BUILDING MANUAL

FOR SELF-HELP BASIC EDUCATION PROJECTS BY COMMUNITIES IN NIGERIA

A GUIDANCE BUILDING MANUAL

FOR

SELF-HELP BASIC EDUCATION PROJECTS

IN

NIGERIA

A PUBLICATION OF THE DEPARTMENT OF PLANNING, RESEARCH AND STATISTICS, UNIVERSAL BASIC EDUCATION, IBB CLOSE, WUSE IV, ABUJA. NIGERIA

2004

Published by:

UNIVERSAL BASIC EDUCATION
IBB CLOSE, WUSE IV,
ABUJA, NIGERIA

Prepared by:

Technical team
ARC. MOLKAT MUTFWANG **B.Sc, M.Sc.mnia, aniob, aarches**
ARC GODWIN GBE **Bsc, Msc Mnia**
ARC. ADAMU TEIBE SHAMAKI **Bsc, Msc (ARC), GMNIA**
EGNR. SAAD SADIQ **B.ENG, GMNSE, MNISE**
ENGR. ABDULMUMIN TANKO KOFA **B.ENG., Msc, MNSE**
MR.PETER NICHOLAS BUBA **Bsc(Q/S), ANIQS,RQS, FICEN**
MR CHUDI IKEDIONWU **Bsc(Q/S) ,M.Sc, ANIQS, ANIOB**
ARC. BULUS DRAMBI KWADA **Bsc, M.Sc, Mnia, MBA, MIAD**
ARC. RICHARD BAMIDELE IBIOLOLA **OND, Bsc, G/MNIA**
EMMANUEL HOSEA DADIREP **Esq. B.A. (Hons), PGDM,MBA,LLB(Hons), MNIM**

Graphic Artist
EMMANUEL HOSEA DADIREP **Esq. B.A. (Hons), PGDM,MBA,LLB(Hons), MNIM**

Review Team
Mal. MUHAMMAD BELLO. M
MR.BON CHUKE
DR.T.ADEKOLA
ARC EZEKIEL SHEYIN **Bsc, Msc (ARC), GMNIA**
EMMANUEL HOSEA DADIREP **Esq. B.A. (Hons), PGDM,MBA,LLB(Hons), MNIM**

Consultant
ARC JOHN JORDAN **RIBA, MI Mgt**

General Editor
ARC. MOLKAT MUTFWANG **B.Sc, M.Sc.mnia, aniob, aarches**

Production
MR GARBA KWANDI. **HND (COMP.), MNCS**

Supervision
PROF. GIDADO TAHIR, **(NATIONAL COORDINATOR, UBE)**
DR ANDREW EKPUNOBI **(DIRECTOR, PRS, UBE)**
MAL. BELLO KAGARA. **(WORLD BANK PROJECT COORDINATOR, UBE)**

The Universal Basic Education fully acknowledges the fact that this document is based on a similar document produced by the Microprojects Unit, National Commission for Development Planning, Federal Republic of Zambia in 1994.

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Introduction

- **What this book is for**
- **How to use it**
- **Essentials for good building**

WHAT THIS BOOK IS FOR

The Project Implementation Manual is in one volume. It should help you understand and answer many of the technical questions you may have during your project.

Building does not have to be a mystery. It is not difficult to understand the theory of building – to know what is important and why.

However, the information in this Manual is mainly A GUIDE.

It will not make you building experts. Building is highly skilled job that takes years of practice to get right.

You have a qualified Supervisor, and experienced Foreman and skilled labourers working on your project. They are your experts.

HOW TO USE THIS BOOK

Each chapter deals with one stage of construction, from clearing the site, to painting the finished building. It also includes chapters on rehabilitation, roads, wells and VIP's.

Use this book to:

- ***help you understand what the builders are doing and why.***
- ***check for yourselves that the builders are doing things right.***
- ***ask the builders and Supervisor questions about what they are doing, so that you are going to make sure things are done right.***

Some skilled labourers may be building in a certain way simply because they have not been told there are better ways. Watch what they are doing. Compare it to what is in this book. Discuss the different methods with your Building Supervisor and skilled labourers.

ESSENTIALS FOR GOOD BUILDING

There are 7 things that you definitely need if your construction is going to be successful.

1. **Committee:** The Committee is there to manage the project. You should have at least one person with technical knowledge who can judge how well things are going. If you use this book properly, most of the committee members should be able to understand what is going on.

2. **Supervisor:** Your must have one. He must be qualified and experienced and he must visit your site regularly, if he is not resident.

3. **Plans:** You must have a full set of plans for all your buildings and make sure they are followed closely.

4. **Money:** You must manage your finances so that you always have money available to buy materials and pay your labour, or you will need more money with every delay.

5. **Materials:** Your materials must be good quality and be at the site when they are needed. They must be stored properly and securely.

6. **Labour:** The labour you employ must be highly skilled and enthusiastic.

7. **Time:** You must meet the time schedules specified by the Planning committee.

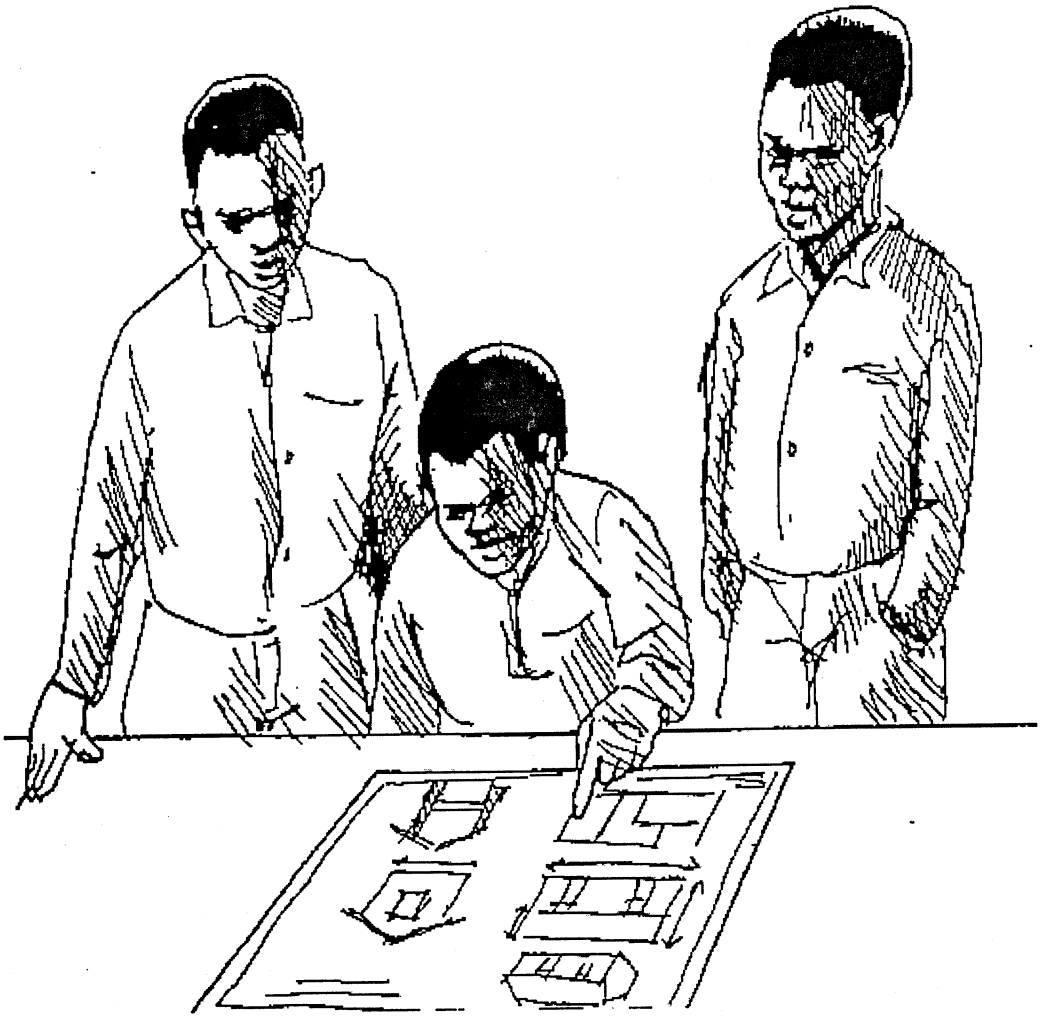
Above all else, PAY ATTENTION TO DETAILS and your building will last a long time. There are often alternative ways of doing things. If you read this manual carefully you will be able to discuss these alternatives with your supervisor and choose the methods most appropriate for your project.

2

Project Planning

2.1 The purpose of plans

2.2 Using Plans



INTRODUCTION

The building plans should contain all the information you need to construct each building – measurements, construction notes and special materials .

Take time to understand these plans. Ask your Supervisor to help you. It is the only way to check what the builders are doing.

HOW THE BUILDING IS DRAWN

Building plans are drawn in a special way, giving as much information as possible in a limited space.

Each drawing on a plan has a different name. The main ones are:

1) **The FRONT ELEVATION**
   What you would see if you looked straight at the front of the building. There might also be a BACK (or REAR) ELEVATION.

2) **The SIDE ELEVATION**
   What you would see if you looked straight at the side of the building. There might be a LEFT SIDE ELEVATION and a RIGHT SIDE ELEVATION.

3) **The ROOF PLAN**
   What you would see if you looked down from the sky, directly on top of the building. It is often drawn without the roof sheets shown.

4) **The FLOOR PLAN**
   Looking down from the sky on top of the building BEFORE the roof is fitted.

5) **The FOUNDATION PLAN**
   Looking down from the sky on top of the building BEFORE the slab is laid.

1) SECTIONS

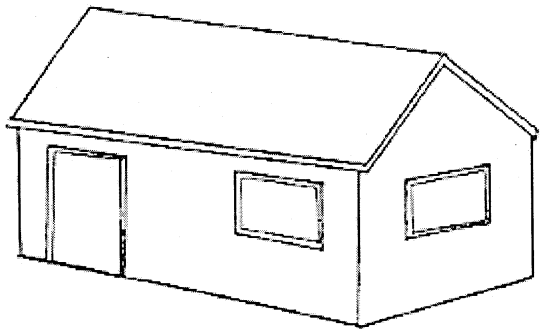
Imagine that you have cut the building in two. The section is what you would see if you looked straight at one cut piece. There may be several sections.

2) DETAILS

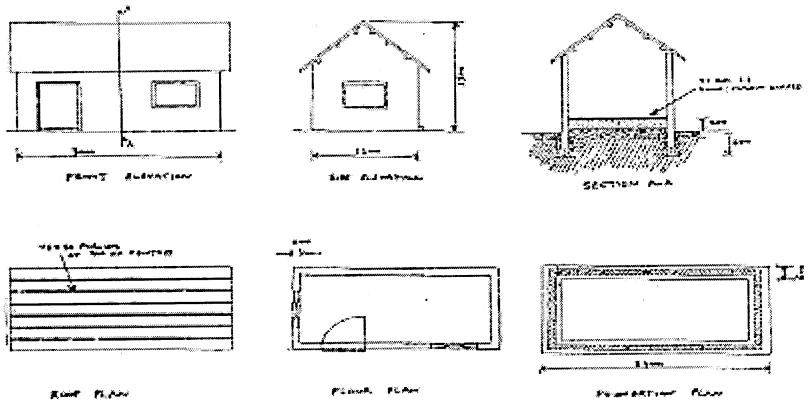
These are small areas of the building and are drawn larger to give more information about how they are constructed.

EXAMPLE

Looking at this building.



A simplified plan for this building is shown below. A proper plan would include much more information, but try to understand this one first. Then compare it to the plans sent you for your buildings.



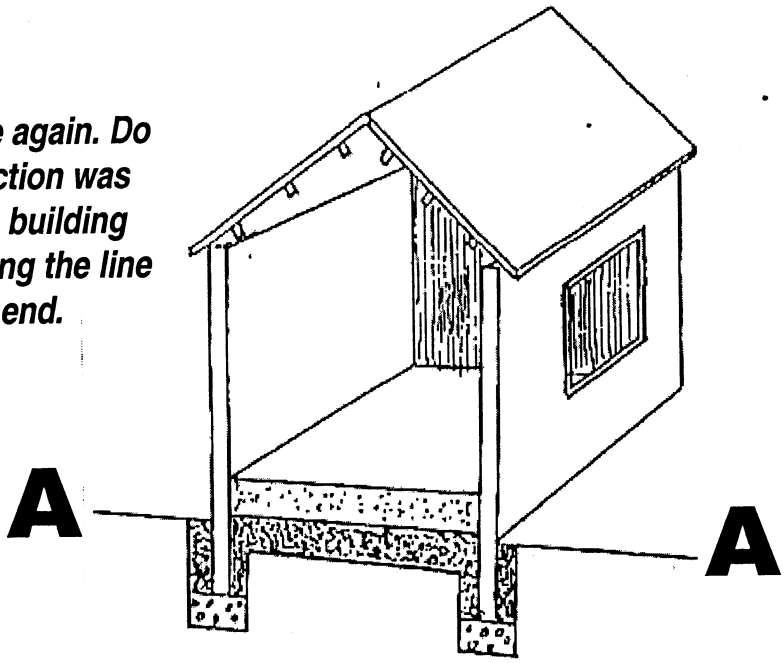
Can you see that the measurements are given on different elevations? It will be the same with your building plans. If you cannot find a measurement on one elevation, look for it on other elevations. Everything should have a measurement somewhere on the plan.

SECTIONS

Sections are necessary to be able to see details of things that would be hidden in the other views.

There may be several sections on your plans. Each section will have its own name such as section AA Section BB and so on. Look for a line in one of the elevations that has an "A" at each end. This is where section AA came from.

Look at the example again. Do you see how the section was drawn? Imagine the building being cut in two along the line with an "A" at each end.



Do you see how this looks like the view called Section AA? If not, get the Supervisor to help you.

Do you see why the section is important? Without it you would not know how deep the foundations are, or be able to see details of the floor. The section gives us information that no other elevation can.

HOW YOU SHOULD USE PLANS

Your building Supervisor and Foreman will be using the plans all the time to construct the building properly. You should use the plans to check :-

1). **SHAPE** : Is the building going to be the right shape ?

2) **SIZE** : are all the dimensions are on the plans.

3) **MATERIALS** : the plans will often say what type of materials should be used.

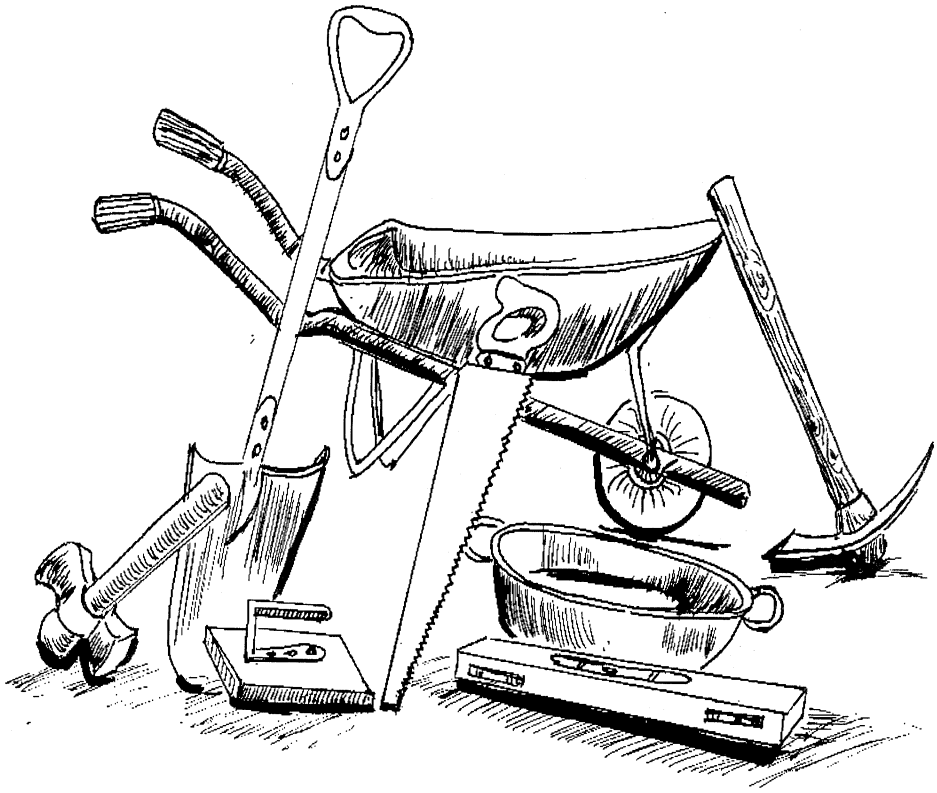
4) **METHODS** : the plans also give written notes on construction of certain things.

The plans will include technical terms. Look up the Glossary to find out what these terms mean.

3

Getting Started

3.1 Tools
3.2 Water
3.3 Storage of Materials
3.4 Access road to site
3.5 Site Clearance
3.6 Sourcing of Material / Transportation
3.7 Sourcing of labour



3.1 Tools

Importance of tools :
Tools you will need :
Care of tools :

- It is very difficult to produce good quality work using bad tools.

- The main tools that will assist in improving quality and efficiency includes:-

❖ ***ACCURACY TOOLS***

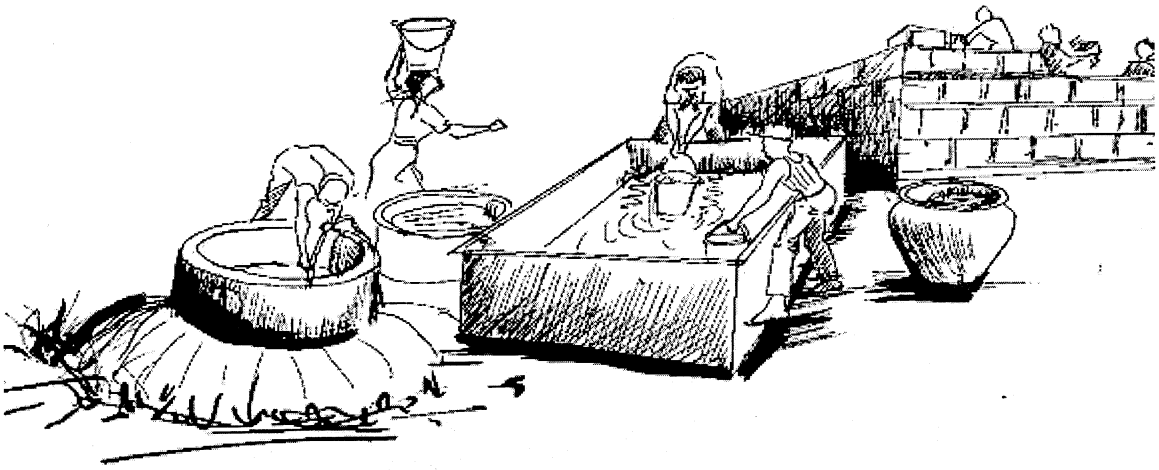
- Spirit levels
- Measuring
- Building lines
- Building Square

❖ ***EFFICIENCY TOOLS***

- Trowels
- Head pans
- Wheel barrows
- Shovels with metal handles
- Buckets
- Pegs
- Hammer
- Large and Small wood Saw

3.2 Water

Builders require a constant supply of clean water at every stage of the building.



- Make water reservoir and keep it full.
- Acceptable sources of clean water include pipe-borne water, well water, running stream water & rain water
- Dirty water weakens your building materials. Do not use dirty water for the works.

3.3 Storage of Materials

- A temporary shade should be constructed for the storage of materials such as cement, tools etc.
- A nearby house could be used for storage of materials for security or cost reduction.
- Materials need a cool and dry storage

3.4 Access Road to site

- Provide appropriate access to site for easy movement of people and materials.

3.5 Site Clearance

- Before Construction, the building site must be cleared

- **Cut down long grass, remove large stones.**

- **If you have to cut down any trees (only trees that interfere) stump out completely or they may cause problem in the future.**

3.6 Sourcing of Materials & Transporation

- Identify the sources of the materials you will require.
- Bulk purchases are encouraged because they are easier & cheaper
- Locally available materials should be given priority.

3.7 Sourcing for Labour

- Identify sources of labour required.
- Locally available labour should be given priority in engagement.
- If not locally available, skilled labour must be sourced from nearby locations.

RECOMMENDATION

- ***Skilled labour should never be compromised, especially if not locally available.***
- ***The procurement of key materials locally, in bulk with good storage will ensure some cost-savings in the project.***
- ***A good project can hardly be realized using poor tools.***

4

Site Planning

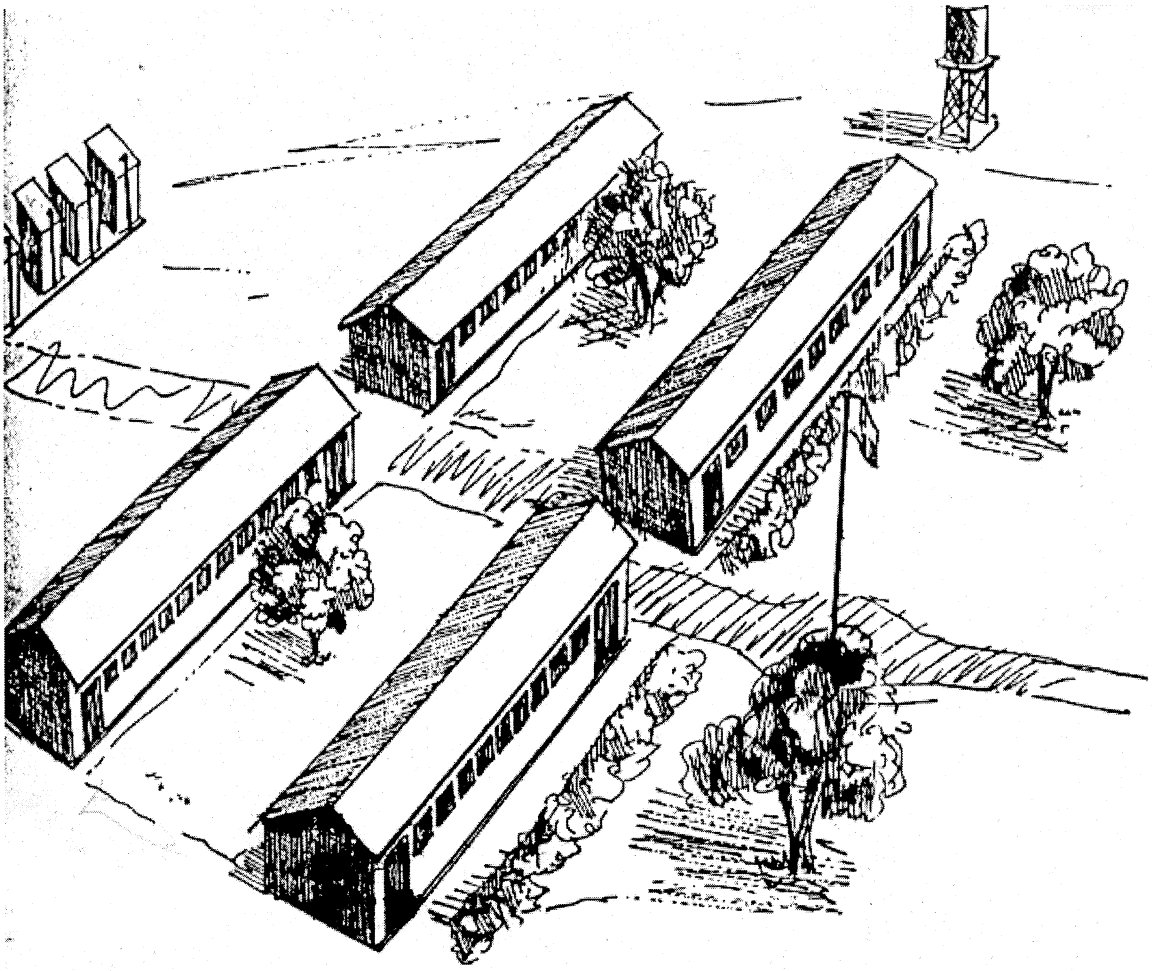
4.1 Selecting the site

4.2 School Concept

4.3 Design Concept

4.4 Preparing the site

Short ends of each block faces the prevalent direction of winds in a well planned school



4.1 Selecting the Site

Look at the following things:

a. **Soil Type -** the soil should be firm. Buildings constructed on loose sand or clay will require stronger, more expensive foundations

- Avoid very rocky soil, or it will be difficult to dig the foundations

b. **Level -** Try to find a level site. It will save work later.

c. **Trees -** Trees provide shade from the sun, shelter from the wind and their roots stop the soil being washed away by the rains. Try to site your buildings so that you do not have to cut down any tree.

Trees such as Eucalyptus demand a lot of water, increase the distance to 1.5 metre times the height of any water-hungry trees. If you do not do this, the trees will take water from the soil under your buildings. This can make the foundation crack.

d. **Other Buildings -** Think about where you site your new buildings in relation to existing ones. The existing buildings can shelter the new one from the winds.

4.2 Orientation

Once you have decided where to put your building, you can decide which direction it should face. Think about the following things:

1. **Wind**

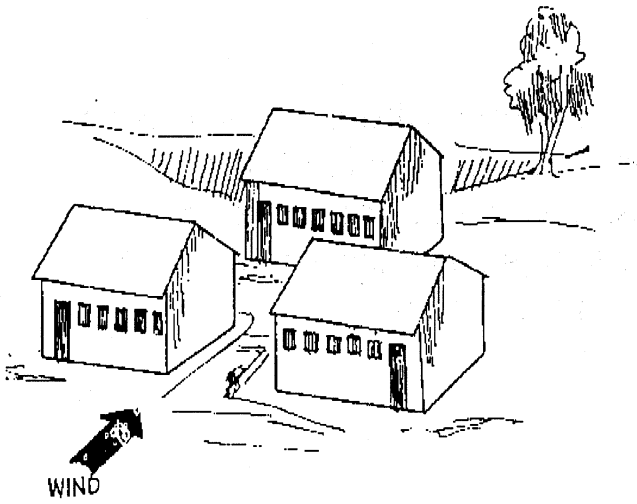
Storm - If the short sides of the building point in the direction of the strongest wind, less wind and dust will blow into the building.

GOOD

Strong wind

BAD

Strong wind



3. Other Buildings -This about the view from your windows. If there are other buildings near by, do you want your house, class-room, etc, to look directly at them or not.

Of course, it will probably not be possible to satisfy all these considerations. Decide which are the most important to you.

4.3 School Concept

- Classrooms & Playgrounds should be located in such a way that LEARNING & PLAYING take place simultaneously, without interference.

4.4 Design Concept

- The recommended space per child in a classroom is 1.4m^2 for Semi Urban & Urban schools and 1.2 m^2 per child in small schools in rural areas

- The recommended shape of a typical Classroom should tend towards being a square.

- The classroom sizes are consequently

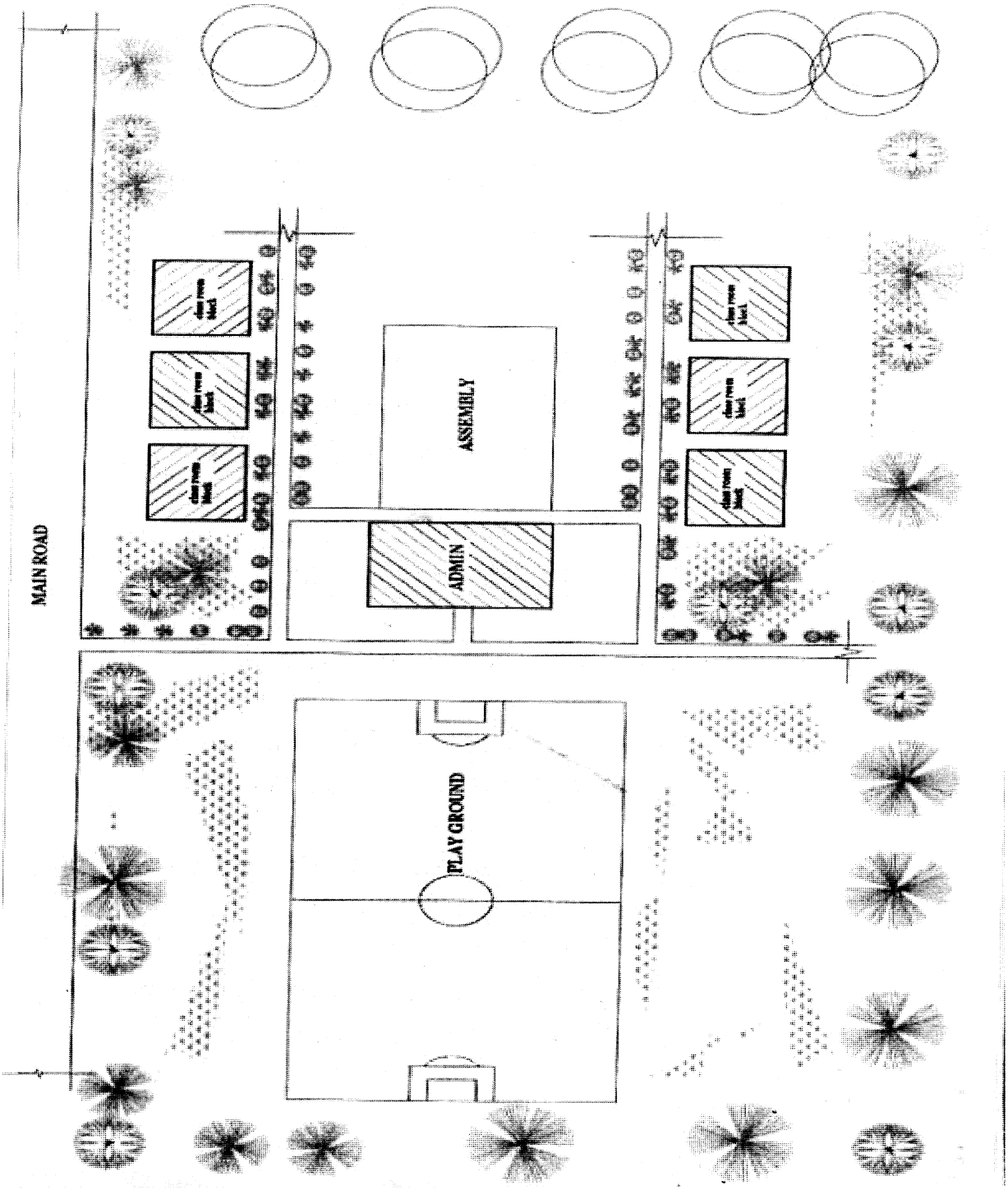
  a) 4.0m x 6.0m i.e 24m^2 for rural schools (@ 20 pupils per classroom)

  b) 6.0m x 7.0 m i.e 42.0m^2 for Semi-Urban Schools (@ 30 pupils per classroom).

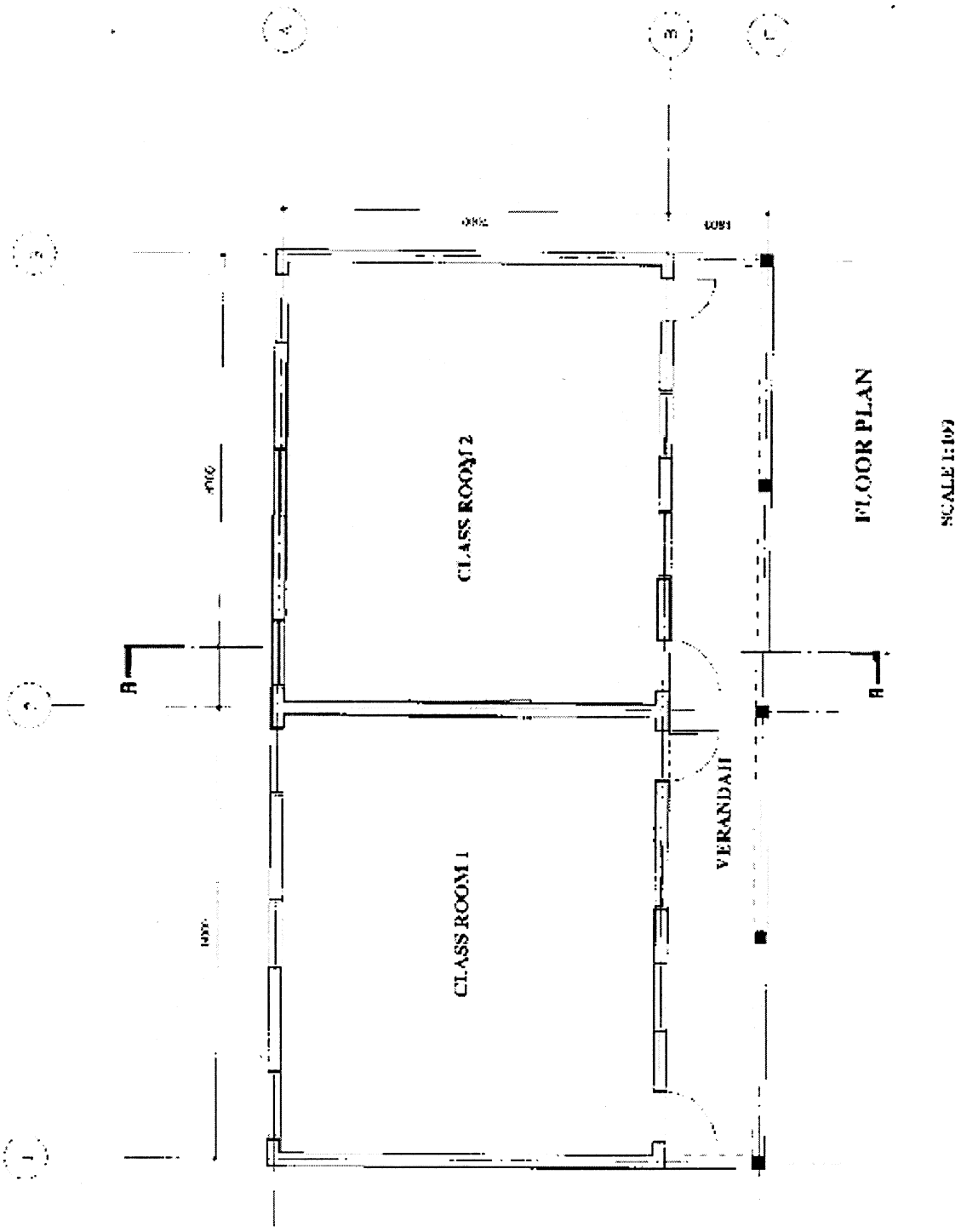
  c) 7.0m x 8.0m ie 56.0m^2 for Urban Schools (@ 40 pupils per classroom)

4.5 Design Examples

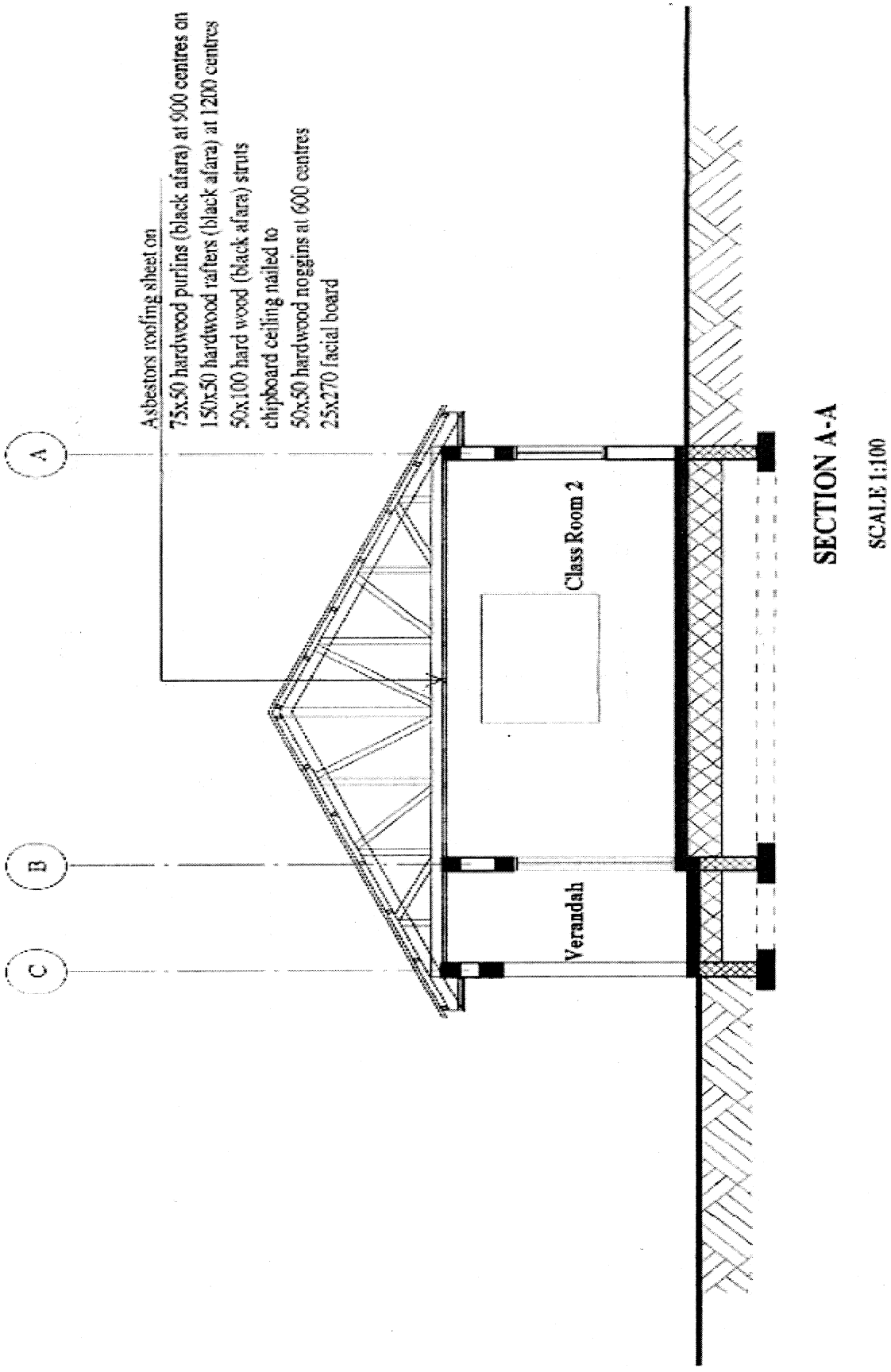
Example – No1.



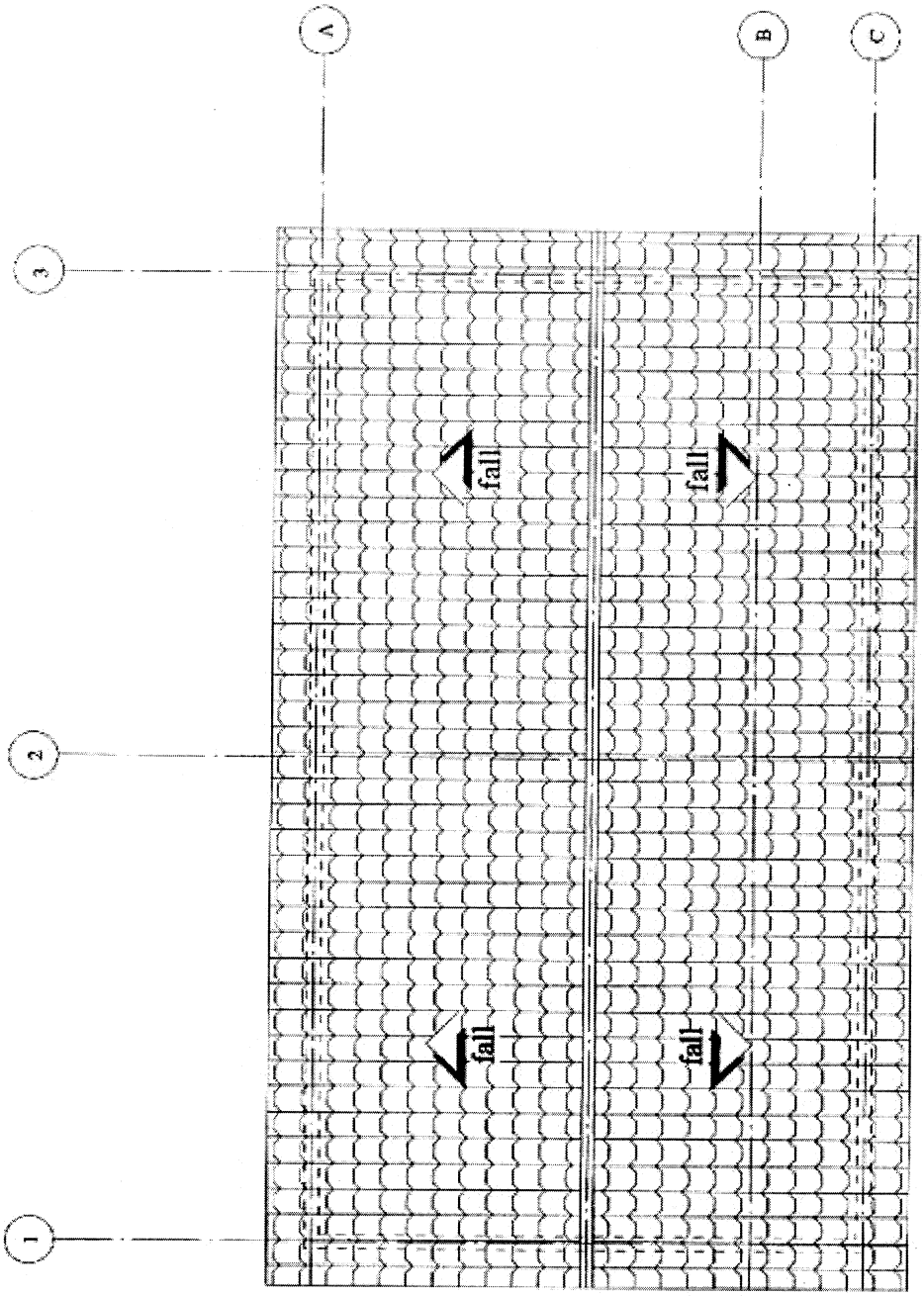
Example – No2.



Example – No3.


A
B
C
Asbestos roofing sheet on
75x50 hardwood purlins (black afara) at 900 centres on
150x50 hardwood rafters (black afara) at 1200 centres
50x100 hard wood (black afara) struts
chipboard ceiling nailed to
50x50 hardwood noggins at 600 centres
25x270 facial board
Class Room 2
Verandah
SECTION A-A
SCALE 1:100

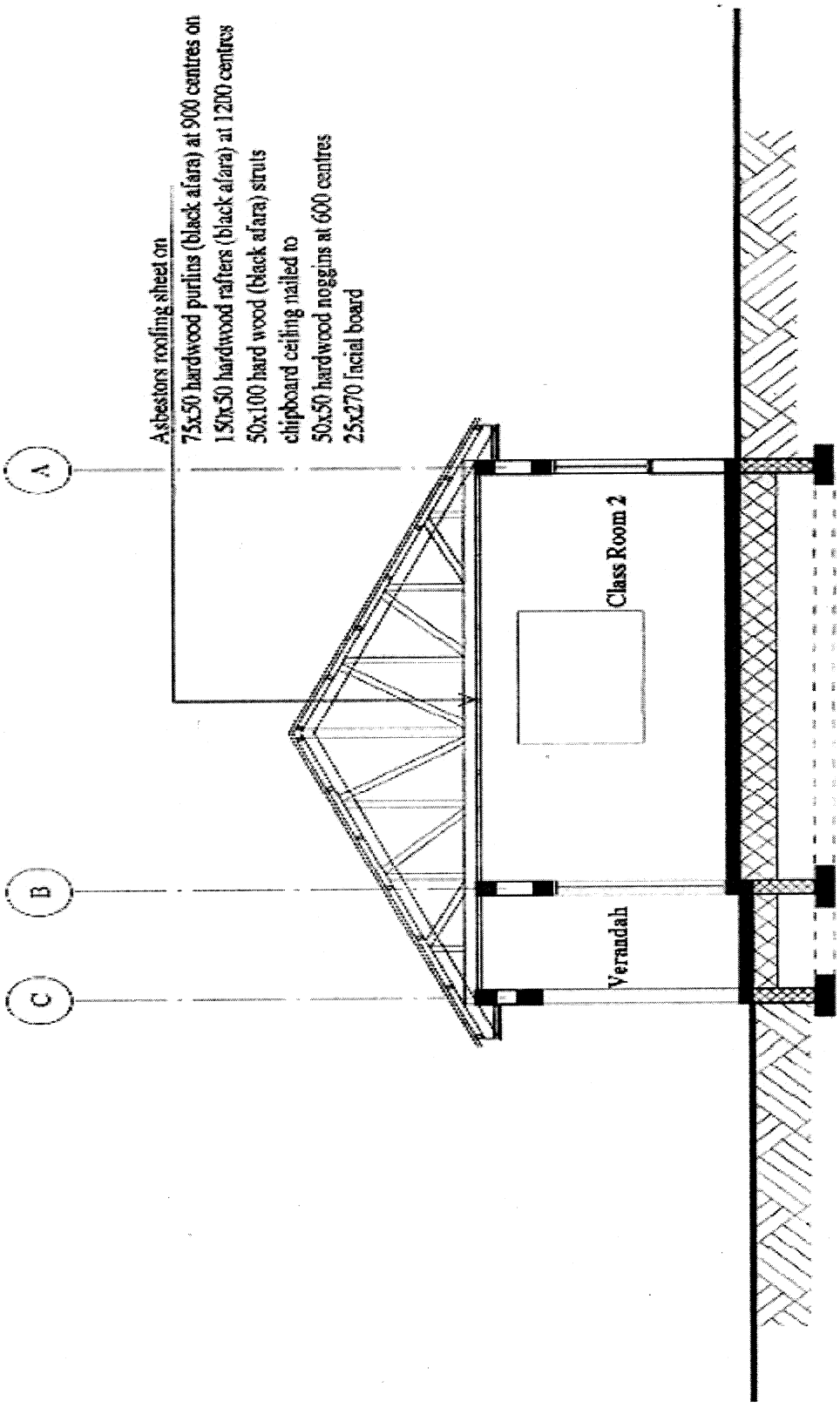
Example – No 4.



ROOF PLAN

SCALE 1:100

Example – No 5.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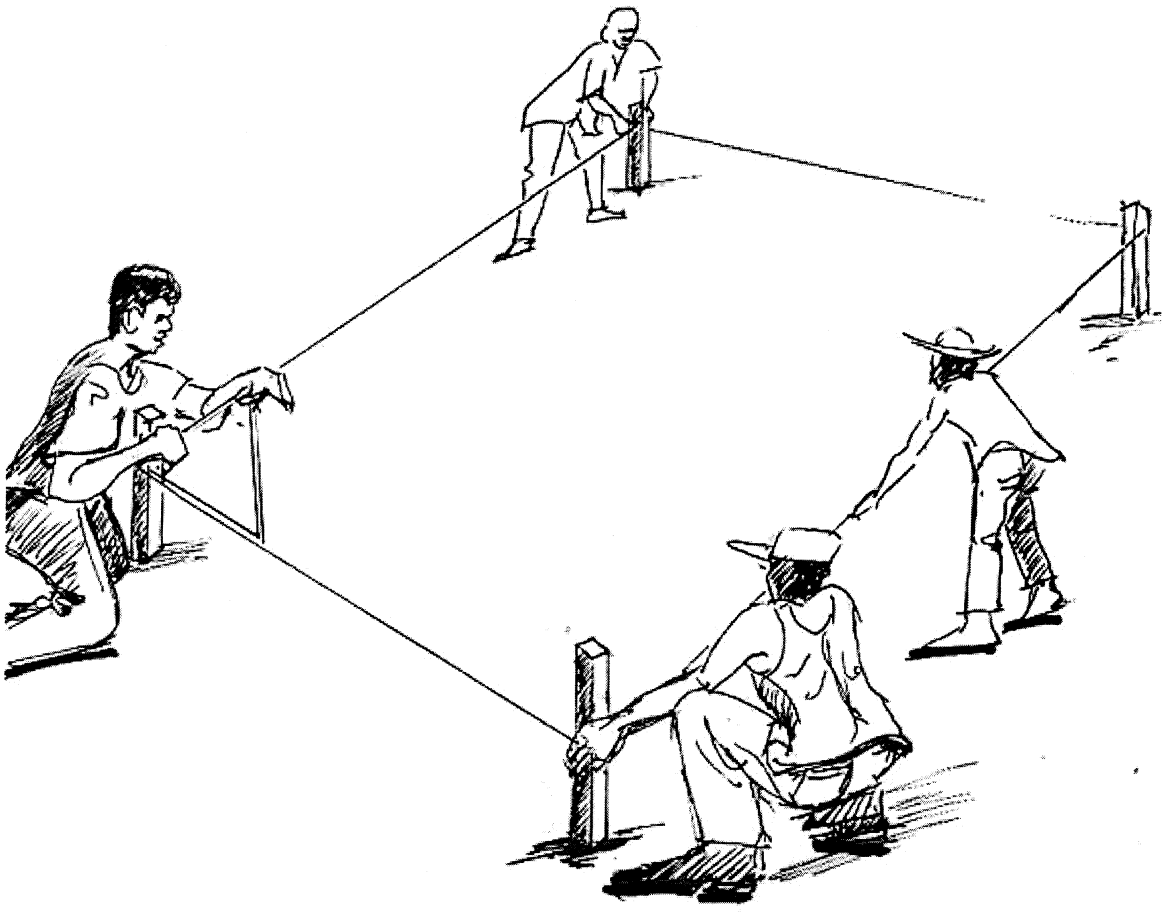
25x270 facial board
A
B
C
Class Room 2
Verandah
SECTION A-A
SCALE 1:100

5

Setting Out

5.1 Meaning and importance of setting out

5.2 How to set your building out accurately

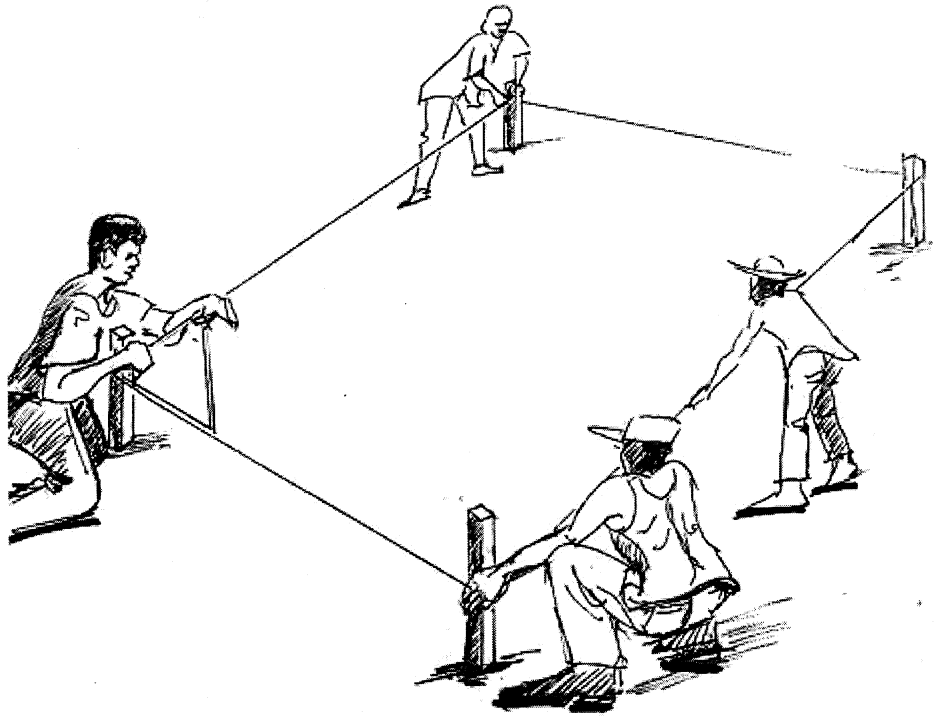


5.1 The Meaning and Importance of Setting Out

- **Setting out** means marking the positions where the foundation trenches for all the walls of the building will be dug.

- Everything else will depend on the setting out being accurate.

- The entire foundation should be set out at one time, rather than over several days to avoid tampering with the initial work



The supervisor should do this job personally, with one or 2 assistants. Always use a proper building line. This will not stretch or break easily.

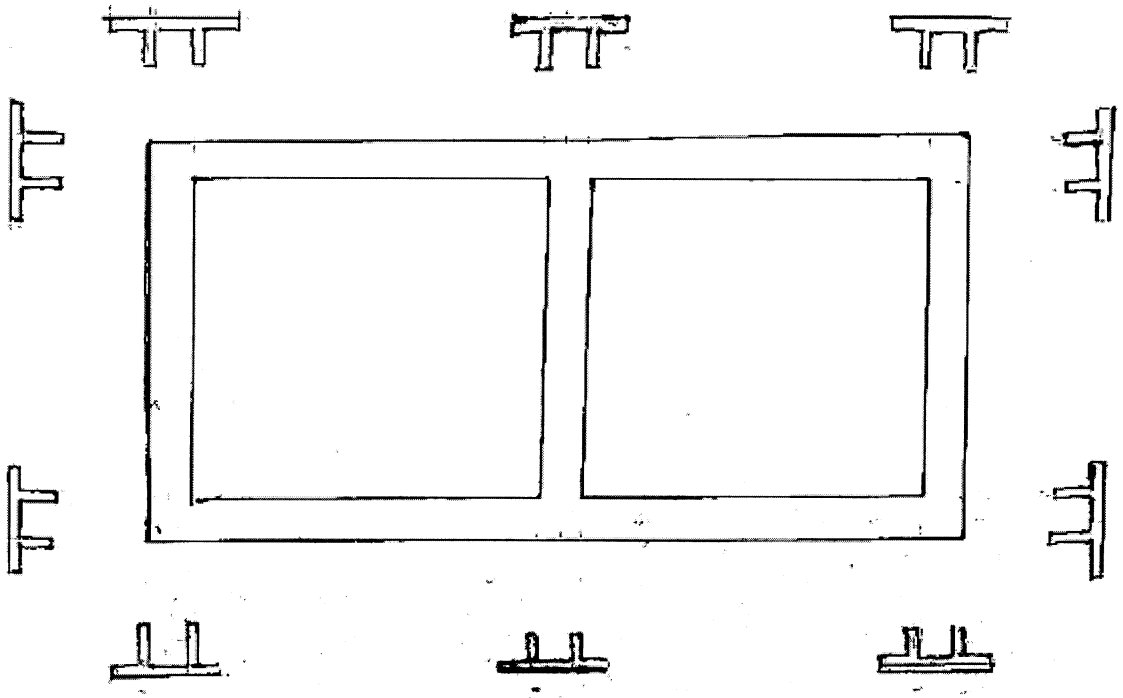
5.2 How to Set your building Out Accurately

a) Preparation

The area to be set out must be completely cleared. Grass should be cut down and any stones or roots removed.

The topsoil should be removed down to a depth of at least 150mm, or until the firm, undisturbed soil is reached.

PROFILE BOARDS should be made in advance. They should be wider than the foundation trench. Look at the illustration.



b) # Accuracy

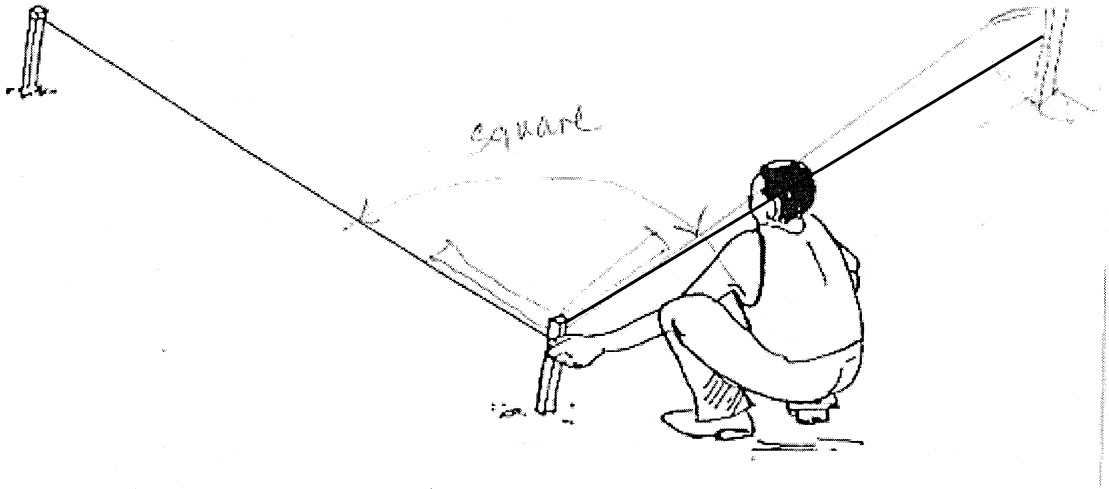
The setting out MUST be accurate. The Building Square is used to ensure that the layout is accurate. Every corners of the building must be square. That means being at a right angle (90 degrees).

If the corners are not quite square it will cause problems at every stage in construction.

The supervisor must check and double-check every angle and measurement personally.

c) The Outside Walls

- The front of your building is marked out with a length of building line between 2 pegs. One peg marks one corner of the building.



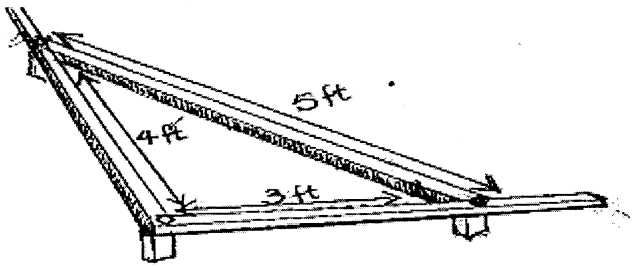
- A line is put in from this peg to represent one end of the building. This line should be at a right angle to the first as much as possible even visually.

- The building square is used to make this corner exactly square.

- In a situation where the building square is not available, you can make an improvised one by :

a) Cutting three pieces of wood of 3ft,4ft & 5ft lengths
b) Joining the three pieces to form a triangle.
c) Use the newly constructed triangle as your square.

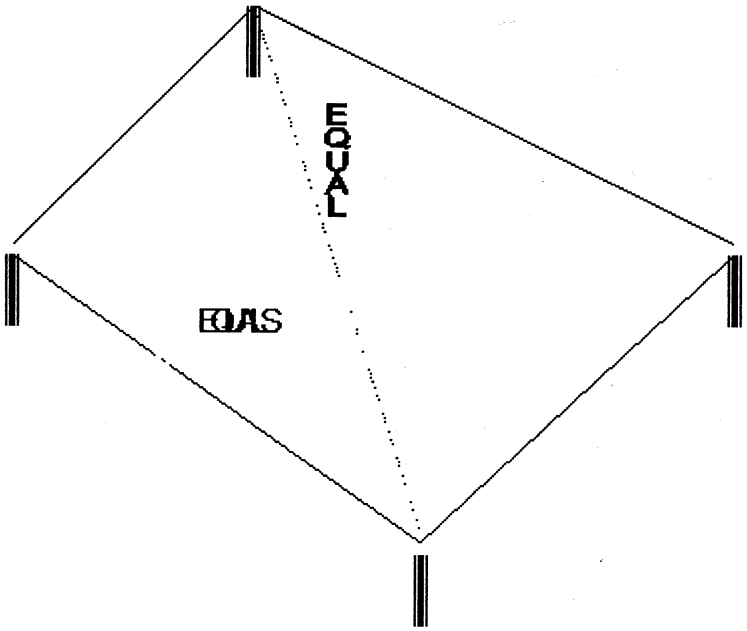
d) Confirmation of Accurancy



- What is done above is for one side of the building. This procedure is repeated for the other sides of the building.

- When all lines are drawn for the outside walls, the Supervisor must double check that everything is square.

- He does this by measuring the distance from each opposite corner, as shown in the sketch.

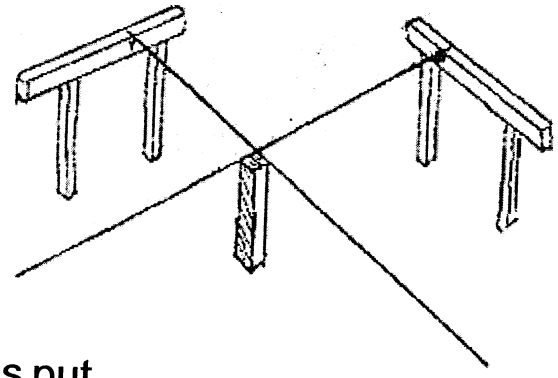


If these 2 distances are the same, then the building should be square.

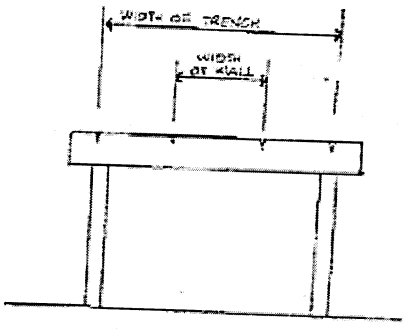
If these 2 distances are not the same, the person setting out the building has made a mistake. Do not take anything for granted. Check and double check. Correct where necessary.

e) Profile Boards

- The profile boards are firmly fixed about 1.5m outside the lines of the building. They are used to ensure that the accurate measurements and setting out which was done will be preserved.



- A Saw notch or Nail is put in the board in line with the main lines of the building

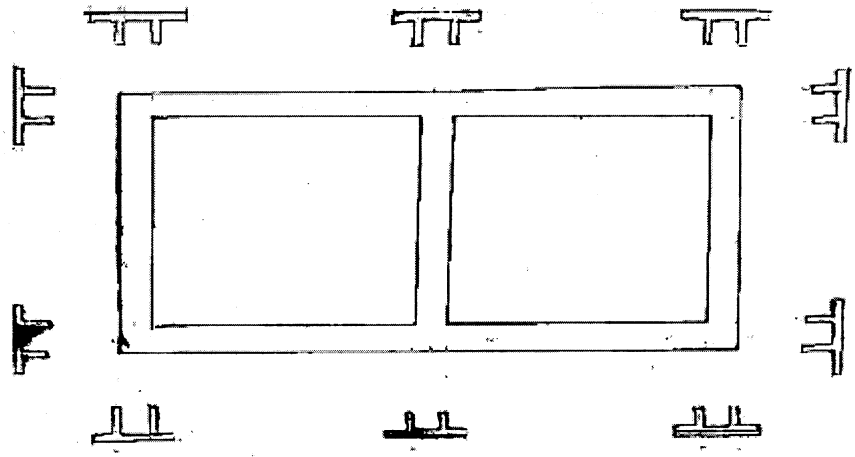


- Other nails or notches are put in to mark the width of the foundation trenches. The trenches should be about 3 times as wide as the foundation wall.

f) Inside Walls

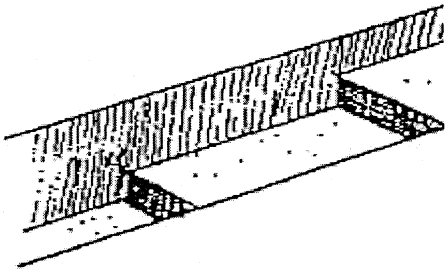
Lines are now put in for the inside walls, following the same procedures as for the outside walls.

Profile boards are also put in to mark the inside walls.

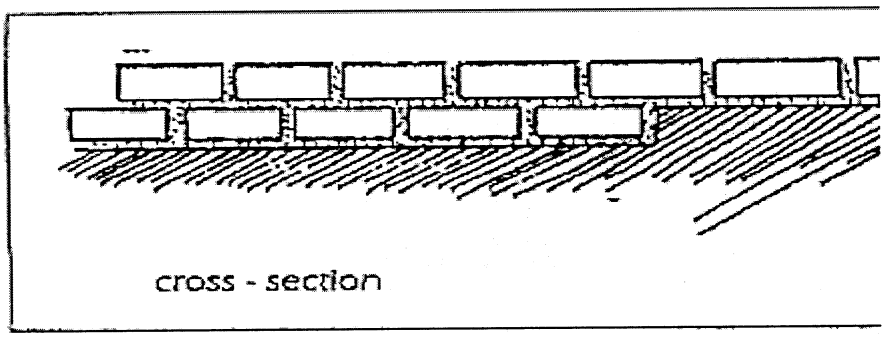


g) Building on a Slope

When building on a slope the trench has to be dug in level steps.



The size of the steps must be as deep as one or two cours block. This will keep the courses level.



cross - section

Recommendations

- ***The Supervisor should be personally be responsible for setting out***
- ***Setting out MUST be accurate***
- ***All angles and measurements must be checked and double checked***

6

Concrete, Mortar and Plaster

6.1 Cement, sand and stones

6.2 Making the mix

6.3 Concrete

6.4 Mortar

6.1) a) Definition

Concrete : is a mixture of Cement, Sand, Stone and Water in varying proportions

Mortar : is a mixture of Cement, Sharp Sand and Water in various proportions

Plaster : is a mixture of Cement, Smooth Sand and Water in various proportions.

The strength of the concrete, mortar or plaster depends on:

- ***The type of materials used in the mix***
- ***The quantities of each material in the mix***
- ***How well the materials are mixed.***

This chapter will tell you how to choose the best materials and how to make the various mixes.

b) **Mixes**

Look at the table. It tells you;

- ***the names of the different mixes you will be using,***
- ***where each mix is used***
- ***what ratio the materials should be mixed in, i.e what quantity of sand be mixed with what quantity of cement etc***

GUIDE TO MIXES

NAME OF MIX	WHERE USED	MATERIALS		
		Cement	Sand	Stones
Mass Concrete 1 : 3 : 6	Foundation	1 part	3 parts	6 parts (Smallest- 0.5cm) (Largest -6cm)
Reinforced Concrete 1:2:4	Floor Slabs Lintels	1 part	2 parts	4 parts (Smallest 0.5 cm) (Largest 2.5 cm)
Screed 1: 6	Floors	1 part	6 parts	None
Mortar1: 6	Bricks	1 part	6 parts	None
Plaster 1: 6	Walls	1 part	6 parts	None

Each mix contains cement, sand and sometimes stones.

i) **Cement** : Only buy fresh cement. If it is lumpy, do not buy it or use it.
Cement is easily spoiled, so it is very important to store it properly.

ii**).Sand** : Sand is used in all mixes. There are different types of sand.

iii**).Sharp Sand**: Which is coarse and free from humus & clay and is used for concrete mixes.

iv).**Plaster Sand**: Sand which is smooth and fine but free from clay & humus.

v).**Stones**: Stones must be broken down to the right sizes, although you may be able to find gravel in river beds for the smaller stones.

- The stones must be strong and clea

c) Mixing the Materials

The cement must be mixed with the other materials – the sand, stones and water –

PROPERLY and in THE RIGHT QUANTITIES.

i) **Quantities *(Proportioning)***

The mix will be weak if it contains too much sand or too many stones or too much water or too little cement. If too much cement is used, the mix will be hard to work with and expensive.

The quantity of each material is called a PART.

Let's say you are making concrete. For concrete you should use a **1:2:4** mix, or **1:3:6 mix**

For Example

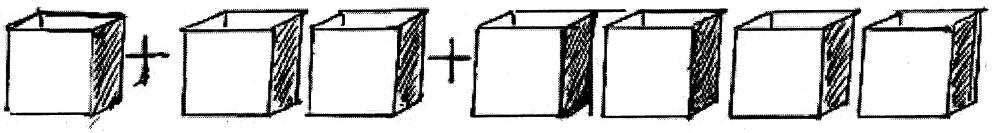
The 1 : 2 : 4 mix is 1 <u>part</u> Cement + 2 <u>parts</u> sand + 4 <u>parts</u> stone

It consists of :

1 Head pan of cement + 2 Head pans of sand + 4 Head pans of stones

or

1 bucket of cement + 2 buckets of sand + 4 buckets of stones



Do you see the important thing here?

- Whatever container is used to measure the "parts", it must be the same CONTAINER and VOLUME for each material.

- **It is bad practice to mix**

1 bag of Cement + 2 WHEEL BARROWs of Sand + 4 WHEEL BARROWS of Stones.

Because it is **assumed** that 1 wheelbarrow will hold 1 bag of cement. However most wheelbarrows will hold more than a bag, so measuring this way will mean the qualities are not right.

ii) **Mixing**

How the materials are mixed and how much water is added will determine the strength of the concrete and how easy it is to use.

NOTE:

- You should already have made a concrete slab or basin for mixing. Never allow the labourer to mix on bare ground.

- The best method of mixing is the **THREE TIMES DRY – THREE TIMES WET** method.

Three Times Dry

- The amounts of sand, cement (in that order) are put in a pile at one end of the mixing slab.

- This mixture is called the DRY-MIX.

- The dry-mix should be uniform in

- colour if it has been done correctly.

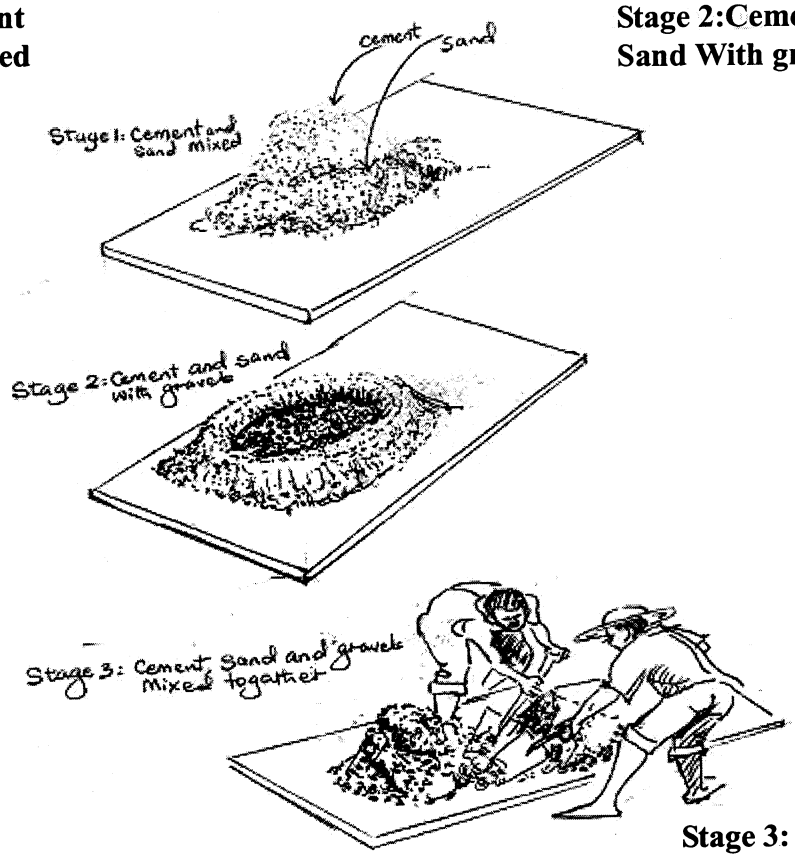
- the cement / sand mixture being added to the stone

should run down the sides of heap.

- *This is repeated 2 more times.*

Stage 1, Cement and Sand Mixed

Stage 2:Cement and Sand With gravels



Stage 3: Cement, Sand and gravel Mixed together

Labourers with shovels should stand facing each other over the pile and turn the whole heap over from one pile to another pile at the other end of the slab

NOTE:

- Never let the labourers add water before the dry ingredients are properly mixed.

- The heap of dry-mix is formed into a hollow ring. There should be no mixture left in the center.

- Some water is poured into the hollow ring.

- The dry-mix is pushed into the water, spreading it out. No water should escape through the ring.

- When all the dry-mix has been heaped in the center of the slab it will have absorbed all the water.

- The heap is turned over, as with the dry mix.

- This sequence is repeated two more times, adding a little water each time.

- The labourers must add only enough water to make the mix just soft enough to work with.

The prepared mix should be covered with cement bags to stop it drying out too quickly.

NOTE:

- Many labourers make the mix too wet because it is much easier to work with. This is WRONG and the Supervisor must not tolerate it.

- The building Supervisor and Foreman must watch the first batches of concrete, mortar and plaster being prepared, to make sure the labourers know how to do it properly.

The labourer must never prepare more mix than can be used in 30 minutes, since the mix will begin to set after that time.

d) Concrete

Concrete is a mixture of cement, sand, stones and water in specific proportions.

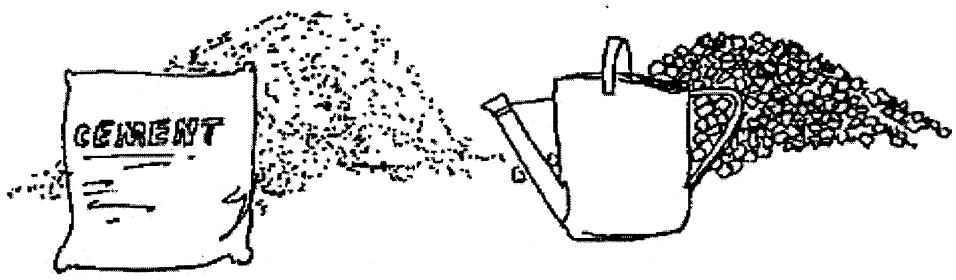
Your buildings will need 2 types of concrete:

Mass Concrete:

This is used in the foundation. It can have quite large stones in it –up to a maximum size of 6cm in diameter.

Reinforced Concrete:

This is used for the floor slab and lintels. Reinforced concrete has smaller stones in it –up to a maximum size of 2.5cm. Metal bars or mesh are put into reinforced concrete to give it strength.



e) Pouring and Compacting

- Concrete should be quite stiff if it has been well made.
- Concrete should always be poured in layers. No layer should be thicker than 100mm (4").
- Each layer must be compacted with a TAMPER (rammer) to get rid of any air in the concrete. This makes it stronger. A tamper is simply a heavy weight on a long stick.

f) Curing of Concrete

Concrete sets hard because the cement and the water are slowly reacting together. This hardening process is called **CURING**.

Concrete must be allowed to cure fully before any more work is carried out on it.

Concrete must be kept wet until it is fully cured. If the concrete dries out too quickly:

- the hardening process will stop and the concrete will be weak,
- the concrete will dry too and develop cracks.

g) Mortar and Plaster

Mortar is a mixture of cement, sand and water. It is used to fix bricks or blocks firmly in place.

Mortar is also used to cover walls to give them a smooth, waterproof surface. In this case it is called PLASTER.

NOTE:

The sand used for plaster must be clean. Wash it if necessary.
Good mortar should:

- be easy to use,
- harden quickly, so it does not cause delays in building,
- be strong, long lasting and weatherproof.

The experience of the builders is essential in finding the best mix, but as a guide, a typical mix for mortar will be about:

1part cement

6 parts sand

Experienced labourers will often replace up to $^1/_3$ of the cement with lime sand to make a more workable mix. This also helps plaster stick better to the walls.

NOTE:

The labourers should use only enough water to be able to work with the mortar. Too much water will weaken the bond.

Make sure your supervisor is at the site when the builders first make mortar or plaster, so he can check they are making good mixes.

h) Reinforcing Material

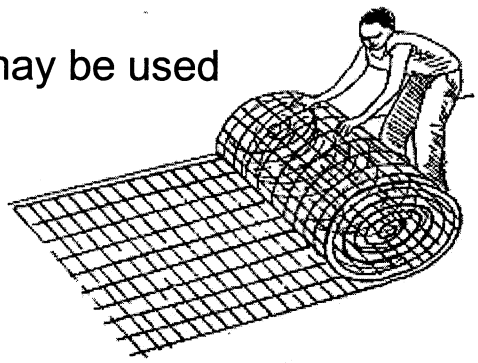
Reinforcing bars and mesh are used in the walls, slab and lintels to give them added strength.

The reinforcement is made of metal and comes in different sizes and shapes.

There are 3 main types:

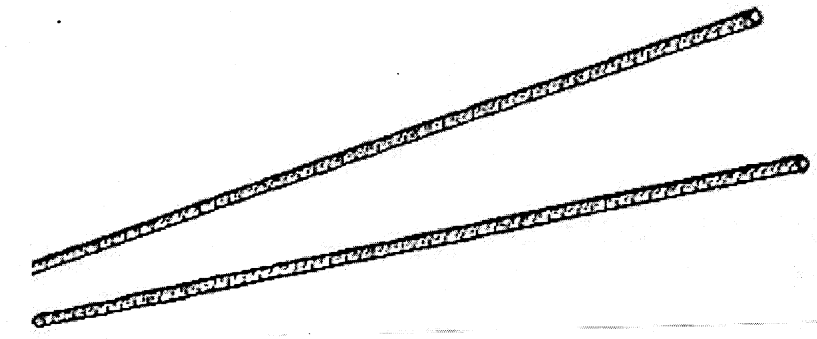
BRC Mesh

It is like a wire mat and may be used in the floor slab.



Iron bars

This is usually simple metal rods used in lintels, columns and beams, they can be twisted or smooth.



RECOMMENDATIONS

It is important that the reinforcement bars are free from rust or grease before use.

The reinforcing materials must be completely embedded in the concrete where it is used.

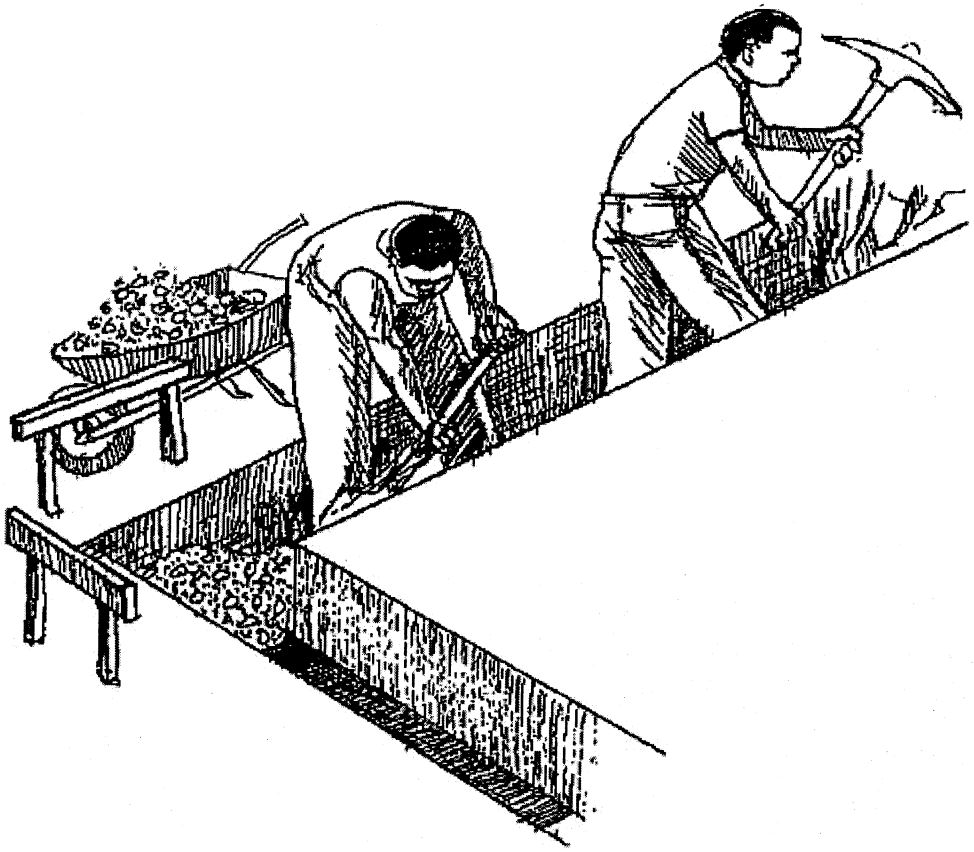
Reinforced concrete must be well compacted to get rid of all air pockets. If this is not done, the reinforcing material will rust over time and the structure will weaken.

7

Foundations

7.1 Foundation Types

7.2 Constructing the Foundation

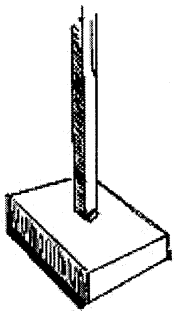


7.1) Foundation Types

The foundation is the most important part of any building. It must be strong enough to support the entire weight of the building.

PAD

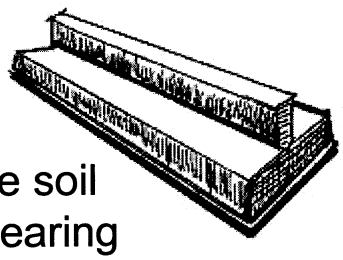
Suitable for buildings with columns on firm and stable soils. It requires Reinforcement.



PAD:

STRIP

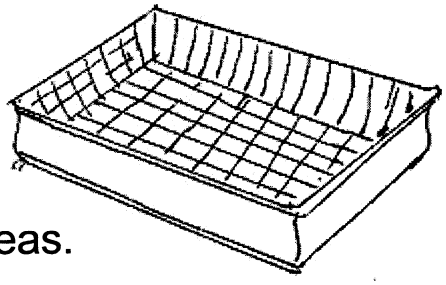
Suitable for simple buildings in firm and stable soils. Where the soil is weak or loose soil and low bearing capacity, it may require reinforcement or ground beams.



STRIP:

RAFT

Suitable for large building in water logged Clay & Sandy areas. It is always reinforced



RAFT:

The soil that support your foundation must be firm and solid. Soil which contains a lot of loose sand or clay is not strong.

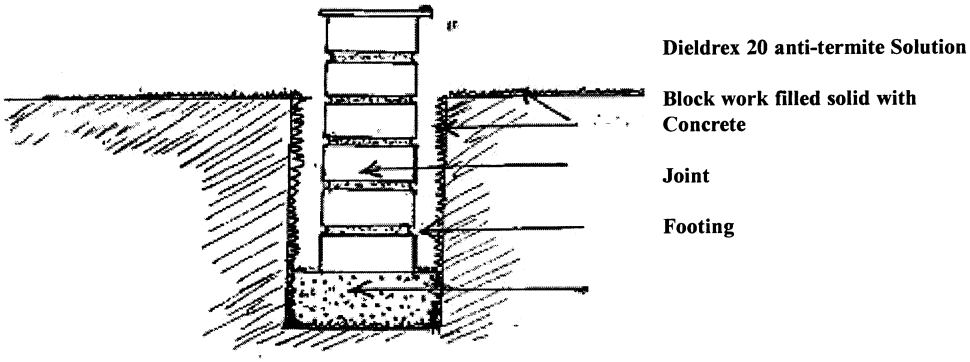
Examine existing buildings at the project site. If they have serious cracks in the walls. Then it is possible that the soil in your area is not strong and the building has sunk slightly into the ground. This is a sign of foundation failure.

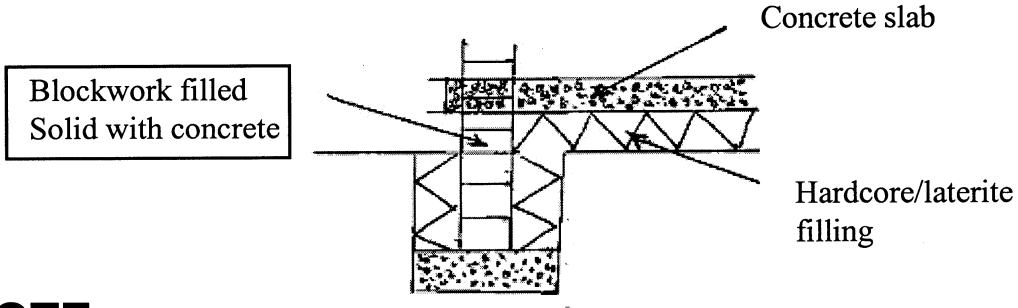
a)

Parts of Foundation

The foundations are made up of different parts as shown below.

- the FOUNDATION TRENCH
- the FOOTINGS, which is a layer of concrete in the bottom of the foundation trench.
- the FOUNDATION WALL, which are the bricks or blocks that you lay in the foundation trench.
- BACKFILL, which is the laterite or hardcore used to fill up the foundation trench. The backfill must be well compacted and treated with ant chemicals eg Dieldrex 20.





NOTE

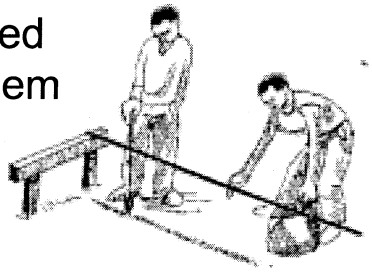
In areas of high termite infestation, it is recommended that the bottom and sides of all trenches should be sprayed with anti-termite solution.

7.2) Constructing the foundations

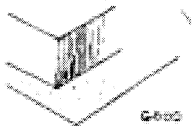
i) Digging the Foundation Trenches

When all the lines for the foundation are in, a trail of sand is laid on the ground to mark where the labourers must dig.

The building lines should be removed while digging is going on, to stop them being broken or getting in the way.



Any time you need to check that the digging is accurate. Simply put back the lines between the notches or nail of the profile boards.



Foundation trenches should always be dug deep enough to reach firm soil. The <u>minimum</u> depth of the foundation trench should be 600mm below the original ground level . The actual depth must be based on the supervisors advise & soil type. The sides of the trenches must be vertical and the bottom level. The corners must be square.

Check that the soil at the bottom of the trench is firm. If not, the Supervisor must ensure that action is taken to reinforce the building. Some suggestions are given below.

ii) Modifications for Weak Soil

Deepen the trenches until firm soil is reached. If firm soil cannot be reached, consider the following options:

- Reinforce the footing with appropriate iron rods
- Lay a reinforced concrete slab (about 200mm thick) complete- ly on the building area and construct the entire building on this.
- Put in a ring beam at wall plate level. A ring beam is a strip of reinforced concrete that goes right round the building.

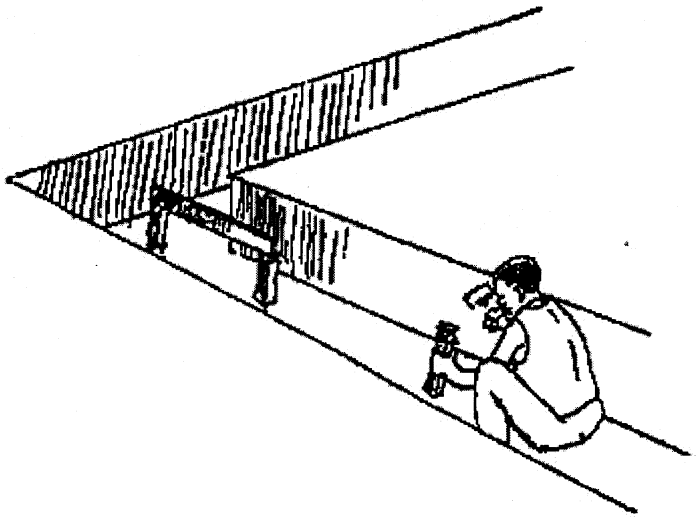
These modifications are expensive and may not stop the building from subsiding. It is much better to look for a better site.

If you are in any doubt, SEEK SPECIALIST HELP.

iii) Marking the Depth of Foundation Footings.

Pegs are driven into the bottom of the trench, so that the length of peg sticking out of the ground is equal to the depth of the footings. This should be about 200mm.

The tops of the pegs must be level. If they are not then the trench is not level



The trench must be made level by **REMOVING** soil, never by adding soil. If soil is added, the foundation may fail. It may mean digging the trench slightly deeper, but it will ensure your building remains strong.

iv) The footings

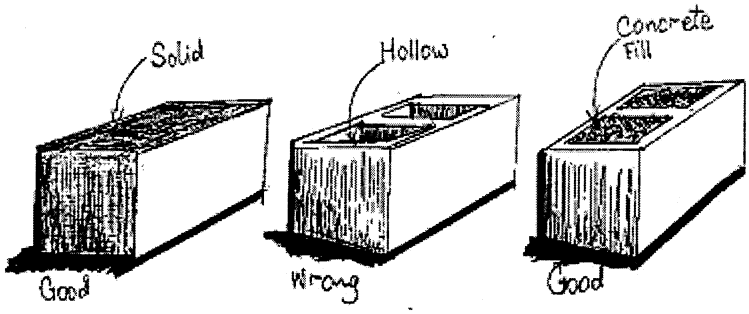
The footings spread the weight of the walls over a wide area.

The footings should be a 1 : 3 : 6 or 1 : 2 : 4 mix.
The concrete is compacted and leveled to the height of the pegs in the trech, using a straight edge or strike board.

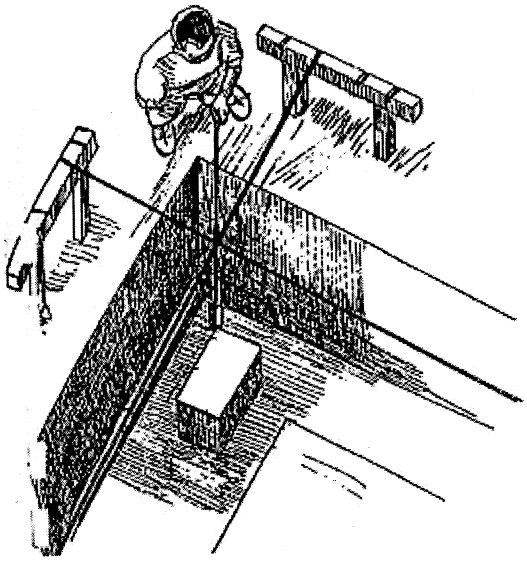
The pegs should be removed and the holes filled with concrete.
See chapter 6.

v) Foundation Wall

The foundation wall is built in the center of the footings. Properly burnt bricks or SOLID concrete blocks can be used to
make the foundation wall.



If building with burnt bricks, use the strongest bricks in the foundation walls, because they must support the entire building.



The foundation wall must be started at the corners. Put the lines back over the profile boards and make sure the corner bricks or blocks are in exactly the right place.

vi) Plastering and Backfilling

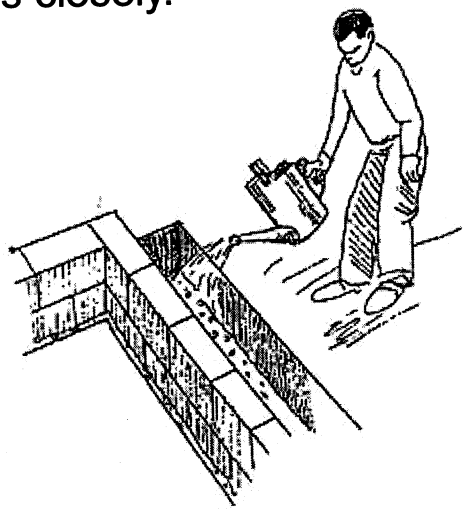
The outside of the foundation walls should be plastered. The foundation trenches are then refilled and compacted. This is called **BACKFILLING.**

vii) Ant / Anti-termite Treatment

It is essential that you add anti-termite solution (eg. Dieldrex .20) to the trenches when you backfill.

Read the instruction on the container carefully. Follow the instructions closely. All chemicals are dangerous.

Do not walk on soil treated with Chemicals.



viii) Verandah Poles and Piers

if you are using metal verandah poles, the labourers should leave a gap in the foundation wall down to the footings.

Once the foundations are complete and the verandah is laid, the pole is set into the hole and filled around with concrete.

It is also acceptable to make brick Verandah piers instead of metal poles, but make sure an ant guard is put in the pier to stop ants getting to the roof timber.

RECOMMENDATIONS

- *The foundation MUST BE STRONG, or your building may collapse.*
- *If there is any doubt about how firm your soil is SEEK SPECIALIST HELP.*
- *Reinforced foundation in weak soil. is more expensive, but necessary.*
- Always fill the holes of hollow blocks in foundation with concrete.

8

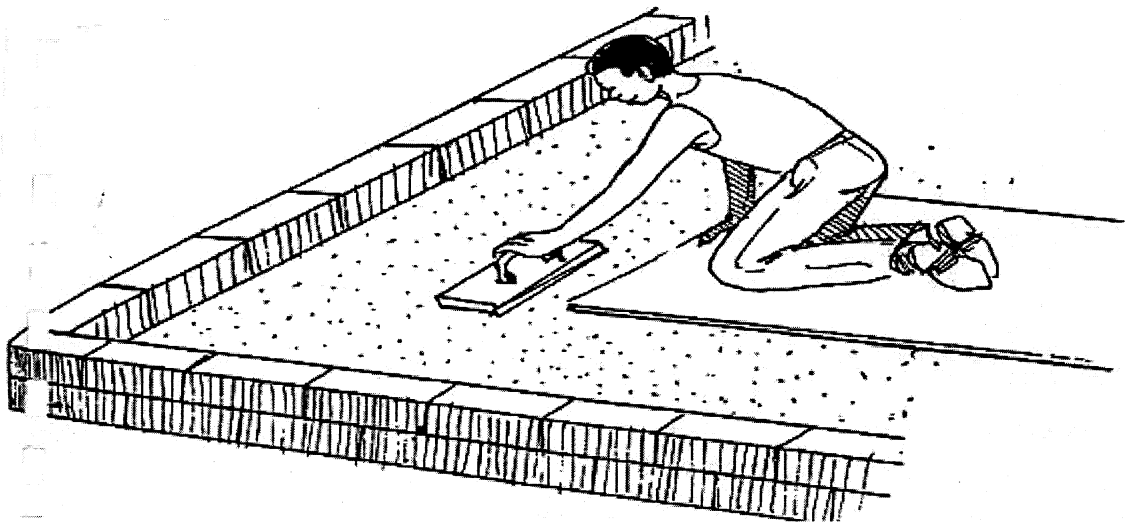
Floors

8.1 Types of floors

8.2 Parts of a floor

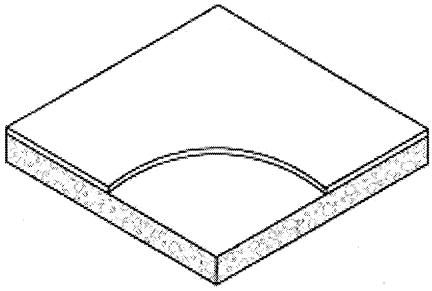
8.3 Making a good floor

8.4 The floor screed



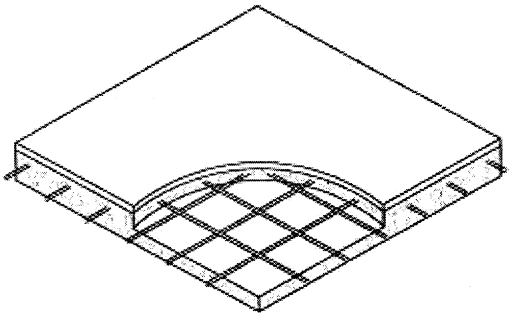
8.1) Types of Floors

1. MASS CONCRETE FLOOR



MASS CONCRETE FLOOR

2. REINFORCED CONCRETE FLOOR

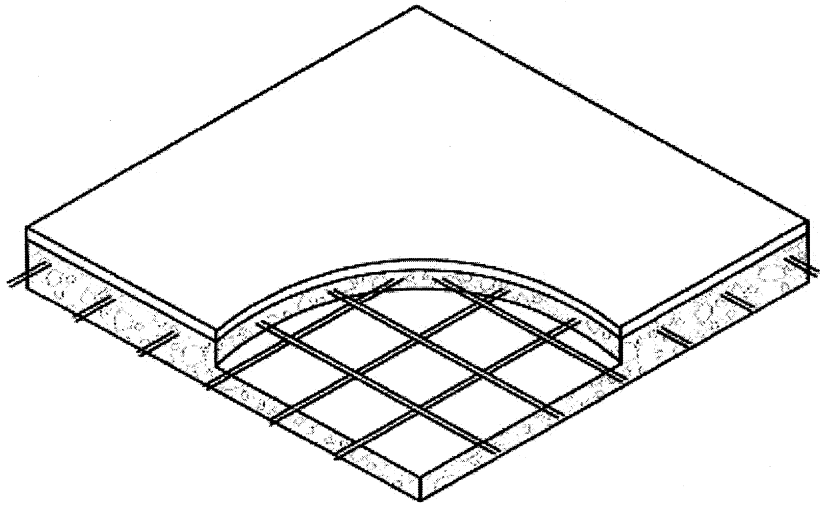


REINFORCED CONCRETE FLOOR

8.2) Parts of a Floor

a) Reinforced Concrete floor

- The main parts of the floor are:
- the hardcore or laterite fill,
- a layer of plastic, called the damp proof membrane (DPM),
- the base, which is normally a reinforced concrete slab,
- the top layer, which is called the floor screed.

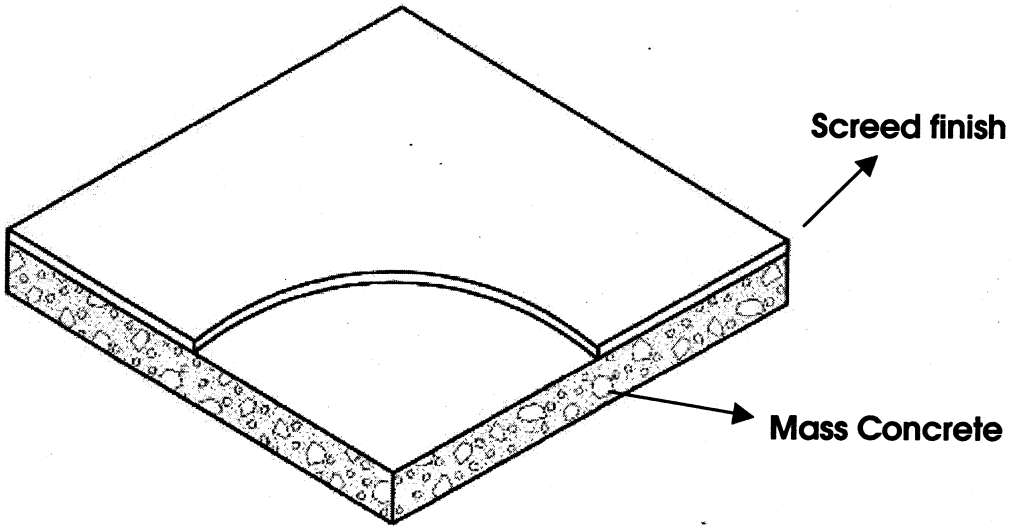


REINFORCED CONCRETE FLOOR

Getting the floor right is difficult. If it is not done with care your floor will soon have serious cracks in it, especially large public rooms such as classrooms.

b) Mass Concrete Floors

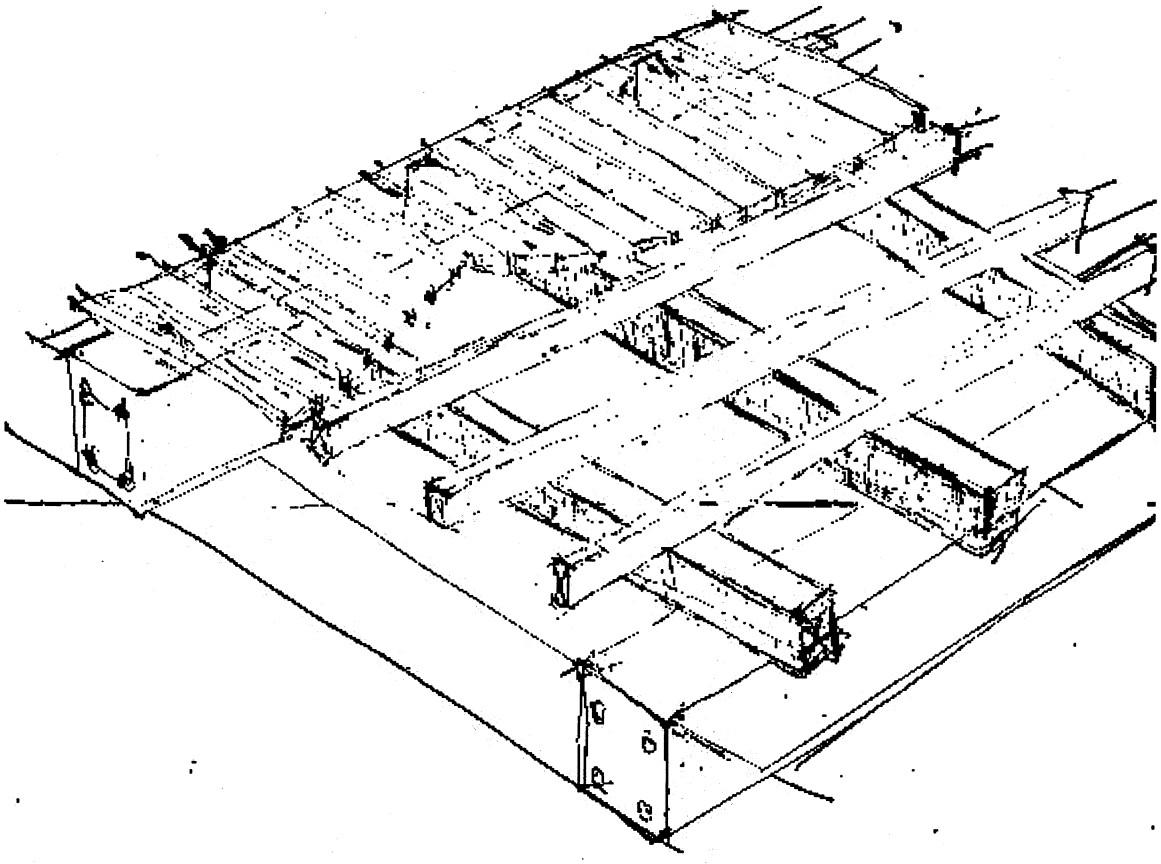
It is the same with the reinforced concrete floor except that there is no reinforcement.



MASS CONCRETE FLOOR

c) Suspended Timber Floor

It consists of timber joists which carry the load, the RUNNERS which distribute the load and the TIMBER BOARDS which form the last layer – the walking surface.



Suspended Timber Floor

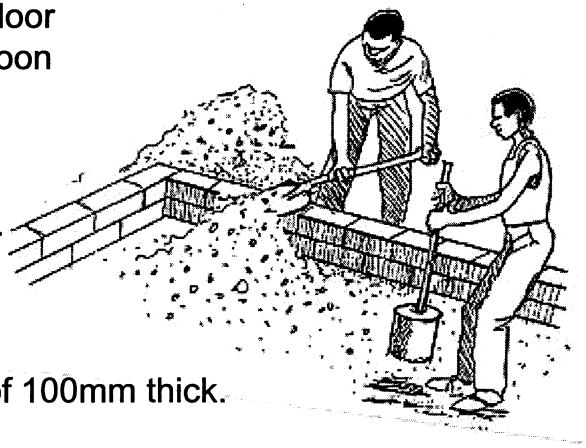
8.3) The Procedure for Making A Good Floor

Example : Reinforced Concrete Floor

Stage 1: Fill-up the rooms (The Fill)

The following material can be hardcore or laterite. This is called The Fill.

- If it is not well made, it will compress under the weight of the floor slab and your floor will soon have cracks in it.
- The total depth of the fill must be at least 150mm.



- The fill is done in layers, each layer a maximum of 100mm thick.
- Compact each layer. This is easier to do if each layer is watered.

Stage 2 : Add Anti-Termite Treatment

At this stage you must apply an anti-termite eg Dieldrex 20 in the fill to protect your building.
Do not walk on material treated with Chemicals.

Stage 3 : Add Damp-Proof Membrane

- The Concrete floors include a damp-proof membrane (DPM) which protects your buildings from moisture rising up through the ground, especially in marshy areas.

- The DPM is made from sheets of THICK plastic or polythene sheet.

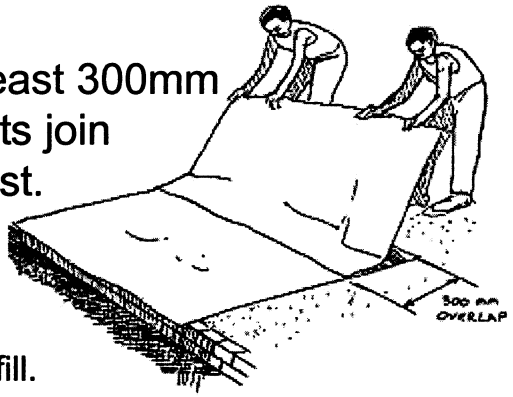
- Make sure the plastic you buy is thick and strong.

NOTE

- If thick plastic is not available, you can use 2 layers of Thinner sheet, NEVER use a single sheet of thin plastic.
  If you do, it will tear.

- The plastic sheets
  are laid on top of the fill.

- Have an overlap of at least 300mm where each of the sheets join to stop water getting past.

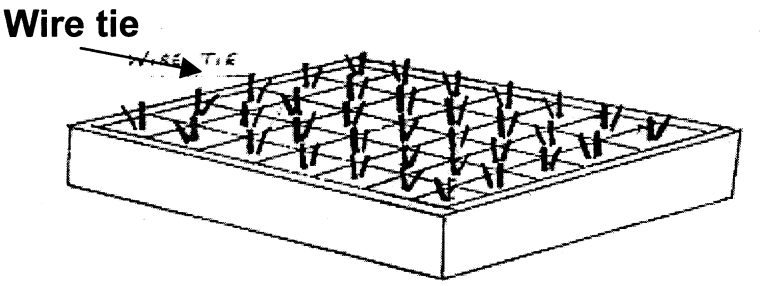


NOTE:

Brush a thin layer of sand over the fill. This reduces the chances of sharp stones tearing the plastic.

Stage 4 : Lay the Slab

- Reinforced concrete floor slabs make the strongest floors. It is advisable to use this type of floor if it can be afforded.



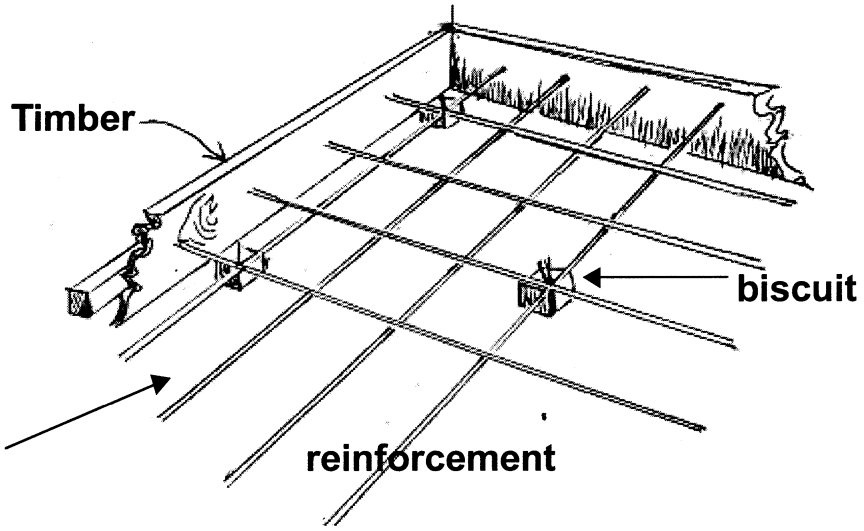
Stage 4(a) Laying the Reinforcements.

- the slab should be reinforced with iron rods or wire mesh (BRC).

- Prepare supports for the reinforcement to raise it up about 50mm off the ground. This is commonly called "Biscuits"

  The reinforcement is tied to the supports with wire ties.

  The common method of laying slabs is to lay a single floor slab which covers the foundation walls.



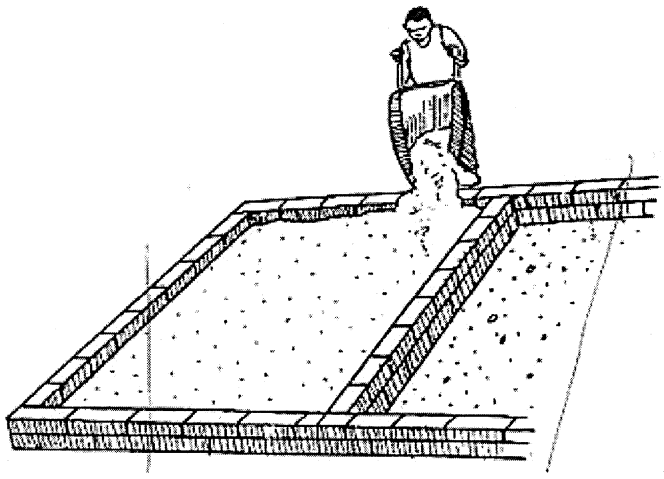
Stage 4(b) : Pouring the Concrete

- The slab should be a minimum of 100 mm thick, 1:2:4 concrete mix for reinforced floors and 1:3:6 in Mass Concrete Floors.
- Pour the concrete, make sure it completely surrounds the reinforcement.
- Compact the concrete well with a tamper.
- Level the concrete using the edge boards as guides.

Stage 5 : Curing

- cover the slab with sand and leave it to harden (cure).

- keep the slab damp while curing takes place.



8.4) The Floor Screed

- the floor screed is a thin layer (1 : 6 cement: sand mix) laid on top of the slab.
- The floor screed layer should be 50mm thick.
- Use sharp sand.
- the floor screed must be compacted and levelled.
- the screed surface is worked with a float until moisture comes through. It is then sprinkled with cement. Use a tin with holes in the bottom to get an even cover.
- The cement should be worked into the screed using the float. If done properly, this gives the floor a very hard, smooth finish.
    - The surface is finished off with a steel float
    - The floor must be kept damp while curing takes place.

RECOMMENDATIONS

- *The hardcore or laterite fill must be well compacted.*
- *Use THICK plastic sheet for the damp proof membrane*
- *Reinforced concrete slabs make the strongest floor*
- *Take care to give the floor screed a smooth, hard finish*

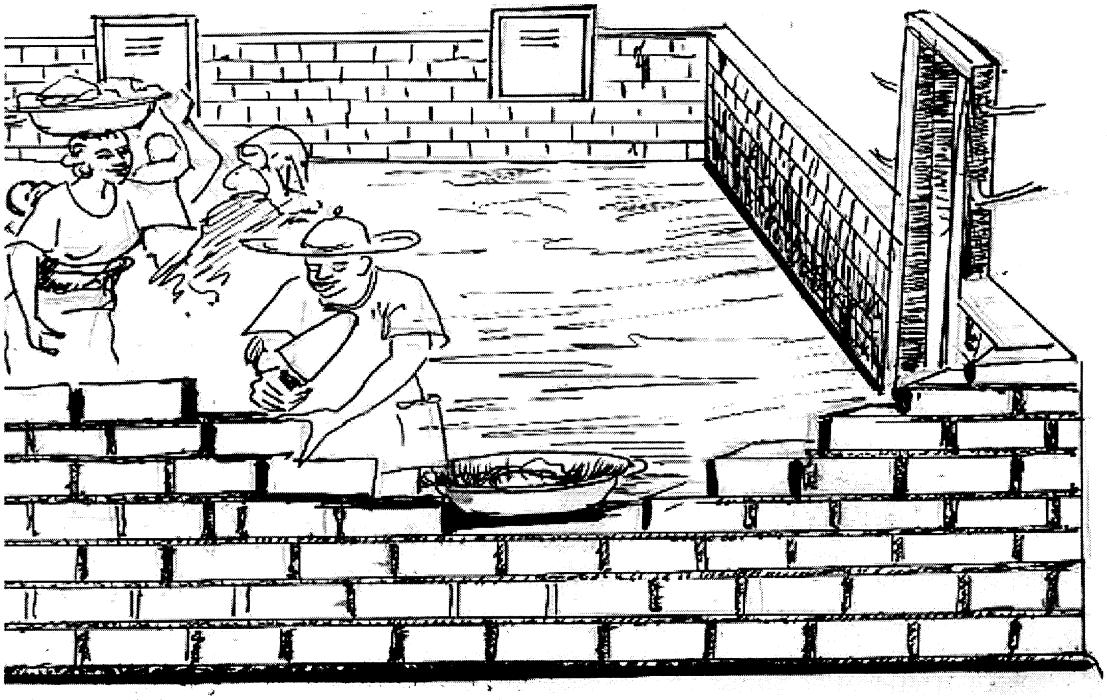
9

Walls

9.1 Wall Types and Materials

9.2 Bonding

9.3 Building the walls

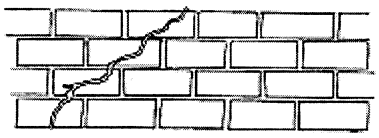


Introduction

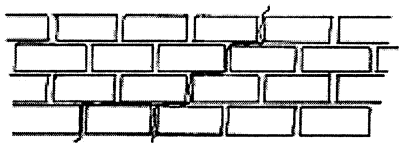
- Each layer of bricks or blocks in a wall is called a COURSE.

- These are held together by a mixture of sand and cement called MORTAR.
  Making mortar is described in Chapter 6.

- When mortar dries it should be almost as hard as the bricks or blocks.



strong bricks or blocks with weak mortar will result in cracks that go through the mortar and around the bricks.



Strong mortar with weak bricks or blocks will result in cracks that go through the middle of bricks.

9.1) Materials & Types of Walls

a) Types of Walls

- Irrespective of materials in use, a wall could be load bearing or non-load bearing.
- Load bearing walls support the roof. They must be 225mm thick for block. They can be built by using 180mm bricks.
- Non-load bearing walls are also known as partition walls but do not support the roof. They must be at least 150mm thick.

b) Materials used in building classroom walls include:

- Bricks
- Blocks
- Timber
- Bamboo
- Stones
- Mud

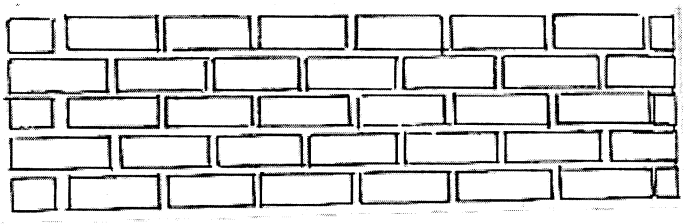
9.2) Bonding

Example : Brick or Block walls.

- The pattern of bricks in the finished wall is called the BOND. The commonest bond is shown in the illustration below.

Notice that:

there are no vertical joints in the wall. This would make a weak bond.



9.3) Building the Wall

a) Laying Bricks or Blocks

Mortar will not stick easily to dry bricks. Therefore the labourers should:

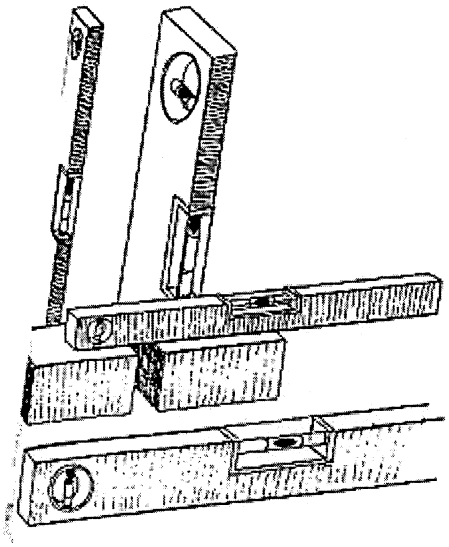
- wet the previous course before laying the mortar for the next one, and
- wet each brick or block before it is laid.

Mortar dries out quickly when it is spread on the wall, so the bricks should be laid quickly.

b) The first Courses

All walls must be built accurately, but special care must be taken with the first 2 courses. If they are not right, the rest of the building will also be wrong.

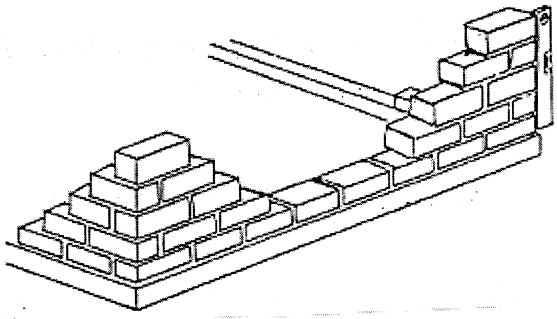
Since the lowest bricks or blocks carry the greatest weight, always use the strongest bricks or blocks and this must be accurately laid. Check Verticality and Horizontality. The supervisor must check them regularly.



c) Corners

- The accuracy of the walls depend on the corners

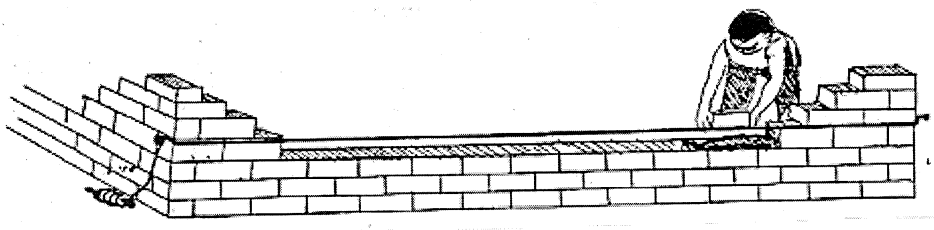
- The corners must be built first. Each corner is built up, several courses, then the walls in between are built. Not more than 4 courses should be built at a time to allow the mortar to harden.



d) Main Walls

- Spirit levels or plumb should be used to check that the corners are level and vertical.

- When the mortar has hardened a little, a building line is fixed at each corner and pulled tight. The line is held about 4mm away from the wall by a stick or peg at each corner. The bricklayers use the line as a guide, keeping the gap constant by eye. They should not try to build close against the line.



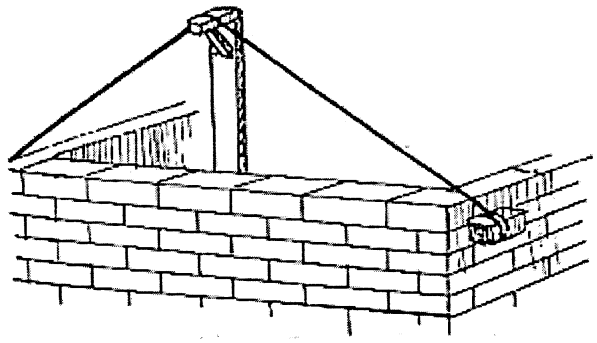
e) Roof Ties

- When the walls have reached about 1 metre from the top, make sure lengths of strong wire of about 4 metres long are built in. These wires will be used later to tie down the roof.

- For buildings with concrete Headcourses, the roof ties should be 8mm Iron bars cast into the Headcourse to hold the roof rafter later.

f) Gables

- Gables are the pointed walls of the building. Extra care should be taken to make sure the gables are accurate if they support any part of the roof. If they are not accurate, the roof will be difficult to construct.



- One method of building the gables accurately is to:

- fix a vertical plank to the middle of the gable walls

- the top of the plank should be at the height of the gable.

- Attach a line over the plank down to the side wall. Bricks are used to keep the line tight.

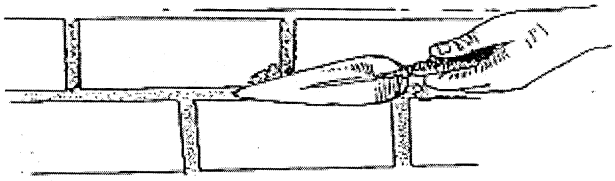
- the bricklayers use this line as a guide to make the gables.

g) Pointing and Raking out

- Pointing is tidying up joints to make them neater and more weather proof. This is important if the walls will NOT be plastered.

- If the walls will be plastered, the mortar between bricks or blocks should be raked out to about 6mm deep before it sets. This makes a groove which helps the plaster stick to the wall.

Mortar should be raked out before it dries completely.

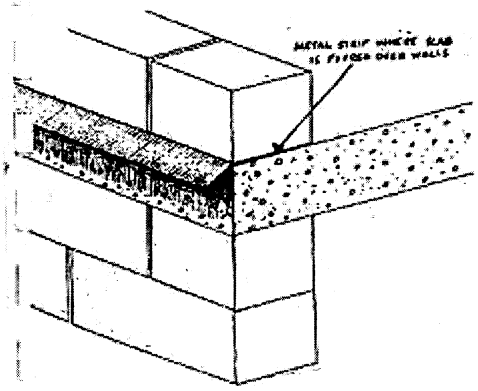


9.4) Ant Guard

In ant and termite infested areas :-

- Your building should be protected from ants by an ant guard.
- The ant guard is put in at slab level. It should go right round the outside of the building
- The ant guard should be at an angle and have sharp corners, which ants find difficult to get over.
- The ant guard can be made in different ways:-

a) from metal strip. This is probably the best option, although ideally all joints need to be soldered to keep out ants.



b) you can extend the slab past the walls as shown below as an ant guard.

NOTE:

- There must be no holes in the ant guard. Ants or termites can get through a small hole.
- Advantages of this method is that the builders are familiar with it and it is possible that the slab can act as an ant-barrier.

RECOMMENDATIONS

- *Make sure your builders construct all the walls at the same time – not the outside wall first, then the inside walls. Your building will be stronger this way.*
- *A good bricklayer will always produce neat mortar joints of constant thickness*
- *Have an ant or termite guard in your building at slab level if necessary.*
- *Always start walls at corners*
- *The first 2 courses must be accurate*
- *Build wire ties into the walls for fixing down the roof.*

10

Roofing

10.1 Choosing Roof Types

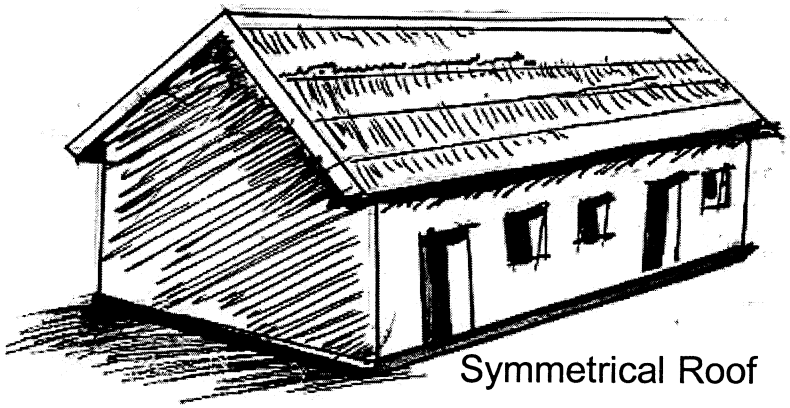
10.2 Choosing Roofing Materials

10.3 Constructing the roof.

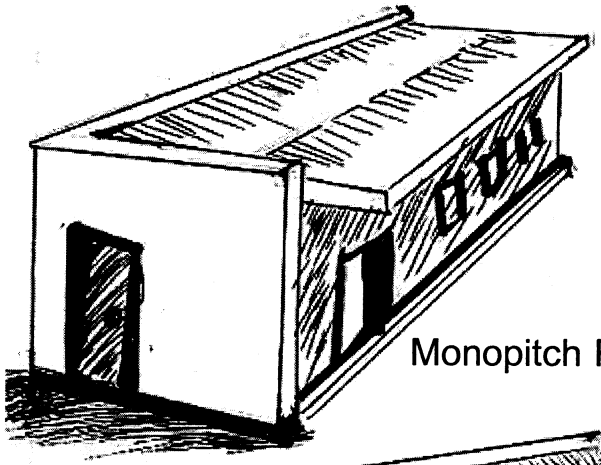
10.4 Planning the Roof

Introduction

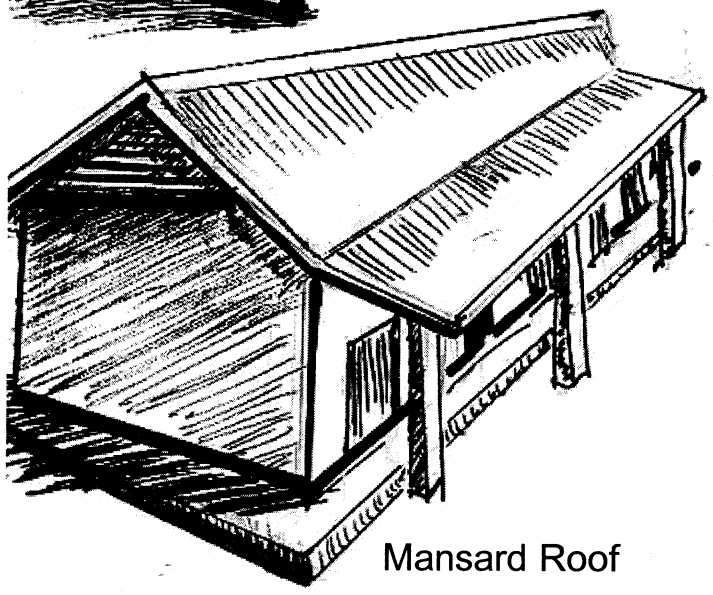
10.1 Common Types of Roof



Symmetrical Roof



Monopitch Roof



Mansard Roof

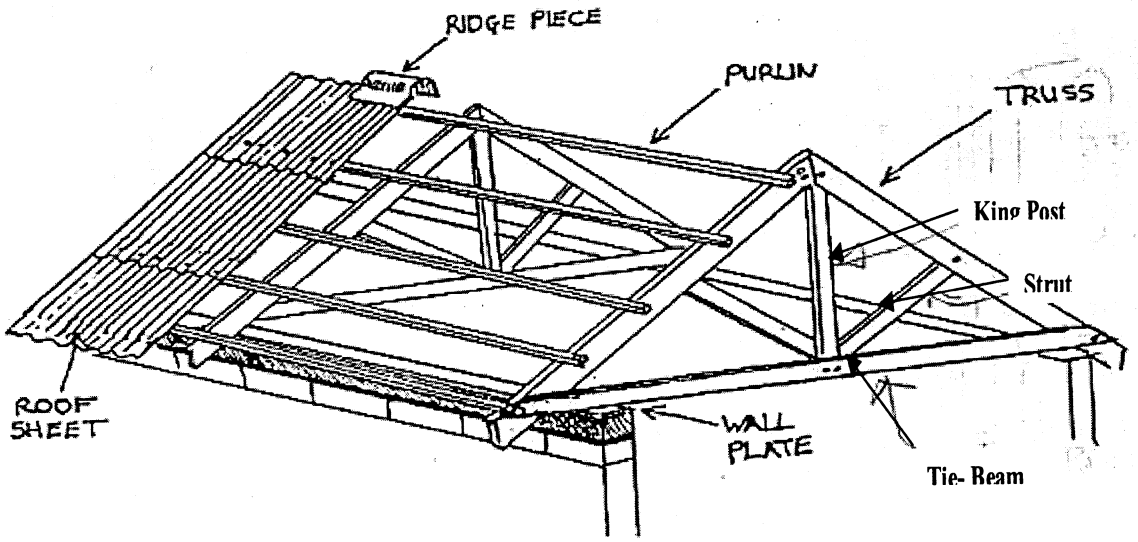
- Roofs should be selected on the basis of function
- In areas of heavy rainfall, roofs should have a high slope possibly in two or more directions ie Symmetrical or Mansard roofs.
- In areas of low rainfall, slopes can be gradual and in a single direction.
- Roofs should be carefully chosen and built to resist windstorms.
- The less exposure to the direction of strong winds, the better.

10.2MAJOR PARTS OF THE ROOF

The main parts of roof are shown in the illustration below:

1. **Wall Plate** :-
   The first part of the roof that is fastened to the walls and carries the rest of the roofing parts.

2. **Rafters** :-
   The Sloping first part of main frame that rests on the wall plates.



3. **Tie-Beam :-**
   The horizontal part that joins the two ends of the rafters
4. **Struts :-**
   The members that connect the rafters to the tie-beam
5. **King Post :-**
   The central strut which determines the height of the roof.

3. **The Purlin :-**
The members that are fixed to the rafters at regular intervals to carry the roofing sheets.

7. **Roofing Materials (Sheets) :-**
the covering material fixed to the purlins prevents rain & sunshine into the building.

Talk to your Supervisor and be sure that either he or the carpenter is able to build the roof well. Many roofs have been ruined by poor workmanship.

10.2 CHOOSING ROOFING MATERIALS

A) Framing Materials :
- *Tmber,*
- *Steel*
- *Bamboo*
- *Concrete*
- *Palm Trunk (Azara)*

B) Covering Materials :
- *Thatch (Grass, Palm fronds)*
- *Raffia fronds*
- *Galvanised Iron Sheets*
- *Aluminium Sheets*
- *Corrugated asbestos sheets*
- *Roof tiles (concrete tiles, Clay tiles).*

C) Criteria for Selection :

1. ***Climatic Condition eg***
   - Amount of Rain – Humidity
   - Amount of Heat
   - Amount of Wind
   - Amount of Salt in the atmosphere

2. ***Availability, Cost & Maintenance***

3. ***Availability of necessary skilled labour.***

RECOMMENDATIONS

i. Roof type	-	Symmetrical roof
ii. Roof trade	-	Timber is recommended because of its availability, low cost and easy maintenance
iii. roof covering	-	G.I. Sheets corrugated asbestos sheets, tiles (assorted), aluminium

IMPORTANT NOTES

1. Anti – termite treatment – ensure that every piece of timber is well soaked in anti-termite solution such as Solignum

10.2 EXAMPLES IN TIMBER CONSTRUCTION

Length of Sheets

a) Number of Sheets & Spacing
b) Number and Spacing of Purlins
c) Joints & detailed connections.
d) Typical Sizes of timber roofing
   - rafters 150 x50m (2" x 6")
   - tie – beam 150 x 50 m (2" x 6")
   - King Post 150 x 50 m (2" x 6")
   - Wall plate 100 x 100 (4 x 4)
   - Purlins 75 x 50 (3" x 2")
   - Struts 50 x 100 (2" x 4")

IMPORTANT

NEVER have an overlap of less than 1 ½ corrugations between sheets

Number and Spacing of Purlins
Roof Connections

Make sure all roof
timbers are securely
fixed to prevent wind
lifting the roofing.

Tie timbers down securely
using the wire ties built in to the wall.

PLANNING THE ROOF

Roofing sheets come in different sizes. You must PLAN your roof in advance, to decide:

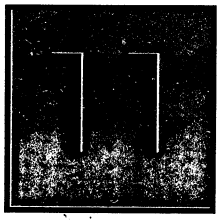
- *what lengths of roof sheets are to be bought*
- *how many of each size is to be bought.*
- *the number and spacing of purlins to suit these sheeets*

Use experienced men to calculate the right combination to suit your roof. Draw sketches of the roof to help in planning. Consider the following things:

Lengths of Sheets

When calculating the lengths of roof sheet required:

- allow an overhang of 300 mm at the bottom of the roof.



Doors & Windows

11.1 Types of Doors & Windows

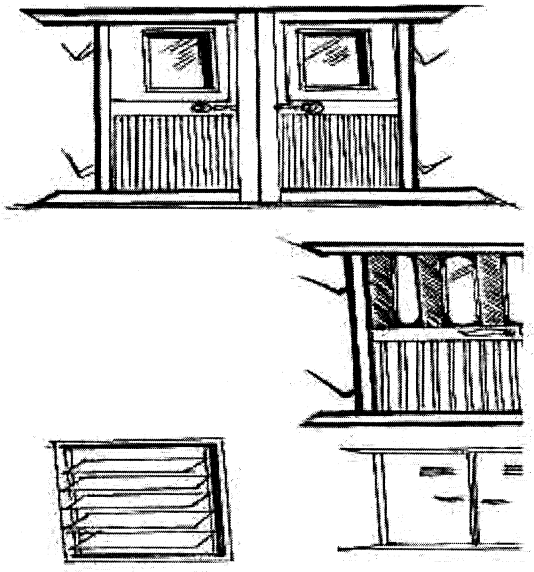
11.2 Materials (Metal or Timber) For Doors and Windows

11.3 Fitting door and windows frames

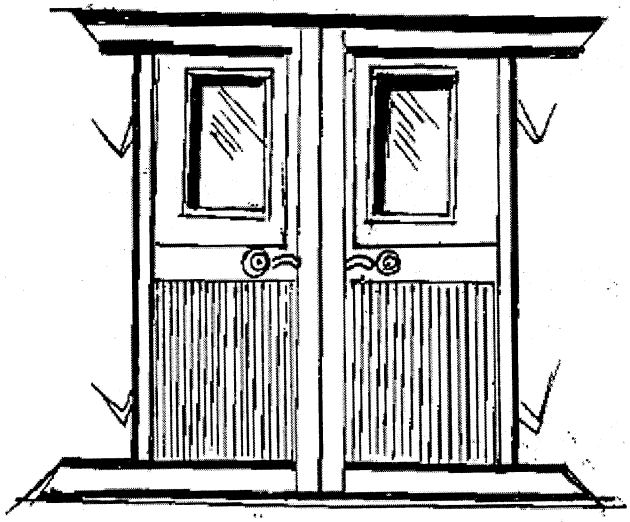
11.4 Lintels

11.5 Fixing Burglar bars and grill doors

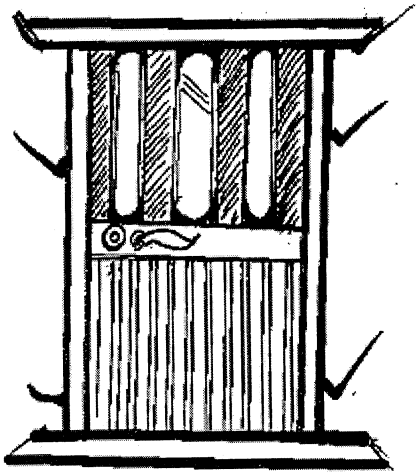
11.6 Fixing Locks & Hinges



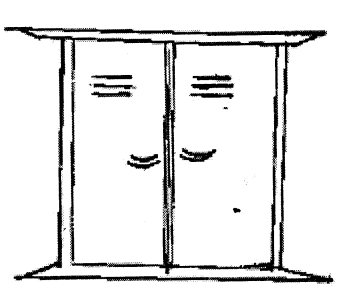
11.1 Types of Doors & Windows



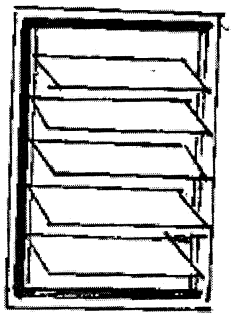
1. DOUBLE-LEAF HINGED DOORS (WOOD OR METAL FRAMES & PANELS)



2. SINGLE-LEAF HINGED DOORS. (WOOD OR METAL FRAMES & PANELS)



A) TROPICAL STEEL WINDOWS .



B) LOUVRE – WINDOWS

(WOOD OR STEEL FRAMES)

11.2 Materials for Doors and Windows

Doors

There are various types of materials to choose from:

- ***Wooden doors***
  - Hollow or Solid
- ***Metals doors-***
  - Metal with glass or Wooden Panels, Wooden or Metal Frames

Windows

- Wooden Windows – louvre (Jalousy) or Panelled.
  - Metal Windows
  - Metal with glass or timber panels
  - Wooden or Metal Frames

11.3 Fixing Door and Window Frames in Place

The frames can be fixed as the walls are being made or the openings can be left in the walls and the frames fixed later.

If your project is in an area where security is a problem, the frames could be tempered with or removed before they are fixed into the wall. In this case complete the walls first.

If the frames are fitted later, the right sized gaps must be left in the walls. The gap should be equal to the width of the door frame, plus about 12mm on either side for fixing it in place.

11.4 Lintels

Door and window openings make the wall weaker, so a support is
needed above EVERY door and window to make the wall strong again. These supports are called LINTOLS (which can also be spelt lintels).

A poor lintel will sag and crack because of the weight of the wall above it.

The best lintel are made from reinforced concrete. There are 2 types:

a) Cast in-situ Lintels.

If the lintels is cast in-situ, it is made in position above the door or window opening.

The advantage of this method is that it is easier to make the lintels fit the opening accurately. These lintels are also slightly stronger, so you should consider them for very large windows.

The disadvantage is that it slows down the building work. The builders have to make the formwork, pour the concrete and leave it to cure before they can continue with the courses above the lintel.

b) Pre-cast Lintels

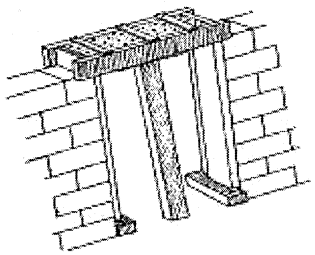
A pre-cast lintel is one that is cast on the ground and allowed to dry before being lifted into position.

The advantage of this method is that the lintels can be made and fully cured before they are needed. It is a simple matter to fit them to your building and there will be no delays in the building work.

11.5 Making a Lintel

The best lintels are cast in a timber formwork. When casting lintels in-situ the formwork must be well supported on the walls

The formwork should be at least 300mm longer than the opening, so that there is at least 150mm of lintel "bearing" on each side.



The reinforcement bar should be about 25mm above the bottom of the box. Use bar at least 12mm in diameter. Bend the end of the bar round to form a hook.

If the lintel is less than 1200mm long, three reinforcing bars are enough. If the opening is wider than this. Four reinforcing bars should be used. These are tied together with 8mm stirrups using binding wires.

A 1:2:4 concrete mix is used for the lintel. The maximum size of stones in the mix should be 19mm across.

NOTE :

Make sure that the reinforcement bar is in the formwork before pouring the concrete.

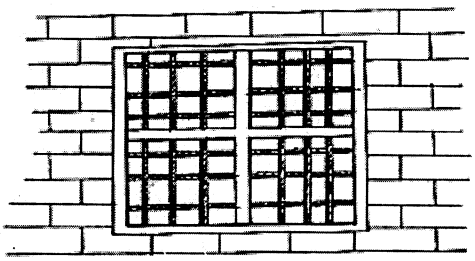
The concrete should be poured into the formwork and compacted by tapping it down with a suitable tool. Tapping the sides of the box also helps compact the concrete.

If you are making pre-cast lintels, mark the top of the lintels. It is easy to turn the lintel round and forget where the reinforcement is. The bars MUST be near the bottom of the lintel.

11.6 Burglar Bars

If vandalism and theft are a problem in your area:
Fit burglar bars to all windows and grill doors (burglar bars) to all timber doors.

- Consider casting burglar bars into window cills and lintels, or fixing them into the walls as you build. This is the strongest type of construction. Be careful to check which way the windows open before fixing the bars on one side or the other.



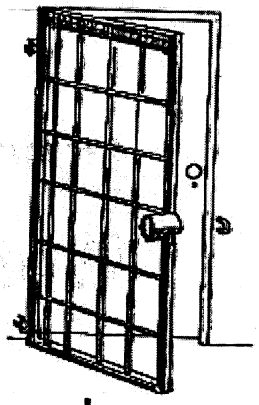
- some window frames come with burglar bars attached. Use these, or weld bars to your window frames.
- make sure the burglar bars are welded BEFORE fitting the glass. The frame will bend slightly when it is being welded and this can break the glass.

weld the bars to each other for added strength.

11.7 Locks and Hinges

The following are the common types available

- Mortice locks for doors
- Padlocks with staples for doors
- Belts for doors and Windows.



Metal hinges are used for fixing doors and windows to frames.

Most cheap mortise locks are not strong or durable it is therefore better to use padlocks in addition to the mortice locks.

Always use wood screws and not nails for fixing hinges and locks. Also make sure the hinges and locks have all the screws in place.

RECOMMENDATIONS

- *All doors and windows must have reinforced concrete lintels above them*
- *Take time to choose the most appropriate doors and windows for your project*
- *If necessary, fit secure burglar bars and grill doors to combat theft.*
- *Where timber doors are to be used, solid hardwood doors are preferable to plywood flush doors.*
- *Always use wood screws and not nails for fixing hinges and locks.*
- *Anti termite treatment should be applied to the back of timber frames before fixing them back.*

12

Wall Finishes

12.1 Plastering

12.2 Painting

12.1 Plastering

Plastering is the application of Cement and Sand motar to the wall beams & columns. Plaster can be applied to internal and external walls to obtain a truly flat surface and stop water penetrating the walls and make them attractive, easy to paint and to clean.

Good plaster will have no gaps or cracks and should stick well to the walls.

Mixes: Should be 1 part of cement to 6 parts of clean fine sand

a) When to Plaster

All new buildings will move slightly as they dry out or the foundations settle. This is perfectly normal and you do not usually have to worry.

However, if walls are plastered as soon as the building is finished, the plaster may crack because of this movement.

It is better not to plaster until the building has settled. This can take several weeks.

You may not be able to wait this long, but try to wait as long as possible. Build other targets if you have any and then come back to finish the plastering.

This will reduce the number of cracks that appear in your plaster.

Two thin coats will last longer than one thick coat. It will take longer to do this way, but the results are worth it. Discuss it with your Supervisor.

b) How to Plaster

- any holes or hollows in the walls should be filled and any projecting bricks chiselled off.
- All loose dirt and dust must be thoroughly cleaned from the walls.
- The walls should be sprayed with water very well before applying plaster, to stop the walls absorbing moisture from the mortar, thus causing hair cracks.
- Place plaster screeds at convenient distances to form guides for straightening the surface.
- Plastering should always start at the top of the walls and work downwards.
- A board should be laid at the bottom of the wall, to collect any mortar that drops. This can be used again, provided it is still fresh.

External walls should be plastered when they are not in the full sun to avoid cracks due to quick water evaporation from the plaster

Plaster must be applied evenly and to the correct thickness.

No sandcrete block walls should be plastered until at least one month after date of manufacture.

On outside corners this is done by using EDGE BOARDS. These are fixed so that they project past the end of the walls by the desired thickness of plaster.

On inside walls, the best plasterers will:

- use a straight edge or a long wooden float range to flatten any high spots.
- go over the surface with a wooden float.
- finish off with a metal plasterer's trowel. This has an edge up to 12" long. A normal trowel is too small.
- Another method is to prepare SCREED stings first.
- A screed is a strip of mortar, carefully applied so that the finished surface is perfectly vertical.
- The screed is smoothed by moving a smooth, flat plank vertically up and down over it.
- The screeds are used as a guide for the application of the rest of the plaster.
- If two coats of plaster are being used, let the first coat dry for a few hours then scratch the surface with nails hammered through a plank of wood. This gives a better surface for the second coat to stick to.
- Sprinkle the surface with water before applying the second coat.

c) Joints

Wherever possible, an entire wall should be plastered in one go.

Plastering should never finish at a corner.
The plasterer should continue plastering at least 150mm past the corner.

d) Curing

- like concrete, plaster has to be left to cure.

Keep the plaster damp for about 1 week after finishing, especially walls that are in the sun. If you do not do this, the plaster will dry out too quickly and you will get large cracks.

12.2 Painting

a) Types of Paints

Primer: This is the first coat. It is used to seal the surface.

Note: Please do not use white wash

Undercoat: It is used to give the wall a base colour and prepare the surface for the top Gloss coat.

Gloss: This is an oil based paint. It is more expensive than water based paint, but the painted surface is easier to clean.

Emulsion: This is a water based paint. It does not need separate primer or undercoat.

NEW PAINTING:

Walls being painted for the first time should have three coats: One undercoat and two top coats.

New wood should be primed before the other coats.

RE-NEW PAINTING:

Walls that are being repainted usually just need two coats. Undercoat is not used unless the existing paint is very poor or there is to be a change of colour.

b) Thinners

Read and follow the instructions on the tin of paint carefully, because some modern paints do not need thinning, or even stirring.

If your paint needs to be thinned to make it easy to apply, then:

- water based paints can be thinned using water

- oil based paints need proper thinners. If you cannot buy thinners, you can use kerosene although this is not so good.

NEVER use diesel or petrol.

Many painters will thin the paint too much, which will result in a very poor finish. Paint should be thinned only enough to apply it evenly and smoothly.

c) Selection of Paints

The commonly used paints are Emulsion and Gloss

The bottom 1.5 metres of wall, or any wall that is likely to be dirtied should be painted with oil based paint. This makes it easy to clean marks off the walls.

Paint other areas with emulsion paint.

RECOMMENDATIONS

- *2 thin coats of plaster are better than 1 thick one*
- *keep plaster damp as it dries*
- *do not add too much thinner to paint*
- *Wash all paint brushes immediately after use*
- *Provide resistance to moisture penetration.*
- *Give a pleasant appearance*
- *Protect the structural wall from driving rain and sand storm*
- *Increase the heat resistance, sound and thermal insulation properties of the walls.*

13

External Works

13.1 Drainage

13.2 Landscaping

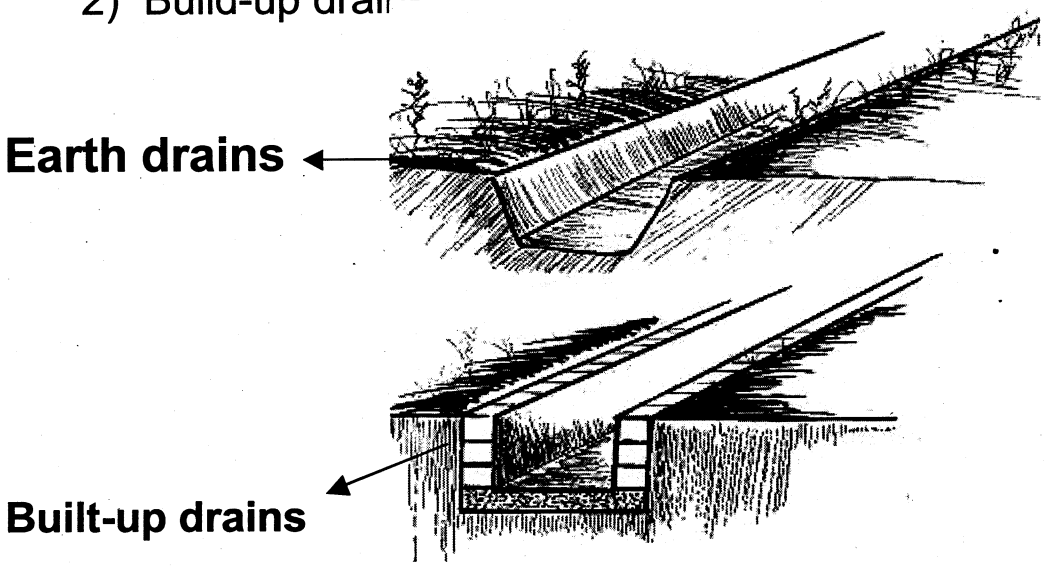
13.3 Water Supply

13.1 Drainage

Surface Water and Underground water can be dangerous to buildings, so there is need to provide good drainage by way of constructing adequate drains around buildings.

There are two(2) main types of drains.

1) Earth drains
2) Build-up drains



a) Earth drains

Can be rectangular or trapezoidal in shape and are constructed by digging the drains to the required depth and width.

b) Built-up drains

Can be rectangular or trapezoidal in shape and are constructed by using blocks or reinforced concrete.

NOTES

- There should be adequate slope along the drains so that water flows naturally.

- Ensure the drains take the water well away from buildings, wherever possible into natural ditches or water courses

- Do not allow drains to create pools of water as this can be unhygienic.

13.2 Land Scaping

Plant trees, hedges and flowers to demarcate the site, define path ways and land usages, beautifying the school in order to protect it from wind, sun and water erosion.

However large trees should not be planted close to buildings.

13.3 Water Supply

A School needs clean water for drinking. The following are possible sources of clean water:

- Wells
- Rain Water
- Stream Water
- Tap Water

a) Wells

There are 2 types of wells-open wells and boreholes.

Open Wells - are used where the water level is not deep. They are cheap to install, easy to maintain and can be dug. Water is usually drawn by bucket, chain and windlass.

Boreholes - are used where the water level is much further below the ground and hand pumps are used to draw water. Boreholes have to be sunk with specialist equipment. They are much more expensive to install and maintain.

b) Siting of Well

- The water in the well must not be polluted.
- Ideally the well should be at least 100m away from any pit latrines, if space allows.
- Try to site the well uphill of any latrines, so there is even less chance of pollution.

c) Rain water

This can be harvested during rainy season from the roof to a storage container. First rains should not be harvested because of the dirt that accumulated on the roof during dry season.

d) Stream water

Where stream is the available source of water, it could be collected but MUST be boiled thoroughly before drinking.

e) Storage

A good storage facility should be provided in the school. Plastic Storage containers are preferable to metal because of rusting. If metal must be used it must be painted internally with anti-rust paint.

NOTES

- The best time to dig the well is towards the end of the dry season. When the ground water level is low.
- Ideally the well should be dug at least 3 meters deeper than the dry season water level.
- Ensure that the well is dug vertically
- The top of the well must be clean, safe and protected from surface water, therefore, build a wall around the top of the well and provide a lid to prevent anything falling in.
- If the well is to supply an overhead tank, then an appropriate water pump is provided.

14

Ventilated Improved Pit Latrines

14.1 Types of VIP Latrines

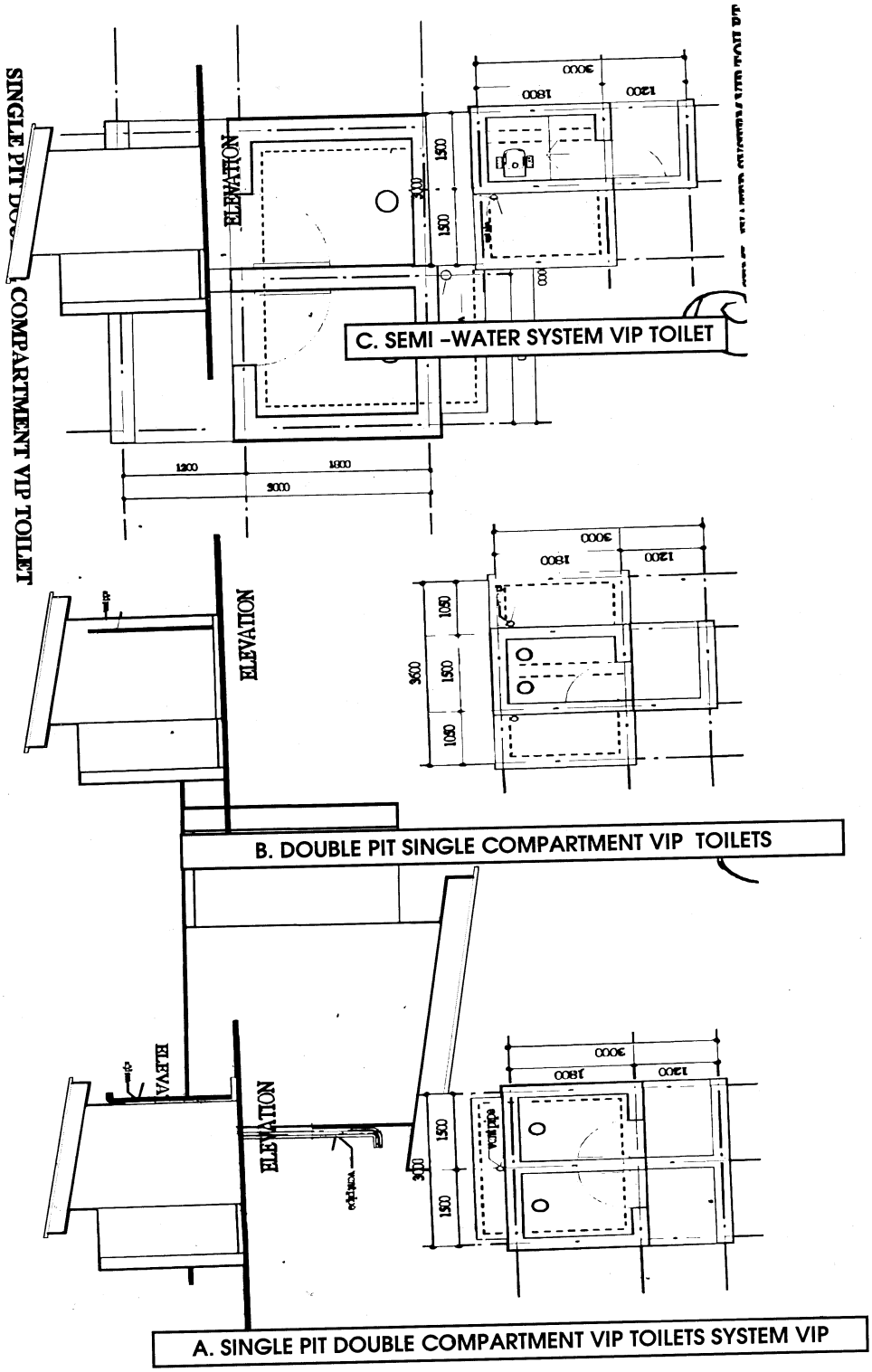
14.2 How a VIP Latrine Works

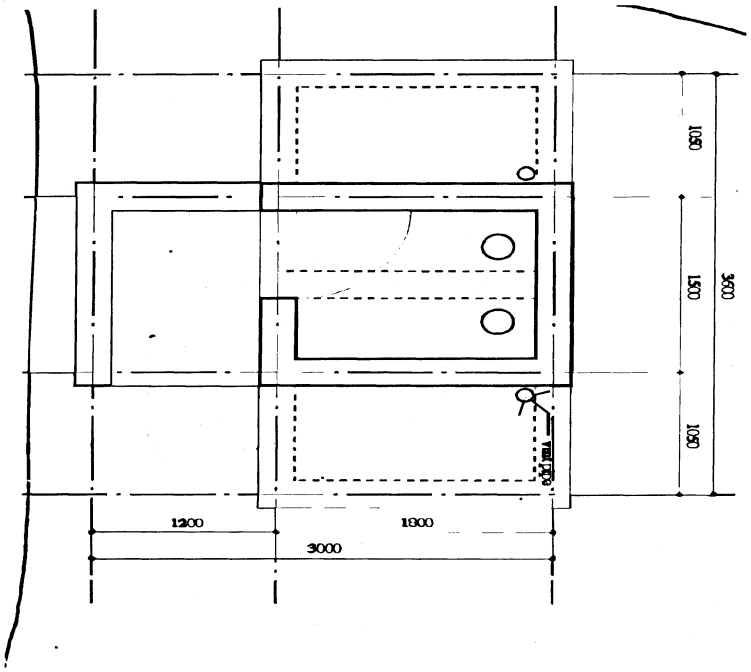
14.3 Siting the VIP Latrine

14.4 Constructing the VIP Latrine

14.1 Types of VIP Latrines

TYPE A SINGLE PIT, DOUBLE COMPARTMENT VIP

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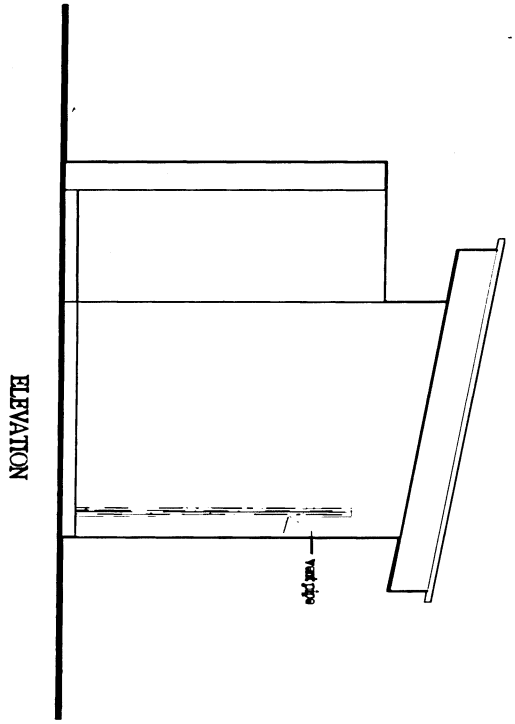
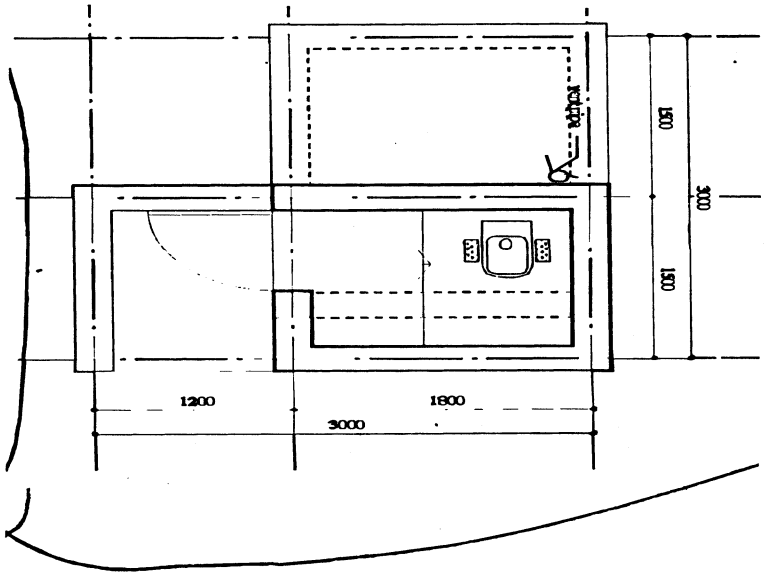
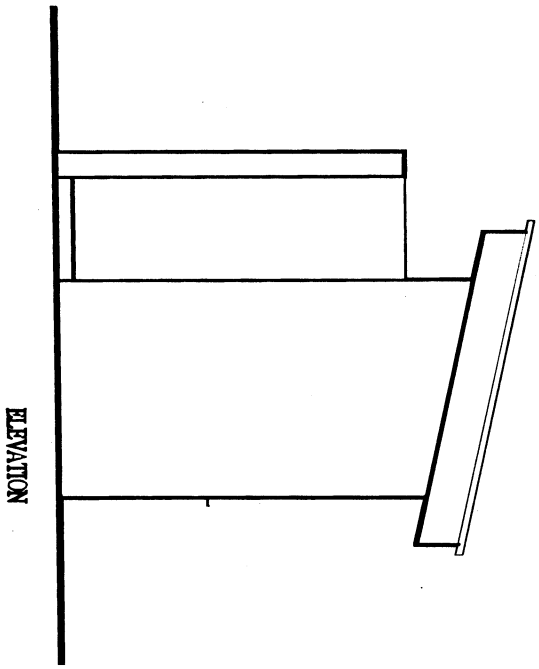

ELEVATION

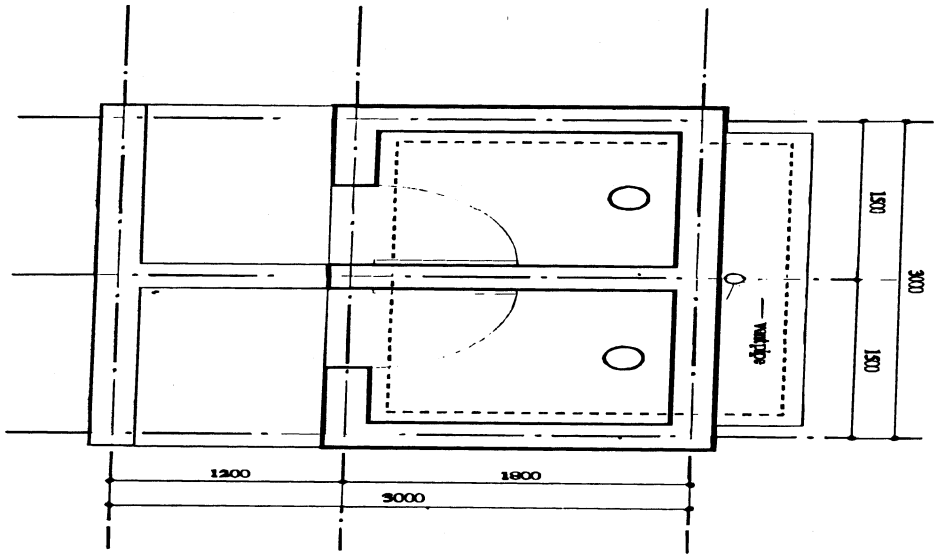
TYPE B: DOUBLE PIT SINGLE COMPARTMENT VIP TOILET

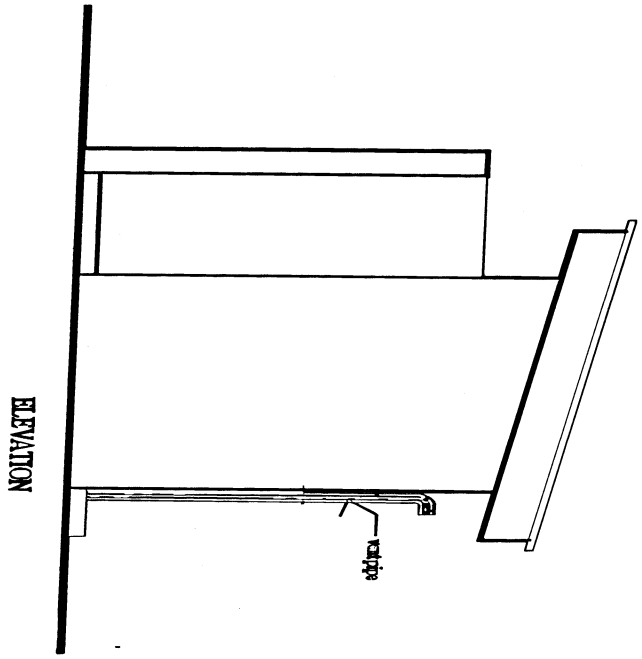




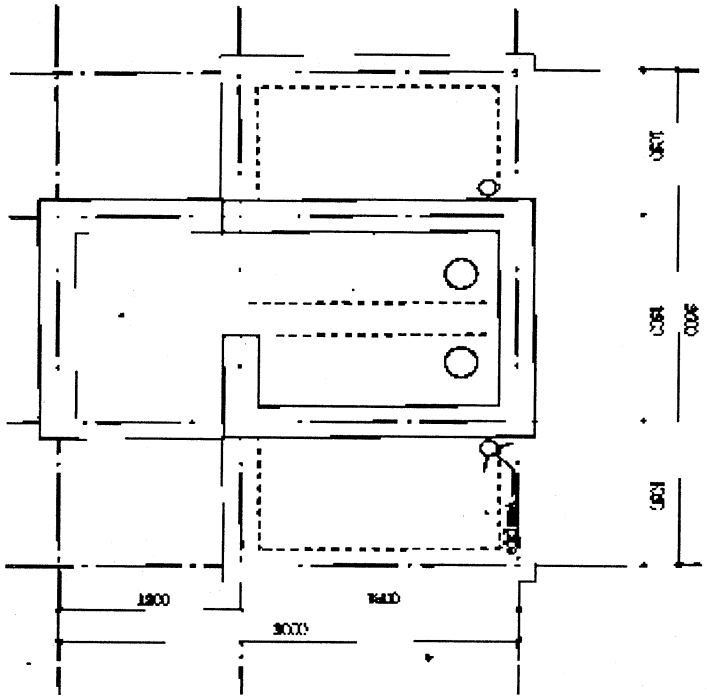
14.2 How a VIP Works

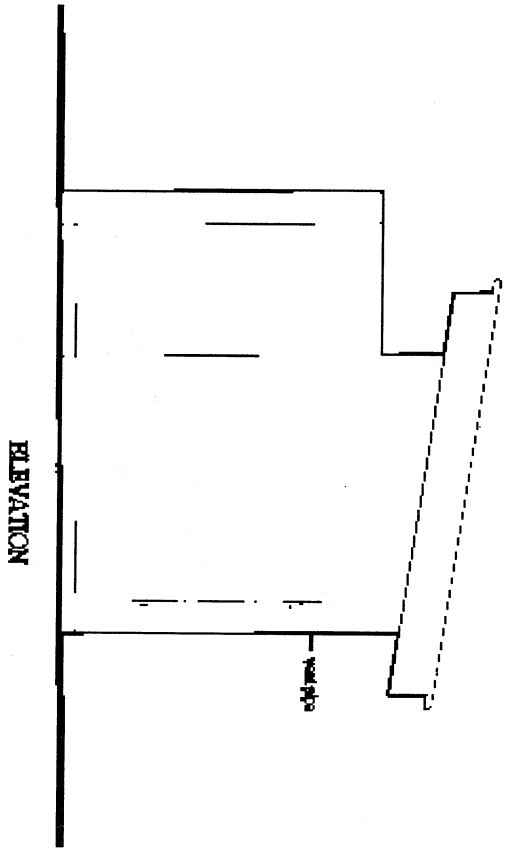
SINGLE PIT DOUBLE COMPARTMENT VIP TOILET





DOUBLE PIT SINGLE COMPARTMENT VIP TOILET





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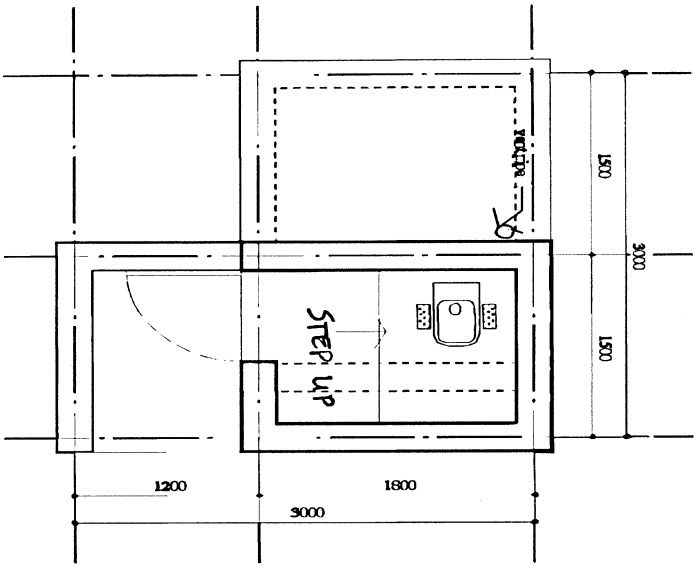
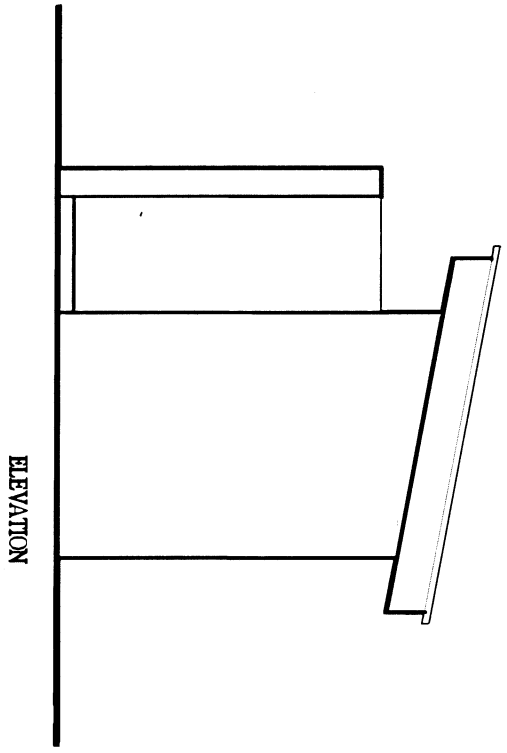
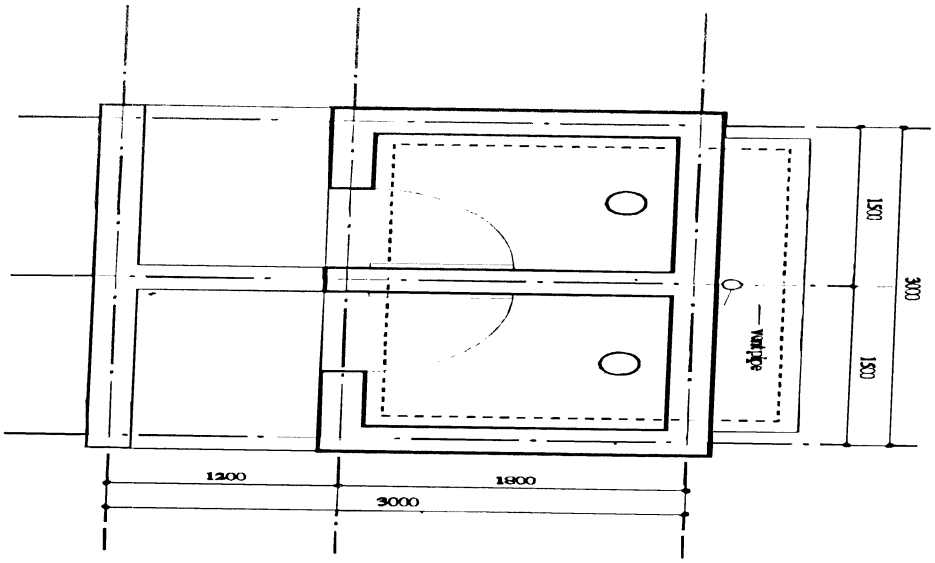
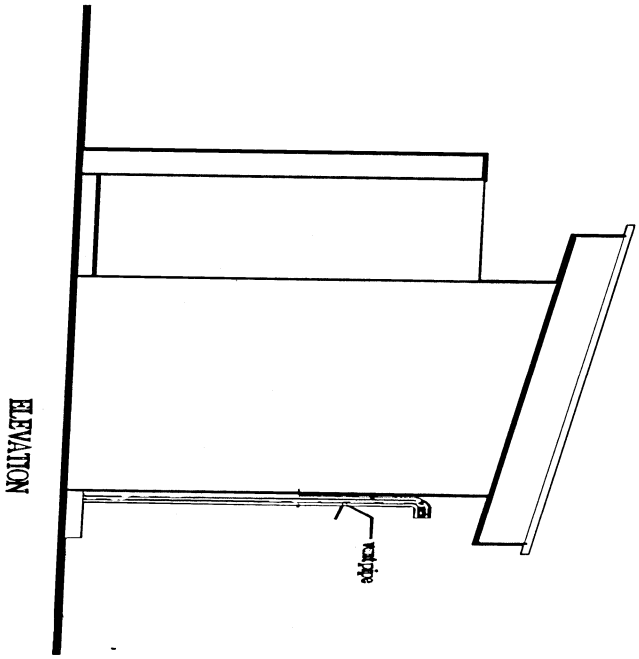


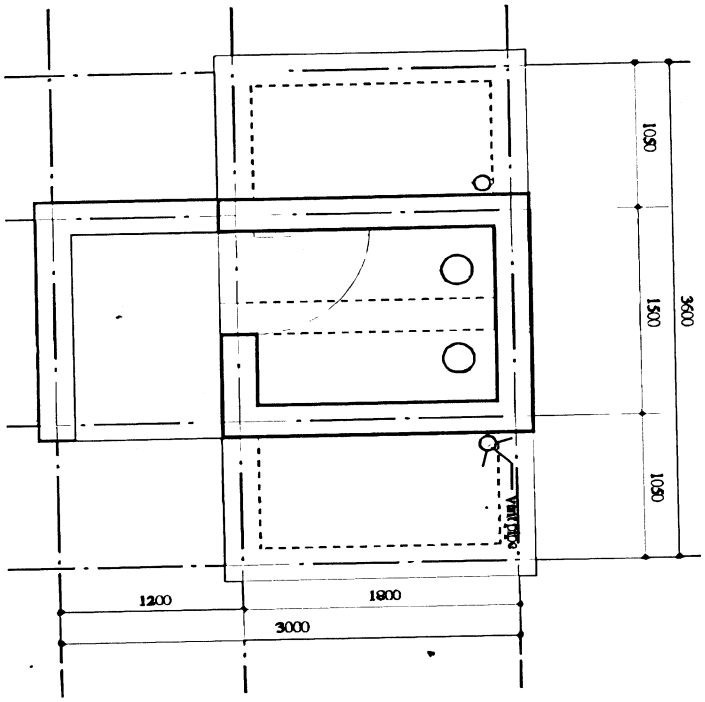


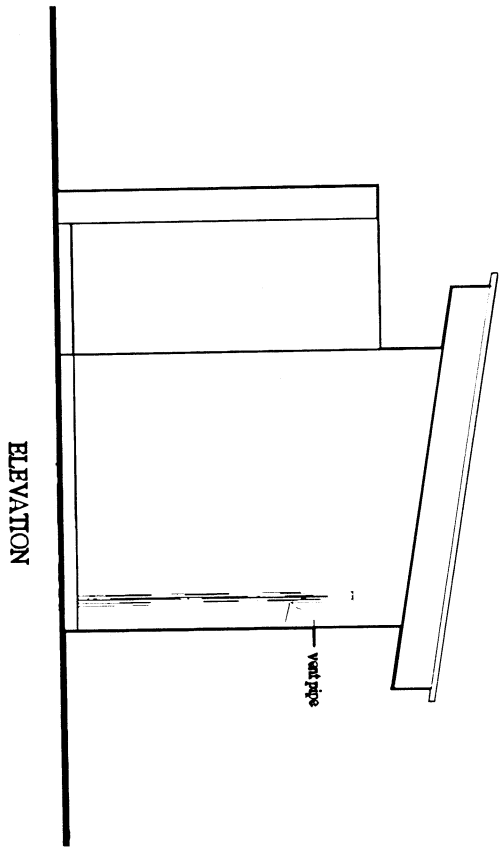
SINGLE PIT DOUBLE COMPARTMENT VIP TOILET



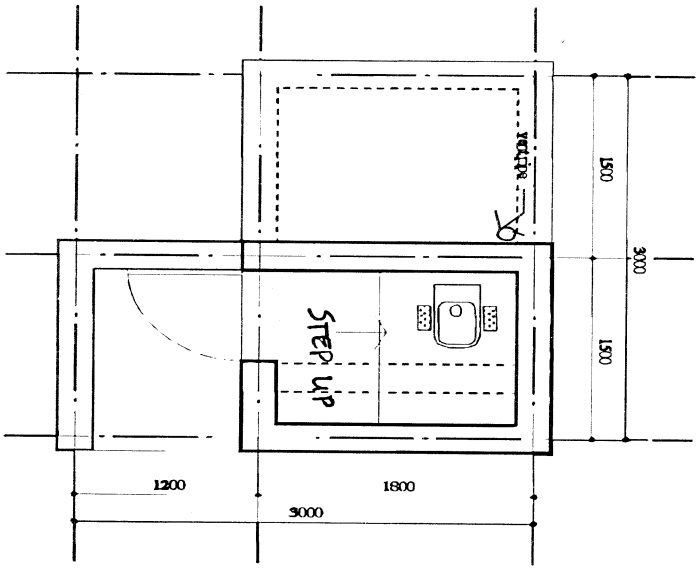


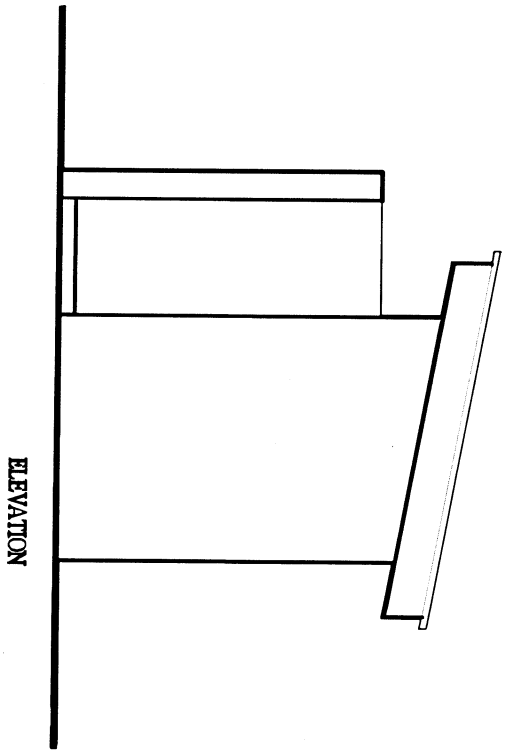
DOUBLE PIT SINGLE COMPARTMENT VIP TOILET





DOUBLE PIT SINGLE COMPARTMENT VIP TOILET





The VIP is designed to do 2 things:

1) **Not to smell.**

- The sun warms up the vent pipe and so the air inside the vent pipe get hotter.
- This causes the air inside the pipe to rise up and out through the top of the pipe. Because the vent pipe goes into the pit, fresh air is sucked down the squat hole.
- This keeps the air fresh, inside and outside the VIP.

2) **Trap flies which would spread disease.**

- Flies are attracted down the squat hole by the smells.
- When the flies want to leave the pit they fly towards the light.
- Since the inside of the VIP should be dark, the only light the flies in the pit can see is up the vent pipe. The flies fly up the vent pipe are trapped by the mesh at the top and die.
- This stop the flies spreading disease and keeps the inside of the VIP free of flies.

To make all this happen it is important to follow the designs carefully.

ACTION	REASON
Do not put windows in the VIP or	The flies will see the light through the squat hole and come out this way.
Paint the vent pipe black, because	Black absorbs more heat, so the pipe will get hotter and cause the bad air to rise fast.
Position the vent pipe on the sunny Side of the VIP, so that	The pipe gets as hot as possible
Put the door facing the prevailing winds,	So that the air moves through the VIP hole and the vent.

14.3 Siting the VIP

V.I.P means VENTILATED, IMPROVED PIT LATRINE
VIP'S are simple structures, but there is still a lot of detail to follow if they are to work correctly.

Follow each step carefully:

- Avoid sites with very sandy soil if possible, because the pit is more likely to collapse.

- The VIP must be at least 15 metres but ideally 100 metres from any well. Build the VIP downhill from the well to reduce the chances of polluting the water.

- The bottom of the pit should be at least 2 metres above the water table, even in the rainy season.

- Site the VIP so that the vent pipe is on the sunny side and the door faces the direction of the prevailing winds.

14.4 Constructing the VIP Latrine

a) Digging the Pit

- Dig the pit 0.9 metres wide and at least 3 metres deep.
- Ensure the sides are vertical and it will not collapse.
- In unstable soil dig the pit 1.2 metres wide and line it with bricks or blocks built up on top of concrete foundation or a 50mm deep ring of concrete. The lining must have holes in it to let liquids soak out of the pit.

b) The Foundation

The Foundation of the VIP has 2 purposes :

- It reinforces the top of the pit, stopping the pit from collapsing,
- it supports the walls of the VIP.

PROCEDURE

i) Remove the top soil above the pit as shown in the plans. For a singlecompartment VIP, the hole should be a rectangle, about 2.5 metres long, 1.5 metres wide and 0.3 metres deep. It is not central over the pit.

ii) In unstable soil, make a 100mm deep concrete around the top of the pit. Build a wall on top of this up to ground level.

iii) Pack the rectangular hole with hardcore or laterite. Compact it well.

c) The Slab

The slab is reinforced concrete and supports the main structure.

- You can either cast the slab in-situ over the pit, or make a pre-cast slab and lift it into position.

- There will be two holes in the slab, the squat hole and the vent pipe hole. Block the position of these holes. The vent pipe hole can be made with a short length of pipe. You can make the shape of the squat hole with damp cement : sand mix (1 : 10). Leave it to harden overnight.

- Metal reinforcing bars are required to give the slab strength. The bars should be 10 or 12mm in diameter. Cut the reinforcing bars to fit the slab.

- Prepare the concrete mix. The mix should be 1:2:4 and quite dry.

- Pour the concrete into the mould carefully to a depth of 20 – 30mm. Make sure it fills all the corners and be careful not to disturb the objects put in to make the holes.

- Place the reinforcing bar on the concrete, as shown in the illustration above. The bars should be about 200mm apart. Tie the bars together where they cross.

- Fill the rest of the mould with concrete, making a slight depression down to the squat hole.

- Compact the concrete using tampers until moisture comes through. This gets rid of all the air bubbles in the concrete.

- Smooth and polish the surface to make it easy to clean

- When the surface is firm, cover the concrete with a sand layer about 30mm deep. Leave the concrete to cure for several days, but make sure the surface is kept moist while curing is taking place.

- If you made a pre-cast slab, lift it into position when the concrete is completely cured.

d) The Structure

- Leave the sand layer on the slab, it will protect the surface while the VIP is being completed.

- Build the walls of the pit latrine as shown in the plans. Build wire ties into the walls to secure the vent pipe.

- The roof sheets are supported on purlins. Soak the purlins with termite protection, such as Solignum, before fitting them. The roof should slope from front to back.

- Plaster the walls and paint the outside of the VIP .

e) The Vent Pipe

- The vent pipe should be long enough to extend at least 500mm above the highest part of the roof.

- Metal or asbestos pipes should have an inside diameter of at least 100mm. Brick vent pipes should be 200mm square and the inside should be smoothly plastered.

- Paint the vent pipe black

- Remove the blocks used to make the holes and place the vent pipe in position. Secure the vent pipe to the wall with the wire ties.

- Make sure the joint between the vent pipe and slab is well sealed, to stop flies and bad air escaping.

- Fix a fine mesh fly screen over the top of the pipe. This is VERY IMPORTANT. The mesh traps the flies, preventing them from escaping. Use nylon mesh if possible, since this will not rust.

- Break open the squat hole and brush the floor clean.

The VIP is now complete and ready to use

RECOMMENDATIONS

- *Keep VIP's as far away from wells as possible at least 15.0 m*
- *Make sure the pit is deep and stable*
- *Reinforce the slab*
- *Do not put windows in your VIP so that flies are forced to follow through the vent-pipe*
- *Put the vent pipe on the sunny side of the VIP and paint it black – helps to heat the air in the vent-pipe therefore improving the removal of bad air.*
- *Have the door facing the prevailing winds to enhance ventilation.*
- *ALWAYS cover the vent pipe with mesh to trap flies.*

15

Glossary of Technical terms

Glossary of Technical Terms

A/C Sheets	-	asbestos cement roofing sheets
Aggregates	-	the stone chippings that are mixed with cement to make concrete and mortar.
Apron at the	-	the area of concrete laid around a well or down stream side of a bridge or culvert.
Back fill	-	the hardcore or laterite used to refill excavations in building.
Bay	-	a slab is divided into sections called "bays" to avoid problems associated with pouring a very large slab.
Bord	-	the pattern of bricks laid in a wall
Plaster Sand	-	fine sand (also called pit sand)
Builder's Square	-	instrument used to obtain right angle (90^0)
Camber	-	the angle on a road to improve drainage
Cast	-	making something into a particular shape
Cast in-situ	-	casting in place, eg. casting a lintel on a wall

Compacting	-	hammering concrete or hardcore to make it stronger
Culvert	-	drainage pipes laid under a road
Curing	-	hardening process of concrete and plaster
Damp proof Course	-	laid in walls above slab level to stop damp
Damp proof membrane	-	Plastic sheets laid under a floor slab to stop damp rising.
Range	-	tool used in plastering to obtain level surface
Emulsion	-	water based paint
Float	-	flat metal or wooden tool used to smooth concrete and plaster.
Floor screed	-	thin top layer of a floor
footing	-	concrete layer at the bottom of the foundation trench
formwork	-	sides of a mould. Temporary support for wet concrete
foundation wall	-	bricks or blocks below slab level
foundation	-	materials, usually concrete, on top of which a building is erected.

Gables - pointed end walls of a building

Gloss - oil based paint

hardcore - mixture of strong, coarse materials such as stone, gravel, broken bricks, etc.

laterite - strong red coloured soil

levelling - making sure something is exactly horizontal

line level - small spirit level which is hung on a line to check foundations, slabs etc are horizontal

lintels - beams put over door and windows openings, usually reinforced concrete.

Load bearing walls - walls which have to support a considerable weight e.g the roof or an upper floor.

Mass concrete - concrete which includes large stones (up to 6cm across) in the mix.

Mix - the blending of materials used to make concrete and mortar.

Mortar - cement and sand mix used to fix bricks in place

Formwork - container used to give a special shape to some materials e.g. concrete lintel, brick.

Non-load

Bearing walls - walls which do not have to support any additional weight.

Parts - the term used to describe the quantity of each material in a concrete or mortar mix.

Plaster sand - fine sand (also called building sand)

Plaster - mortar mix use to cover walls

Plumb - vertical

Plumb bob - tool used to check if a surface something is vertical

Pointing - tidying up mortar joint in brickwork or block work

Pre-cast - concrete which is cast at some distance from its intended final position.

Profile boards - boards used in setting out a building

Purlins - supports which roof sheets are fixed to

Putty - used to fix windows panes into frames

Rafters - large roof timbers the main slanting frame of roof that purdins are fixed to.

Raking out - removing a little mortar from joints to provide a good surface for plaster.

Reinforcement bar - metal rods used to reinforce concrete

Reinforced

concrete	-	concrete strengthened with metal rods
Ridge	-	top of roof
Ring beam	-	strip of reinforced concrete laid completely around walls to give a building more strength.
Roof ties	-	wires built into walls and used to fix down roof timbers.
Rubble	-	any solid waste materials e.g broken blocks, bricks and stones.
screeds	-	strips of accurately laid plaster
seasoning	-	drying process for timber
setting out	-	normal process of a building drying out and/or compressing the soil it is built on.
settling	-	normal process of a building drying out and/or compressing the soil it is built on.
Sharp sand	-	coarse sand
Silt	-	very fine particles in soil- between sand and clay
Slab	-	large are of concrete support for a floor.
Spirit level	-	tool used to check things are horizontal and vertical
square	-	exactly 90 degrees, or a right angle
stable soil	-	firm, undisturbed soil which will support a building and not change shape whether wet or dry.

Straight edge	-	length of metal or wood, used to check things are straight.
tampers	-	heavy weight, used to compact concrete
timber	-	sawn wood
topsoil	-	the soil nearest the surface best for plants but not stable enough for building
topsoil	-	the soil nearest the surface best for plants but not stable enough for building
trusses	-	large triangular wooden structures supporting the roof
unstable soil	-	weak soil, such as clay or very loose sand
V.I.P	-	Ventilated Improved Pit Latrine
Wall plate	-	timber laid on top of a wall, which the roof timbers are attached to
Warping	-	bending and twisting of wood as it dries