should be calculated properly before starting work.

Useful Websites and Ressources

International Centre for Earth Construction (CRATerre-EAG)
School of Architecture of Grenoble
www.craterre.archi.fr

Building Advisory Service and Information Network (basin)
www.gtz.de/basin

Brick Development Association (BDA)
www.brick.org.uk

Brick Industry Association (BIA)
www.brickinfo.org

Fondation Belge de la Brique (FBB)
www.brique.be

FFTB (Fédération Française des Tuiles et Briques)
www.fftb.org

FCB Bibliography

This bibliography is not intended to be exhaustive, but rather is a listing of some interesting and useful books.

Beall, Christine. Masonry Design and Detailing for Architects, Engineers and Contractors. 4th ed. McGraw-Hill, New York, USA, 1997.

Günter Pfeifer, Rolf Ramcke, Joachim Achtziger, Konrad Zilch. Masonry Construction Manual. DETAIL Bauten + Produkte, München, Germany, 2001.

Lawrence, S. Detailing of Clay Masonry Walls. Clay Brick and Paver Institute, Baulkham Hills, Australia 2000.

Lynch, G. Brickwork: History, Technology and Practice. Vol 1 & 2, Donhead, Wimbledon, UK, 1994.

Parry J.P.M. Brickmaking in Developing Countries. Building Research Establishment, Garston, UK, 1979.

Peter Cartwright. Bricklaying. McGraw-Hill, New York, USA, 2002.

Plumridge, A., Meulankamp, W. Brickwork, Architecture and Design. Seven Dials, London, 2000.

vars. Bricks and Mortars – Overseas Building Notes No. 173. Building Research Establishment, Garston, UK, 1977.

CEB Promotional material

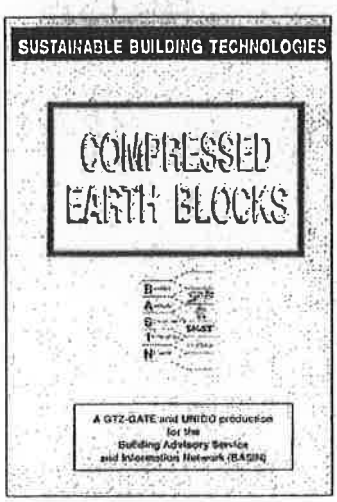
The following material has been specially prepared to promote compressed earth block technology amongst all who are involved in the building sector: governments, clients, national standards bodies, chambers of commerce, funders, technical endorsement companies, insurers, scientific and technical centres, laboratories, architectural and engineering practices, commercial enterprises, etc. It enables the impressive performances of the contemporary technology to be visualised in an eye-catching way.

EXHIBITION

Building with compressed earth blocks
CRATerre-EAG: Rigassi, V.
CDI, Brussels, Belgium, 1995.
110 x 75 cm. Colour, 23 panels.

This exhibition's large, exceptionally fine colour photographs and its concise, precise texts cover all aspects of the technology and give a spectacular demonstration of the contemporary performances of this material. It has already been shown on the occasion of industrial working seminars and international meetings in such cities as Lusaka, Libreville, Yaoundé, Brussels, Frankfurt, Grenoble, Bordeaux, etc.

The touring of the exhibition is organised by the CDE and CRATerre-EAG.



VIDEO

Compressed earth blocks
CRATerre-EAG, GTZ-GATE, UNIDO, DesignWrite Productions.
CRATerre-EAG, Grenoble, France, 1994.
VHS-PAL, 24 min, colour.

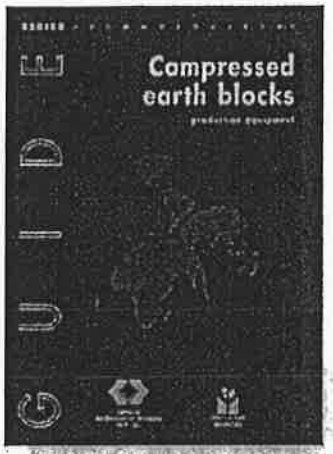
This video gives an overview of compressed earth block technology. After first placing earth once more in the historical context of architecture, this documentary shows uses of CEBs which are suited to modern building requirements, a range of different production machines, and examples of the current use of compressed earth blocks in various parts of the world.

Distributed by CRATerre-EAG/BASIN.

CEB Technical documents

The following documents have been specially prepared so that together they form a coherent ensemble, enabling all the main stages of compressed earth block production, design and construction to be thoroughly understood.

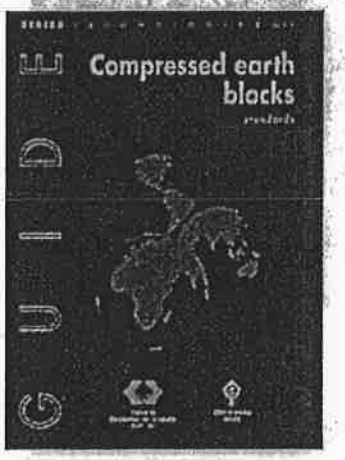
EQUIPMENT



Compressed earth blocks : production equipement
CDI Guide, "Technologies series" N°5
CRATerre: Houben H., Rigassi V., Garnier P.
CDI, Brussels, Belgium, 1996
210 x 297 mm, 149 pages, graph., ill., tab., bibl.
ISBN 2-906901-13-X

This guide, published by the CDI in its "Technologies series", is now in its third edition. It presents a complete and detailed inventory of compressed earth block production equipment manufactured and marketed in ACP and EU countries. It also contains selection criteria as well as technico-economic factors. The guide is an irreplaceable aid to decision-making on investment.
Distributed by the CDE and CRATerre-EAG.

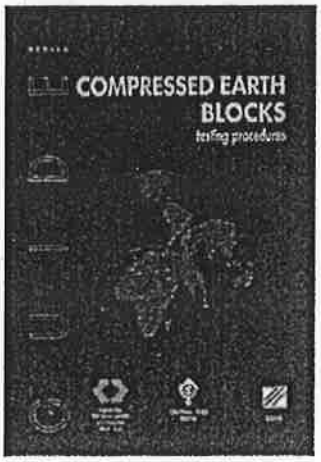
STANDARDS



Compressed earth blocks: Standards
CDI Guides, "Technologies series" N° 11
CRATerre-EAG: Houben H., CDI: Boubekeur S.
CRATerre-EAG, Brussels / Villefontaine, Belgium / France, 1998.
210 x 297 mm, 142 pages, graph., ill., tab., bibl.
ISBN 2-906901-19-9

This guide puts forward a body of standards ratified as African Regional Standards which should henceforth enable planners to accept proposals from contractors and builders for the utilisation of compressed earth blocks.
The guide is also intended to be helpful in drawing up National Standards for compressed earth blocks.
Distributed by CDE and CRATerre-EAG.

TESTING PROCEDURES



Compressed earth blocks: Testing procedures
CDE Guides, "Technologies series" N° 16
ENTPE: Mesbah A., Morel J.C. - CRATerre-EAG: Houben H., Rigassi V.
CDE, ENTPE, CRATerre-EAG, Villefontaine, France, 2000.
210 x 297 mm, 121 pages, graph., ill., tab., bibl.
ISBN 2-906901-28-8

This guide is intended for all those who need to fully understand and assess product quality, whether they are responsible for producing, prescribing or using CEBs. The procedures described are applicable both by laboratories and by SME/SMIs, notably in introducing a quality or certification system. These procedures will facilitate exchanges between producers, laboratories, or technical centres, clients and contractors, and will enable them to guarantee the quality of their work to their end-users.
Distributed by CRATerre-EAG.

PRODUCTION

Compressed earth blocks. Vol.1 : manual of production
CRATerre-EAG : Rigassi V.
Aus der Arbeit von GATE, Friedrich Vieweg & Sohn, Braunschweig/Wiesbaden, Germany, 1995.
210 x 297 mm, 104 pages, graph., ill., tab., bibl.
ISBN 3-528-02079-2

This manual provides decision-makers, designers, brick manufacturers and building entrepreneurs with the information they need on compressed earth block production. It is designed to enable an overall understanding of a production unit, as an aid to financial planning, and to help with the technical mastery of all stages of production.

Distributed by CRATerre-EAG/BASIN.

DESIGN AND CONSTRUCTION

Compressed earth blocks . Vol. 2 : manual of design and construction
CRATerre-EAG : Guillaud H., Joffroy Th., Odul P.
Aus der Arbeit von GATE, Friedrich Vieweg & Sohn, Braunschweig/Wiesbaden, Germany, 1995.
210 x 297 mm, 148 pages, graph., ill., tab., bibl.
ISBN 3-528-02079-6

This manual covers all theoretical and practical aspects of design and construction. A large part of the document is devoted to practical, finished examples. It provides answers to all the factual questions which field practitioners ask themselves, be they land use planners, architects, engineers, entrepreneurs or builders.

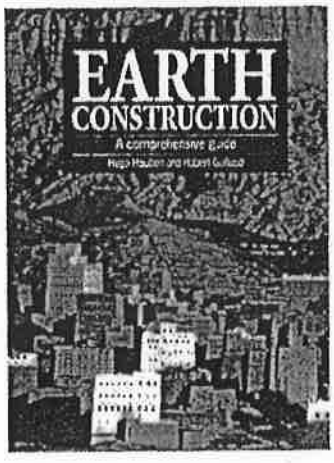
Distributed by CRATerre-EAG/BASIN.

BASIC INFORMATION

The basics of compressed earth blocks
CRATerre: d'Ornano S.
Aus der Arbeit von GATE, GTZ, Eschborn, Germany, 1991.
210 x 297 mm, 28 pages, ill.

This booklet lists advantages and constraints, briefly describes the production process and gives indications on the general approach operators wishing to launch an activity in the field of compressed earth blocks should follow; it also addresses some basic economic aspects.

Distributed by CRATerre-EAG/BASIN.



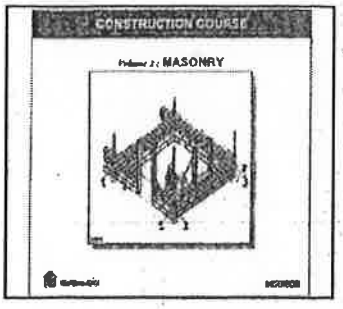
SCIENCE AND TECHNOLOGY

Earth construction: a comprehensive guide
CRATerre-EAG: Houben H. and Guillaud H.
IT Publications, London, United Kingdom, 1994
175 x 250 mm, 372 pages, graph., ill., tab., bibl.
ISBN 1-85339193-X

In the nature of an encyclopaedia, this book covers all aspects of contemporary earth construction technology. Each chapter summarises the most recent work on the subject. An indispensable aid for technicians, engineers and architects interested in or working in the field of earth construction.

Distributed by bookstores, ITDG Publishing and CRATerre-EAG.

CD-ROM



Construction Course. Vol. 2 - Masonry
Douline A., Carazas-Aedo W., Dugelay S., Moriset S., Ochoa Mendoza E., Rodriguez J., Sekhsaria P.
CRATerre-EAG, Villefontaine, France - MISEREOR, Aachen, Germany, 2003
CD-Rom, 92 technical sheets, 54 posters

This pedagogical material is the result of 10 years collaboration between Misereor, CRATerre-EAG and Technical Training center in Africa. Together, they acquired expe-rience in the knowledge transfer which allows:
- to introduce training of building systems based on the study of local know-how, into the existing programmes;
- to apply, directly on construction site, an active pedagogy, largely illustrated.

Distributed by the MISEREOR and CRATerre-EAG.

This *Technical Guide on Site Construction Skills for Bricklayers of Fired Clay and Compressed Earth Bricks* is part of the CDE sector strategy and programme for building materials in Western Africa (ECOWAS) and Cameroon.

This *Technical Guide* focus on the construction needs of the ACP countries, particularly to the requirements for provision of low-cost housing, energy-efficient housing at economic prices, bearing in mind the climatic conditions prevailing in particular countries, which influence housing design.

The objectives of the *Technical Guide* are:

- to provide ACP bricklayers with direct exposure to EU best-practice in the skills of bricklaying and site preparation for construction of brick houses to enhance their skills for the benefit of both their companies and the brick sector as a whole.

- to strengthen the capacity and technological know-how of the ACP vocational schools by assisting them in the training of best practice in bricklaying during building projects.

- to encourage the dissemination of the "best-practice" bricklaying and site preparation skills among individual bricklayers, companies and sector institutions.

Many technical documents and books on FCB and CEB have already been published so far, but very few cover masonry work in a comprehensive and appropriate way for masons and other "field workers". The idea is not to develop a "new" guide but rather to make available to this target group a useful document that could be at the same time a handbook and a teaching aid. That is the reason why this *Technical Guide* contains a large number of illustrations and graphics that can be immediately understood by artisans, masons and entrepreneurs and help to achieve better quality in masonry work. This document will also be useful to anybody who is interested in improving his masonry knowledge and skills.