



BUILDING WITH STONE AND EARTH

PART 1

Earth is a popular building material all over the world. It can be used by itself, but if there is stone available, then the two can be used together to make very good buildings indeed. And it is not very difficult to do - this article will show you how.

Why use stone and earth?

The first of several very important reasons is that they can be free! The materials - stones, and earth from termite mounds (anthill soil) - can cost nothing. If you are lucky they can be gathered close by, perhaps even clearing agricultural land in the process. Secondly, you can do the work yourself. You do not need a mason and you will need only simple tools.

Earth buildings will last a long time, much longer than ordinary housing. In some parts of Africa, the grandfathers cannot remember their houses being built. This is because there is no wood for termites to eat - you use their homes instead!

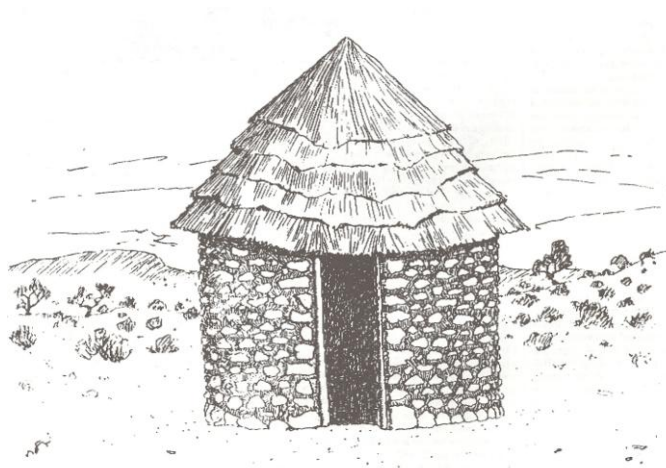


Figure 1: A rondavel built of earth and stone.

Houses built with these materials are cooler in the summer and warmer in winter than expensive houses built with blocks and corrugated iron. They look much better too, because they use traditional materials.

Tools and materials

The tools required for working with earth and stone are simple and inexpensive. Try to borrow those that you do not already own.

You should be able to collect the different shapes that you will need, but it will save time searching if you have a simple 'club' hammer. Then you can shape some of the stones, and break others for the small pieces that will be needed to help fill the centre of the wall. It can also be useful to have a crow-bar to break off good pieces of stone from large boulders and rocky outcrops.

You will be using material from termite colonies to make the mud mortar, so you must have a spade or shovel and a pick to loosen the earth. You may also need a wheelbarrow to bring the material to your site. Containers to bring water and to mix the mortar in are necessary; although you can also mix in the wheelbarrow.

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If the building is to be square, four straight poles are used for marking out; if it is round then you need only one pole. You will also need string, a measuring stick about 45cm long (the length of your forearm from elbow to fingertips), and a simple 20cm-long wooden peg that is sharpened to a point at one end. You will also need two door poles.

They should be the height of the doorway that you require, and as straight as you can find. To clean and finish off the wall you will need a medium-sized paintbrush and some water.

Planning and preparation

First choose your site, depending on what you are building. Lavatories should be away from and downhill of houses, for example. If there is a termite hill nearby you can work near to it, saving yourself some work in moving the material about.

Then make a list of the tools that will be needed, and plan to buy or borrow any that you do not already have.

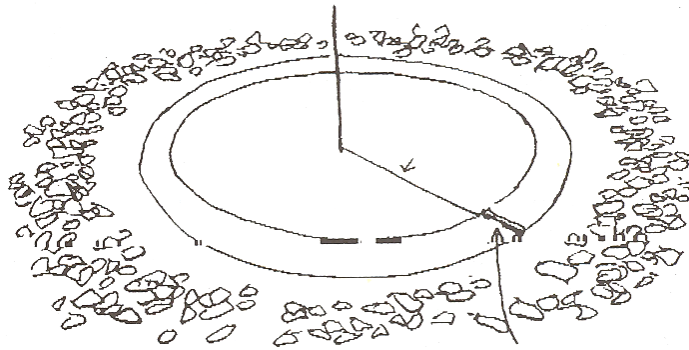


Figure 2: Marking out a round building

Next you will need building stone. If there is not enough stone near your home, then begin collecting it well before you are ready to build. The amount that you will need will depend on the size of the building, but collect as much as you can to start.

Clear the ground, uprooting and carting away all the scrub, bushes, and other plants that are on the building site. Then level the site, removing all the lumps and bumps until it is all flat. Finally, unless the ground is sandy, stamp on the ground to make it as hard as you can.

Stone and mud walls will not be damaged when the rains come as long as you follow the Golden Rule: keep the top and bottom dry. First a layer of stones is placed at the bottom dry, without any mud mortar. Then when you come to build the roof, the overhang is made as long as possible, to keep the falling rain away from the wall. There are one or two other things you may want to do, but we will deal with these when describing the building.

Foundation

For this article, we will build a circular rondavel. It is possible to build without using any strings or pegs to help you mark out the position of the wall, but it is much more difficult, and never looks as good.

Stick a straight pole into the ground where the centre of your building will be. Then tie a piece of string to this pole, and the pointed peg to the other end of the string, at a length of just under half the width of the building. With the string taught, scratch a circle in the

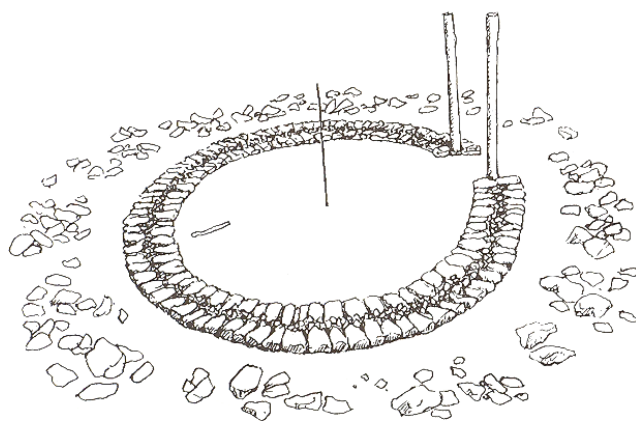


Figure 3: The first two lines of stones are laid in perfect concentric circles. Make sure that they are level, and fill the space in between with small pieces of stones

earth. Re-tie the peg two footsteps further along the string from the central pole, and draw a second circle on the ground. These concentric circles mark out your foundation layer of stones. Keep the string attached to the central pole, for you will need it again when building the main wall.

Now put in two poles where you want your door to be, as wide apart as you want to make your doorway, exactly half-way between the inner and outer circles. Use straight poles, and make sure they really are vertical, not at a slight angle.

For the foundation, choose the flattest stones you can find. Lay them around one of the lines, with their ends touching each other. Move to the other line and do the same again. You will now have two lines of stones laid in two concentric perfect circles.

There are two very important things to do at this stage. First, ensure that each of the stones that you have laid sits firmly on the ground. Gaps will make the stones unstable, so put small, wedge-shaped pieces of stone underneath where necessary. Secondly, fill the spaces between the stone circles with waste (smaller pieces of stone). These can be collected, or you can smash larger stones with your hammer. You will now have what looks like a flat stone path. The wall will be built on top of this, so try to keep the stones roughly the same height as each other. If you have a big stone that sticks up a bit, for example, take it out, dig a little hole in the ground, and then put it back. It should now be the same height as the stone beside it.

Now test the wall: walk on all the stones you have laid. If you have placed them correctly, there should be very little movement under your weight, if any. When you find a loose stone, place more wedges around it until it no longer moves.

Building the wall

First, you will need to do a couple of simple things so that you can make the sides of your rondavel vertical and keep the wall the same thickness all the way up.

The wall that you are going to build is a little less wide than the foundation layer, enabling the weight of the wall to be spread better over the foundation. Take the string that is tied to the central pole, remove the peg, pull the string out tight towards the edge of the foundation layer, and tie a knot in it. Now this knot must be a little bit inside the outer edge of the foundation layer, by about the width of three fingers. Every stone you now lay will use this knot to place it in the right position. The other thing you need is a measuring stick. It must be narrower than the foundation layer by three fingers' width at each end. This stick is exactly the same width as the wall you are to build, so that the foundation layer will stick out by three fingers' width both on the inside and outside.

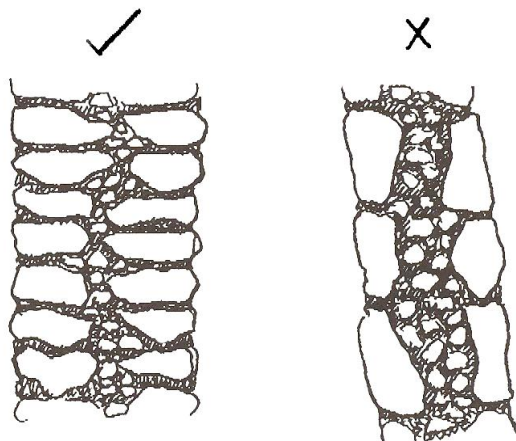


Figure 4: The longest side of the stones run into the wall.

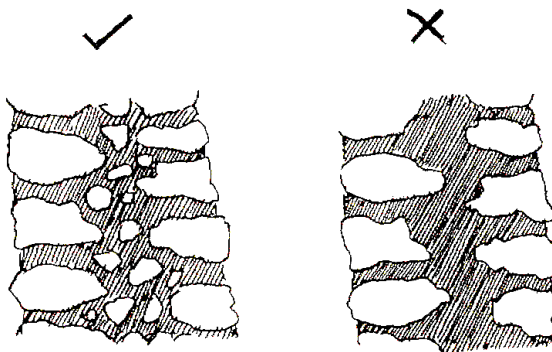


Figure 5: Fill the middle of the wall with plenty of small stones as well as mud.

Now mix up some mud mortar (termite soil and water); it should be thick, but wet (like cement mortar). Place some on the foundation layer, the same width as your measuring stick. Do not put too much along the foundation at once, or it will dry before the stones are laid. Place two or three stones on the mortar one after the other, so that their outer edge is exactly in line with the knot you tied in the string.

Then take your measuring stick, line up one side of the stones you have just laid, and lay several more opposite them. The outer faces of these stones should exactly line up with the other end of the stick.

Once you have laid stones on the inside and outside, you must fill the middle. First put a layer of smaller stones into the centre. If these do not fill up the middle completely, add a thin layer of mud and then some more small stones. The mud should touch all the stones in the wall.

There are two very important rules that you must keep in mind all the time when laying the stones. First, always have the longest side of the stone running into the wall, not along it (see drawing above). The more it goes into the centre of the wall, the stronger the wall will be. Next, never fill the centre of the wall with just mud. It can be very tempting just to heap mud into the middle to level up, but this is very bad practice and will weaken the wall.

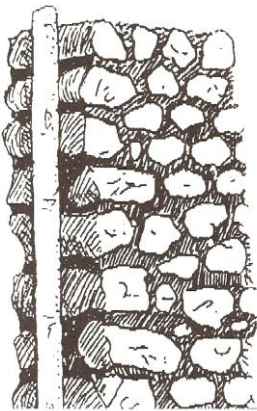


Figure 6: Try and find longer stones for the doorway, one laid across and two running back into the wall

There should only be enough mud to bind the stones together. The same goes for the mud between the layers of outer, or face stone. Put them onto just enough mud that the stone sits securely.

Keep the stones level. A very common fault is to lay a stone so that the top surface slopes steeply outwards. Think what will happen when you have to put a stone on top of this; it will slide out. You may have to support the stone to make it level; use stone wedges, not just mud.

Always, always check each stone's position using the knot or measuring stick. It is the only way to keep the wall straight and true, and the same thickness all the way up. Stand back and look at what you have done from time to time, to see if any mistakes have crept in. Finally, try to keep mud off the outer faces of the stones; it looks much better.

Carry on until you reach the door poles. Here, it is best if you use a stone at least as long as the measuring stick, so that one stone runs right across the wall. If that is not possible, find two stones of equal size that together are the same width as your wall.

The best way to build at the door poles is shown in the diagram at left.

Running the stones first across, and then back into the wall is best, otherwise simply use stones that are as square as you can find, trying to break the joints. Remember the mud will hold the stones strongly.

With the first layer completed, you can begin another, working in exactly the same way. The only thing to do with each new layer is

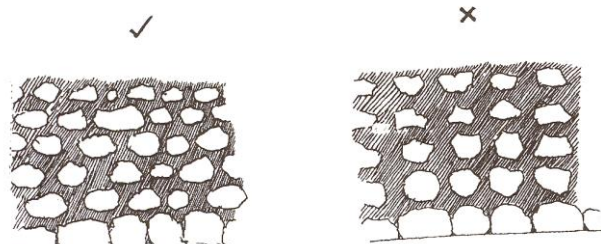


Figure 7: Break the joints, so you do not get lines of stones sitting on one another.

to try and make sure that you 'break the joints'. This means that stones are not laid exactly on top of the one below, but half on one and half on another. If you were able to use a single stone laid across the wall at the door frame on the layer below, this time use two stones, as in the diagram at the very top of this page.

You can make the wall even stronger if you can find a number of stones the same length or a little longer than the measuring stick, apart from those you should try and find for the doorway. Put them at intervals across the wall at about knee height so they stretch from one side to the other. If they are a bit longer, but only an inch or two, than the measuring stick put the extra length on the outside - to protect your knees!. They will help bind the two sides together. If you have enough, put them about three feet apart. You can repeat this every five or six layers if you have the right stones.



Figure 8: Brushing the joints with clean water must be done after each day's work.

resistant to the rains.

Once the joints have been brushed - and it does not take long - continue building in just the same way as before, layer by layer, concentrating on the key points as you go. How high you make the wall is entirely up to you, but the height of the top of the door poles will be about right. Once the building is completed, go over the joints for a final brushing.

Roofing

You can use any of the usual roofing methods, but your rondavel will look much more attractive, and keep an even, pleasant temperature inside if it is thatched. Corrugated iron is ugly, very noisy when the rains come and worse, very expensive.

Part two of this article in the December issue will explain how to use this technique to construct a square building, and how to build single skin walls which use less stone and are quicker to erect.

By the end of the first day, you should have laid two or three layers. The next day, whether or not you are going to do another session of building, take the paintbrush and some water in a container. The mud will be rather rough, sticking in here and out there, and in places will have shrunk away from some of the stonework as it dried. Use the wet paintbrush to smooth out the joints.

By doing this job no later than the next morning, the mud will still be just soft enough to press back against the stonework where necessary. This is an important job; not only will it make your rondavel look much smarter, but it will also make it more

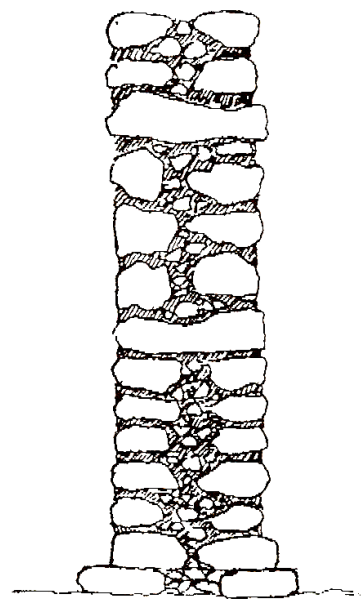


Figure 9: Lay long stones that go right across the wall if you have them.

Also see [Building With Stone and Earth - Part 2](#)

This article was originally produced for the *Appropriate Technology Journal* Vol. 24 No 2. September 1997 by Richard Tufnell, a dry stone mason with many years experience of dry stone.

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