

SELECTING SOIL FOR THE CARTEM 'ELEPHANT' BLOCKMAKER



The Cartem Elephant Blockmaker will produce high quality durable and strong building blocks from many different soils, and the following guidelines will show how to select, test and mix suitable soils and then how to handle, cure and build with the blocks produced.

Selecting the Soil

Soil for the making of durable building blocks should contain fine gravel and sand to form the body of the block, plus a small amount of clay to bind these basic materials together. Suitable soil is widely available in many areas of the world. When you select a source from which it is to be dug make sure this will be big enough to produce all the blocks needed for the project. As a guide, a single storey house with a floor area of 50 square metres will require about 3,000 blocks of the size produced by the 'Elephant' Blockmaker (29 x 14 x 10cm) and will need a pit able to supply about 17 cubic metres of soil.

The constituents of soil can vary even within a quite a small area. Variations can be checked by digging trial holes. First dig out a square metre of top soil from several different sectors to a depth of 300mm or so. (Top soil varies in depth but can be recognised by its appearance and musty smell). The soil below should then be removed to a depth of about 2 metres. This will clearly reveal the layers of top soil, clay and sand – known as the 'soil profile'.

The top soil itself contains organic material, is dark in colour and often smells musty. It is useless for blockmaking. Below this is the clay, which is a lighter colour and tends to be sticky. It will contain some silt or very fine sand. A certain amount of clay is essential in the soil mix for making good building blocks. The lowest layer of the soil profile is the sand – a very gritty material which contains some stones and gravel. This is the main component for blockmaking.

Testing the Soil

The soil taken from the trial holes can be checked for the presence of clay by three simple tests.

1. The Cube Test

All stones should be removed from the small sample. The soil should then be moistened and formed by hand into a cube with sides of about 25mm (Fig. 1). If the cube is easy to form the sample contains a large amount of clay. Let the cube dry in the sun for a day. If it shows surface cracks this is another indication of a large amount of clay in the soil. If it falls to pieces when dry the sample contains too much sand or silt.

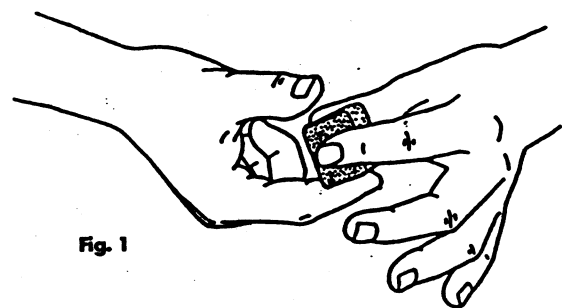


Fig. 1

2. The Rolling Test

Select a sample from the trial dig that appears to contain both clay and sand. Remove all stones and form the soil into a ball about the size of a hen's egg. Add enough water to make the sample easy to mould by hand, then place the ball on a clean flat surface and try to roll it with the palm of the hand into a long thin cylinder, half the thickness of a pencil (Fig. 2). If it is difficult to roll, add more water.

If the ball breaks up as soon as you start rolling it the sample contains a lot of sand and only a little clay. If it is easy to roll to the thickness of a pencil it probably contains enough clay for blockmaking. If it is easy to roll to half this thickness it contains a lot of clay and a little sand.

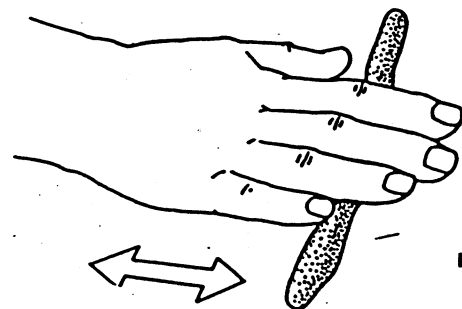


Fig. 2

3. The Bottle Test

This test enables you to measure the clay content of a soil sample. The value of the test is that if it shows the clay content in the sample is very small you can save time by rejecting the source of the material and look for a suitable one.

You will need either a clear glass jar with a screw-on lid or a glass bottle with a screw-on cap. Ensure that the soil sample is free from lumps and stones larger than the thickness of a pencil.

Fill one-third of the jar with soil; add an equal quantity of clean water and screw on the lid (Fig. 3). Shake the jar vigorously (Fig. 4) then leave it for 30 minutes. The hard pieces of soil will soften and separate. (You can help this process by adding a teaspoonful of common salt to the water.)

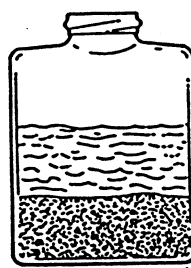


Fig. 3

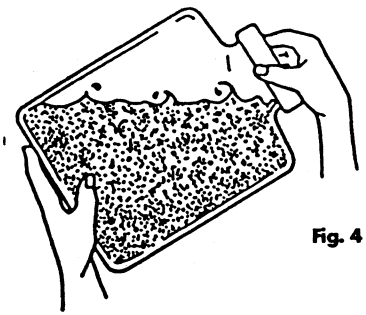


Fig. 4

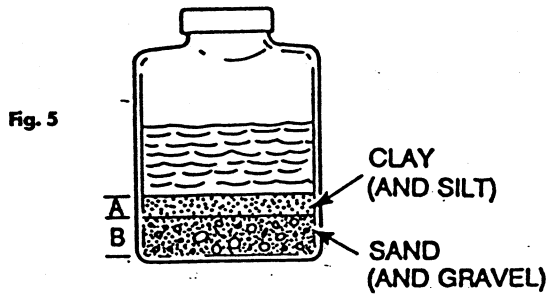


Fig. 5

Shake the jar thoroughly again and place it on a level surface. After a few minutes the water will become clear and show, at the bottom, a layer of sand (and gravel) and above this a layer of clay and silt (Fig. 5). Measure the thickness of the layer of clay and compare this with the thickness of the whole sample. **FOR BLOCKMAKING THE CLAY MUST BE AT LEAST ONE TWENTIETH PART OF THE WHOLE SAMPLE.**

4. The Shrinkage Test

Clay shrinks as it dries. Some clays shrink more than others. You need to measure the shrinkage of the soil sample to test its suitability for blockmaking and especially to estimate how much stabiliser must be added to produce satisfactory blocks. For this test you will require a mould in the form of a wooden box made to the dimensions shown in Fig. 6.

The inside of the mould must be oiled or greased so that the samples can be easily removed after shrinkage. Make a paste from the sample soil and water. The consistency of the paste should be such that, when tamped, water comes to the surface. Fill the mould with the paste and knock it a number of times on a hard surface to release trapped air. (This may produce bubbles on the surface). Smooth the top of the mould and leave it to dry in sun for five days, or in the shade for about two weeks. The sample will have shrunk in length (Fig. 7). Measure the gap between the end of the sample and the mould. According to the shrinkage table below you can now determine whether the soil is suitable for blockmaking, and if so, how much stabiliser must be added.

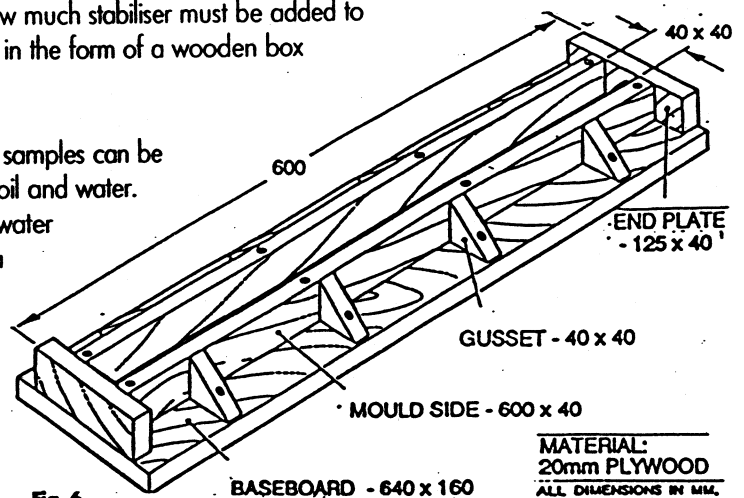


Fig. 6

MATERIAL:
20mm PLYWOOD
ALL DIMENSIONS IN MM.

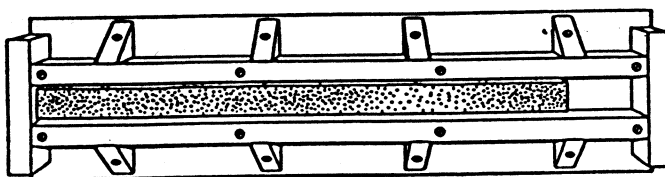
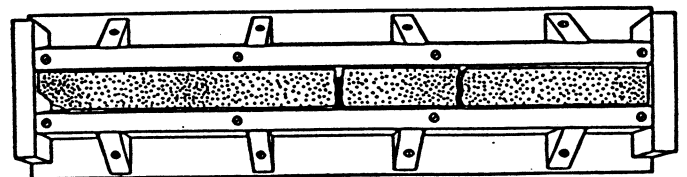


Fig. 7



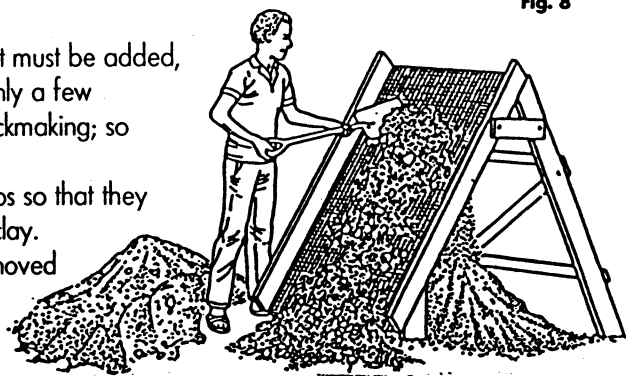
Shrinkage	Recommendation
Less than 15mm	Not suitable unless more clay is added. You could add more clay and carry out another shrinkage test.
15mm to 30mm	Add 1 part of cement to about 20 parts of soil (by volume).
30mm to 45mm	Add 1 part of cement to about 15 parts of soil OR 1 part of lime* to 7 parts of soil.
45mm to 60mm	Add 1 part of cement to 12 parts of soil OR 1 part of lime* to 6 parts of soil.
More than 60mm	not suitable unless more sand is added. You could add more sand and carry out another shrinkage test.

*Quick lime is not recommended. Hydrated lime must be of good quality and may cost more than cement. When added to water it must be handled with care. Protect the eyes and do not let the liquid touch the skin.

Digging the Soil

Having tested the soil for suitability and checked for the amount of stabiliser that must be added, the next task is to remove all the top soil from the selected area. This may be only a few centimetres deep or more than a metre. The top soil itself is not suitable for blockmaking; so stack it on one side and carefully retain it for agricultural use: it is valuable.

The clay and sand should be spread out to dry. Break down any large lumps so that they dry more quickly. For blockmaking you will need a mix of fairly fine sand and clay. Large lumps and stones must be sieved out through a 6mm mesh (Fig. 8) or removed by hand if a sieve is not available. One cubic metre of sieved soil will produce 200 blocks. If rain is likely, cover the stock pile of sieved soil to keep it dry.



Mixing

You now have a stock of sieved soil and should also have bags of cement or hydrated lime and a supply of water close to hand. Measuring and careful mixing of the soil with cement or lime and water is an extremely important part of the process of producing good quality blocks. Observe the following procedure with care.

Prepare a non-absorbent mixing surface, such as a flat board. Use a single volume of measurement, such as a bucket or a specially made box. Spread the required amount of dry soil over the mixing area and add the cement by sprinkling it evenly over the soil (Fig. 9). (According to the results of the shrinkage test described above, you will need to add one bucket of cement to 12, 15 or 20 buckets of soil). Mix thoroughly (Figs. 10 and 11) until the colour is even: poor mixing will produce poor blocks. Moisten the surface of the mix by sprinkling it with water (Fig. 12). Turn the mix over before adding more water. Do this several times.

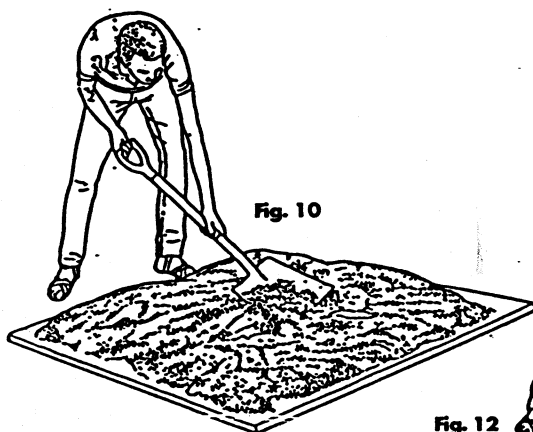


Fig. 10

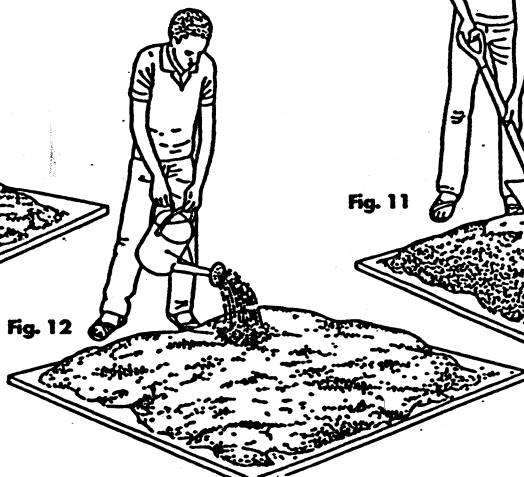


Fig. 12

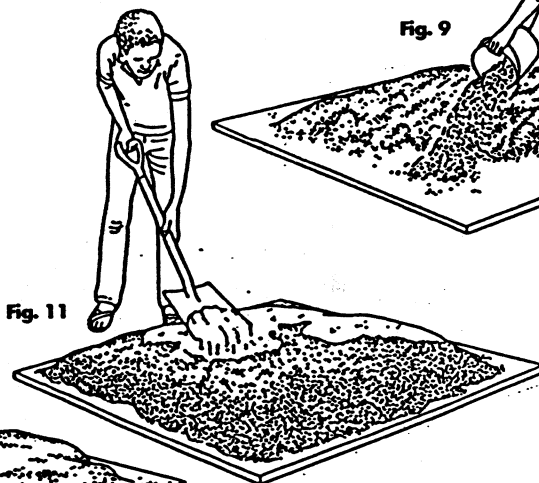


Fig. 11

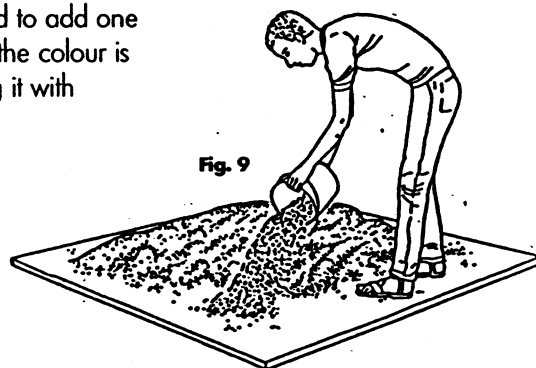


Fig. 9

When mixing, DO NOT make a hollow in the heap and pour in water to make a pool: the mix will be too wet. Also, DO NOT make large heaps of the mix as this produces damp lumps that prevent good mixing. Instead, be sure to spread the mix over the whole area so that the sprinkled water contacts it evenly. You will know the mix is satisfactory when a sample passes the simple but important Drop Test described below.

The Drop Test

Squeeze a handful of the damp mix into a ball. Drop this onto a hard surface from a height of about 1 metre (Fig. 13).

The mix is right if the ball breaks into four or five large pieces (Fig. 14). If the sample breaks into many pieces or shatters (Fig. 15), the mix is too dry: you must add more water. If it stays in one piece and is just flattened (Fig. 16), the mix is too wet: you must add more soil and stabiliser in the correct proportions.

This test is a useful guide. Nevertheless, if during blockmaking you see water dripping down the sides of the mould this shows that the soil mix is too wet. Repeat the Drop Test during blockmaking to ensure that the water content is correct.

By following all these tests you have now made sure that the soil itself is suitable for blockmaking, that the correct amount of stabiliser has been added and that the mix has been properly made. Blockmaking can now proceed.



Fig. 13



Fig. 14



Fig. 15

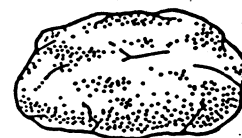


Fig. 16

Elephant Blockmaker now produces High Quality Stabilised Soil Building Blocks.

Curing the Finished Blocks

Handle the finished blocks with care as they are removed from the machine and stacked. Before curing they are easily damaged. Curing is a process by which excess moisture is slowly and evenly evaporated and the blocks attain their full strength for building work. There are two stages – primary and secondary curing.

Primary Curing

Primary curing takes from about two to five days, depending on the local soil, the climate and the choice of stabiliser: when the lime is used as a stabiliser the full five days will always be needed. During this stage of curing most of the moisture in the blocks is retained: the blocks must therefore not be exposed to the sun or their surfaces will dry out too quickly: this causes cracking and weakens the blocks. A good indication that primary curing is complete is when the blocks become lighter in colour compared with newly made ones.

The blocks should be stacked on a hard, flat and level site near the machine. They can be protected from direct sunlight by covering with a plastic sheet or by empty sacking. If the cover is not complete any exposed blocks should be lightly sprinkled with water once a day. The stack should be not higher than three blocks: the uncured blocks are not yet strong enough to support a greater weight. (See Fig. 17).

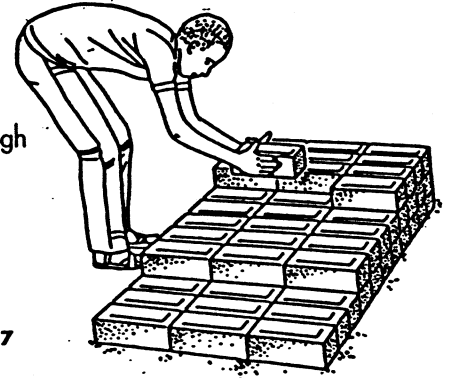


Fig. 17

Secondary Curing

During this stage the blocks attain their full strength. If possible they should be stacked close to the new building works, ready for use. As for primary curing select a site that is hard, flat and level. The stack should not be more than 1.25 metres high and covered till cured. Each new layer of blocks added to the stack should be sprinkled with water.

Secondary curing of the blocks is usually completed about two to three weeks after they have been made. This period will vary according to the soil, the weather and the type of stabiliser: when lime is used as a stabiliser the blocks may need four weeks to attain full strength. Testing will show whether or not curing is satisfactory and the blocks can be used.

Testing the Cured Blocks

Five blocks selected at random should be tested by immersing them in water overnight for at least 12 hours, then dried in the sun for a full day. This procedure must be carried out seven times. If the blocks then slake or fall to pieces this indicates that the mix must be modified or there is a fault with the stabiliser: or it may even be necessary to find another source of soil.

A simple way of testing the bending stress of the blocks is illustrated in Fig. 18. The blocks should be capable of being loaded to a weight of 50–60kg for single-storey buildings. For taller structures you should consult a qualified structural engineer, as other factors (such as wind loading) affect the design.

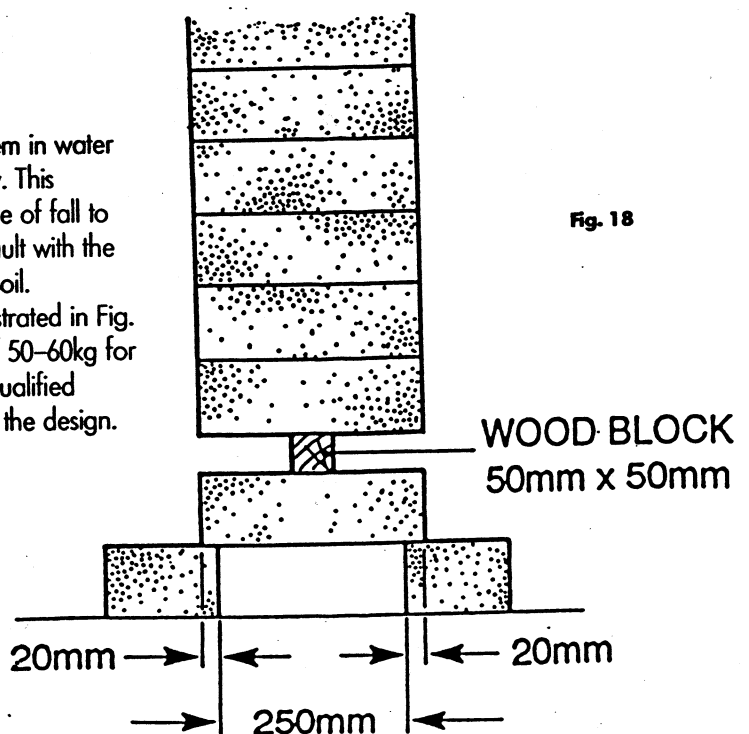


Fig. 18

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