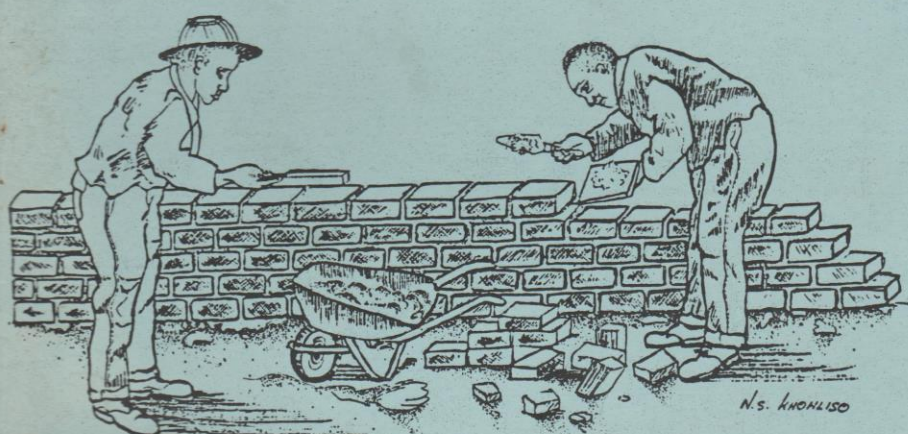
BOOK 3 SELF-HELP SERIES

GUIDE TO SOIL-CEMENT BUILDING

R4-00



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☐ TABLE OF CONTENTS

□ LIST OF FIGURES

NOTE: There is no Figure 5.5.

□ FOREWORD

Self-help building is not a new concept, in fact the vast majority of housing throughout the world is owner-built. Building your own house is the logical solution to housing your family within your financial means. Besides the added advantages of;

a) A house that is specifically designed to suit your families needs
b) A house that suits your particular site conditions
c) The satisfaction of knowing that your house is well built because you were intimately involved with every aspect of its construction.

The intent of these booklets is to provide the reader with information on how to go about designing and building simple buildings with soil-cement blocks. It is not intended to make an expert builder out of the reader but rather to provide necessary advice and details for the layman.

There are literally thousands of books on how to build simple structures with many different types of materials and techniques. TATU has a great many of these in its library at Mt. Pleasant.However, these books are generally not suitable for local conditions in Transkei. This booklet brings together, in simple language, the technical information and techniques necessary for basic building construction. The building technology presented here is both simple, low cost and appropriate to Transkei. A further objective is to help builders to understand exactly how a building is put together and why certain things are necessary, such as level foundations and brickforce are necessary. If the guidelines given in this booklet are understood, learned and used by builders in Transkei there will be a significant improvement in the standards of rural buildings. The people using these guidelines should get better housing value for their time and money.

W.G.SOAL

part 1 INTRODUCTION

The use of soil-cement in building construction is not a new technology and has in fact been used in many countries throughout the world. It is however a relatively new technology to Transkei and therefore warrants further explanation.

A broad definition of soil-cement is natural soil that has been "stabilized" by the addition of cement to enhance the best qualities of the soil and at the same time impart other properties which the soil alone does not possess. The stabilization process consists of taking the soil from the earth, pulverizing it, adding to it a small amount of cement (usually about 5% by volume), adding water until optimum moisture content is reached, and subjecting it to moderate pressure. The result is a material able to bear a much higher work-load than could be carried by soil without cement, and durable enough to withstand the continuous effects of atmospheric agents.

The obvious advantages of soil-cement blocks are:

1. They can be made on site, using material excavated locally,thereby reducing transport costs.
2. They require a relatively small capital investment
3. It is easy to learn to make the blocks and even women and children can utilize the machine.
4. They are far cheaper than more conventional baked bricks or concrete blocks.
5. The insulative properties of soil-cement blocks are superior to both baked bricks and concrete blocks.
6. Soil-cement blocks, if made and cured correctly, can meet the standards for single storey construction set by the SABS.

A major criticism of soil-cement blocks is that they are susceptable to water erosion. However, simple tests carried out by TATU have indicated that if made correctly they do not easily break down when submerged in water for long periods. TATU has blocks which have been submerged in water for over 6 months without showing signs of deterioration, as well as a rain water tank, made of soil-cement blocks, which seeps water continually, yet the blocks still remain solid.

Not withstanding the above, certain precautions can be taken to protect the blocks from the detrimental effects of water. These include damp-proofing, water resistant finishes, etc all of which are described in detail in this booklet.

part 2 ☐ GENERAL PRINCIPLES

2.1. Introduction

A good building will be designed so that:

1. It can be built with the money and skills available
2. It will meet the needs of the users
3. It will be easily expanded in the future
4. It uses locally available resources such as stone, earth, wood, etc

Another important thing to consider when designing or constructing a building is where it will be built and which way (north, south, east, or west) it will face. Site selection and the position of the building on the site are influenced by four important factors:

1. LOCATION : is the building going to be built at a place (location) where it will be close to most of its users.
2. TERRAIN : Is the land flat, hilly or mountainous? Is it well drained or marshy and wet? Are there rocks to move or dig through?
3. SIZE OF SITE : Is there enough land for the building and future additions?
4. CLIMATE : The temperature, prevailing winds, and rainfall all affect the comfort and health of the people using the building.

Before construction of the building can begin or plans can be drawn the builders need to consider three things:

2.1.1. site & position

* What land will the building be constructed on?
* Where on this site will the building be place?

(Figure 2.1)

Fig. 2.1

2.1.2. size, shape & floor plans

* How many rooms will the family or community need?
* What size will each room be?
* How will each room be placed in relation to the others (that is, what will the floor plan be)?
* What shape will the building be? Round? Rectangular? Some other shape?
* Will there be a ceiling and if so
* How high will the ceiling be?
* Where will doors and windows be?

(Figure 2.2)

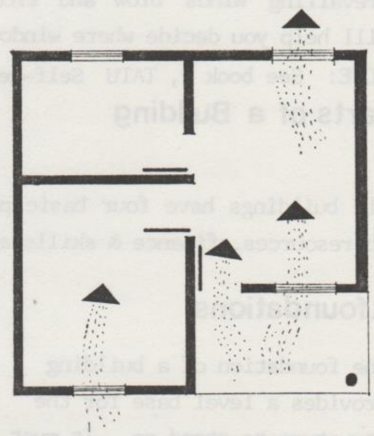


Fig. 2.2

2.1.3. construction materials

* What will the foundation and floor be made of?
* What will the walls, windows, and doors be made of?
* What will the roof be made of?

(Figure 2.3)

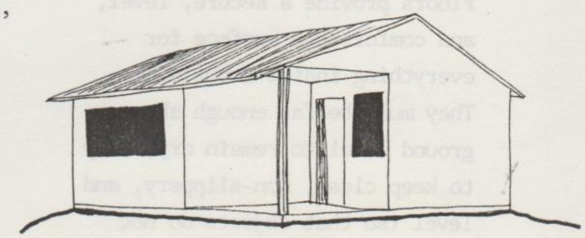


Fig. 2.3

2.2. The Building Site

This is the place where you are going to build and you must try to work out the best way to use the site.

The first thing to establish is where north is on your site as the north facing side of your building will be the sunny side and therefore the warmest and brightest side. (See figure 2.4)

The next consideration is to establish the direction from which the prevailing winds blow and from which the rain comes. Knowing this will help you decide where windows and doors should be placed.

NOTE: See book I, TATU Self-help series for information on orientation.

2.3 Parts of a Building

All buildings have four basic parts and these must be designed according to resources, finance & skills available. (Figure 2.5)

2.3.1. foundations

The foundation of a building provides a level base for the structure to stand on. It must be strong enough for the building that sits on it; it must be level and plumb (straight up and down); and it must be secure from damage by water, frost & settling earth.

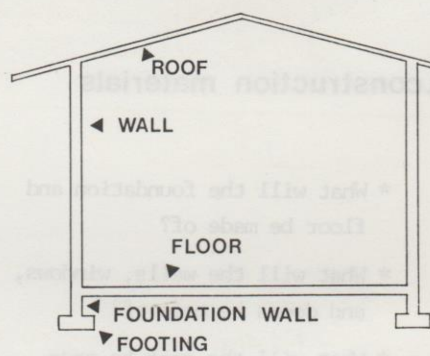


Fig. 2.5

2.3.2. floors

Floors provide a secure, level, and comfortable surface for everything inside a building. They must be far enough above ground level to remain dry, easy to keep clean, non-slippery, and level (so that objects do not roll or slide).

2.3.3. walls, doors & windows

Walls provide privacy and shelter from the elements. They also hold up the roof. They must be thick enough to protect the inside from heat or cold, strong enough to support the roof and withstand wind pressure, and high enough so that people can stand comfortably without

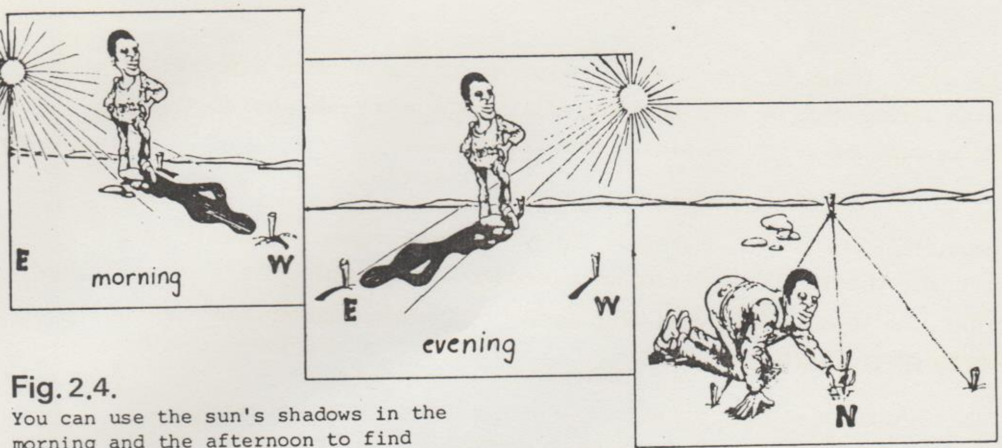


Fig. 2.4.

You can use the sun's shadows in the morning and the afternoon to find north. At sunrise, mark your shadow with 2 pegs. Put the first peg in the ground where you are standing and the second peg at the end of your shadow.

At sunset, stand at the same place and mark your shadow with the third peg. Draw 2 lines from these 2 pegs to the first peg. Then draw a line halfway between them. This line is the north direction.

Fig. 2.6.

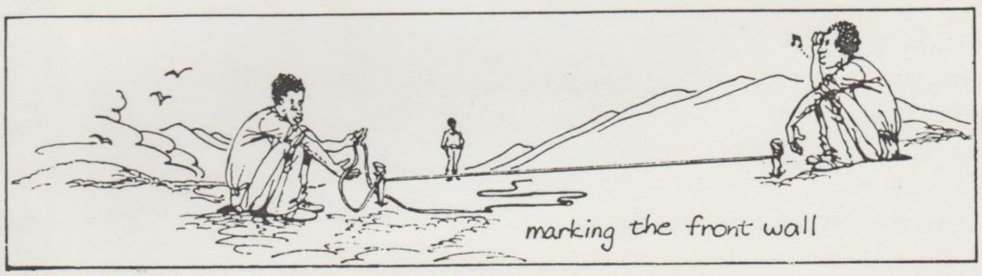
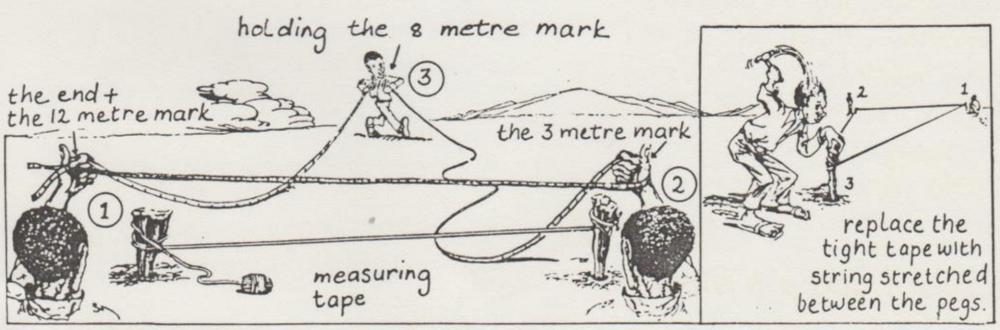
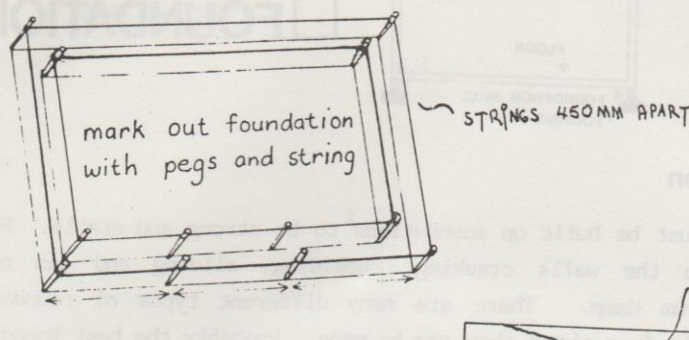


Fig. 2.7.



SOURCE: ALL THREE OF THESE FIGURES COME FROM "THE PEOPLES WORKBOOK" WRITEN, COMPILED & PUBLISHED BY THE ENVIROMENTAL & DEVELOPMENT AGENCY IN JOHANNESBURG. PAGES 477 AND 478



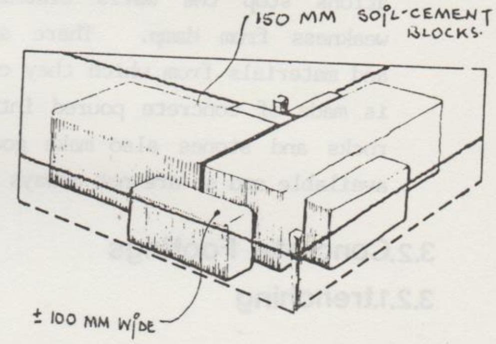
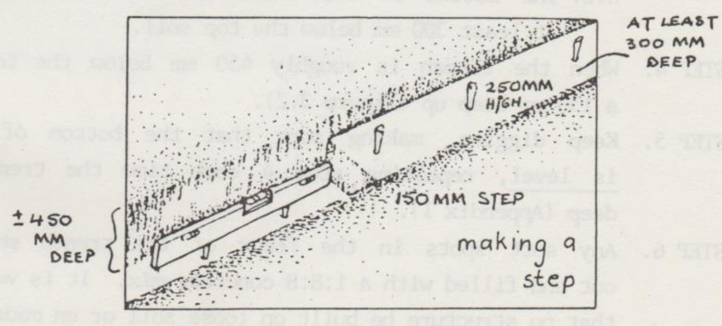


Fig.3.1.

SCOURCE: TAKEN FROM "THE PEOPLES WORKBOOK" E.D.A.

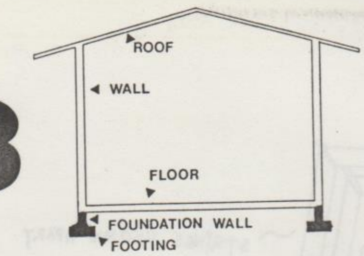
PAGES 482

Fig.3.2.



SOURCE: TAKEN FROM "THE PEOPLES WORKBOOK" E.D.A. PAGE 482

part 3



FOUNDATIONS

3.1 Introduction

All walls must be built on foundations to be strong and stable. Foundations stop the walls cracking, subsiding, sliding and can reduce weakness from damp. There are many different types of foundations and materials from which they can be made. Probably the best foundation is made of concrete poured into trenches to form a footing. However, rocks and stones also make good foundations, but these are often not available and so are not always a viable option.

3.2. Concrete Footings

3.2.1. trenching

STEP 1. Mark out the corners and then, with pegs and string mark out the foundation trench 200 mm wider than the wall will be. (Figure 3.1)

STEP 2. Mark a line on the ground with a spade or a pick using the strings as a guide.

STEP 3. Begin digging the trench at the lowest corner of the building.
N.B. The bottom of the trench should be flat / level and at least 300 mm below the top soil.

STEP 4. When the trench is roughly 450 mm below the top soil make a 150 mm step up (figure 3.2).

STEP 5. Keep digging, making sure that the bottom of the trench <u>is level</u>, repeating step 4 each time the trench gets too deep (Appendix I).

STEP 6. Any soft spots in the floor of the trench should be dug out and filled with a 1:8:8 concrete mix. It is very important that no structure be built on loose soil or on made up ground.

STEP 7. Hammer in pegs all along the trench so that the top of each peg is 250 mm above the bottom of the trench and level with those on each side of it. (Figure 3.2.).

The trench is now ready for pouring.

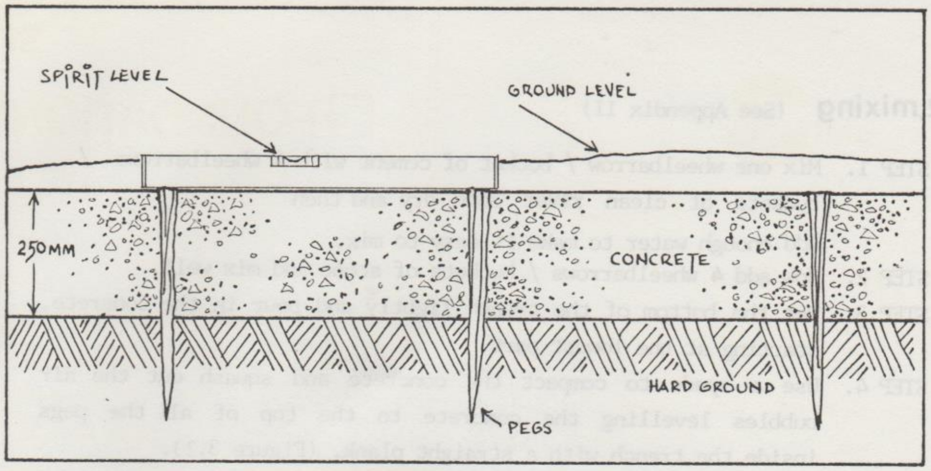


Fig.3.3.

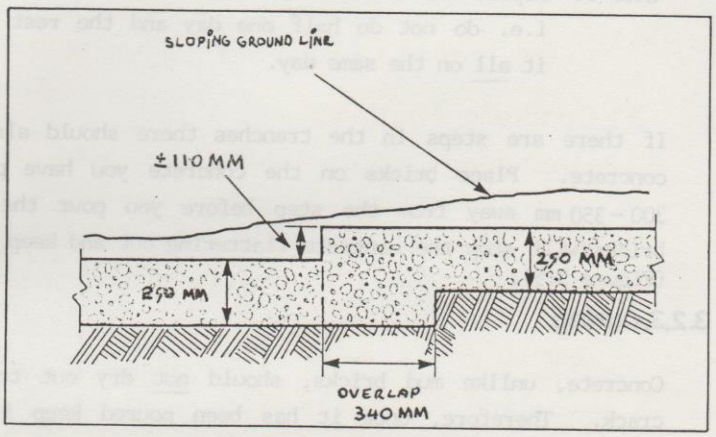


Fig.3.4.

SOURCE: "THE GENTLE ART OF CONCRETING" ARTICLE IN WEEKEND WORKSHOP APRIL 1984

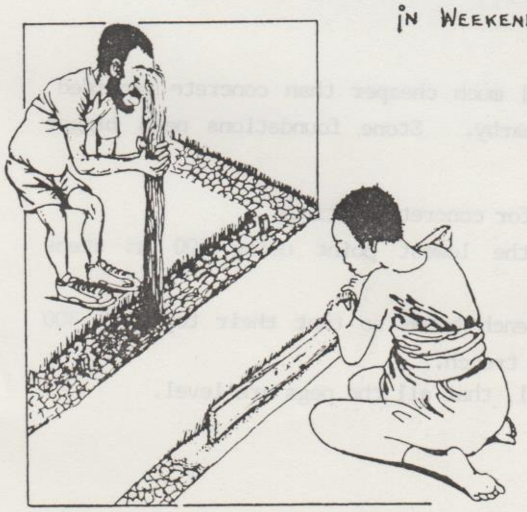


Fig.3.5.

SOURCE: "THE PEOPLES WORKBOOK" BY E.D.A PAGE 483.

3.2.2. mixing (See Appendix II)

STEP 1. Mix one wheelbarrow / bucket of cement with 4 wheelbarrows / buckets of clean river sand dry and then Add enough water to make it easy to mix.

STEP 2. Now add 4 wheelbarrows / buckets of stone and mix well.

STEP 3. Wet the bottom of the trench lightly and pour in the concrete, starting at the lowest part.

STEP 4. Use a spade to compact the concrete and squash out the air bubbles levelling the concrete to the top of all the pegs inside the trench with a straight plank. (Figure 3.3).

STEP 5. Repeat the above steps until all the footing has been poured i.e. do not do half one day and the rest the next day. Do it all on the same day.

If there are steps in the trenches there should also be steps in the concrete. Place bricks on the concrete you have poured (figure 3.4) 300 - 350 mm away from the step before you pour the next layer. The bricks will stop the concrete flattering out and keep the corners square. (Figure 3.5).

3.2.3. curing

Concrete, unlike mud bricks, should not dry out too fast or it will crack. Therefore, once it has been poured keep it wet for at least 3 days by sprinkling it with water twice a day and then covering it with damp sacks, plastic, wet grass or corrigated iron.

3.3. Stone Foundations

Stone foundations are very good and much cheaper than concrete provided there are lots of stones nearby. Stone foundations need bigger trenches (about 600 x 600 mm).

STEP 1. Mark out the trenches as for concrete footings

STEP 2. Dig the trenches from the lowest point using 200 mm steps if the site slopes.

STEP 3. Hammer pegs into the trench botom so that their tops are 300 mm above the floor of the trench.

STEP 4. Check, with a spirit level, that all the pegs are level.

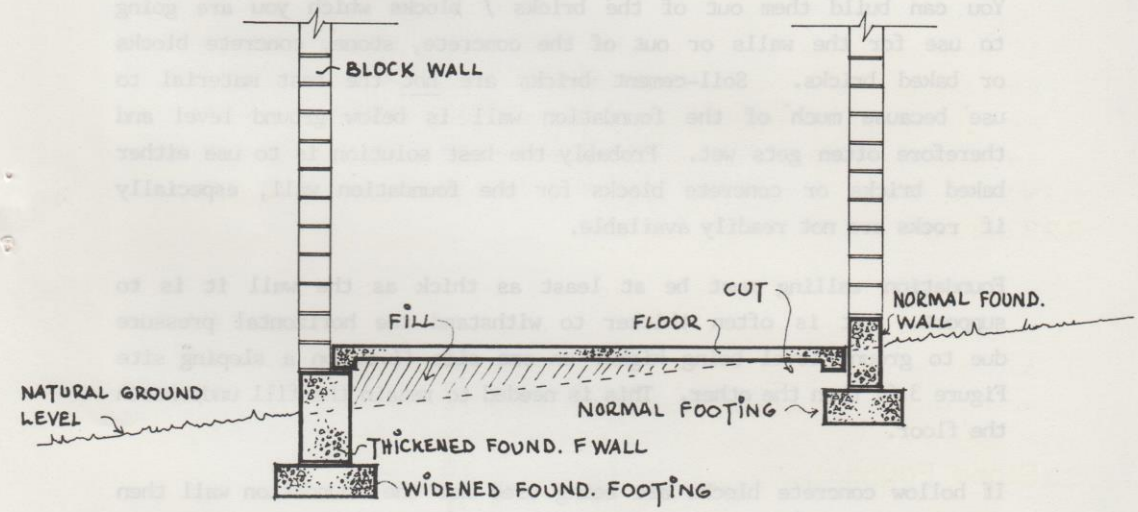


Fig.3.6. FOUNDATION DETAIL FOR A SLOPING SITE

STEP 5. Fill the trench with stones and rocks to just below the tops of the pegs.

STEP 6. Hammer the stones down with a thick plank or pole so that they are tightly packed together. (Figure 3.5).

STEP 7. Mix one wheelbarrow / bucket of cement with six wheelbarrows/ buckets of clean river sand and add just enough water to make it into a thick porridge.

STEP 8. Pour the mixture over the stones up to the tops of the pegs and level it off with a plank.

3.4. Foundation Wall

The foundation wall is the beginning of the walls of the building. You can build them out of the bricks / blocks which you are going to use for the walls or out of the concrete, stone, concrete blocks or baked bricks. Soil-cement bricks are not the best material to use because much of the foundation wall is below ground level and therefore often gets wet. Probably the best solution is to use either baked bricks or concrete blocks for the foundation wall, especially if rocks are not readily available.

Foundation walling must be at least as thick as the wall it is to support. It is often thicker to withstand the horizontal pressure due to ground level being higher on one side (i.e. on a sloping site Figure 3.6) than the other. This is needed to retain the fill underneath the floor.

If hollow concrete blocks are being used for the foundation wall then they should be filled with concrete to make them stronger.

N.B. Remember to put a plastic damproof course on top of the foundation wall before continuing the wall up. (Figure 5.2).

Fig.4.1. RAKING THE SUB-FLOOR

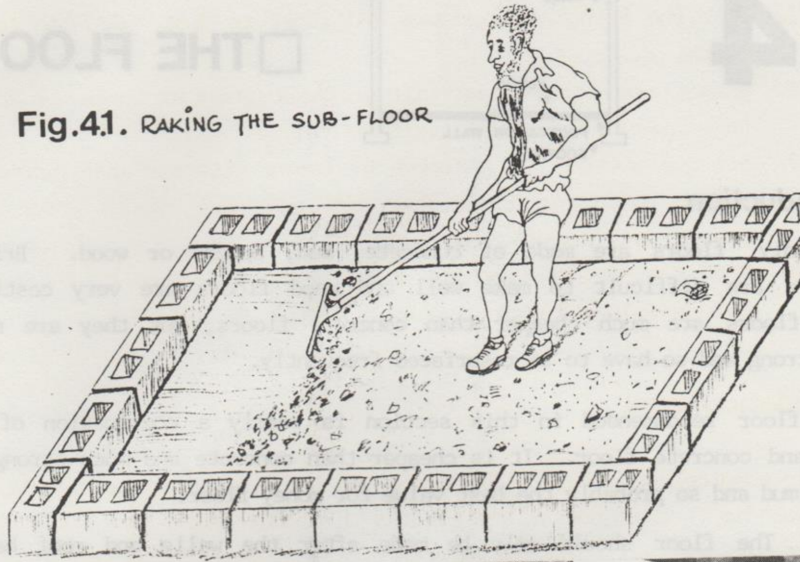
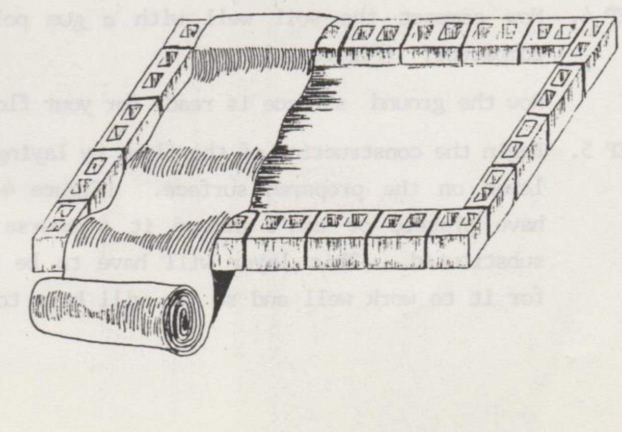


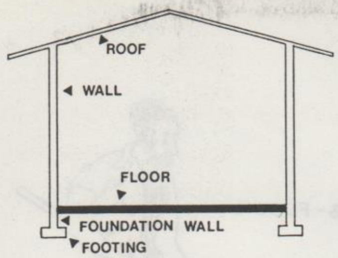
Fig.4.2. COMPACTING THE SUB-FLOOR

Fig.4.3.

D.P.M. (DAMPROOF MEMBRANE) FOR THE FLOOR



part 4 THE FLOOR



4.1.Introduction

Commonly, floors are made of concrete, mud, bricks or wood. Brick floors are difficult to make well and wood floors are very costly. Mud floors are much cheaper than concrete floors, but they are not as strong and so have to be resurfaced frequently.

The floor recommended in this section is really a combination of a mud and concrete floor. It is cheaper than concrete and much stronger than mud and so probably the best value for money floor.

NOTE: The floor should only be made after the walls and roof have been finished.

4.2.Soil-Cement Floors (See Figure 4.4 and Appendix II)

This floor is made up of a number of layers starting with the compacted base and ending with a strong coloured with the compacted base and ending with a strong coloured screed finish.

STEP 1. Excavate all the top soil and organic material until you reach the sub-soil layer. Make sure the whole floor surface is level and solid. Excavate all soft spots.

STEP 2. Rake up the top 10 mm of the bottom of the excavated floor and sprinkle a little cement all over the floor. Now rake it again to mix in the cement. (Figure 4.1).

STEP 3. Add a small amount of water, with a watering can, until the soil is just damp.

STEP 4. Now compact the soil well with a gum pole, thick plank or compactor. (Figure 4.2)

Now the ground surface is ready for your floor.

STEP 5. Begin the construction of the floor by laying a plastic damproof layer on the prepared surface. (Figure 4.3). If you don't have plastic or can't afford it a course sand layer can be substituted. This layer will have to be about 200 mm thick for it to work well and so you will have to dig deeper

STEP 6. Next mix a soil-cement mixture of 2 parts cement to 2 parts water to 16 parts cleaned and sieved soil. Compact this mixture well into the floor to a depth of 100 mm.

STEP 7. Repeat step 6 using a 3:2:15 soil-cement mixture.

STEP 8. Cure as for curing concrete section 3.2C.

4.3. Floor Finish

The sub-floor is now complete and it is not advisable to put the screed on until the walls are plastered and ceilings are finished.

STEP 9. The final layer of the floor is a 20 mm pigmented screed which provides colour to the floor and gives it a hard durable surface. See Appendix III for mixing details.

NOTE : Soil-cement floors like concrete and brick floors tend to be cold to sit on. TATU is at present exploring ways in which they can be made warmer by using sawdust in the sub-floor layers. A fact sheet on this will be published as soon as the experiments are completed, (probably mid 1985).

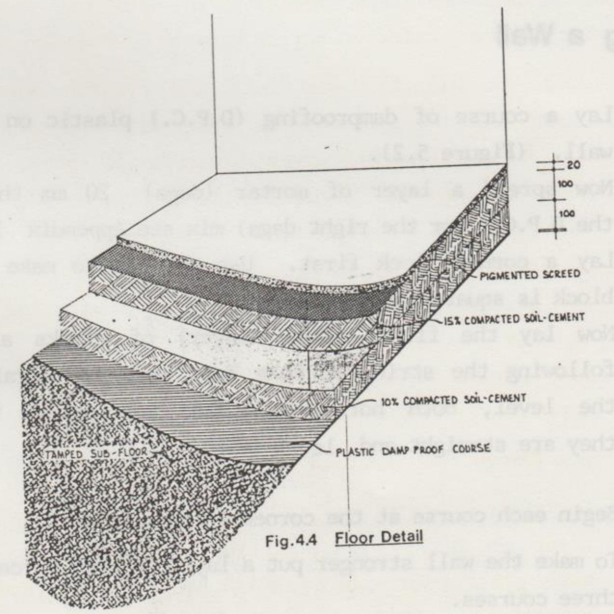
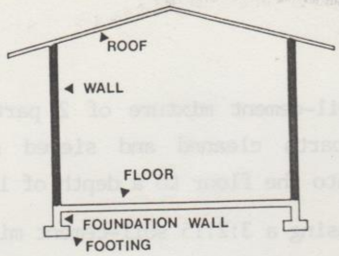


Fig.4.4 Floor Detail

part 5 □ THE WALLS



5.1.Introduction

Before work on the walls begins it is very important that the foundation wall is level. Also as each course goes up it is important that it is directly above the last one. To make sure that your wall is horizontal and vertical you will need a spirit level, plumb-line and a ball of string. You can make your own spirit level.(see Appendix I).

Another helpful tool for wall construction with bricks or blocks is a builder gauge or profile. This consists of a piece of wood marked in lengths corresponding to the height of the block plus the thickness of the mortar joint between courses. You will need two of these. (See Appendix IV).

When work begins on a wall, a plumb and level gauge / profile is placed at each end of the section of wall (figure 5.1) With the help of a taught string, attached to each gauge / profile, the courses can be kept "perfectly" horizontal and vertical.

5.2.Building a Wall

STEP 1. Lay a course of damproofing (D.P.C.) plastic on the foundation wall. (Figure 5.2).

STEP 2. Now spread a layer of mortar (daga) 20 mm thick on top of the D.P.C. For the right daga) mix see Appendix II.

STEP 3. Lay a corner block first. Use strings to make sure that the block is square and straight.

STEP 4. Now lay the first course (layer) of blocks along the wall following the string to make sure they are straight and using the level, both horizontally and vertically, to check that they are straight and level (Figure 5.3)

STEP 5. Begin each course at the corner (figure 5.4)

NOTE : To make the wall stronger put a layer of brickforce at every three courses.

N.B. : Don't forget to leave spaces for doors (i.e. the size of the door frame to fit in, once you are at floor level. (Figure 5.12). This should be at least 150 mm above ground level.

Fig.5.1. USING A BUILDING PROFILE

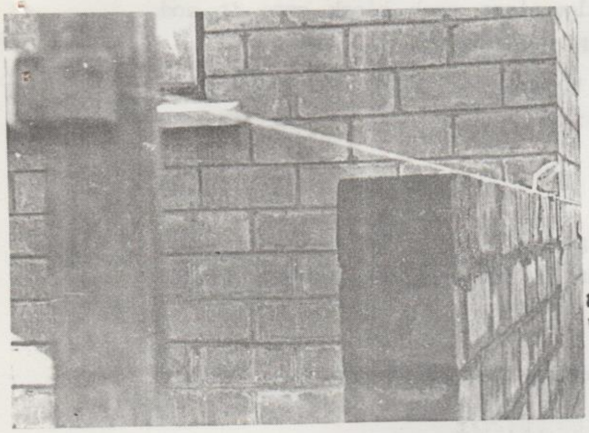


Fig.5.2. DPC FOR WALL

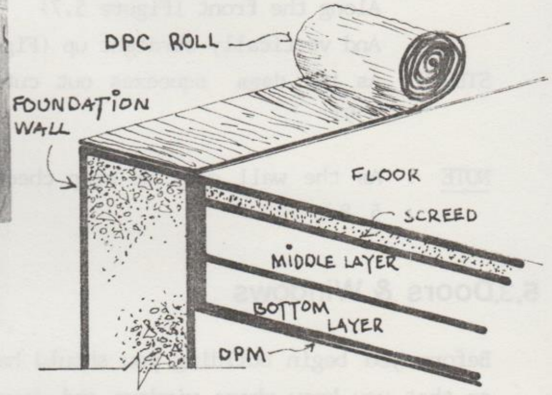
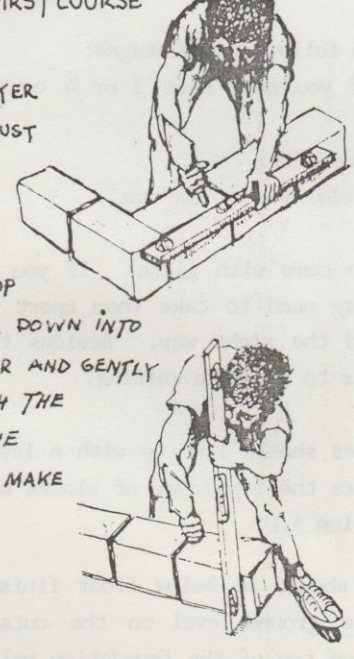


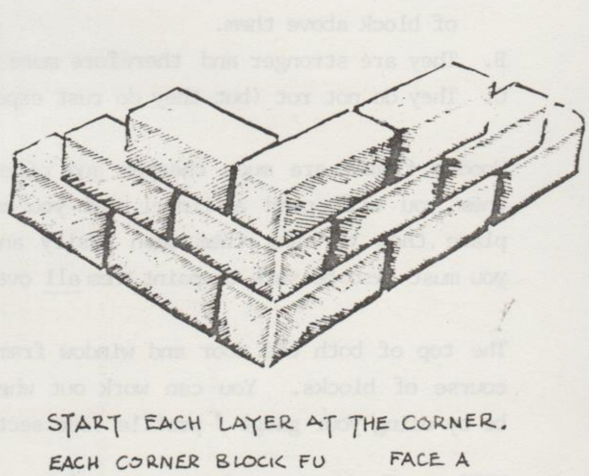
Fig.5.3. FIRST COURSE



THE FIRST LAYER OF BLOCKS MUST GO RIGHT AROUND THE BUILDING.

GENTLY DROP EACH BLOCK DOWN INTO THE MORTAR AND GENTLY TAP IT WITH THE BACK OF THE TROWEL TO MAKE IT LEVEL

Fig.5.4. CORNERS



START EACH LAYER AT THE CORNER.
EACH CORNER BLOCK FU FACE A DIFFERENT WAY FROM THE CORNER BLOCK BELOW IT

SOURCE: FIGURES 5.3 + 5.4. E.D.A "PEOPLES WORKBOOK" 1978

STEP 6. For the second layer and all others thereafter spread a 10 mm layer of daga and gently place each block onto it and fill up with daga between each block and the next one.

STEP 7. Gently tap each block down to make it level and check each block is level in 3 directions:

Along the top (Figure 5.6).
Along the front (Figure 5.7)
And vertically straight up (Figure 5.8)

STEP 8. As the daga squeezes out cut if off with the trowell (figure 5.9)

NOTE : As the wall goes up keep checking that it is vertical (Figure 5. 8)

5.3.Doors & Windows

Before you begin building you should have a plan of one sort or another so that you know where windows and door are going to be. (Figure 5.11). If you are using steel door and window frames they have to be built in as you lay the blocks. (Figure 5.10). Always put a layer of brick-force blow the window openings.

Steel frames are expensive but do have the following advantages:

A. You may not need to use lintels if you only have 3 or 4 courses of block above them.
B. They are stronger and therefore more durable.
C. They do not rot (but they do rust especially near the sea).

Wooden frames are much cheaper and often come with glass. If you use them you will need a lintel and you may need to take them apart and plane them to make them open easily and the right way. Besides this you must also be sure to paint them all over to stop the rotting.

The top of both the door and window frames should line up with a layer/ course of blocks. You can work out where the top layer of blocks will be by using your gauge / profile (see section 5.1).

NOTE : The bottom of the door frames should be below floor finished level on the inside and above ground level on the outside (150-200 mm above ground level on top of the foundation wall).

Fig. 5.6. LEVELLING THE TOP OF THE WALL

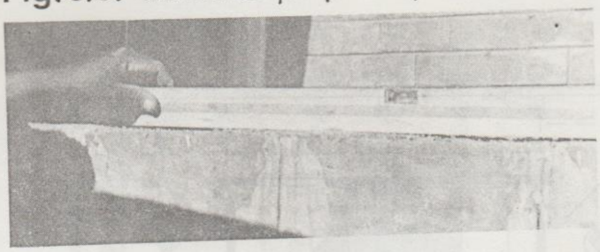


Fig. 5.7. LEVELLING THE SIDE OF THE WALL

SOURCE: THE PEOPLES WORKBOOK E.D.A. 1979

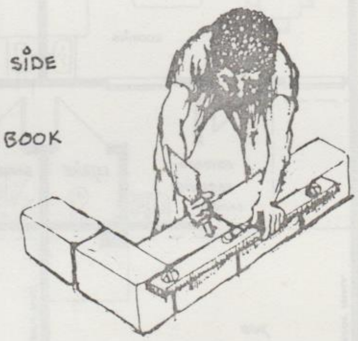
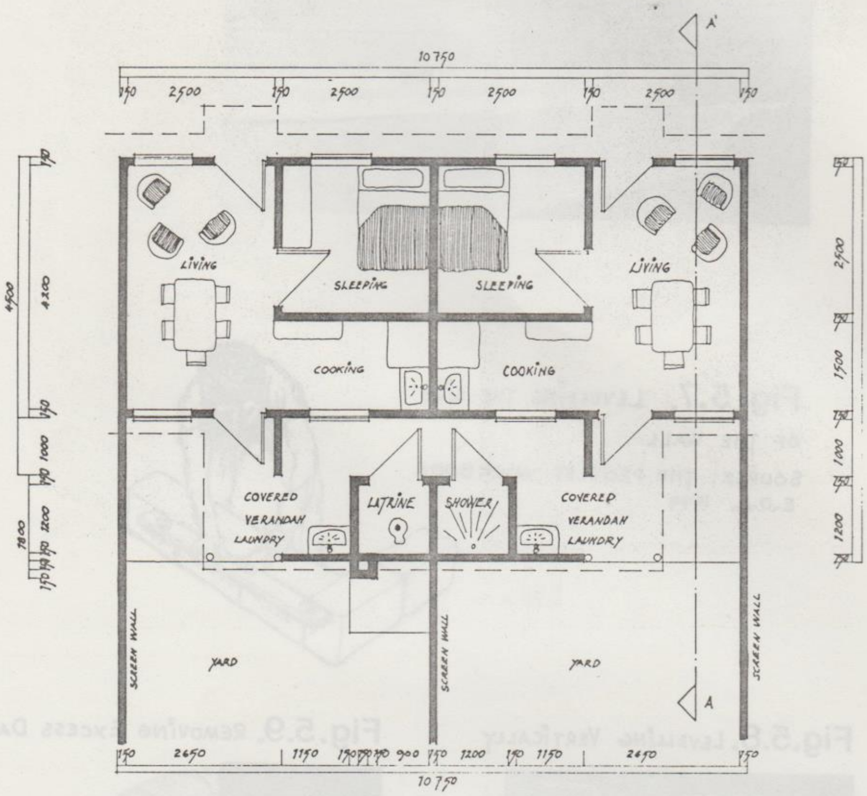


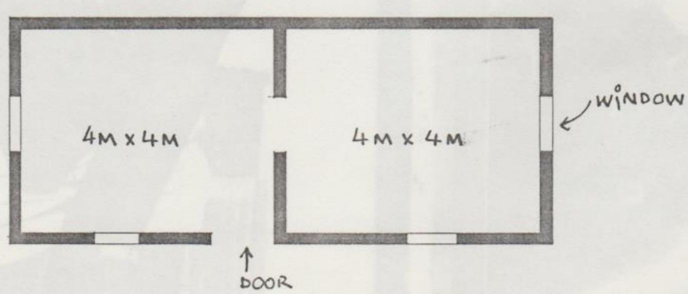
Fig. 5.8. LEVELLING VERTICALLY

Fig. 5.9. REMOVING EXCESS DAGA

Fig. 5.10.



COMPLEX FLOOR PLAN WITH DETAIL INFORMATION ON HOW TO BUILD IT, MEASUREMENTS, FITTINGS, ETC.



SIMPLE FLOOR PLAN WITH ENOUGH INFORMATION FOR A WELL KNOWN TRADITIONAL TECHNOLOGY

NOTE: THE SOURCE OF ALL THE FIGURES ON THIS PAGE IS "THE PEOPLES WORKBOOK" PUT OUT BY THE EDA. PAGES 492 + 493

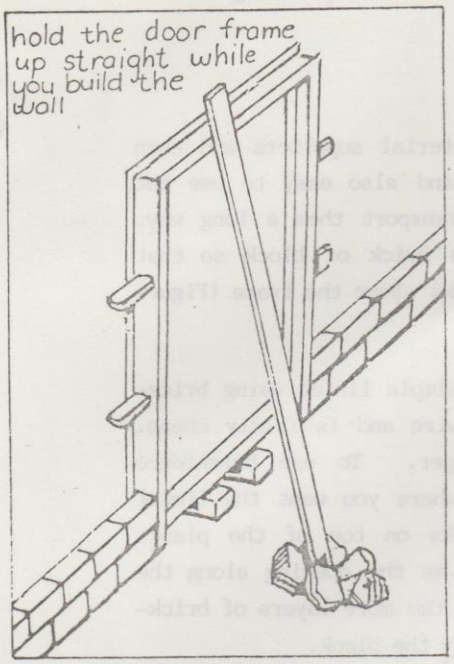


Fig. 5.11 FITTING A DOOR FRAME

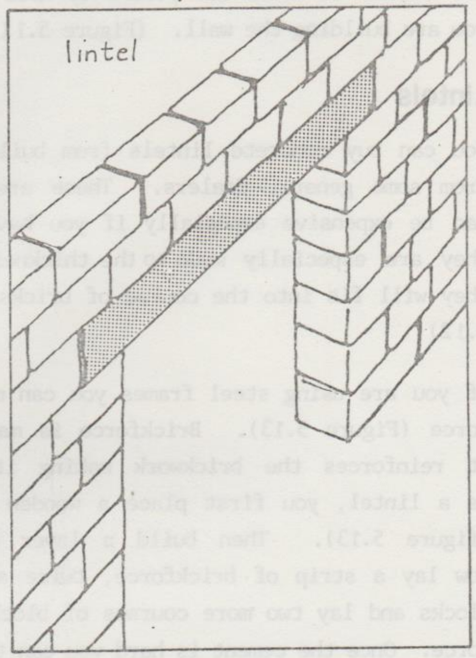


Fig. 5.12 PRECAST LINTEL

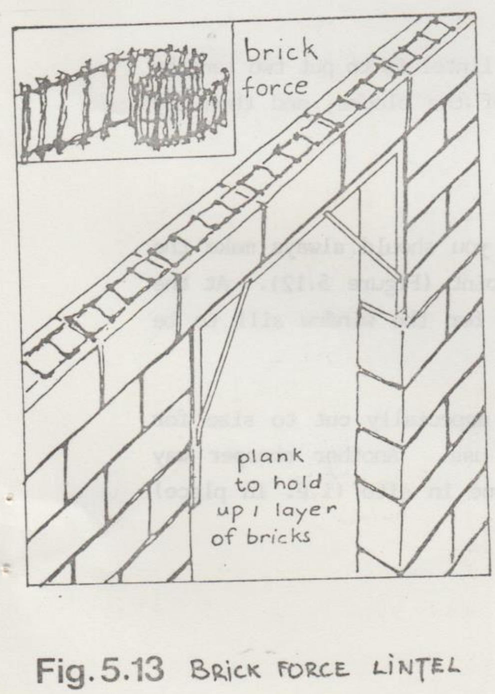
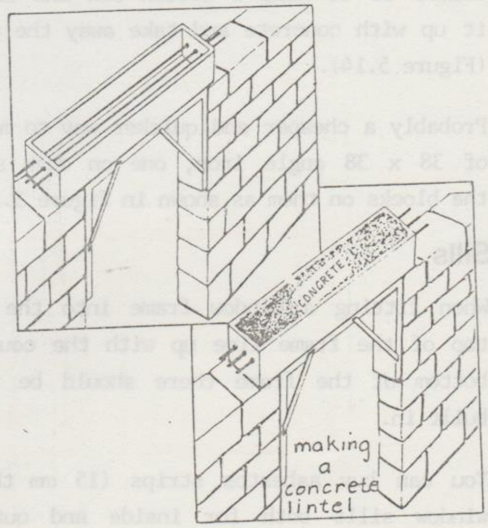


Fig. 5.13 BRICK FORCE LINTEL



You can also use U-blocks and wire to make a lintel. Lay U-blocks across a plank over the opening. Then lay 2 bars of reinforcing steel or 10 pieces or wire in the bottom of the U-block and fill the hollow with concrete.

Fig. 5.14 INSITU LINTEL

Use blocks or rocks and planks to hold the door frame up straight while you are building the wall. (Figure 5.11).

5.4. Lintels

You can buy concrete lintels from building material suppliers and even from some general dealers. These are good and also easy to use but can be expensive especially if you have to transport them a long way. They are especially made to the thickness of a brick or block so that they will fit into the course of bricks / blocks above the frame (Figure 5.12)

If you are using steel frames you can make a simple lintel using brick-force (Figure 5.13). Brickforce is made of wire and is fairly cheap. It reinforces the brickwork making it stronger. To use brickforce as a lintel, you first place a wooden plank where you want the lintel (figure 5.13). Then build a layer of blocks on top of the plank. Now lay a strip of brickforce, twice as long as the opening along the blocks and lay two more courses of blocks with two more layers of brick-force. Once the cement is hard you can take away the plank.

Another way to make your own lintel, especially if you are using wooden frames is to make a wooden box and lay reinforcing rods in it. Fill it up with concrete and take away the planks when the concrete is hard. (Figure 5.14).

Probably a cheaper and quicker way to make a lintel is to put two lengths of 38 x 38 angle iron, one on each side of the blocks, and then lay the blocks on them as shown in figure 5.15

5.5. Sills

When fitting a window frame into the wall you should always make the top of the frame line up with the course joint (Figure 5.12). At the bottom of the frame there should be space for the window sill to be built in.

You can buy asbestos strips (15 mm thick) especially cut to size for window sills both for inside and outside use. Another cheaper way of making a strong good sill is to cast one in situ (i.e. in place) out of concrete (figure 5.16).

To do this you must first make a form in which the concrete will be cast. The outside form consists of a 50 x 76 mm (purlin) plank nailed to a 25 x 114 mm plank as shown in figure 5.17. Do not forget to nail the 10 mm reinforcing bar to the form to make a drip groove. The drip groove stops water running along the sill and penetrating the wall. Also you will need some plastic to put under the sill and chicken mesh to reinforce the concrete. Use a 1 cement to 3 sand to 3 small stone mixture for the concrete. (Figure 5.16).

REMEMBER : Put a layer of brickforce under each window and above the windows as described under lintels.

(Figure 5.17)

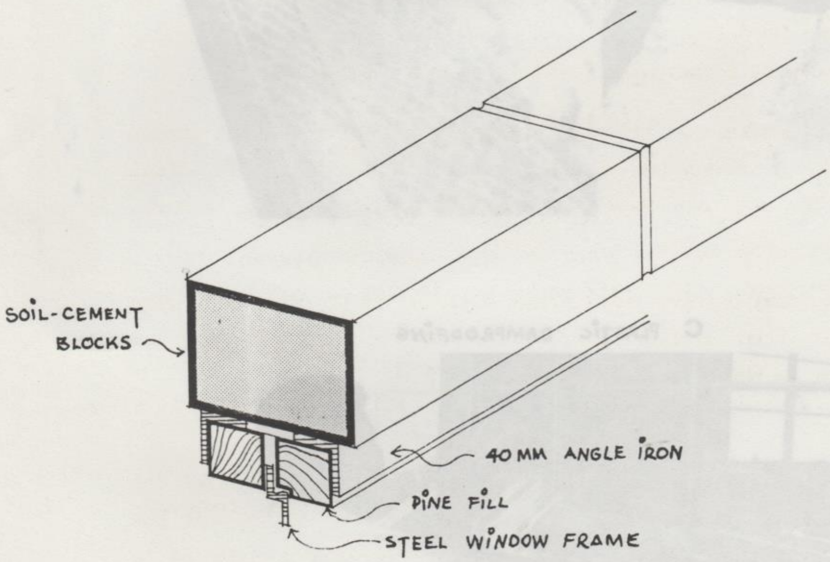
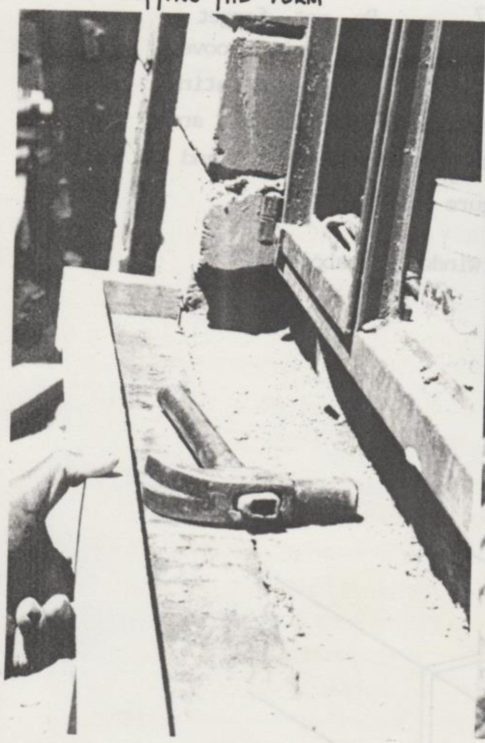
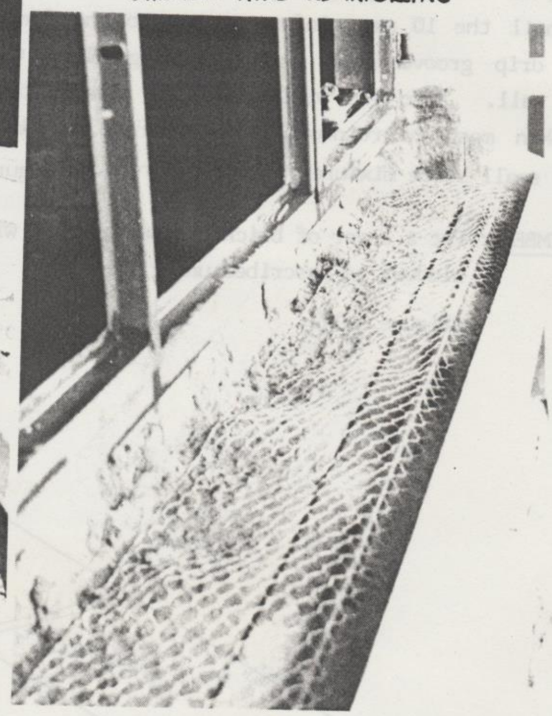


Fig.5.15. ANGLE IRON LINTEL

a FITTING THE FORM

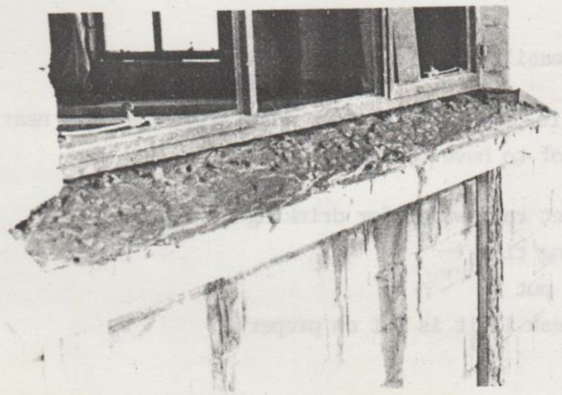


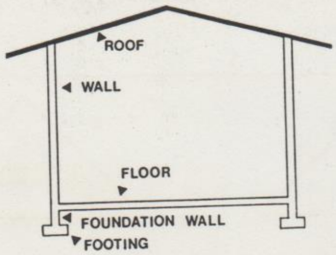
b CHICKEN WIRE RE-INFORCING



C PLASTIC DAMPROOFING

SILL PRIOR TO PLASTER FINISH





part 6 □ THE ROOF

6.1. Introduction

Probably the cheapest roofing material to use is thatch. It is also a good roof because it keeps the building cool in summer and warm in winter, grass is free or cheap and easily replaced. However, thatch has many disadvantages some of which are :

1. It is not good to collect water for drinking off a thatch roof.
2. It needs to be repaired and renewed frequently.
3. Insects like to live in thatch.
4. Grass is not always easy to come by.
5. Thatch can be messy dropping bits into your rooms and onto your things.
6. Thatch burns easily

Corrigated iron is expensive but in most areas (except near the sea) it is a better roof to have because;

1. You can collect rain water for drinking from it
2. It lasts a long time
3. It is easy to put on
4. It does not leak if it is put on properly
5. It is clean

But unless you fit a ceiling to your corrigated roof it will make your building hot in summer and very cold in winter.

Before you begin building your roof you must have decided what type of roof you are going to have and what materials you will need to build it. There are many different shapes/types of roof to choose from and your choice will depend on how big your building is and your preference (see figure 6.1).

Probably the cheapest and easiest roof to make is the nearly flat mono-pitch roof. This is the one that will be described in detail in this booklet. If your rooms or building is very big though you may need a gable roof with a truss system to support it. In this case you should contact TATU for advice.

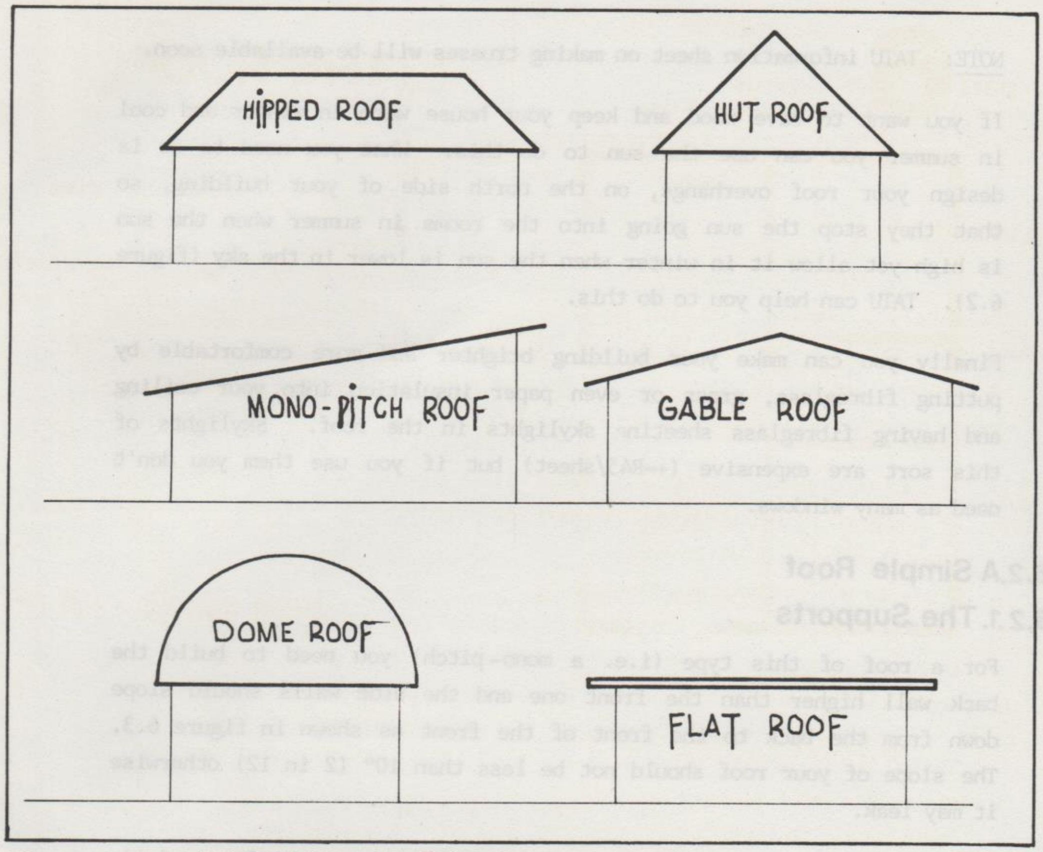


Fig.6.1. TYPES OF ROOF

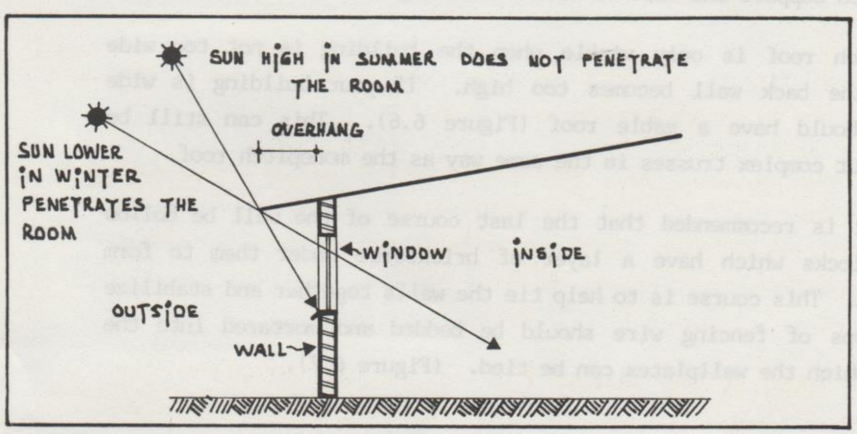


Fig .6.2. ROOF OVERHANG

NOTE: TATU information sheet on making trusses will be available soon.

If you want to save wood and keep your house warm in winter and cool in summer you can use the sun to do this. What you need to do is design your roof overhangs, on the north side of your building, so that they stop the sun going into the rooms in summer when the sun is high yet allow it in winter when the sun is lower in the sky (figure 6.2). TATU can help you to do this.

Finally you can make your building brighter and more comfortable by putting fibreglass, grass or even paper insulation into your ceiling and having fibreglass sheeting skylights in the roof. Skylights of this sort are expensive (+-R45/sheet) but if you use them you don't need as many windows.

6.2.A Simple Roof

6.2.1. The Supports

For a roof of this type (i.e. a mono-pitch) you need to build the back wall higher than the front one and the side walls should slope down from the back to the front of the front as shown in figure 6.3. The slope of your roof should not be less than 10° (2 in 12) otherwise it may leak.

For a building that has no rooms longer than 4 m (see figure 6.4). There is no need for purlings as the roof sheets can be fixed directly to the rafters. If a room is longer than 4 m then you will need an extra beam to support the rafters as shown if figure 6.5.

A mono-pitch roof is only viable when the building is not too wide otherwise the back wall becomes too high. If your building is wide then you should have a gable roof (Figure 6.6). This can still be built without complex trusses in the same way as the monopitch roof.

Finally, it is recommended that the last course of the wall be hollow concrete blocks which have a layer of brickforce under them to form a ring beam. This course is to help tie the walls together and stabilize them. Hoops of fencing wire should be bedded and mortared into the blocks to which the wallplates can be tied. (Figure 6.7).

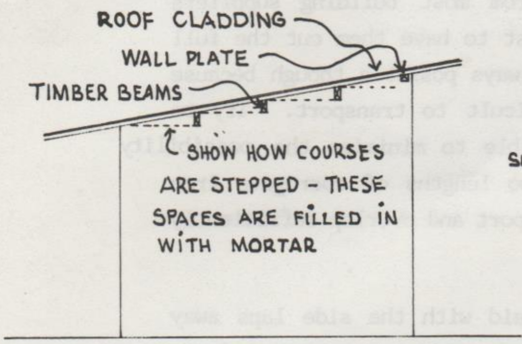


Fig.6.3 **Simple Roof**

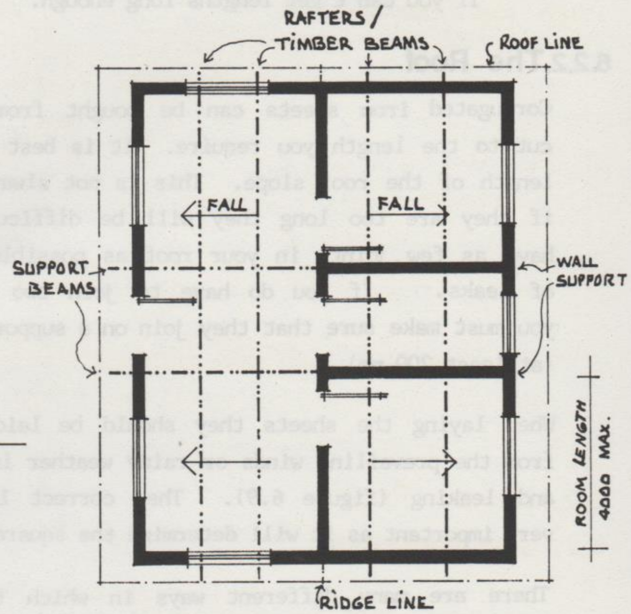


Fig.6.4 **Roof Supports**

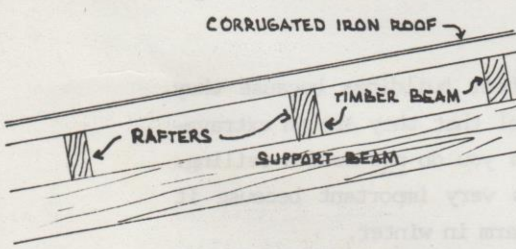


Fig.6.5 **Beam Support**

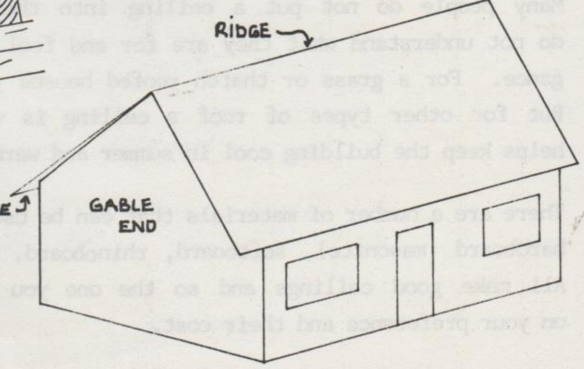


Fig 6.6 **Gable Roof**

NOTE: Figure 6.8 shows how beams rafters and purlins should be joined if you can't get lengths long enough.

6.2.2.The Roof

Corrugated iron sheets can be bought from most building suppliers cut to the length you require. It is best to have them cut the full length of the roof slope. This is not always possible though because if they are too long they will be difficult to transport. Try to have as few joints in your roof as possible to minimize the possibility of leaks. If you do have to join two lengths of corrugate iron you must make sure that they join on a support and overlap sufficiently (at least 200 mm).

When laying the sheets they should be laid with the side laps away from the prevailing winds or rainy weather in order to prevent lifting and leaking (figure 6.9). The correct laying of the first sheet is very important as it will determine the squareness of the roof.

There are many different ways in which to fasten the roof sheets to the rafter or purlin. Galvanised iron roofing screws are probably the cheapest and easiest to use. They should always be driven down straight to ensure a watertight seal. The roofing screw is driven through the crown of the sheet and should not be driven in too deeply or it will flatten out the sheet (Figure 6.10).

6.2.3.The Ceiling

Many people do not put a ceiling into their buildings because they do not understand what they are for and feel that they are an extravagance. For a grass or thatch roofed houses you do not need a ceiling. But for other types of roof a ceiling is very important because it helps keep the building cool in summer and warm in winter.

There are a number of materials that can be used for a ceiling including hardboard (masonite), softboard, rhinoboard, asbestos and many others. All make good ceilings and so the one you use will probably depend on your preference and their cost.

A ceiling is made up of three layers :

A. The first layer is the structure usually made from 38 x 38 brandering. This is nailed onto the bottom of the roof rafters in a grid pattern (figure 6.11). The spacing of the brandering will depend on the size of boards you are using for the ceiling.

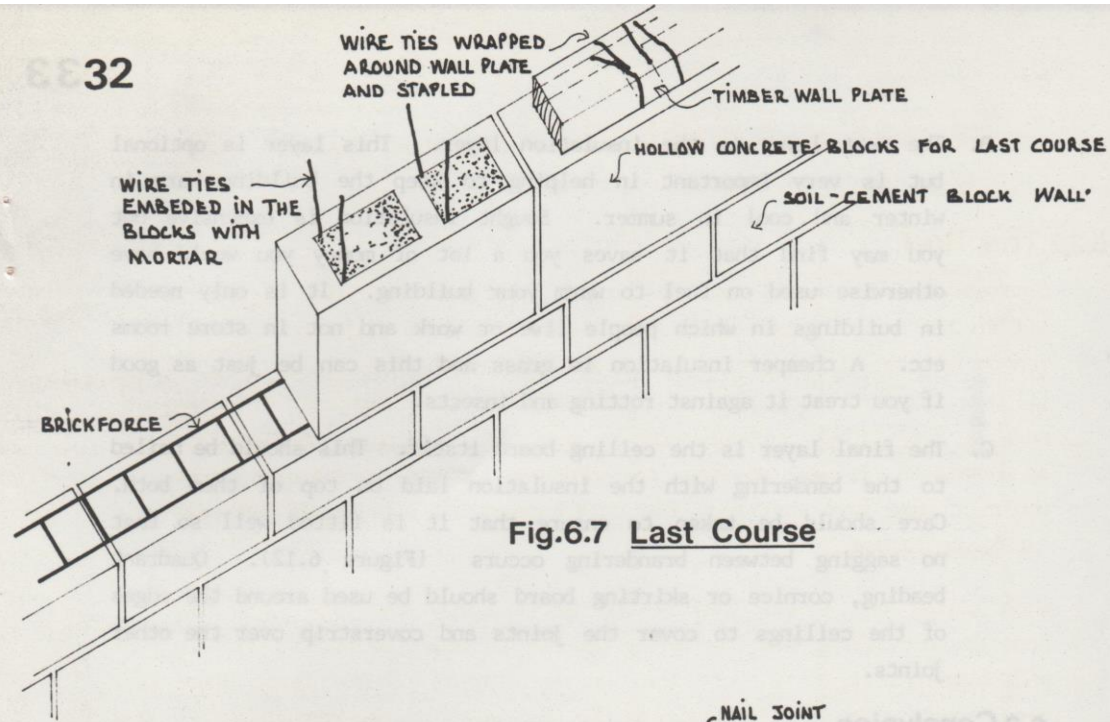


Fig.6.7 Last Course

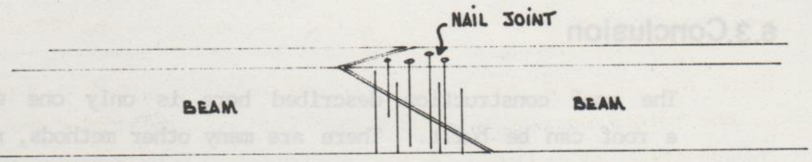


Fig.6.8 Timber Joint

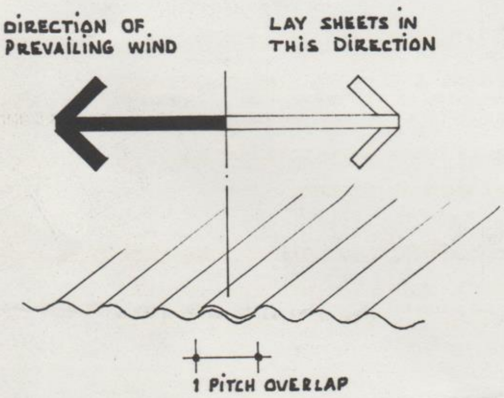


Fig.6.9 Laying Roof Sheets

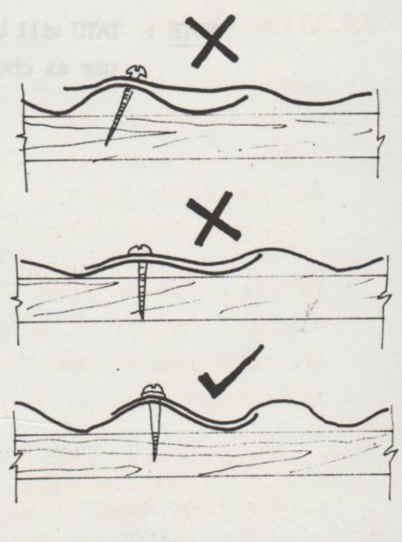


Fig.6.10 Fixing Roof Sheets

B. The next layer is the insulation layer. This layer is optional but is very important in helping to keep the building warm in winter and cool in summer. Bought insulation is expensive but you may find that it saves you a lot of money you would have otherwise used on fuel to warm your building. It is only needed in buildings in which people live or work and not in store rooms etc. A cheaper insulation is grass and this can be just as good if you treat it against rotting and insects.

C. The final layer is the ceiling board itself. This should be nailed to the bandering with the insulation laid on top of them both. Care should be taken to ensure that it is fitted well so that no sagging between brandering occurs (Figure 6.12). Quadrant beading, cornice or skirting board should be used around the edges of the ceilings to cover the joints and coverstrip over the other joints.

6.3.Conclusion

The roof construction described here is only one way in which a roof can be built. There are many other methods, many of which are just as good, the one you choose will be up to you depending on preferences, costs and skills needed. If you are stuck and need help contact TATU or seek assistance from a qualified builder.

NOTE : TATU will be distributing a booklet on how-to treat grass for use as cheap insulation.

Fig.6.11 Ceiling Detail

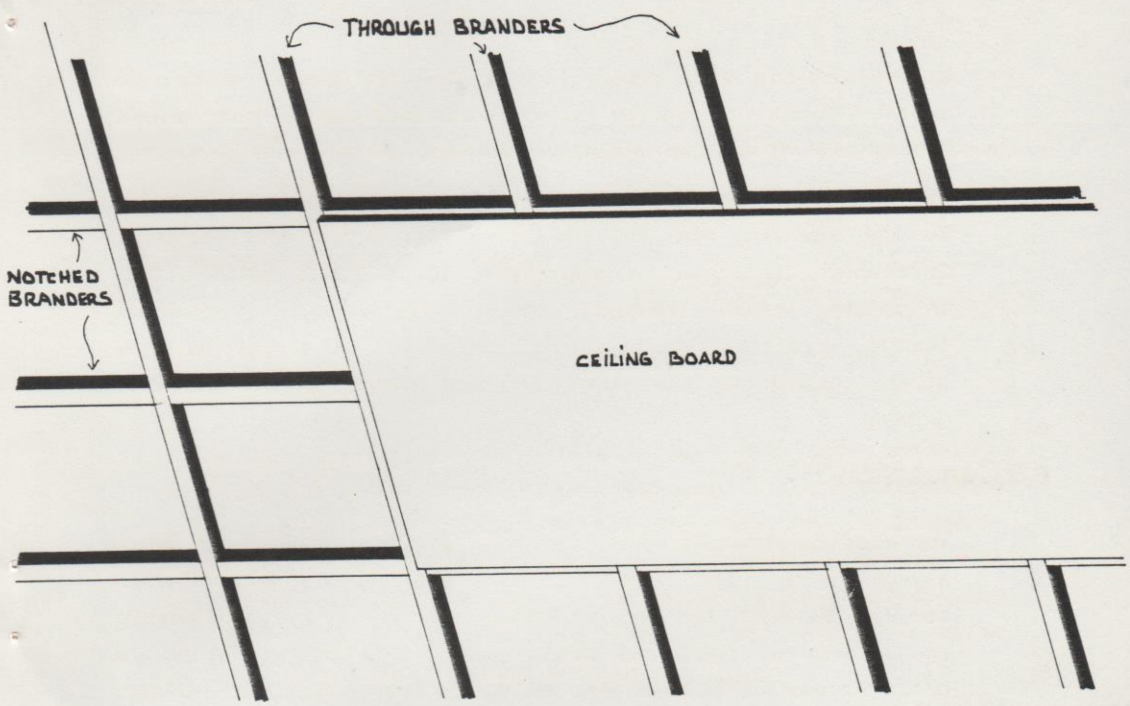


Fig.6.12 Brandering Spacing

TYPE OF CEILING	BRANDER SIZE	THROUGH B CENTRES	NOTCHED B CENTRES	NAIL SIZE* (CLOUT NAILS)
HARDBOARD /MASONITE 1200 WIDE	38 x 38	450	450	25 MM
6.4 RHINOBOARD 1200 WIDE	38 x 38	450	600	25 MM
6.4 RHINOBOARD 900 WIDE	38 x 38	450	900	25 MM
SOFTBOARD 1200 WIDE	38 x 38	450	600	30 MM
ASBESTOS 1200 WIDE	38 x 38	450	600	30 MM
PINE TUNG 'N GROOVE	38 x 38	450	450	PANEL PINS 40 MM

* NAIL EVERY 2 TO 300 MM

part 7 FINISHES & EXTRAS

7.1. The Walls

Soil-cement blocks, if made correctly, are very durable but it is better if you make them more durable by coating them in one way or another. This coating not only protects the bricks but can enhance the looks of the building. So in order to improve upon the natural wall surface, it is usual to apply a coating of one sort or another, which could be one of the following:

A. A paint
B. A plaster
C. A wash

A. A PAINT: There are many paints on the market today which are made for all sorts of applications and some of these are suitable for use on soil-cement blocks. Common water based PVA, for instance, works well especially for internal use. However, a problem with most paints is that they have to be renewed quite frequently and so although they are relatively cheap in the short term it is costly to keep replacing every few years.

You can make a cement based paint yourself which is said to work well. What you do is mix

1 Part calcium sterate powder with
2 Parts calcium chloride powder
50 Parts cement
25 Parts clean fine sand
50 Parts water and
3 Parts powdered oxide for colour

Once all these are mixed well pour the mixture through a flyscreen. It is now ready to paint onto the wall which must be wet before painting begins. You will need to do two coats and allow at least 12 hours between each coat.

B. A PLASTER: Both traditional and modern buildings are usually plastered with a mortar of one sort or another. The problem is that traditional plasters of dung and clay are not strong and need to be repaired frequently while cement plasters are very expensive and if they are too strong cause cracking on soil cement block walls. If you do want to plaster your building you can just add cement (as you do for soil-cement blocks) to the soil, making a plastering mortar. A good mix for this plaster is one part of cement to between 5 and 8 parts of sandy soil. Another good plaster mix for soil-cement walls is one part cement to one part lime to between 10 and 16 parts of sandy soil. A problem with using plaster is that usually this too must be painted which is an additional cost. Plaster does however give a good strong smooth waterproof finish to your building.

C. A WASH: A wash is a cement based liquid which is brushed onto the wall to form a thin waterproof screed. Below are a few different mixtures which can be used.

1. Pigmented wash: The first coat is 1 part cement to 3 parts water "painted" onto the wall. After 24 hours make a mixture of:

   1 Part powdered oxide colouring to
   20 Parts cement to
   300 Parts clean fine sand to
   as much water as is needed to make it fluid enough to brush onto the wall.

2. Bitumen Cement Wash : First "paint" on the bitumen in small sections and then throw dry sand onto the wet bitumen. If you paint too great an area with bitumen it will dry before you can put the sand on and the sand will not stick. Once this has been done apply a cement wash.

3. A slurry : Mix equal parts of cement and lime together with enough water to make a thick liquid. If you want a gritty texture add some clean sand. Don't forget to moisten the wall before applying the slurry. If you want you can colour this slurry with powdered oxide as well.

7.2 The Floor

Making the floor is described in detail in part 4 of this booklet.

7.3. Extras

There are many extra things that you can add to your buildings to make it more comfortable or to improve it. Some of these things include:

A. Solar water heaters
B. Walkways / Verandahs
C. Built in furniture
D. Water systems
E. Skylighting
F. Screen walls

These will not be dealt with in any great detail in this booklet but merely toutched on to provide some basic understanding about the implications of these "extras".

A. SOLAR WATER HEATER

Solar water heaters are, as the name implies, water heaters which use the sun to heat water. They require little maintenance and do not have any other running costs and so provide cheap hot water. If designed and built well a solar heater can make water very hot and provide enough hot water for a family each day.

These can be very expensive if bought as a whole system but can also be very cheap, though not as efficient, if they are home made. A simple solar water heater is shown schematically in figure 7.1. This is not a thing that can be built without knowing more about solar water heater workings and should you be interested in one you should contact TATU who is experimenting with some low cost solar water heaters at present. The NBRI has also published a number of information sheets and booklets on solar energy, one of which, "Introductory Guide to Solar Energy", gives a design and "how to" instructions for building your own solar water heater.

B. WALKWAYS AND VERANDAHS

These can often easily be added to a building for little extra cost. These can replace passages which are expensive spaces and provide usable protected spaces. They can also help cool down your house in summer.

The best way to add one to your building is to extend the roof over the walkway area and support its end with columns or gumpoles

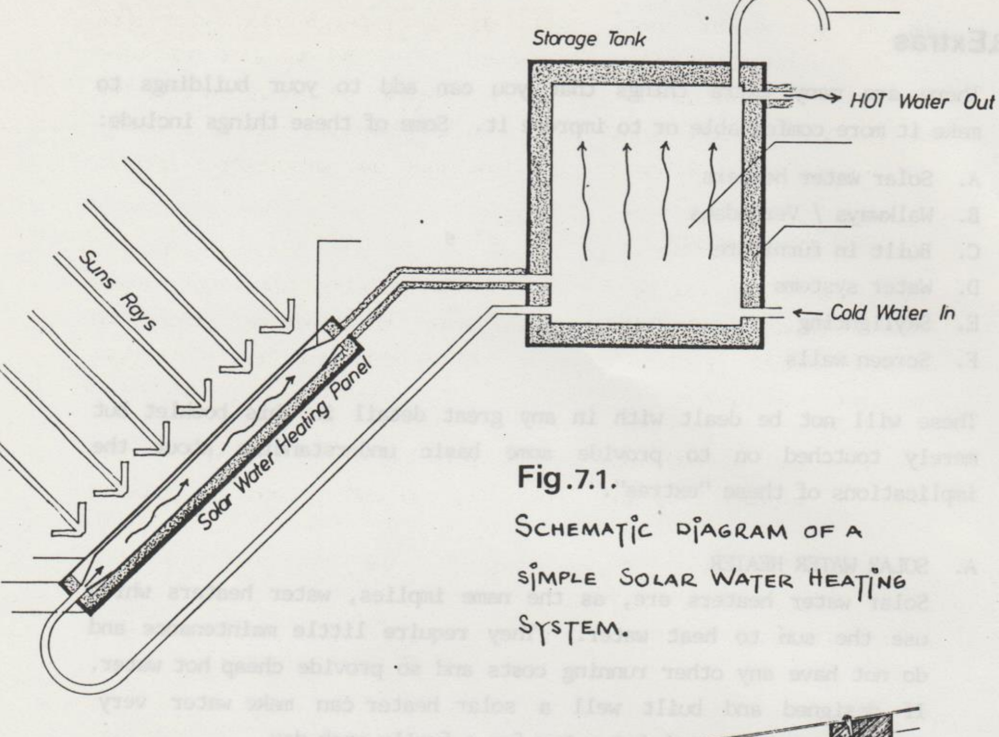


Fig. 7.1.

SCHEMATIC DIAGRAM OF A SIMPLE SOLAR WATER HEATING SYSTEM.

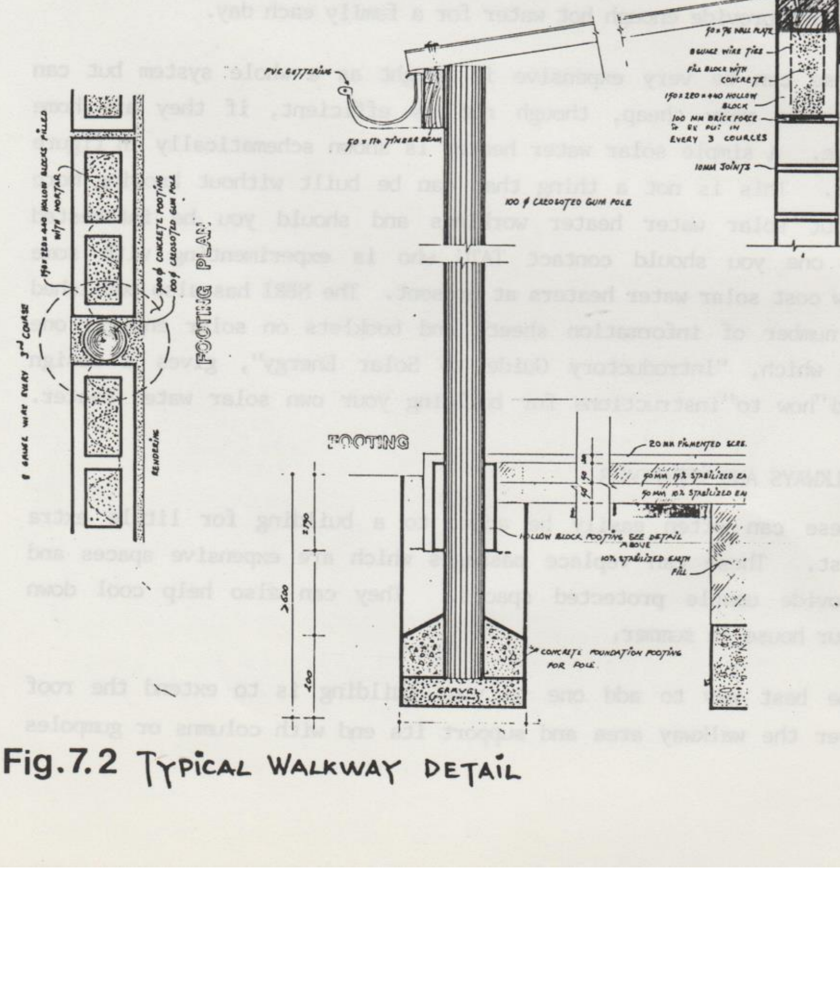


Fig. 7.2 TYPICAL WALKWAY DETAIL

(Figure 7.2). If this is not possible, because your roof is already too low, you can do it another way. If you are in doubt then contact TATU for advice.

C. BUILT IN FURNITURE

You can save a lot of money if you build in your own furniture as you build your building. For instance you can build in beds, cupboards, kitchen units, wall units, bench seats and many other things. The problem is that you need to plan your building well to do this because once the building is complete it will be difficult and expensive to change it.

You can also make tables, benches and other furniture from rough cut wood and scraps from the building itself. These are much cheaper than bought furniture and usually much stronger and better because they are made to meet your own needs.

D. WATER SYSTEMS

You can save yourself and your family a lot of time and trouble if you collect and store rainwater from your roof. Guttering and water tanks for storage are well worth their cost in the time they save the household and they provide good clean healthy water.

E. SKYLIGHTING

This has been mentioned before under the section on the roof. These are very expensive, but they do save on windows and make rooms much brighter and healthier.

F. SCREEN WALLS

Because soil-cement blocks are so cheap it is not expensive to build screen walls and boundry walls, etc for privacy, security and aesethic beauty.

part 8 □ CONCLUSION

The building method described in this booklet is not the only good way or best way to build. There are many ways in which one can build and this is only one way, a simple building method which has been used by TATU on a number of buildings and proved to work. A major problem that confronts any owner- builder is to estimate the amount of materials needed to build the building which is planned. It is very important that this is done so that waste is not excessive and therefore costs are kept to a minimum. Appendix V "Estimating Materials" tries to help the inexperienced builder to estimate the quantities of materials he will need to construct the building. These tables and formulae are as simple as possible and if used correctly will give fairly accurate estimations.

At present the Design & Construction Unit of TATU is compiling a set of designs for buildings of all types including: schools, clinics, community halls, animal enclosures, houses and many others. These are available from TATU at little or no cost and with them come details on how to build the building. TATU will also give advice and assistance to all builders and has standard details for building in soil-cement and making trusses.

☐ REFERENCES

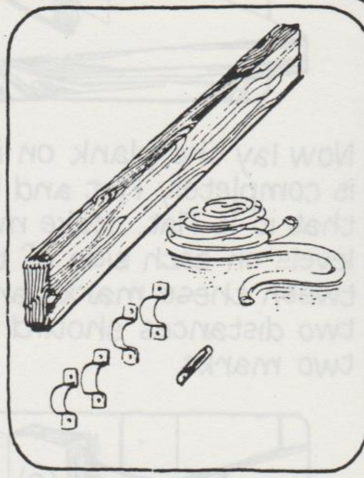
1. Blakie Johnson Builders Manual
2. Enviromental Development Agency 1981 "Peoples Workbook"
3. Gallant P. 1977 "Self-Help Construction of 1-Story Buildings" U.S. Peace Corps.
4. Peace Corps "Handbook for Building Homes of Earth"
5. TATU 1984 "Guide to Soil-Cement Brickmaking" Self-Help Series
6. U.N. 1964 "Soil-Cement: Its use in building"
7. U.S. 1974 "Earth for Homes" Dpt of Housing and Urban Development.
8. van Dresser P. 1977 "Homegrown Sundwellings" Jenelyon, Santa Fe, New Mexico.
9. Weekend Workshop "The Gentle Art of Concreting" 1984.

HOW TO MAKE A WATER LEVEL

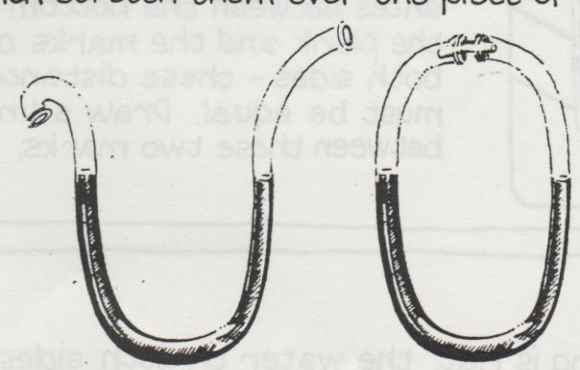
Spirit levels are expensive to buy. It is much cheaper to make a water level. You can use a water level in the same way as a spirit level.

You will need:

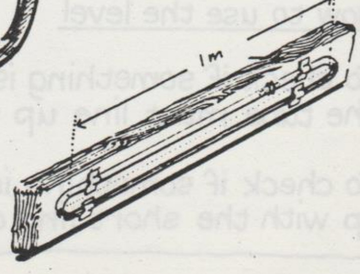
- A straight wooden plank 1,1m long.
- 2½ m of thin clean plastic tube (try to get some from a hospital or clinic).
- Brackets for holding the tube on-to the plank. You can make these from scrap pieces of tin, such as beercans.
- A piece of metal tubing which fits tightly inside the plastic tube.

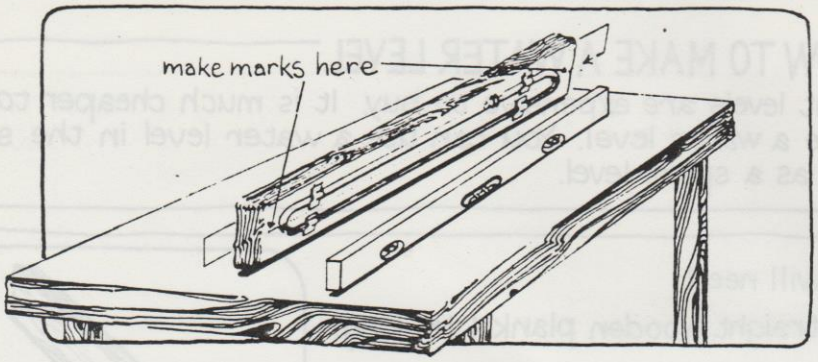


Half fill the tube with water so that the water fills halfway up the two short sides. Then join the two ends of the tube with the piece of metal tubing. Soak the ends of the plastic tube in warm water until they become soft and then stretch them over the piece of metal tubing.

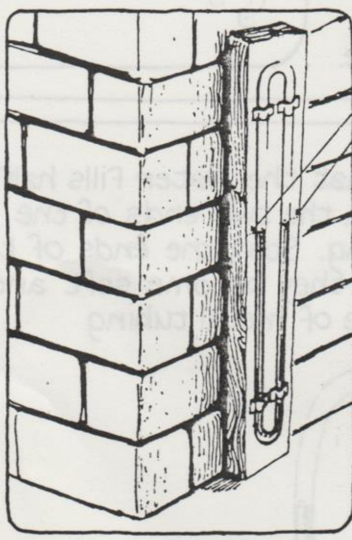


Connect the tube to the plank with the brackets, so that the distance between the short sides of the tube at each end of the plank is exactly 1m.





Now lay the plank on its edge on a surface which you know is completely flat and level. Borrow a spirit level to check that it is flat. Make marks on the plank next to the water levels on each side of the tube. Measure the distances between these marks and the bottom of the plank. These two distances should be equal. Draw a line between the two marks.



Now hold the plank against something which you know is perfectly straight up. Again check it with a spirit level. Mark the water on both sides. As before, measure the distances between the bottom of the plank and the marks on both sides – these distances must be equal. Draw a line between these two marks.

<u>How to use the level</u>

To check if something is flat, the water on both sides of the tube must line up with the long line on the plank.

To check if something is straight up, the water must line up with the short line on the plank.

SOURCE: COPIED FROM "THE PEOPLES WORKBOOK" BY E.D.A PAGES 479 + 480

APPENDIX II Different Mixes For Hand Compaction

	NORMAL					STRONG				
	CEMENT	SOIL	STONE	SAND	LIME	CEMENT	SOIL	STONE	SAND	LIME
FOUNDATIONS	1		4	4		1		3	3	
FLOOR SCREED	1			8		1			6	
TOP LAYER	1	7				1	5			
BOTTOM	1	10				1	7			
MORTAR S–C BLOCKS	1	8				1	5			
CONC. BLOCKS	1			9		1			6	
PLASTER (CEMENT)	1			6		1			5	1
PLASTER (SOIL–CEMENT)	2			8	1	2			5	1
LINTEL	1		3	3		1		2	2	
SILL	1					1		2	2	
BRICKS (SOIL–CEMENT)	1	20				1	15			
BLOCKS (CONCRETE)	1		12			1		4,5	4	

NOTE: Use the same container for measuring each whether it be a bucket, wheelbarrow, shovel or other convenient container.

* River gravel

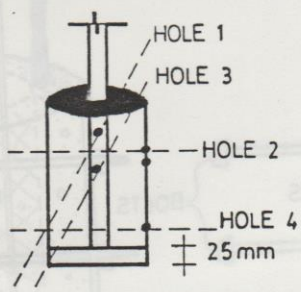
APPENDIX III How to make a compactor

The best compactors are made from metal but you can make them out of wood. This compactor is made from the following materials;

Materials	Tools
1,5m lenght of galvinized pipe 25-30mm in diameter	hacksaw
200mm length of galvinized pipe 75-100mm in diameter	Drill & bit to suit bolts
4 bolts long enough to go through the thick pipe	2 spanners to fit the the bolts
1 shovel of cement	tin snips
2 shovels of clean sand	
2 shovels of 19mm stone	
350 x 200mm piece of small chicken mesh.	

STEP 1: Cut the thin pipe to suit your height, ie. not taller than chest height. Also cut the thick pipe and the chicken mesh if not already cut.

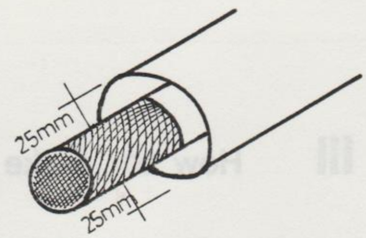
STEP 2: Drill 4 holes through both pipes to take the bolts as shown below;



The holes are drilled at right angles to one another alternatively.

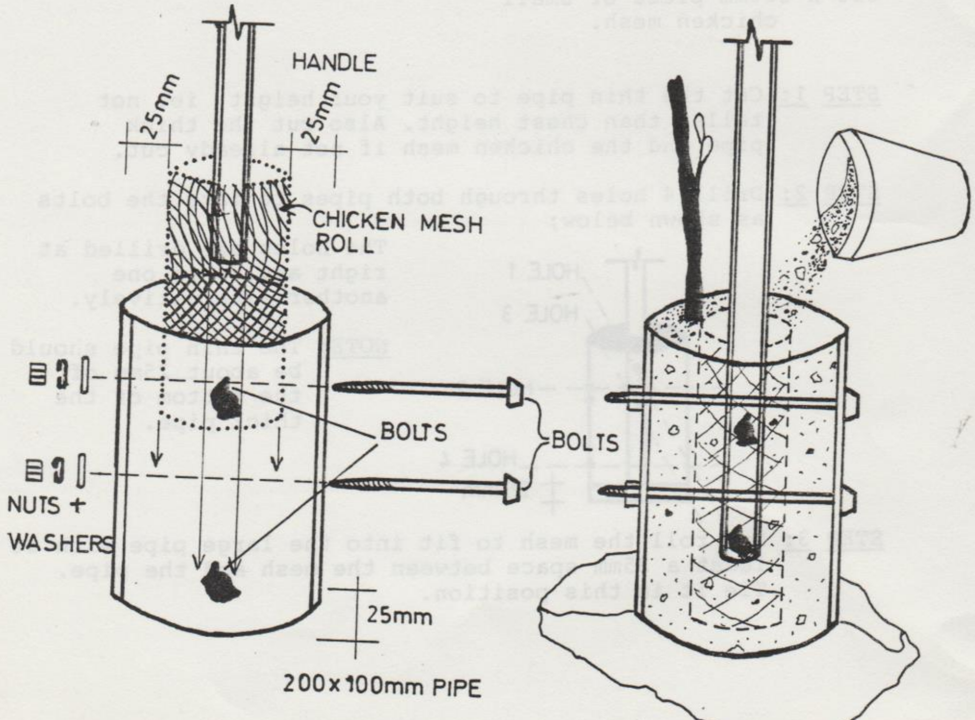
NOTE: The thin pipe should be about 25mm off the bottom of the thick pipe.

STEP 3: Now roll the mesh to fit into the large pipe with at least a 25mm space between the mesh and the pipe. Tie it in this position.



STEP 4: Fit the mesh roll into the large pipe and insert the small pipe in the centre. Push the bolts through the large pipe, mesh and small pipe and out through the otheer side. Fit the nuts onto the bolts and thighten them up.
Stand it on a piece of plastic on a flat surface.

STEP 5: Mix the concrete adding just enough water to mix it properly. pour the mix into the big pipe. Compact it with a stick or metal rod making sure there are no air spaces left in the pipe.
Cover with plastic and leave to cure for at least 1 week wetting it every second day.

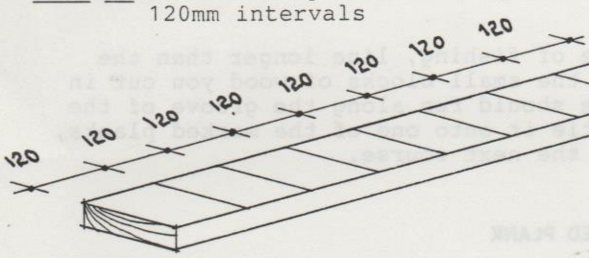


APPENDIX IV How To Make a Building Profile

A simple building profile can be made very cheaply and quickly in the following way. All you need is;

Materials	Tools
2 pieces of 38 x 76mm planed all round timber each 2,1m long.	saw
2 pieces of 38 x 76 x 200mm planned timber	square
1 reel of heavy guage fishing line	hammer & nails
	pencil
	Tape measure
	knife

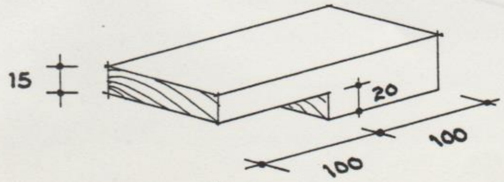
STEP 1: With the tape measure & pencil mark each plank at 120mm intervals



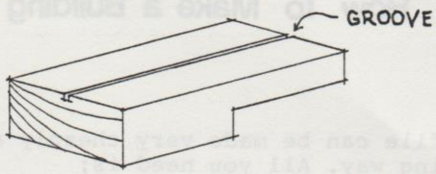
STEP 2: Using the square draw a line right accross the plank at each mark you made in step 1.

STEP 3: Saw along each of these lines so that the cut is only 5mm deep.

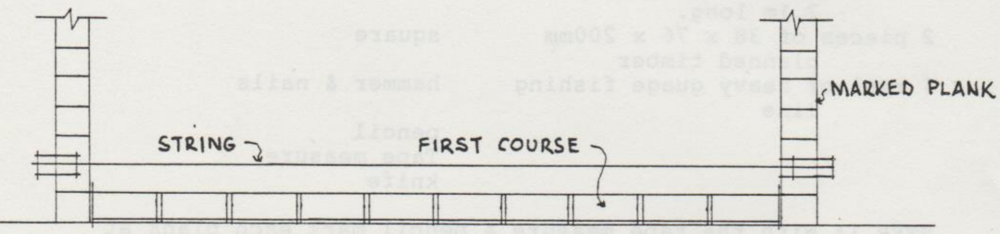
STEP 4: Cut the 2 small pieces of timber as shown in the drawing below.



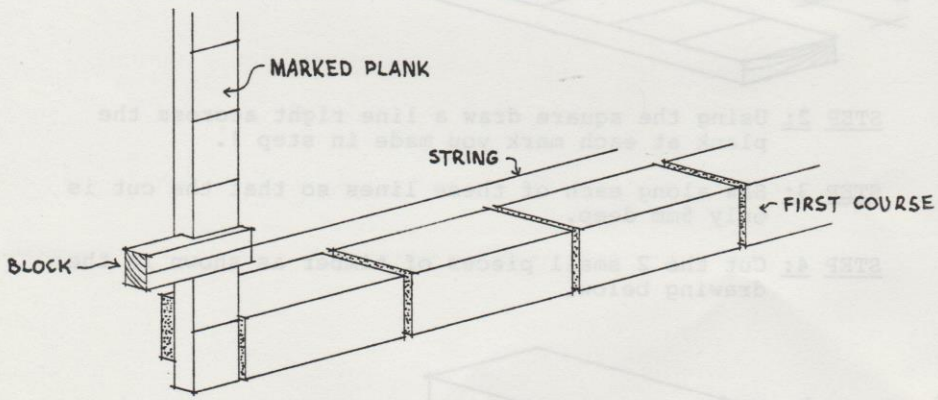
STEP 5: Cut a groove down the centre of each of these pieces as shown below. This is for the line to run along.



STEP 6: Now set up the profile with one marked plank at each end of the wall and with the bottom of each plank lined up with the top of the first course of bricks.



STEP 7: Next tie a piece of fishing, line longer than the wall, to one of the small blocks of wood you cut in step 5. The line should run along the groove of the block and then tie it onto one of the marked planks, at the mark for the next course.

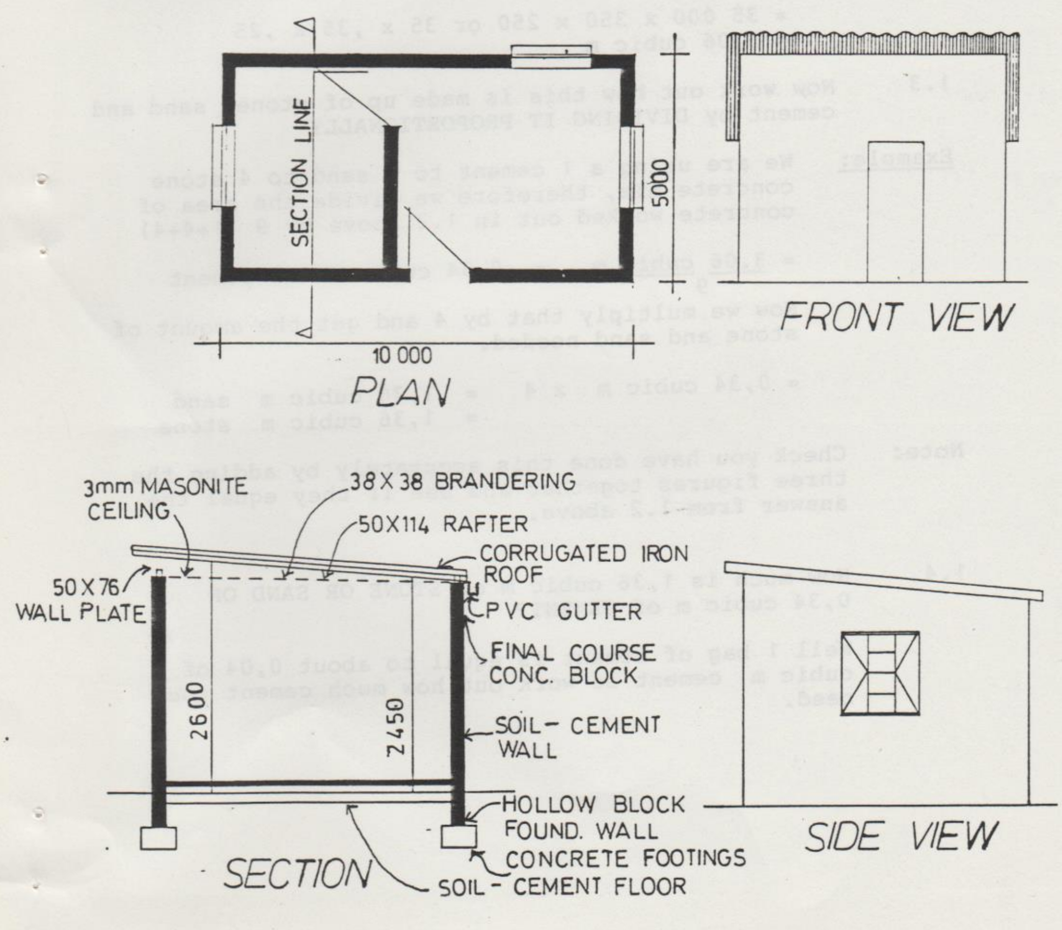


STEP 8: Pull the line taught and repeat step 7 at the other marked plank. The line now marks the top of the next course of bricks to be laid. Once these are laid move the line up to the next mark and begin laying the following course of bricks. Repeat this procedure until the wall is finished.

APPENDIX V Estimated Materials

This simple step by step guide to estimating materials is intended to give the owner-builder a rough idea of how much of each material will be needed to complete his building.

To help simplify the instructions a simple building will be used as an example. This building is shown below.



LETS BEGIN°

1. FOUNDATION FOOTING

1.1 Measure all the WALLS to find the TOTAL WALL LENGTH

Example: Front wall + backwall + 2 side walls + internal wall

= 10+10+5+5+5
= 35m

1.2 Multiply this figure by the WIDTH & THICKNESS OF THE FOOTING to find out how much concrete is needed.

Example: Total length of wall x width of foundation x thickness of foundation

= 35 000 x 350 x 250 or 35 x ,35 x ,25
= 3,06 cubic m

1.3 Now work out how this is made up of stone, sand and cement by DIVIDING IT PROPORTIONALLY

Example: We are using a 1 cement to 4 sand to 4 stone concrete mix, therefore we divide the area of concrete worked out in 1.2 above by 9 (1+4+4)

= $\frac{3.06 \text{ cubic m}}{9}$ = 0,34 cubic m of cement

Now we multiply that by 4 and get the amount of stone and sand needed.

= 0,34 cubic m x 4 = 1,36 cubic m sand
= 1,36 cubic m stone

Note: Check you have done this accurately by adding the three figures together and see if they equal the answer from 1.2 above.

1.4 How much is 1,36 cubic m of STONE OR SAND OR 0,34 cubic m of CEMENT?

Well 1 bag of cement is equal to about 0,04 of cubic m cement so work out how much cement you need.

Example: $\frac{0,34 \text{ m}}{0,04}$ of cement = 8,5 bags of cement

Plus 1 bag to cover wastage.

Now 1 builder's wheelbarrow of 19mm stone is equal to 0,072 cubic m. of stone and likewise 1 builder's wheelbarrow of clean sand is equal to 0,072m of sand. Now work out how much of each you need.

Example: $\frac{1.36 \text{ m}}{0,072}$ of stone = 19 wheelbarrows of stone

and $\frac{1,36 \text{ m}}{0,072}$ of sand = 19 whellbarrows of sand

Now you can cast your concrete footings.

2. FOUNDATION WALL + FINAL COURSE (hollow concrete blocks).

2.1 Measure the WALLS to find the TOTAL LENGTH OF WALL You should know this figure as you did it in 1.1 above.

2.2 Divide the length of wall by the LENGTH OF A BLOCK + WIDTH OF THE MORTAR JOINT. This will give you the number of blocks needed for 1 course.

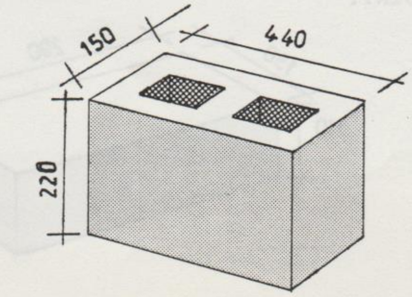
Example: $\frac{35\text{m}}{\text{length of block + thickness of Mortar joint.}}$

$= \frac{35\text{m}}{0,44 + 0,01}$

= 78 blocks/course

2.3 Divide the HEIGHT OF THE FOUNDATION WALL (i.e. height from the top of the foundation footing to the top of the floor (at least 200mm above ground level)) by the HEIGHT OF THE BLOCKS YOU ARE USING + the THICKNESS of the MORTAR JOINT.

Example: $\frac{\text{height of foundation wall}}{\text{height of block + thickness of joint}}$



$= \frac{1,15m}{,22 + ,01}$

= 5 courses

2.4 Multiply the answer from 2.2 with the answer from 2.3 and you will know how many BLOCKS you need for FOUNDATION WALL.

Example: 78 blocks x 5 courses

= 390 blocks

2.5 Remember to ADD one course of blocks to the answer you got in 2.4 to provide enough blocks for the LAST course.

Example: 390 blocks +(1x78 blocks)
= total blocks needed 468

2.6 To allow for BREAKAGES add 10% to the answer in 2.5 and order or make that amount.

Example: 468 total blocks needed + (10%) 47.
= 515 number of blocks to order.

3. WALLS.
This is done in the same way as you worked out the blocks for the foundation wall except that the soil-cement blocks are a different size.

3.1 TOTAL LENGTH of WALLS = 35m

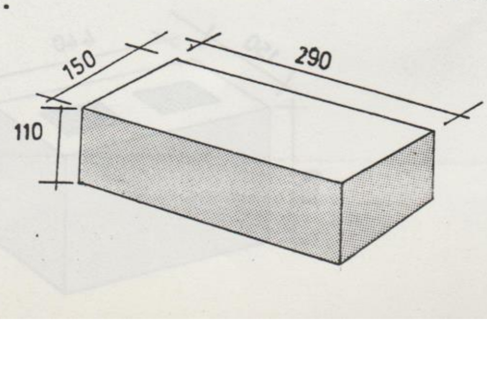
3.2 Divide LENGTH of WALL by LENGTH of BLOCK + WIDTH of the MORTAR JOINT = no. of blocks needed for 1 course.

Example: $\frac{35m}{\text{length of block + width of joint}}$

$= \frac{35m}{,290 + ,01}$

= 117

3.3 Divide the HEIGHT of the WALL (from the top of the foundation wall to the bottom of the top course) by the HEIGHT of the BLOCK + the THICKNESS of the JOINT.



Example: 1. height of back wall = 2,45m
height of front wall = 2,6m
therefore average height
$= \frac{2,45 + 2,6}{2} = 2,525$

2. height of wall = 2,525 - top course
= 2,525 - ,230
= 2,295m

3. No. of courses = $\frac{\text{wall height}}{\text{block height + joint}}$

$= \frac{2,295m}{0,110 + ,01}$

= 19,125
therefore = 20 courses

3.4 Multiply the answer from 3.2 with the answer from 3.3 to get the TOTAL NUMBER of BLOCKS needed for the WALLS.

Example: 117 blocks x 20 courses
= 2 340 blocks

3.5 Now ADD 10% for wastage + breakage

Example: 2 340 + (10%) 234
= 2574 blocks

4. CALCULATING THE MORTAR QUANTITIES.

4.1 Divide the number of blocks needed by 100

Example: $\frac{\text{total number of blocks}}{100}$ =

1. Foundation + top course $\frac{515}{100}$ = 5,15

2. Walls $\frac{2574}{100}$ = 25,74

4.2 Use the table below to find the CUBIC METRES of MORTAR needed to lay 100 blocks.

Example: If nominal size of blocks used will be 110 x 150 x 290, then 0,065 cubic m of mortar is needed to lay every 100 blocks.

TABLE V.1. QUANTITIES OF MORTAR REQUIRED TO LAY 100 BLOCKS/BRICKS.

Nominal size of block/brick mm	Cubic metres of mortar
220 x 220 x 440	0,092
150 x 220 x 440	0,073
110 x 220 x 440	0,073
110 x 150 x 290	0,065

* For mortar joints 10mm thick included 25% waste allowance

4.3 Multiply the answer from 4.1 with that of 4.2 to get the total cubic metres of mortar needed.

Example: 1. 5,15 x 0,073 = 0,38 cubic metres
2. 25,74 x 0,065 = 1,67 cubic metres

therefore, we need a total of 2,05 cubic metres of mortar.

4.4 The table below will help you work out how much cement and sand is needed or you can do it as shown in section 1.

TABLE V.2 MATERIALS REQUIRED TO MAKE 0,1 CUBIC M OF MOTAR

MIX BY VOL. Cement	Sand	Soil	Lime	50KG BAGS OF CEMENT	25KG BAGS LIME	CUBIC METRES SAND	WHEELBARROWS SAND
1		8		,25			
1		5		,5			
1	9			,25		0,09	1.25
1	6			,33		0,09	1.25
1	5		1	,33	,5	0,07	1.00
2	8		1	,5	,5	0,07	1.00
2	5		1	,5-,66	,5-,66	0,06	1.00

4.5 Now multiply the answer from 4.3 by 10 and then by the answer from 4.4 to get the total amount of cement and other materials needed for the mortar.

Example: Cement (1) (10 x 0,38) x ,25 = 1 bags of cement
(2) (10 x 1,67) x ,5 = 8,5 bags of cement

1. Using a 1:9 cement to sand mix
2. Using a 2:8:1 cement to sand to lime mix

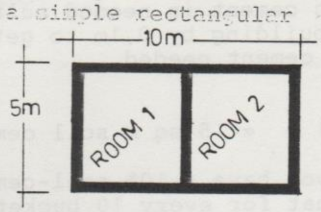
LIME: (1) No lime
(2) (10 x 1,67) x ,5 = 8,5 bags of lime

SAND: (1) (10 x ,38) x 0,09 = 0,342 cubic m
(2) (10 x 1,67) x 0,07 = 1,169 cubic m
or
(1) (10 x ,38) x 1,25 = 4,75 wheelbarrows
(2) (10 x 1,67) x 1 = 16,7 wheelbarrows

5. FLOOR

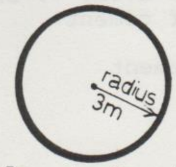
5.1 Work out the area in metres square of the building by
i) Multiply the length by the width if it is square or rectangular,
ii) Multiplying the radius by 3,14 if it is round, and
iii) Working out the area of each room if it is not a simple rectangular

Example: i)



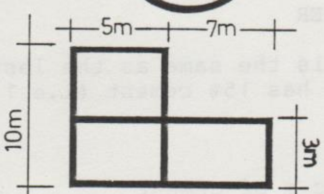
5 x 10 = 50 sq m

ii)



3 x 3,14 = 9,42 sq m

iii)



(3 x 7) + (5 x 10)
= 21 + 50
= 71 sq m

5.2 D.P.M. (DAMPROOF MEMBRANE)
1 Roll of DPM is 6m wide and 30m long.
therefore it is = 180 sq m
To find out how many rolls of DPM

We need we must multiply the area of our building by 0,25 and add this to the total area then divide by 180 sq m

Example: $\frac{(50 \text{ sq m} \times 0,25) + 50 \text{ sq m}}{180}$

$= \frac{12,5 + 50}{180}$

= 0,35 rolls Or 110m of 6m wide DPM

5.2 DPC (DAMPROOF COURSE)

1 roll of DPC is 30m long and you need the 150 mm wide one. Take the total length of the walls (see section 1.1) and divide by 30m to get the number of rolls you need

Example:

$\frac{35m}{30m}$ = 1.17 rolls

5.3 FLOOR: BOTTOM LAYER

This layer is 100 mm thick compacted soil-cement with 10% cement. to find out how much cement is needed multiply the area of the building by 0,1m to get cubic metres of soil cement needed.

Example:

50 sq m x 0,1 m = 5 sq m soil cement

Now if you have a 10% soil-cement mixture it means that for every 10 buckets of soil there should be 1 of cement

Example:

$\frac{5}{11}$ = 0,45 cubic m cement

5.4 FLOOR: MIDDLE LAYER

This middle layer is the same as the last but instead of a 20% cement it has 15% cement (i.e 1 cement to 8 soil)

Example:

$\frac{5}{8}$ = 0,625 cubic m of cement

5.5 FLOOR: TOP LAYER (SCREED)

This layer is only 20 mm thick and is made up of 1 part to 8 parts sand

Example:

50 sq m x 0,02 = 1 cubic m

$\frac{1}{9}$ = 0,11 cement + 0,89 sand

6. ROOF

This section includes the wall plate, roof support, roof cladding, insulation + ceiling support + cladding.

6.1 WALL PLATE:

This is only needed on walls where the roof is to be supported

Example:

back wall + front wall
= 10m + 10m
= 20m of wall plate

The best length to buy is 2,1m, so you will need 10 lengths

6.2 ROOF SUPPORT:

Rafter spacing should be between 1,2 and 1,5m

Example:
This building is only 5m wide so we will only need 2 rafters, each 10m long, between the wall plates. This makes the distance between wall plate and rafter 1,25m

Again it is cheapest to buy 2,1m lengths and you will need 10

6.3 ROOF CLADDING:
Here corrugated iron is recommended. To estimate how much you need to divide the length of the building and overhang by 610 mm (effective coverage of 1 sheet allowing for overlap).

Example:

$$\frac{10m + ,370 \text{ overhang}}{,610} = 17 \text{ sheets}$$

Now if you can transport them get the length you need (i.e. width of building and overhangs)

Example:

5m + 0,1 = 5,1m

If you can't easily transport these then you will need to divide by two or three. If you do this remember to add 100 mm to each sheet for overlapping.

Example:

$$\frac{5,1m}{2} = 2,55m + ,10m$$

$$= 2,65m$$

So we will need either 17 sheets 5,1m long or 34 sheets 2,7m long.

6.4 INSULATION:

This is 50mm thick and comes in rolls 1,2 or ,7m wide + 10m long. It is better to use the 1,2m wide rolls as it is less work and will not need to be cut if your spacing between rafters is 1,2m. 1 roll is therefore + 12 sq m (1,2 x 10).

Example:

$\frac{50 \text{ sq m}}{12 \text{ sq m}}$ = 4,17 rolls are needed

6.5 CEILING SUPPORT:

38 x 38 brandering is used and estimating how much you will need depends on the ceiling cladding you are to use. If you use rhino board or masonite of standard width 1,2m and your rafter centres are 1,2m apart then you only need brandering between. If your raters are further apart you will need more brandering.

A good rule of thumb is to work on needing +- 5m of brandering/sq m of ceiling.

6.6 CEILING CLADDING:

Most ceiling board is 1,2m wide. This is the best size to use. To estimate how much you need divide the width of your building by 1,2 and this will give you the number of sheets across. Then divide the length of the building by the length of the sheet (This differs and depends on what you can transport obviously the longer the better because there are less joints)

Example:

$\frac{5}{1,2}$ - thickness of walls (,150 x 3) = 4 sheets

$\frac{10}{3,3}$ - thickness of walls (,15 x 2) = 3 sheets

Therefore we need 12 sheets 1,2 x 3,3m

7. OTHER ITEMS TO REMEMBER

1. Guttering
2. Paint
3. Coverstrips + Beading
4. Skirting Boards
5. Lintels for each door + window
6. Sills for each window
7. Poles for verandahs
8. Glass for windows
9. Putty
10. Roofing screws
11. Nails
12. Ridge caps
13. Rainwater tanks
14. Built in fittings such as cupboards, sinks, etc
15. Plumbing
16. Electricity

APPENDIX VI Advice To Owner – Builders

If you live in a Municipal area or township you will probably not be allowed to build with soil-cement blocks. This is because antiquated and inappropriate building regulations, usually inherited from past colonial governments, prevail in most places in Southern Africa. Town engineers and other officials are, for many reasons too frightened to change these regulations. They maintain that we must have the same as first world countries and that we must not accept anything less even if we can't afford them. The result is abnormally high standards, which makes building far too expensive for the average family and which causes them to be eternally indebited to the bank. Because of this people must now rely on subsidised housing from the government. This often results in the family paying more than they can afford for less space than they need. Finally it is not in the interests of the conventionally trained builders and professionals to have cheaper buildings as that would mean less money for them. It is unfortunate that it is on these people, who have vested interests in expensive buildings, that the government must rely for expert advice. So once again the rich get richer at the poors expense.

However if you live in the rural areas and have access to some land then you will have no problem building with soil-cement because there are no outdated regulations, as yet, there.

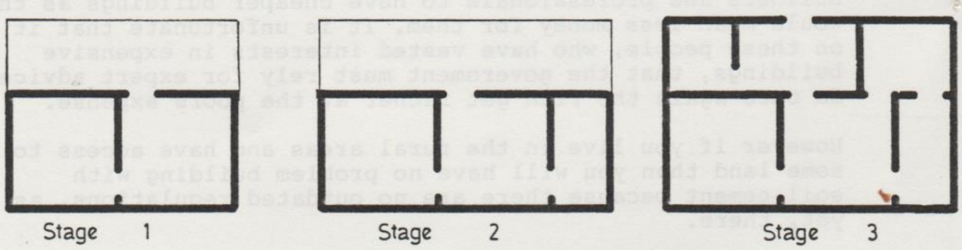
GETTING A PLAN DRAWN

It is very important that you get plans drawn as they will help you;

1) make sure that you get exactly what you want in terms of space, rooms, windows & doors.
2) estimate the approximate cost of the materials needed to build the building without forgetting any major item.
3) control the builder and make sure that he does exactly what the plans require and not less
4) plan the ordering of materials in advance, so that they will arrive on site in time, thereby ensuring that the building is not delayed while waiting for materials to arrive.

WHO CAN DRAW PLANS?

Architects, draughtsmen and often builders can draw plans for you. Architects are however very expensive and unless your building is to be fairly large and complex or in a Municipal area you shouldn't use them. Draughtsmen are usually much cheaper than Architects and if they work for you in their own time instead of firm time they will be even cheaper.
Before you talk to anyone about drawing plans for you, you should be reasonably clear in your own mind as to how much you are prepared to spend on the building and what exactly you want the building to be used for, ie. a house for a family of 6 with a garage, kitchen, toilet & bathroom, three bedrooms and a living room.
Once you are reasonably clear about this go and see the person you have chosen to draw your plans and tell him all the things you want and how much you have to spend on the building. While discussing the plans with the draughtsman remember that every square metre of building is going to cost you between R100 & R200. Therefore in order to get the best value for money try and reduce the amount of space wasted on passages, rooms that are too small or too big for the use you will make of them and other useless spaces. For instance, it is a waste of space to have a large bedroom for only one person to use.
Also it is important that you plan your building so that it can be altered or expanded in the future tc suit the changing neeΐs of the occupants.



TALK TO THE BUILDERS

Once you have a plan drawn to your satisfaction, take it to several builders in your area, discuss it with them and ask each of them to give you a written quote for building it. The builders quote may be on the basis that he supplies all the labour and materials or only the labour and it will then be up to you to supply the materials. Make sure that you know which of these types of quotes each builder is giving you and get them to write it in their quote.

Choosing a builder is very important. There are many people who call themselves builders and yet know little or nothing about building. Just because a person can build a wall it does not mean that he can build a house.

Check on each builder by;

1) Seeing if he can read the plans you have
2) Talking to people who have had buildings built by him and see how happy they are with their building
3) Look at the buildings he has built and check carefully for cracking, leaking, straight doors & windows and quality of finish.

Make sure that you get a firm price from the builder in the form of a written quote that states clearly;

1) Exactly how much his bill will be
2) When he will begin work
3) How long he will take to complete the job
4) Exactly what he is going to do
5) Exactly what he expects you to do or supply
6) At what stages you will pay him and how much for each stage

The builder will need to be paid as work progresses. It is a good idea to agree before work begins on a rate. A good example to follow is shown below;

Example:

If the total cost of the buildingis R10 000 you should give the builder R3 000 (30%) when he has completed the foundations
R3 000 (30%) when he has completed all the blockwork to roof height
R3 000 (30%) when he has finished the job, and
R1 000 (10%) a month or two after you have moved in to make quite sure that everything has been done properly.

REMEMBER:

1) Cheapest is not always the best. It is often better to pay a little more for a better job.
2) Never pay the builder any money before he begins work.
3) Beware of extras - before you add anything find out how much it will cost you. Lots of small things add up to one big thing°

4) Have a complete design of the building before you begin getting quotes.
5) Check the builders references and inspect some of the buildings he has built.
6) Keep close control of materials on site
7) Use Appendix V to help you estimate the amount & cost of the materials for the building. This will help you keep check on the builder and also get a rough idea of how much you should pay the builder. Usually the cost of the materials is equal to about half the total cost of the building so you should expect to pay the builder roughly the same amount as you expect to spend on the materials.
8) It is better to have a completed two room building than an incomplete four room building.
9) If you are short of money get your house designed so that it can be built in stages and only build what you can afford now. When you have more money it will be easy to add on.
10) A well built building is an asset that increases in value every year while a poorly built building is an expensive liability that will cost you more and more as it gets older.
11) Often it is better to spend a little more in the begining on better materials and in so doing save yourself time and money on maintenance in the future.

APPENDIX VII

ITEM	SOURCE	UNIT	APPROX COST/ UNIT	REMARKS
Brick Machine	Ellson	1		for making soil-cement
	Transido	1	R700-00	blocks
	Doubel	1	R123-00	for making hollow
	Jesson	1		concrete blocks
	Ellson	1	R130-00-	for making concrete bricks
	Doubel	1	R450-00	
	Jesson	1		
Cement	Jobs	50kg.	R7-00-	make sure that the cement
	Buffalo Timber	"	R9-00	is <u>not</u> old or it will not
	Mandlakomoya	"		work well for you
	TATU	"		
	City Paints	"		
	Quality Plumbers	"		
	Spargs	"		
Concrete Blocks		1	80c- R1-25	instead of making your own you may prefer to buy them already made
Corrugated Iron		m	6-20	Roof cladding
	Jobs	"		
	Buffalo Timber	"		
	Mandlakomoya	"		
	City Paints	"		
	Quality Plumbers	"		
Door Frames Steel	Jobs	150 x 811	40-00-	steel are usually the best
	Buffalo Timber	150 x 811	50-00	but they are expensive &
	Mandlakamoya	150 x		shouldn't be used near the
	City Paints	150 x		sea
Wooden	Jobs	811	Salinga Meranti	usually meranti or salinga which is the cheaper one
	Buffalo Timber	"	SAP R30-00	sometimes you get pine also but often these are
	Mandlakamoya	"		of poor quality use them only inside the building
	City Paints	"		and paint them well.

ITEM	SOURCE	UNIT	APPROX COST/ UNIT	REMARKS
D.P.C.& D.P.M.	Jobs	Roll	R 2-55	you must put this in your building or else the damp will erode away your walls
	Buffalo Timber	"		
	Mandlakamoya	"		
Elect-rical	Jobs	some		
	Buffalo Timber	"		
	Mandlakamoya	"		
	Quality Plumbers	"		
	Spargs	"		
	B.V.Supermarket	"		
	Dynamo	all		
	National Electric	"		
Glass	Jobs	sq m	R22-00	the smaller the panes the cheaper to buy & replace than big panes also get safety glass for places that children may run into
	Buffalo Timber	"		
	Mandlakamoya	"		
	P.G.Glass	"		
Guttering				
Galv.	Jobs	m	2-95	it is good to spend a little extra to fit guttering to your building so that you can collect water for drinking & the garden. galv. is cheaper but if you live near the sea it is better to use P.V.C. as it does not rust
	Buffalo Timber	"		
	Mandlakoyma	"		
	Quality Plumbers	"		
P.V.C.	Jobs	6m	R22-00-	
	Buffalo Timber	6m	R31-00	
	Mandlakoyma	6m		
	Quality Plumbers	6m		
Gypsum Board	Buffalo Timber	sq m	R6-00- R12-00	this can be used for ceilings and also for internal walls instead of block walls
Insul-ation	Jobs	Roll	R100-00	this is expensive but can save you money in the future in fuel bills
	Buffalo Timber	"		
	Mandlakamoya	"		

ITEM	SOURCE	UNIT	APPROX COST/ UNIT	REMARKS
Lime	Jobs	50kg	R2-00-	this is good to use in
	Buffalo Timber	50kg	R2-50	plaster to save on cement
	Mandlakamoya	50kg		and make the wall more
	City Paints	50kg		water resistant
	Quality Plumbers	"		
	Spargs	"		
Masonite	Jobs	1,2 x 3,0	R10-00	for ceilings and cladding
	Buffalo Timber	"	R15-00	
	Mandlakoyma	"		
	City Paints	"		
Paints Gloss	Jobs	25 lt	R140-00	do not forget to use undercoats and the right PAINT for each type of job
	Buffalo Timber	"		
	Mandlakamoya	"		
	City Paints	"		
	Quality Plumbers	"		
	Spargs	"		
	P.G.Glass	"		
	B.V.Supermarket	"		
	Plascon Evans	"		
P.V.A.	Jobs	25 lt	R60-00	do not forget to use undercoats and the right PAINT for each type of material
	Buffalo Timber	"		
	Mandlakamoya	"		
	City Paints	"		
	Quality Plumbers	"		
	Spargs	"		
	P.G.Glass	"		
	B.V.Supermarket	"		
	Plascon Evans	"		
Pigment	TATU	1kg.	R2-00- R3-00	for colouring cement, "painting" walls & colouring blocks
Plumbing	Jobs	all		use plastic pipes it is cheaper & easier to install
	Buffalo Timber	"		
	Quality Plumbers	all		
	Mandlakamoya	some		
	City Paints	"		
	Spargs	"		
	B.V.Supermarket	"		

ITEM	SOURCE	UNIT	APPROX COST/ UNIT	REMARKS
Sand	B & M Cartage	cubic m	R8-60	if you have no river sand and gravel availabel
Stone &	Transkei Quarries	"	R18-26	
Crusher Dust		"	R6-80	
Screens	Jobs	1	R50-00-	for sifting soil and sand
	Buffalo Timber	1	R70-00	
	Quality Plumbers	1		
Skylights	Jobs	m	R9-50	these are very expensive but if you use them you will not need so many windows & they are cheaper than windows
	Buffalo Timber	m		
Timber 38X38	Jobs	cubic m	R312-00	for most jobs XXX grade wood is sufficient but it is weaker than the more expensive grades
	Buffalo Timber	"		
	U.T.D.C.	"		
50X76	Jobs	cubic m	R502-00	for most jobs XXX grade wood is sufficient but it is weaker than the more
	Buffalo Timber	"		
	U.T.D.C.	"		
50X152	Jobs	cubic m	R718-00	for most jobs XXX grade wood is sufficient but it is weaker than the more
	Buffalo Timber	"		
	U.T.D.C.	"		
Window Frames				
Wooden	Jobs	All Sizes		there are two grades of wood windows the very expensive merhanti & the cheap pine ones are often not worth buying as they swell in the rain & need to be painted yearly & often rot
	Buffalo Timber	"		
	Mandlakamoya	"		
Steel	Jobs	All Sizes	R30-00-	as for wooden frames
	Buffalo	"	R100-00	DEPENDS ON THE SIZE
	Mandlakamoya	"		

ADDRESSES

NAME	ADDRESS	POSTAL ADDRESS	PHONE NO.
B & M Cartage	Thornhill Rd. Umtata	Box 733 Umtata	24321
Buffalo Timber	York Rd. Umtata	Box 234 Umtata	22151 22153
B.V. Supermarket	York Rd. Umtata		22141
City Paints	Durham St. Umtata		23684
Doubel Machines	31 circular Drive Port Elizabeth	Box 7819 P.E.	321164 321165
Dynamo Electric	84 Sutherland St. Umtata	Box 307 Umtata	23629
Ellsons Equip.	8 Refinary Rd. Industries West Germiston	Box 8100 Johannesburg	296997
Jesson Blocks & Moulds	111 Circular Drive Fairview Port Elizabeth	Box 664 Port Elizabeth	325438 324633
Jobs Hardware	48 Sutherland St. Umtata	Box 188 Umtata	22135
Mandlakamoya Wholesale	York Rd. Umtata	Box 107 Umtata	24465 26881
National Electric	44 Sutherland St. Umtata	Box 134 Umtata	22815
Plascon Evans	Vulindlela Indust. Umtata	Box 963 Umtata	24311
P.G. Glass	78 Sutherland St. Umtata	Box 963 Umtata	23336

NAME	ADDRESS	POSTAL ADDRESS	PHONE NO.
Quality Plumbers	8 Owen St. Umtata		23120
Spargs Supermarket	28 Sutherland St. Umtata	Box 218 Umtata	23149
TATU	Mt. Pleasant Farm Thornhill Rd. Umtata	P/Bag X5029 Umtata	23625
Transido	Development House York Rd. Umtata	Box 176 Umtata	26881
Transkei Quarries		Box 103 Umtata	23955