

824 NAOH95

FOR THE  
SANITATION

# **WATER SUPPLY AND SANITATION PROJECT IN OHANGWENA REGION**

**BUILDERS MANUAL FOR THE  
CONSTRUCTION OF SMALLER BUILDINGS**  
Rüdiger Diekman

January 1995

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## **DISCUSSION PAPERS AND REPORTS SERIES**

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Without the assistance of the named gentlemen, and the pleasant atmosphere they created, this document would not have come to light. This manual serves to assist the participants of the building course I was appointed to conduct to overcome smaller every day problems and to run their own business successfully.

Rüdiger Diekmann  
Technical Consultant  
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January 1995

## **1. INTRODUCTION**

*"One of the objectives of the Water Supply and Sanitation Project in Ohangwena Region is to develop local contracting capacity for water supply and sanitation construction. Local contracting capacity means individual, trained artisans who have the capability, tools and knowledge to construct wells, tanks and latrines using locally available materials with the cost affordable for the communities. In addition to classroom and on the job training, a latrine construction manual is to be prepared. To make it easier for the contractor trainees to develop themselves as independent contractors and work in other construction work as well, this manual has been written on a more broad basis. Even though the training of contractors for practical reasons has been concentrated on VIP latrine construction, this manual can be used to support all kinds of small scale building".*

This manual has been prepared with the aim to assist the building contractor to work together with the architect and/or engineer/s in carrying out her/his daily tasks. It wants to promote productivity and quality as well as also to highlight some of the likely problems in construction.

To illustrate the manual, pictures from real situations have been added to point out and underline the various activities described.

This manual focuses on activities at VIP latrine construction sites but much of it is relevant to general building activities. Within the project, the contractors gain construction experience through VIP latrine building. The experience gained in this way will enable the contractor to extend their activities to larger fields of operation. In this way this manual will be a guide for better performance on

site.

The building industry offers many opportunities to motivated and committed individuals. The management of WSSPOR wishes the reader of this manual the necessary ambition, energy, and luck.



Camping on a building site

## **2. OBJECTIVES**

### **2.1 What you need for success**

The reader should understand that sound building practice begins with knowledge, a well organised and disciplined site, excellent productivity, without neglecting quality, a smooth flow and control of materials, punctual certificates for payment with progress to ensure a good cash flow, a correct final account, and last but not least a happy client.

### **2.2 Productivity and quality**

Productivity without quality is absolutely meaningless. There is no sense in hurrying to produce only junk. There is also no sense in playing around on quality without productivity because you will be the loser in the end. The best is to combine both elements in a well balanced way. This can only be achieved by means of experience exercised every day and total commitment. You must feel the pulse of your activities in your fingertips. You must be able to react spontaneously and correctly, both on site and in the office.

### **2.3 Distribution of Responsibility**

It is easy to assume responsibility if all goes well. It takes courage and commitment to take responsibility if things go wrong. People around you notice how you carry your responsibility and they react accordingly. You could win future contracts if your reputation is good. So, if something is amiss, react in a responsible way, it could cost you money, but being positive now will pay back later. Skilful delegation of responsibility is extremely important because you can not do all the work yourself at the same time. As the contractor, you are still responsible for everything that goes on at your building site.



Delivery of material

#### **2.4 Cooperation between contractor and community.**

Always respond to the requests of the community respectfully. Sometimes you may feel that their request is not reasonable. At these times it is even more important for you to try and understand why they make that request. Discuss and negotiate, and be prepared to find a solution that seems right for both them and you. This is called a compromise. Feel your way into a new community, be one of them and be ready to learn from them.



## **2.5 Obligations and consequences**

Meet your obligations positively. Should you not be able to pay an account on the day it is due, phone your creditor or go and see him. Tell him or her your problem so that he/she knows about it and sets a new reasonable date which you then can meet. If you try to avoid the creditor, he or she may think you want to cheat. The result can be that you lose your good reputation, credit facilities or even receive a summons.

## **2.6 Controlling a building site**

Always be in control over your building site however small or large. Your site should be fenced in and have a gate with a lock. Allow no visitors, your own or employees'. They can disrupt work. More accidents happen to distracted workers.

Your site office is next to the gate for business visitors. Have

toilet facilities and also a shed where your workers and you can eat, have tea, or relax during lunch hour. Prepare food on site in a central facility, it saves your fire wood and time of your workers. This prevents continuous absence of someone or all. It promotes productivity.

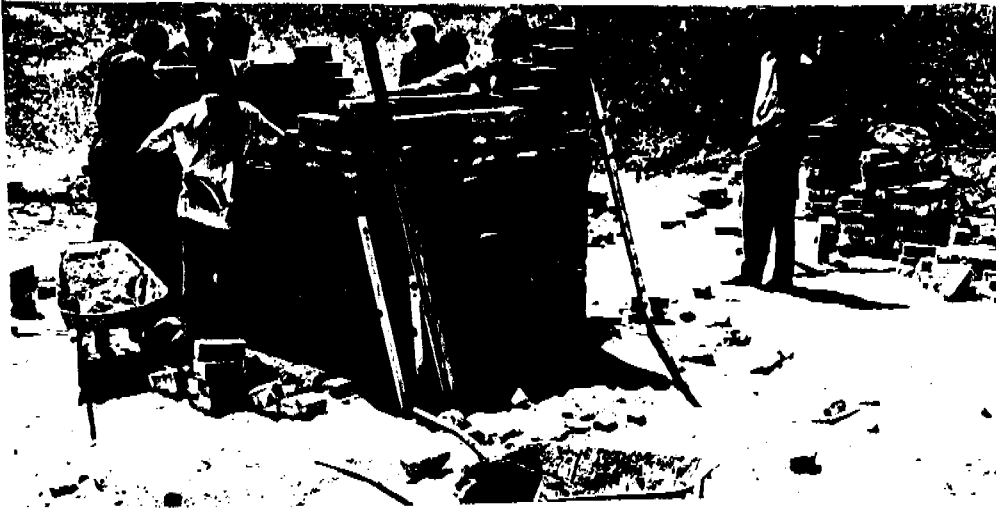
## **2.7 Motivate and control employees**

Motivation starts with the example you set. If you are late for duty your employees will also be, and you can hardly blame them. Be tidy in appearance and expect it from your team. Tidy workers on an organized site tend to make a neat job and like it. Praise a worker if he or she has done well. If someone makes a mistake, explain and show patiently the correct way. Do not shout. Explain to your employees that the slogan "we want more money" is not effective, but commitment and teamwork will see to it that the money rolls in. And don't forget to pay it out to

your workers!

## **2.8 Material control**

If your site is small, control your materials in your site office yourself. Have the office big enough to accommodate shelves and floor space for materials. As your site grows, have a separate store with a storekeeper. A Kardex system, which is a metal container with several drawers displaying overlapping cards will help you organize your stores. The overlapping part shows the name and/or member of the item registered. Details like date of entry, items taken out of stock and stock on hand, are clearly indicated. Put the responsibility squarely on the store clerk's shoulders and pay him or her accordingly. You will cut your losses to a minimum, the flow of material will be smooth, and you will have more time on your hands to supervise your business.



Quality control

## **2.9 Control of administration**

At the beginning of your enterprise you have to do all office chores yourself, in the evenings or over weekends. Should your workload become too much for you, consider having a competent assistant to run your office. The assistant will control your petty cash, will file your invoices, make entries into the ledger and write the accounts. A good assistant breathes down your neck every now and then, and calls you to order. You must

know what is going on in your office and while solving problems she or he should be the one to confide in and advise you. The figures in books kept by the assistant should enable you to make cash flow projections from time to time. Your office should be quiet and secluded and not accommodated in your site office.

## **2.10 Ability to calculate**

Calculations are one of the many important functions in the building industry. These calculations are called quantity survey. A quantity survey means that you have to find out the quantities of the various materials from the drawing in order to establish the correct amount and type of materials to buy. With this information you can then establish the best prices against quality from your suppliers. Mistakes occurring are due to low concentration, or not being completely versed with what you are doing. The penalty can be severe, it could cost you your financial

neck!

## **2.11 Research and marketing**

The contractor must be aware that the scenario in the building industry is always changing and changing fast. New products and materials are continuously introduced in the market and it is for you to find out whether they meet your requirements and your clients approval. It is time consuming to find your way through the maze of articles, especially in the beginning. But spend the time and acquaint yourself with what is going on. The research is an absolute must and can take more than a year before you know what is in demand. It is normally done while you are contracting for smaller jobs. If the general market today in the community is to have toilets it is nice to specialise and enjoy high productivity and good quality. But do not rest assured that this will go on forever, tomorrow it might be that improved housing

is in demand. The quicker you realise what the community craves for the easier it is for you to adapt and be a step ahead of your competitors. And remember, your competitors are not asleep, they are at least as keen as you are.

The successful contractor suggests his/her own creative ideas, to the client, of how to build more economically, attractively and practically. With your creative ideas you are a step ahead of your competitors because no one thinks along the same lines as you do. Test your ideas with your customers. If they don't like them, discard them. Suggest to a client to add this or that to his home while you are on site.

Explain how much more it would cost, if you have to leave after finishing - the cost of a new site establishment, inflation or the adaption of another contractor.

## **2.12 Community motivation**

The contractor should not underestimate his or her role in community motivation. You can point out to future plans, who is building, what, where and why. Listen to what they have to say. Take community representatives by car to other site, even to other contractor's site, and discuss and show them what is new and happening. Refer to their ideas. This does not mean that you will be awarded the contract, but people will discuss your actions among themselves, and consider you a contractor to be reckoned with.

Be as systematic about this as you are with all your other actions. Establish a schedule, who and when to see. Be punctual! with your appointments, it proves that you are organised. Do not pile appointments on top of each other, allow a couple of days before the next. Do not rush your client but be persistent. Remind



the client by word and deed that you are in the game, show him or her your present site without boasting. Be friendly and polite. Never criticise or talk badly of other contractors in your community. People might come to think that you are doing it to cover up your own shortcomings. This kind of thing puts you more in a bad light than your competitor whom you try to run down.

### **3. PRODUCTIVITY**

1. Be exemplary to your employees.
2. Know your trade in side out, and be able to show everyone on the job how it is done practically and efficiently.
3. Solve problems effectively.
4. Improve working methods continuously.
5. Look after your tools or check the person who is appointed to do so.



Productive bricklaying

6. Look after a continuous flow of materials. If your materials are not on site, it means down time which again is a cut into your productivity and profits.
7. Check your materials or control the appointed persons to do so.
8. Be responsible for progress on the job.
9. Control your administration.
10. Check your cash flow.
11. Be punctual as it is seemingly fit for a well organised contractor.
12. Be responsible for occupational safety on site.
13. All this together means productivity. Neglect on any of the above mentioned 12 items means lower productivity and a severe cut into your profits. You can not just raise your prices because you will price yourself out of the market.

#### **4. QUALITY**

1. Quality is achieved by exact know how and performance.
2. Quality is achieved by using the best materials at the best prices and excellent workmanship.
3. Quality shows itself at every stage of the building, even to someone who is not a builder. Even one section done wrongly or sloppily spoils the picture and the quality.
4. Quality building has square corners and rooms, straight and plumb walls, square doors and windows in line, plumb square columns, and reveal smooth plaster and straight flat floor.
5. A building site where quality is a priority, is at all times neat and clean because there is nothing to hide. Rubble is placed out of the way in a corner and is removed on a daily or weekly basis depending on accumulation.
6. Safety on site is part of quality. Protective clothing and

security installations as well as cleanliness make a safe site.

7. A continuous inspection on quality is done by the contractor himself or by the appointed foreman on a daily basis. Any mistakes can be easily repaired without too much damage in materials and labour if found out early.



A new VIP latrine

8. A finished building must have the flair of a new product. It must be clean, neat, without fault and completed on time. It should be an object of pride to you and the owner. There is no better advertisement.

---

**NOTES:**

## **5. DISTRIBUTION OF RESPONSIBILITIES**

As soon as you have secured a client as far as the quoting stage, ask the client to consult authorities available. These are the architect and the various engineers. Explain to the client the advantages and the expenses involved in hiring these professionals. Tell the client how and what they do for him on his site. Tell the client that they control your functions as a contractor, in order to ensure that the client, gets what he pays for - an excellent quality building. Also tell him or her that you welcome their activities. It shows that you are competent. Should your client want to join into the operation with activities, he/she can do so to make some savings. Make the client positively aware that all actions must be planned together in the sequence of operations as the project performs. If the client wishes to engage members of the community for some of the activities, tell him/her that he/she is to supervise and control these activities

personally.

Remember that you, as contractor, will be held responsible for your time schedule by the architect, as well as for the quality of workmanship and material. Should an architect not be appointed for some reason or another it will be the client to whom you will account. On any building site there is always someone who exercises control over the contractor. Be alert. It is the skilful distribution and delegation of all your responsibilities to your subordinates. The accountant, your secretary, the storekeeper, the site agent, the charge hands, the artisans, and even the cleaner, each individual carries a part of your responsibilities, but the ultimate responsibility rests on you.

The various occupations indicated above are just to show you how many people would have to rely on your ability to delegate.



In a small firm you need to delegate more, and everyone needs to take on various tasks.

---

**NOTES:**

## **6. ADMINISTRATION**

Remember the efficient assistant I suggested for your office? The assistant will control the office, and that is what you need. No such a thing for you as a quick grab in the cash box just because you are the owner. She or he is well trained and experienced in bookkeeping to keep an auditor happy. He/she will do the banking and prepare the pay-packets. He/she will write out the cheques. You will have to make sure where the money goes to, before you sign.

However, it is highly recommended that you also understand bookkeeping yourself, so that you can fill in when she is not well or on holiday. Take a course to learn the basics of bookkeeping. Keep your finger on the pulse of your assistant's work, it is the heart of your business. Even a good assistant can make a mistake but you are the one who has to take the responsibility. He/she

will update your filing system on a daily basis and will know where to find everything, even after two or three years. He/she will make sure that no account is paid twice and that all accounts coming in are related to your company. Should you wish to modernize your administration at a later stage, a computer will be useful.

---

**NOTES:**

## 7. COST CALCULATIONS



Explaining construction work.

### Quantity Survey

1. Determine all materials required on the drawing and write them down.
2. Analyse all components of materials on hand, i.e. concrete, cement, sand, crushed stones and water.

3. Establish at which quantities the materials you require are available in commerce, i.e. sand in  $10\text{m}^3$  loads, cement in 50 kg pockets, paint in 5 l or 25 l tins, etc.
4. Analyse these materials according to ratio and sum up the total meters of reinforcing steel and other.

For example:-

$49\text{m}^3$  concrete - ratio 1:2:4 = 1 cement, 2 sand, 4 crush.

$49\text{m}^3 = 7\text{m}^3$  cement at 28 pockets per  $\text{m}^3 >$  buy 200 pockets.

$49\text{m}^3 = 14\text{m}^3$  sand  $>$  buy  $20\text{m}^3$  sand.

$49\text{m}^3 = 28\text{m}^3$  crush  $>$  buy  $30\text{m}^3$  crush.

$$7\text{m}^3 + 14\text{m}^3 + 28\text{m}^3 = 49\text{m}^3$$

Another example:

424m reinforcing steel Y 10 divided by 6m lengths

= 70, 66 lengths  $>$  buy 72 lengths.

5. As in the above example you work out all your materials and after that you fill in the best prices quoted per unit and multiply with the quantities you need.
6. You have now the net cost price of the materials you need on site.

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**NOTES:**

## 8. CALCULATION METHOD

Item	Contractor Engagement	Nett cost per 8 hrs N\$	Working Days	Total Cost
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1	1 Contractor	150.00	20	3000
2	2 Artisans each \$50.00/8 hrs	100.00	20	2000
3	8 Labourers @ \$20.00/day	160.00	20	3200
4	Subtotal Labour	410.00	20	3200
5	Hired Transport	100.00	20	2000
6	Direct Material	1000.00 average	20	20,000
7	Subtotal Lab; Mat; and Trans.	1920.00	20	38,400
8	Overheads 45% of item No. 7	43.20	20	864.00
9	Total contract cost	1963.20	20	39,926.40
10	Net profit c.10%	196.32	20	3073.60
11	GRAND TOTAL			43000.00

Note: Above mentioned figures are only examples!

**Explanation of above items:**

1. Contractor - Owner of the construction company/site
2. Artisans - fully qualified
3. Labourers - General
4. Hired Transport - Lump sum
5. Direct Material - every material items used based on Bill of Quantities
6. Overheads - Administration, staff, municipal fees, rent, insurance, tax and others, depending on size of company.
7. Net profit; for small contracts as indicated, but must be reduced pro rata as contract value increases. Not lower than 4%.



## **9. STORE CONTROL**

To control your materials is another important function. As mentioned before, if your business is still small, store the materials in your site office and exercise control yourself. But however small your business might be there must be order and a system even in the few materials you handle. The bigger quantities can be left in the care of your dealer for the time being. While still small and young in the game, gain as much experience as possible in store control as you can. You will need it to advise your store clerk once you have to establish your own store. Storing costs money. The amount of capital outlay into facilities and material is determined by your turnover and availability of certain materials. The emphasis lies in the difference of facilities and materials. Facilities mean a portable sturdy building, shelves, Kardex system, furniture, lights and ventilation. The size of these facilities is determined by the quantity of material that is used per

month. Do not store more because it would normally not take longer than a month to replenish your requirements. Store only more of an item if it is difficult to obtain.

Materials involve a lot of capital. Do not invest your money in stock that does not move, and do not overstock. Rather let your supplier rather carry the burden. A store clerk is warranted if your turnover is more than two hundred thousand N\$ per month.

Below that amount do it yourself because a store clerk must be paid. But should you have a store clerk employed put all the responsibility squarely on his or her shoulders. Only he/she will have the key to the store and nobody else, not even you. Should you want to make a check on your store clerk or need the key for stocktaking purposes, only then he/she will give the key to you and maybe will take the day off. If any discrepancies arise the

store clerk has to provide good answers or pay up, depending on circumstances. That is where the above mentioned salary is for your protection.

Other duties of the store clerk are to be in the storeroom all the time, keep the Kardex 100% up to date, check incoming and outgoing materials and who required them, and for what purpose. He/She will tell you what to order and you will have to tell whether this order fits into the framework and execute it. He/She will also keep the storeroom neat and clean.

## **10. SITE AGENT**

The site agent is your representative on your on site! With this, all is said that needs to be said. You want to know more? Well, O.K. then. Do not employ your friend because he needs a job. Do not employ a relative because you like him. What you do want is an energetic active person with experience and leadership qualities. He/ She must know building like his/her own pockets. He/She must be able to organise quickly and efficiently even under adverse conditions.

The site agent must instinctively feel who of the workers make a good team. He/ She must be able to negotiate with the architect and engineer as well as with his workers. He/She should represent you on site meetings if you are not available. He/She is not supposed to be anybody's pal on site because there is no time for social talk. The site agent is an authority figure and

should not be interfered with. Pay the site agent very well and add a production bonus at the end of a project. What I cannot tell you is where to find such a person, but you will find him or her, just look hard enough.

---

**NOTES:**

## **11. TOOLS**

1. Tools of building trade are of three categories.
  - (a) Measuring tools
  - (b) Working tools
  - (c) Machinery
2. Measuring tools are delicate instruments which can not be made or repaired by you. Only the best quality tools are used by the competent artisan. Prevent abuse, i.e. do not use a spirit level for jointing. Your measuring tools must be kept clean and dry even during the day. At the end of the day clean and check them, wrap them in protective clean rags, and store them in your lockable tool chest.
3. The same as above applies to your working tools except that certain repairs can be executed by you. Working tools are continuously abused on site such as a steel float is used to cut bricks, a straight edge placed over a couple of buckets

is used to stand on, etc.

4. Clean, sharp and well cared for tools will add to your productivity and quality of the work in hand. For example, a wheelbarrow should not be left with ready mixed mortar over night and be hammered out the next morning. The result is a damaged wheelbarrow and a possible penalty by the client because of wasted material.
5. This brings us to a clean well organised site. A clean, well organized site and clean, well cared for tools speak for a well organised contractor. A well organized contractor delivers automatically a good quality building. If a builder looks after his/her own things he/she will also look after other peoples things. There is no better advertisement for yourself.
6. Neglect your tools and you will find that most of your profits will go into replacing tools and the rest of your profit is

eaten up by low productivity. Your initials engraved or stamped into the tools for easy identification would show caring for your tools . When transporting your tools they should be packed neatly and firmly in your toolbox in order to prevent damage during transport.

7. Machinery is to be kept clean and well maintained. Engines are to be serviced regularly and repaired if necessary. This kind of work is to be done by a competent mechanic if you are not qualified yourself to do it.

Do not attempt any repair or service yourself if even slightly in doubt as to what you are doing. It will end up in breakdowns during operation, which will cost you tenfold in downtime than what you have tried to save by doing the repair yourself.

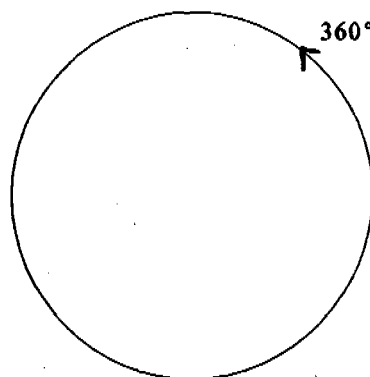


## 12. MEASURING - GEOMETRY

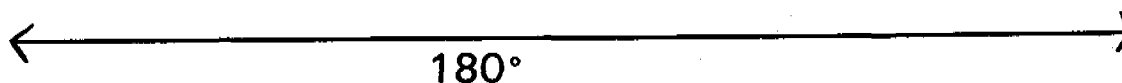


Checking out measurements

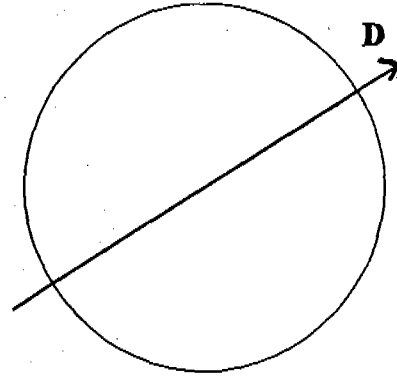
- 1 A full circle has always  
360 degrees.



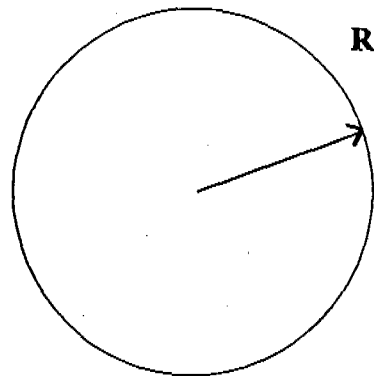
- 2 A straight line is always 180 degrees.



- 3 A straight line going through a circle from end to end is called diameter.

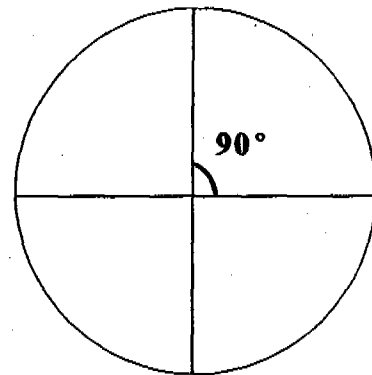


- 4 The line from the centre of a circle to the perimeter of the circle is called radius.

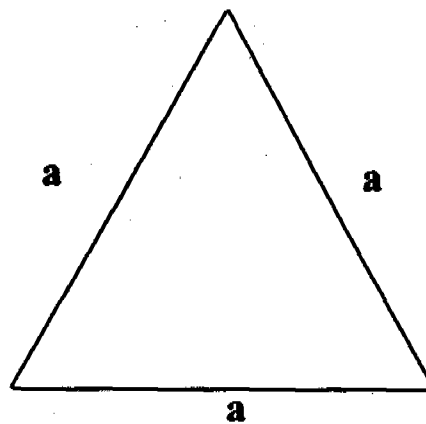


- 5 The radius can point to any of the 360 degrees of a full circle.

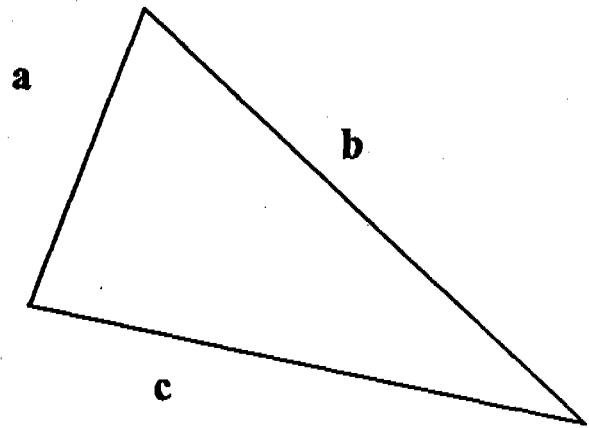
- 6 The radius in a plumb vertical position to the line indicates 90 degrees and is also called a square because it divides a full circle into four sections, i.e.  $4 \times 90 \text{ degrees} = 360 \text{ degrees}$ .



- 7 Further practical division of a square can be 45 and 22,5 degree. The rest of the geometrical degrees is not used in daily building practice.
- 8 The opposite of 45 degrees on a radius is 135 degrees.
- 9 A triangle where each side has the same length is called an equal triangle.



- 10 A triangle where one or two sides do not have the same length is called an unequal triangle.



11. If you come to a situation where the diagonal measurement to obtain a square is not possible you can establish a  $90^\circ$  corner with the following method.
- (a) Establish the exact corner point and hammer a peg into position.
  - (b) Span your building line to the next two corner pegs.
  - c) Measure along one line 4m (or 40cm or 40mm) depending.
  - (d) Measure along the other line 3m (or 30cm or 30mm) depending.

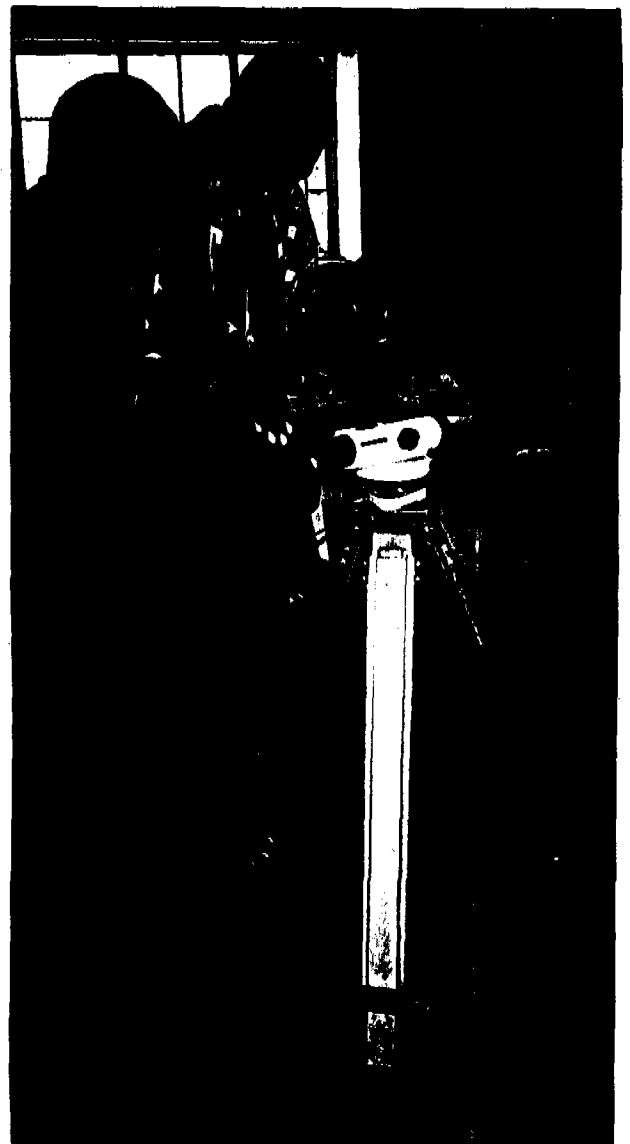
- (e) Now connect the two points along the two lines and the measurement should be 5m (or 50cm or 50mm) depending.
- (f) Should the measurement be less or more than 5m, the angle is not correct and you will have to shift your corner pegs until you get the correct result. You have than  $90^{\circ}$ .
- (g) Do not forget that your corner pegs must correspond with the given measurements on the drawing.

### **13. DUMPY LEVEL (BASIC ONLY)**

1. The dumpy level is a versatile accurate instrument. It can take levels, measure degrees and distance. It may not be used to install surveyor pegs. It is not a theodolite!
2. The dumpy level is an instrument which you put into place, make the necessary adjustments and take various levels at a variety of distances.
3. The dumpy level is mounted on a tripod with a flat or domed base at a convenient height for you personally and the tripod adjusted so that the bubble is inside the round demarkation.
4. Make the final adjustments on the three adjusting screws at the bottom of the instrument so that the bubble is right in the centre of the round demarkation.
5. To make sure the instrument is perfectly adjusted sway the ocular to 90 degrees and check and then to 180 degrees and check again.

6. Now adjust the instrument to the distance of the measuring stick by using the knob on the right hand side until you can see the measuring stick clearly.
7. If any blur is noticed adjust the ocular to your eyesight until the reading is absolutely clear.
8. You can now take your levels at any angle. Make sure that your readings correspond with the level of the bench mark and of the drawing.
9. A bench mark is a solid object out of the way on the building terrain. It can be a manhole, surveyor peg in concrete, a corner of an existing foundation, etc. The reading of the bench mark on the drawing is the base from which you calculate by adding or subtracting your readings until you get what is required on the drawing.
10. The dumpy level is a high precision instrument and never to be abused.

11. Keep the instrument clean and work with clean hands only.
12. When readily adjusted the instrument may not be touched unless with your fingertips to change position of the ocular.
13. Operate the instrument in shade if possible. Direct sunlight onto the tripod will change your adjustment. If so, readjust.
14. Keep the instrument dry at all times. The silicone granules must be kept inside the container of the instrument to keep moisture out.

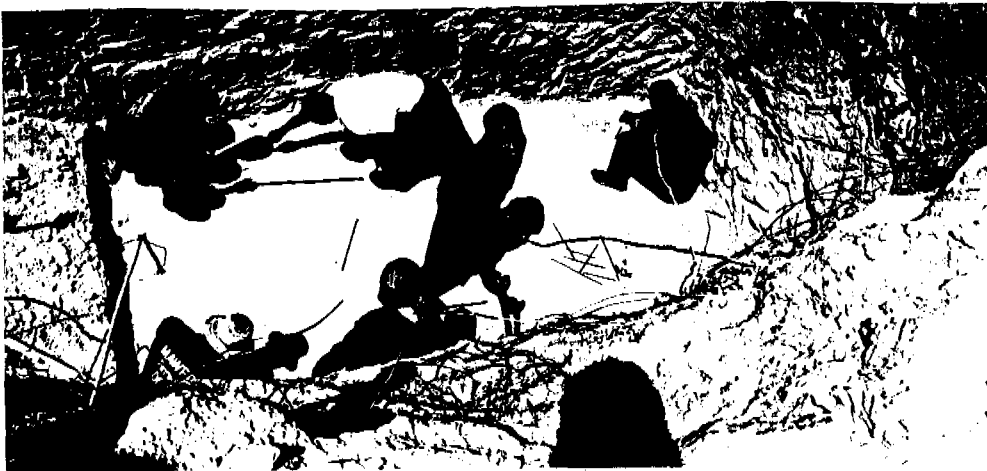


Explaining the adjustment of the dumpy level.



## 14. SETTING OUT A BUILDING

1. When the property has been pointed out by the client to the contractor, determine the boundaries.
2. In case of survey or pegs, find them and plant a thin peg on the inside of the surveyor pegs, at all four points.
3. Fix a tight line to your pegs all around so that all four boundaries are clearly visible.



Setting out a building.

4. In case of a fence the above is not needed.
5. In case of a hole check that the excavation is wide enough so that the walls can be built freely.
6. If a house is built advise your client that the rooms for living should face north so that the house is cool in summer and warm in winter.
7. In a municipal urban area a building with a sloping roof must be 3 meters away from the boundary. This is a standard regulation.
8. Should it be necessary to build on the boundary a fire wall must be built and the roof sloping into the property.
9. After all this has been considered and discussed with the client peg out the building squarely.
10. This is done by a diagonal measuring check. The diagonal points must give the same readings.

## 5. FOUNDATION

1. The foundation is normally designed by an architect or draughtsman. Where extreme loads are placed on foundations a civil engineer is consulted.
2. The contractor is to observe the specifications of a foundation very closely since the whole future building structure is to depend on it.
3. In case of extreme load on a foundation it is reinforced with high tensile reinforcing steel which is shown in a bending schedule on the civil engineers drawing.



Foundation layout of VIP latrine.

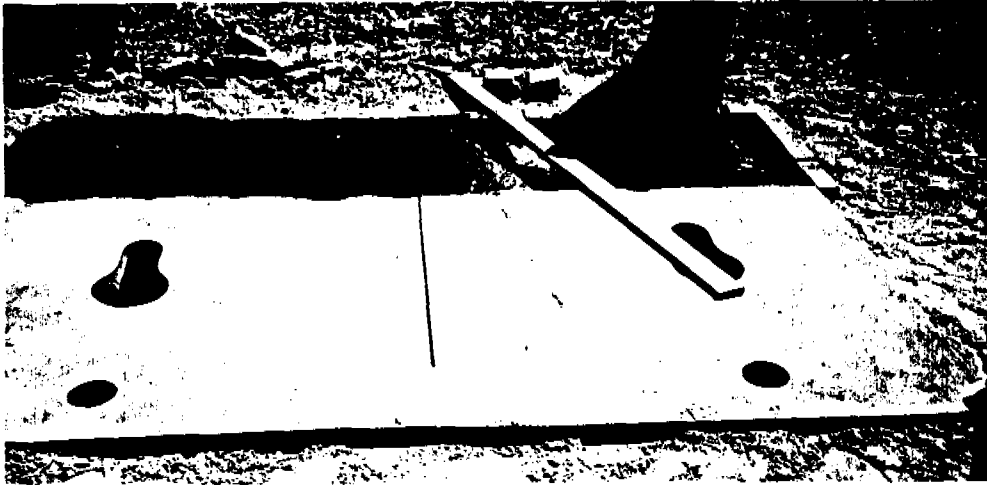
4. On uneven terrain a foundation can be stepped or boxed out.
5. When stepping or boxing a foundation it is important that the continuity of the concrete beam is not impaired! The joint of the upper section and the lower section is to have as much concrete as the rest of the foundation.
6. The stepping should always be so designed that the height of 2 or 4 layers of bricks are accommodated to ensure a neat and level foundation wall.
7. The foundation wall is then covered with a layer of dampcourse before starting to build the walls.

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## **NOTES:**

## 16. CONCRETE

1. Concrete is the most versatile of all building materials. You can find it in the form of foundations, columns, floors, walls, ringbeams, retaining walls, high rise structures, etc.
2. Sand has to have granular quartzite quality and a low clay content and no salt!
3. Crushed stone is to be clean, meaning no sand or crusher dust to be mixed within. Should foreign matter be amongst the stone it must be sieved or washed.
4. Cement is to be fresh. Be very sure. Cement deteriorates within 3 months.
5. Water is to be clean and is measured in litres exact. Do not use saline water.
6. It is of utmost importance to ensure that the mix ratio including the water is absolutely accurate. Solid materials are to be weighed. All this is so important that even your sand may be analysed in a laboratory for its possible mica and clay content and the stone for hardness.
7. The ready mix has to have the consistency of clay pressed together in your hand. Thrown into the air it must stay together when caught and remain smooth.
8. This kind of concrete must be compacted by means of a mechanical vibrator in order to ensure that the air is forced out and that the concrete fills in nicely around the reinforcing steel. If this is not achieved cavities called "honeycomb" will remain and can lead to condemning the concrete.
9. Test cubes will have to be made of daily batches and marked and treated to specification.



Casting of slab in sites.

10. Test cubes are tested on a 7 day and 28 day base and are cured in water. The hardness the test cubes will show is measured in MPa and gives an indication of the quality of concrete .
11. After concrete has been cast and vibrated it is to be left undisturbed for 48 hrs. Only then the shuttering can be removed.
12. The curing of fresh concrete is done by keeping it wet for 10 days at least and is always covered with plastic sheeting for 20 days.

13. Good quality, clean and well oiled shuttering neatly made by an qualified experienced carpenter is a precondition of high quality concrete.
14. If these basic rules are not adhered to minutely the concrete can easily be disqualified which again results in loss of time and money in a severe way.

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**NOTES:**

## **17. MAKING BRICKS**

- 1. The sand should have a quartzite character. Quartz is a hard stone which always has sharp corners and edges, no matter how small it is broken. The colouring of quartz is mostly glassy white, but it can also be transparent or pinkish. Rubbed between your fingers it gives sand a coarse character.**
- 2. The higher the content of sharp quartzite grains the better the quality of the brick.**
- 3. The sand should also contain about 20% clay.**
- 4. The sand should be free of dirt; no grass roots, sticks, plastics or paper.**
- 5. The ratio of cement to be added depends on the hardness required of the brick. The hardness is also measured in MPa.**



6. The right quantity of water added is very important. Too much water will reduce the quality of the bricks drastically regardless of the quantity of cement.
7. Be careful while adding water during your first few mixes until you have established the correct quantity of water.
8. The correct quantity of water will show when you take a handful of the mix into your hand and press a clump. If any cement water protrudes between your fingers the water is too much. If no water shows throw the clump into the air and catch again. The clump should not break up when caught. Repeat this 3 or 4 times. If the clump remains intact you have the right mixture of sand, cement and water.



#### Curing bricks

9. The correct ratio can be established by an experimental mix in order not to foul a lot of material. Take a cooldrink tin and cut open. Fill the tin once only with cement and pour out. Evaluate the quality of your sand in bulk and add 4 or 6 or 8 tins of sand and add to the cement. Mix thoroughly. Then add carefully one tin after the other with water and mix. When you have reached the consistency as described in

item 8 you have the correct ratio. This ratio can now be enlarged to any measuring unit at your disposal, i.e. bucket, drum or wheelbarrow.



Making bricks in the shade of a tree.

10. The better your compaction of your mix in the mould the better the quality of the brick. Even cement can be saved with a good compaction. The finer the grain of sand the better the compaction should be.

11. If no base plates for moulds are available prepare the ground by removing all loose sand until firm soil is reached. Smooth it with a rather long piece of straight wood and wet well. Where possible work in the shade. Bricks should be packed in columns of 100.

Bricks should be cured in shade and be well watered 3 times per day for 7 days and then once per day for again 7 days. After drying a pressure test can be done.

## **18. BRICK LAYING**

1. Start with setting out the 4 corners of a room. Place dampcourse on the foundation and lay two bricks at an angle on each corner in order to determine the inner size of the room according to drawing.
2. Check the measurement according to drawing and measure diagonal until perfectly square. Do not forget to allow for the plaster, otherwise your room will be smaller than required on the drawing.
3. Unless specified otherwise decide which course is easiest to your hand and start building the corners 7 or 8 courses high. Use your spirit level with each brick.
4. When all 4 corners are up make another diagonal check. Do not take for granted that your corners are plumb. Make adjustments accordingly.
5. Make sure you have sufficient mortar between the bricks in

order to allow for unevenness of bricks. Normally each course will be 10 cm high with mortar depending on quality and size of brick.

Brickwork should be always of a good standard quality whether exposed or not.

6. Make a gauge accordingly working out the courses to the height of your door frame which usually will also be the top line of your window frames. The gauge will show an even line of the course.
7. While you build, never touch the building line with a brick. Immediate problems will result showing in quality and productivity.
8. Every time when lifting corners up use your spirit level and measure diagonally. This is quality control.



Bricklaying in the pit.

9. Should the brickwork show joints use a wooden straight edge after 4 or 5 courses, depending on length, to profile joints.
10. Your mortar ratio should never be stronger than your bricks.  
The ratio of the mortar should be of an even quality

throughout in order to minimise cracks.

11. Use brickforce every 4th or 5th course.
12. Protruding mortar on the side of bricks must be taken up with the trowel in the building process. Pick up the mortar that has fallen to the ground every few hours. It is good money lying there. Add a bit of cement and use it.
13. Quality brickwork must show straight and even courses and no cavities in the mortar. A well practised and qualified artisan can lay 1000 bricks in 8 hrs under favourable conditions.



## **19. PLUMBING**

As soon as the foundation walls have been built and backfill is placed in layers and is compacted the plumber can be called in for the laying of the sewerage pipe system.

Levels of the sewerage pipes are to be taken very seriously as well as the positioning. Levels are indicated on the drawing and are to be installed with a dumpy. Should conditions on site allow it the sewerage system can be laid out down to the municipal manhole connection. The meaning of "conditions on site" refers to the inaccessibility of trucks running over trenches. However, should there be a possibility that heavy trucks could bend the newly laid pipes this work is then done in the last phase of construction. We have these days two types for sewerage systems. The manhole type is used to the lesser degree because of the filth when overflowing and cleaning. A manhole can have

up to three separate junctions. The other type is called a stub stack system and consists of pipes, rodding eyes, cleaning eyes and stopends to close off the top of pipes next to the building. The access to clean the pipes with flexible rods is easy and comparatively neat to the manhole system.

### Water reticulation

The cold water reticulation coming from the municipal water meter is chased into the outside wall and up into the roof with a stopcock preferably in the bathroom. From there the reticulation is spread out to the various outlets i.e. bathroom, kitchen, toilet, shower, and hand wash basins. It is also connected to the geyser from where again the hot water reticulation is brought to where required. It is a good practice to insulate the hot water pipes in walls and roof space with a paper bandage or even with old cement bag if it is done neatly.

Three types of geysers are available

1. The electric geyser with a content of from 20 l - 300 l.
2. The gas geyser is always full flow but needs pressure to operate.
3. The solar geyser with a content of 100 - 300 l with an electric standby element for cloudy days.

The electric and gas geyser are relatively cheap to buy but use expensive energy, the solar geyser is rather expensive to buy but is practically maintenance free with free energy.

Pipes for the reticulation system are available in

- a. Galvanised
- b. Copper
- c. Polypropylene
- d. PVC

The most popular is the copper pipe with soldered fittings

## **20. MORTAR AND PLASTER**

Mortar and plaster consist of clean, sifted, fine sand with a cement ratio adjusted to the mix ratio of the bricks used. Both mortar and plaster should not exceed the brick ratio and should rather be less because of uneven tension then occurring in the wall causing cracks. It is a good money saving practice to use "Wallcrete" or a similar product for smooth workability of mortar and plaster. This of course is depending on your specification, if any. Very important is the continuous uniformity of the mix ratio. It is advisable that the newly built walls are kept wet for a day or two. The same is to be applied to the plaster. Walls should only be plastered after the roof sheets have been put on, in order to allow the plaster to dry evenly in the shade.



Preparing the mix ratio for brick making.

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**NOTES:**

## **21. ROOF CONSTRUCTION - CARPENTRY**

Roof constructions can be made of wood or steel. The wooden construction is cheaper and has a lifespan of approximately 40 years if the sheets are not leaking where they are nailed down. In case of fire the whole roof can be destroyed. Termites can also destroy the structure. A steel construction outlasts the lifespan of a house if painted and is of course fire and termite resistant.



Timber roof construction

The carriers of a roof construction are called trusses or beams and are used for gable roofs or flat roofs respectively.

Wooden trusses are always made of S.A. pine and the same wood is used for purlins (75 x 50mm) and bracing (38 x 50mm).

Beams for flat roofs should be made of Laminated pine whereas purlins and bracing consist of S.A. pine.

A roof construction is held down by means of hoop iron anchor for wooden roof construction built into 5 layers of bricks and is bent and nailed to the truss. A steel construction is held down on a solidly concreted baseplate where it is welded onto on one side only. The opposite side is left free to slide over the baseplate with expansion and contraction. The neighbouring truss is then again welded next to the free base plate. In this fashion the roof

will remain in position with strong winds, but can move freely without breaking the building. The carpenter will fit the doors, put in the ceiling, fit built-in cupboard, pelmets and floor skirtings.

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**NOTES:**



## **22. ELECTRIFICATION**

The electric reticulation is made by a qualified craftsman who is tested and licensed by the municipality. No one else is allowed to touch the electric system. Should it be done by an unqualified person it will be detected by the inspector before connecting power. He will then condemn the whole installation and more than double the cost will arise for the contractor to replace it. So, do make false savings.

In your own interest the contractor should plan ahead and call in the electric subcontractor before walls are plastered but with the roof construction in position. Chasing into the walls for the conduct tube can be done by the contractor as method of saving if the electrical contractor agrees and chalks the positions on the wall according to plan . After chasing the walls and the conduit pipes are fitted, the walls can be plastered and primed. Before

painting the electrician will draw in the cables and finalize all after painting. The municipal inspector will have to be called in if all is ready so that he can authorise power connection to the meter board.

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**NOTES:**

## 23. FLOOR

A floor, any floor must be flat, straight and level to a certain extent. With this is meant that a floor should slope very little towards a door leading outside or the outside of a veranda or shed. To put very little slope into figures is 5, 0 mm per 1000 mm or percentage wise 0,5%. This little fall or slope helps to keep rainwater out and the floor is easier to wash. A carpet covered floor is always dead level.

To prepare a good floor your filling between walls should consist of sand. The sand is then watered down and machine compacted. The compaction should be as level as possible. If this is not the case the hollows and dents are filled with concrete for which you are not paid. Use a dumpy level to place your bricks for accuracy and you can also determine the slope of the floor precisely. To use a straight edge with spirit level is alright for

small floors for up to say  $\pm 30 \text{ m}^2$ . Extending this area is not accurate with a straight edge.

The finished floor should be corrected the next day with sand and be kept wet for about a week. After that the floor must dry out. Big floor areas have expansion joints where 10mm soft board is cast in. Equal blocks are to be cast singularly and then the open space in between with the soft board cast the next day.

Use only first class concrete according to specification. Without it make your own good mix with a ratio of 1:2:3 meaning 1 cement, 2 sand, 3 stone, in the procedure referred to in chapter 16. CONCRETE. Do not attempt a bigger area that you can finish in a days work with a good quality finish. Bad work will be condemned or will remain for the daily annoyance of the owner giving you a bad reputation.

The surface can be finished by smoothing the concrete as it is cast.

This is a heavy duty surface used in garages, sheds and factories.

In domestic application a screed is spread over the rough concrete of a 30 to 50 mm thickness depending on specification.

For good bondage use a cement slush on the concrete.

---

**NOTES:**

## **24. CEILINGS**

The framework plan for the ceiling is done by the carpenter. The wood used is S.A. pine bandering 38 x 50mm. The framework is nailed to the trusses or beams consisting of squares 400 x 400mm from centre to centre (c/c). The small squares will prevent a celotex ceiling from hanging where it is not fixed. Furthermore this measurement allows a full board to be nailed over three beads to join.

There are a great variety of ceiling materials on the market to choose from, all being 1,2 m wide and varying in length. The most popular ceilings are celotex or rhinoboard, the latter being fire resistant.

Any ceiling can be covered with insulating material such as glass wool or sisalation.

The joints can be V - shaped, or closed with wooden flat beat or paper strips. The nailheads must be closed with filler and skimmed before primer. The joints against walls are closed with cornice.

Everything must be straight and level. The ceiling height from finished floor level (FFL) must be closely attended to according to plan.

## **25. PAINT AND FINISH**

Where sections of building are completed and the walls have dried out a filler coat can be applied as primer. Then stopping is applied to close small holes. The whole wall can be skimmed in this fashion and then sanded down to a smooth surface. Only after the doors have been fitted and rooms can be locked the final two coats of paint can be applied. After the first coat sand down any protruding particles so that the final coat gives the necessary finish of a new product.

Important is that at all times the greatest care should be taken to ensure that paint is not splashed over steel or woodwork since each receive a different primer. Avoid spilling on the floor, it takes a lot of time to clean.



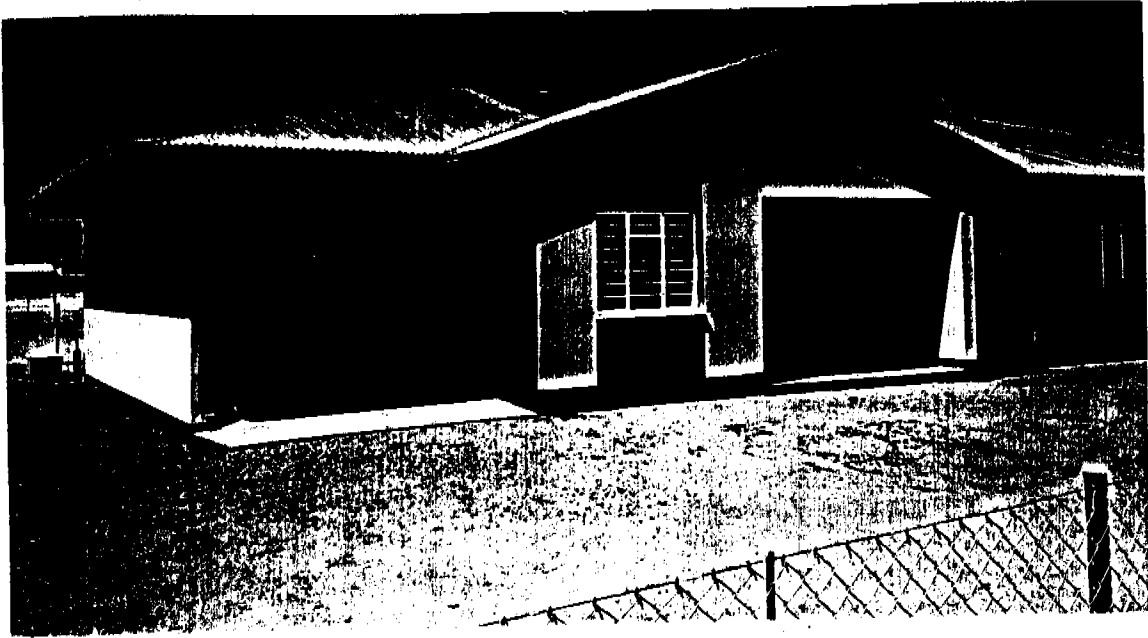
For a two tone finish on the wall start painting from the ceiling downward to the approximate level where the other paint or colour will meet. Now measure the correct height and put in the level marks with your dumpy and shoot a chalk line. Stick the masking tape on the dry paint of the top section and paint the bottom section of the wall. Before drying, strip the masking tape and you have a neat dividing line between the one paint and the other.

## **EPILOGUE**

Dear reader, you have now the basic outlines of how to go about becoming a successful contractor. The crux of the matter is sticking to the rules. Learn as much as you can and learn everyday. Learning is an ever ongoing process. Do not be shy to ask, get a second and third opinion, try out what is best for you and work hard.

One last word on the serious subject of building. Make sure, whenever it is humanly possible, that the money is secure for the project you want to be part of.

Even so, the proverb goes, "there is many a slip between the cup and the lip". Do not become disheartened after a failure or two. Do your work enthusiastically.



A neat new building, well finished, and a clean site

## **Appendix I**

Materials used for the structure shown on the drawing can be referred to on the existing bill of quantities.

Note:- With a change to the drawing the B. o Q. will have to be adjusted accordingly.