Blockmaking from soil using the BREPAK machine

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Blockmaking from soil

A method of making strong building blocks from soil without power supplies has been determined. Dr. Israel Berkovitch traces its development and discusses the qualities of the product.

AFTER EXTENSIVE field trials, a hand-operated blockmaking machine known as BREPAK is at the start of normal commercial manufacture. The first production run of ten machines have all been sold to African countries.

Based on important technological improvements to the widely-known Cinva Ram, the new machine is intended for use in low-cost housing projects. It produces high quality, durable, water-resistant building blocks from local soils stabilised with a small amount of cement or hydrated lime.

Linked with the development of the improved machine was a programme of research on methods of stabilising clay soils and on the compaction pressures needed to produce blocks that would resist the weather. Since earth is widely used as a building material in the developing world, the UK Building Research Establishment (BRE) has examined the various ways in which it can be stabilised and made more durable. In this context what is meant by 'stabilised'? Many clay soils swell when in contact with water (from rain or soil) and then shrink on drying. A product made of such soil may actually disintegrate if it is subject to large amounts of water; alternatively it may crack when it dries. To prevent these changes, clay soils may be stabilised by cement but this is relatively expensive for poor areas and may need to be imported. The research at BRE showed that satisfactory products could also be obtained by stabilising with hydrated lime and applying high pressures.

The Cinva Ram – introduced in 1952 – applies direct ram pressures to the mixture in a mould, using leverage. Early mixtures used with it had up to 20 per cent of cement. The compacting load was about eight tonnes corresponding to a pressure of two MN/sq m and making a soil block measuring 290°140×100mm. Increasing the pressure of forming the blocks, improves the blocks while reducing the need for binder addition, but means increasing the expense of the equipment. What is the most reasonable compromise giving adequate durability of blocks while yet keeping within acceptable cost limits? The researchers decided on a total compacting force of 42 tonnes, since a pressure of 10 MN/sq m. was needed.

In charge of the project is David Webb who explained to me that although the machine now had to be made much stronger, it remained suitable for use for developing world countryside housing – encouraging people to stay in the countryside and still have reasonable homes. He had examined several press designs but they had been too complicated or needed power supplies. But BREPAK uses a hand-operated simple hydraulic mechanism that applies pressure after the soil has been compacted by leverage – and achieves the desired pressure of 10 MN/sq m. Trials and final development were carried out in co-operation with the Housing Research and Development Unit of the University of Nairobi, using four per cent cement in the mixture. Objectives were these:-

- a hand-operated machine of minimum cost
- not too heavy, so that it could be moved on as needed
- capable of manufacturing blocks on site
- employing a much lower proportion of stabiliser.

The recommended procedure is to dig out clay soil, (not top soil), dry it in the sun, crush it to pass through a 5 mm sieve and mix with the binder. If this is lime or cement a simple test of satisfactory mixing is that the mix is uniform in colour.

If the clay content of the soil is over 30 – 35 per cent (all percentages by weight) six to 10 per cent hydrated lime is used as binder; if clay is below 30 per cent then four to six per cent of cement is used. If the lime is more expensive, sand can be added to reduce the clay content. Clay is defined as fine material of size less than two microns.

The minimum of water is added. Simple tests have been suggested for the correct proportion of water. For instance if the user rolls the mix into a ball and fingers keep clean, that is the right amount of water. A further rough and ready test is dropping a ball of the mix onto a hard

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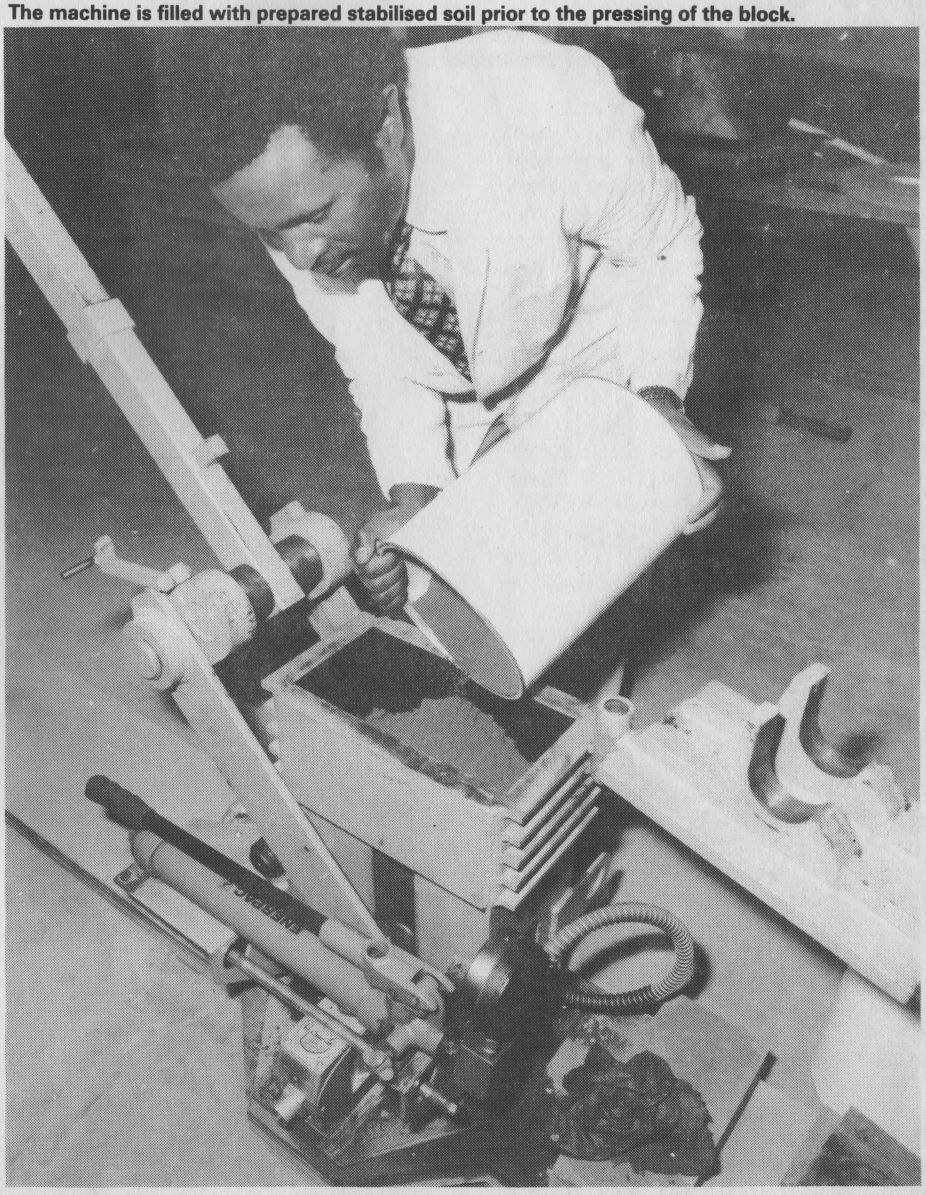
The machine is filled with prepared stabilised soil prior to the pressing of the block.



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floor. If it shatters, it is too dry; if it splashes it is too wet; but if it breaks into three or four pieces, the composition is about right. There are also formal laboratory tests.

The mix is then left about half an hour and a wet weight of 8kg put into the mould. The mix is first compacted, then the pressure applied; overall the thickness is reduced in two main stages from 156 to 100mm. After the block is discharged from the mould it is covered for three to four days and left to cure for two to three weeks according to the binder used.

The product is a dense, hard block that can meet the minimum standards for precast concrete building blocks and has a Strength normally above 3 MN/sq m. In the development lab I saw samples that had been in water for three months and remained intact.

Practical trials

EI Fadil Ali Adam, a Sudanese architect working on the problems of low cost housing, carried out three years research on methods of using what are called the 'black cotton soils' of Sudan. These are among the worst types of soil for building foundations; they have a high shrinkage when they are mixed with water and then dried. But the blocks made with the BREPAK machine using six to eight per cent of hydrated lime have been fully satisfactory (and incidentally, Adam has gained his M Phil which is also satisfactory). One of the machines is now in use near Khartoum for a village project. Another is being used by a VSO*mobile building unit linked with a UN development programme and in close contact with the Ministry of Education.

Following a brief preliminary description of the machine in BRE News, Spring 1982, discussing a Kenyan project, BRE had 300 enquiries from 46 countries, some 16 of these being in Africa. Since then, a licence to manufacture BREPAK has been granted to Welding Industries Ltd of Blackswarth Rd, Bristol, UK. I understand that applications for licences to manufacturers from suitably technically equipped companies in the developing countries will be favourably considered.

What is the production rate for blocks? David Webb working with two labourers made 43 blocks in an hour in lab conditions. In site trials in Kenya the rate has been about 37¼ blocks an hour, 300 in an eight hour day. A typical rural house might have a floor area of 50sq m and need 270 blocks. The machine would be set up and produce the blocks needed in a fortnight, then move on to another position. It weighs 150kg and can be carried by four men. An efficient production team is seen as comprising six men. Two dig and prepare the soil, two prepare the mix by hand and two operate the machine.

The most outstanding field trial has been making blocks for construction a 50sq m medical clinic building in Kenya at Kabiro village in Kawangare on the outskirts of Nairobi. Replacing an improvised, hot and dark structure, the new cooler, modern building is much appreciated by nursing staff and patients.

Research worker El Fadil Ali Adam, M Phil, a Sudanese architect spent three years on the project.

Associated projects

To help in handling the heavy blocks, Webb has also developed a simple block clamp lifter. This holds the block securely when it is being moved and includes a quick release mechanism to use once the block is in position on the wall.

The Intermediate Technology Development Group (ITDG) has developed a simple clay crusher that can be used in conjunction with the blockmaking machine – and of course passing the clay through the sieve specified is essential in ensuring the manufacture of sound blocks.

Further products are also being designed and made with essentially the same technique as the building blocks – though so far they are only lab specimens. They include hollow blocks†, blocks with recesses (the so-called "frogs"), floor tiles and thinner tiles suitable for use as roof tiles. All of these naturally add to the comfort of country living.

The blockmaking machine itself costs about $1,732 at the factory gate as made in the UK. Because the design is based on readily available standard components as found in an industrial country, I understand that estimates for manufacturing it in developing countries lacking widespread supplies of standardised engineering products, indicate that it would cost more.

However the medical building erected as a demonstration unit (quoted above) using the machine and using community labour cost $46 per sq.m**. The project also illustrated the great social advantages by allowing local people to participate on a self-help basis with minimum assistance, it used a large proportion of locally available soil, and it indicates that for big projects it will create employment for unskilled people while not needing any machine or electrical power nor fuel.

Naturally, in any costing estimates based on using the machine built in the UK, it will be necessary to add the costs of packaging and transport to the 'factory-gate' cost. (Details of the machine and the licensing arrangements are available from Victor Dembo, Building Research Establishment, Garston, Watford, WD2 7JR, UK) □

**VSO means Voluntary Service Overseas*
†some have since been used in field trials in Jamaica.
**this compares with costs using concrete building blocks of $97/sq m.