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BUILDING WITH LATERITE BLOCKS[1]

by

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INTRODUCTION

BLOCKS AND BR'CKS ARE USED IN BUILDING CONSTRUCTION ALL OVER THE WORLD. THE FACT THAT IT IS LABOUR CONSUMING IS NOT NECESSARILY A HANDICAP BUT MAY ON THE CONTRARY BE ADVANTAGEOUS IN MANY DEVELOPING COUNTRIES.

COMMON TYPES OF BLOCKS AND BRICKS ARE:

1. CONCRETE BLOCKS
2. BAKED CLAY BRICKS AND BLOCKS
3. AUTOCLAVED DENSE OR LEIGHTWEIGHT CALCIUM SILICATE BRICKS AND BLOCKS

THIS PAPER DESCRIBES A NEW BUILDING MATERIAL, LATOREX, WHICH CAN BE PRODUCED FROM ANY KIND OF LATERITE OR LATERITIC SOIL. LATOREX IS LESS EXPENSIVE TO PRODUCE THAN ANY OF THE BUILDING UNITS MENTIONED ABOVE.

CONCRETE BLOCKS ARE PRODUCED BY CASTING AND IN SOME CASES PRESSING A MIXTURE OF SAND, GRAVEL AND CEMENT INTO THE SHAPE OF DENSE OR HOLLOW BLOCKS.

CLAY BRICKS AND BLOCKS ARE PRODUCED BY BURNING UNITS FORMED FROM PLASTIC CLAYS.

AUTOCLAVED CALCIUM SILICATE BRICKS AND BLOCKS ARE PRODUCED BY CURING A COMPRESSED MIXTURE OF LIME AND QUARTZ SAND IN HIGH PRESSURE STEAM CHAMBERS (AUTOCLAVES).

WHILE THESE PRODUCTS ARE STANDARD IN MANY COUNTRIES THERE ARE A NUMBER OF FACTORS WHICH DETERMINE WHETHER THEY CAN BE ECONOMICALLY PRODUCED IN ANY GIVEN COUNTRY.

CEMENT IS REQUIRED FOR PRODUCTION OF CONCRETE PRODUCTS. IN ORDER TO PRODUCE QUALITY CONCRETE, SAND AND GRAVEL MUST BE PHYSICALLY AND CHEMICALLY SOUND. THIS IS NOT THE CASE IN MANY COUNTRIES.

PRODUCTION OF CLAY PRODUCTS REQUIRES THAT A SUITABLE CLAY IS AVAILABLE AND A BURNING AT CONTROLLED AND FAIRLY HIGH TEMPERATURE.

PRODUCTION OF SAND-LIME PRODUCTS REQUIRES THAT LIME AND FAIRLY PURE QUARTZ SAND ARE AVAILABLE. FOR DENSE BRICKS AND BLOCKS PRESSES ARE REQUIRED. THE HARDENING PROCESS REQUIRES STEAM GENERATORS AND HIGH PRESSURE AUTOCLAVES.

An ideal, low-cost building material for use in developing countries should fulfil the following requirements:

1) The raw materials should be accessible in immense quantities wherever building activities take place, and accordingly the cost of raw materials should be the lowest possible.
2) It should be possible to produce a material of reasonably good quality on large industrial scale as well as in small-scale enterprises by means of primitive techniques.
3) The energy requirements of the production process should be as low as possible. For instance solar heat should be sufficient for chemical reactions to take place.

The LATOREX building material fulfils these requirements.

LATOREX is based on laterite or lateritic soils. It was developed by the authors at the Building Materials Laboratory, the Technical University of Denmark, during the years 1968 to 1971. LATOREX bricks have

BEEN PRODUCED FROM LATERITIC SOILS FROM VARIOUS PARTS OF THE WORLD. FULL-SCALE TESTS FOR PRODUCTION OF HOLLOW BLOCKS ARE NOW IN PROGRESS.

IN THE FOLLOWING, EQUIPMENT AND PRODUCTION METHODS ARE DESCRIBED WHICH COULD BE USED IN THE PRODUCTION OF LATOREX. AS THE PRODUCTION METHOD IS IN THE PROCESS OF BEING PATENTED, IT IS NOT POSSIBLE FOR US TO REVEAL THE MANUFACTURING PROCESS IN DETAIL AT THIS MOMENT. HOWEVER, WE ARE PREPARED TO DISCUSS THE METHOD IN SOME DETAIL WITH INTERESTED PARTIES.

THE ADVANTAGES OF THIS NEW MATERIAL ARE DESCRIBED AND THE COST OF EQUIPMENT FOR PRODUCTION IS ESTIMATED.

PRODUCTION OF LATOREX

LATOREX IS PRODUCED FROM A PRESSED MIXTURE OF CRUSHED LATERITIC SOIL AND AN INEXPENSIVE ADDITIVE. THE HARDENING PROCESS TAKES PLACE IN A PRIMITIVE HEATING CHAMBER WHICH CAN BE BUILT OF PLASTIC FOIL HEATED BY THE SUN.

THE MANUFACTURING PROCESS CAN BE DIVIDED INTO FOUR STEPS:

1) PREPARATION OF RAW MATERIALS
   LATERITIC SOIL IS ESCAVATED AT THE PRODUCTION SITE AND CRUSHED, IF NECESSARY, TO THE FINENESS OF REGULAR BEACH SAND.

2) MIXING
   THE RAW MATERIALS ARE MIXED BY HAND OR IN A MECHANICAL MIXER.

3) BLOCK PRESSING
   THE MIXTURE IS FORMED INTO THE DESIRED SHAPE BY MECHANICAL PRESSING.

4) HARDENING
   BY PROCURING A REACTION BETWEEN ALUMINIUM MINERALS IN THE LATERITE AND THE ADDITIVE, STABLE ALUMINIUM HYDRATES ARE FORMED. THESE COMPOUNDS CEMENT THE

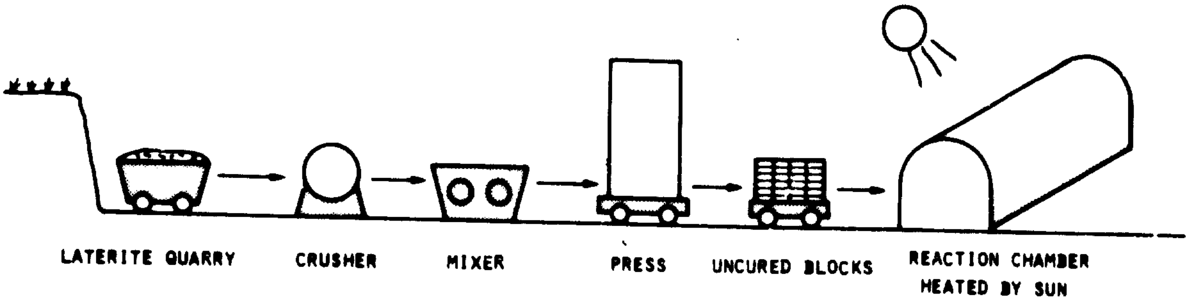
REMAINDER PART OF THE MATERIAL FIRMLY TOGETHER AND ARE RESPONSIBLE FOR THE EXTRAORDINARY HIGH QUALITY OF LATOREX.

THE CHEMICAL REACTION TAKES PLACE IN PRIMITIVE REACTION CHAMBERS, FOR INSTANCE IN PLASTIC TENTS HEATED BY THE SUN.

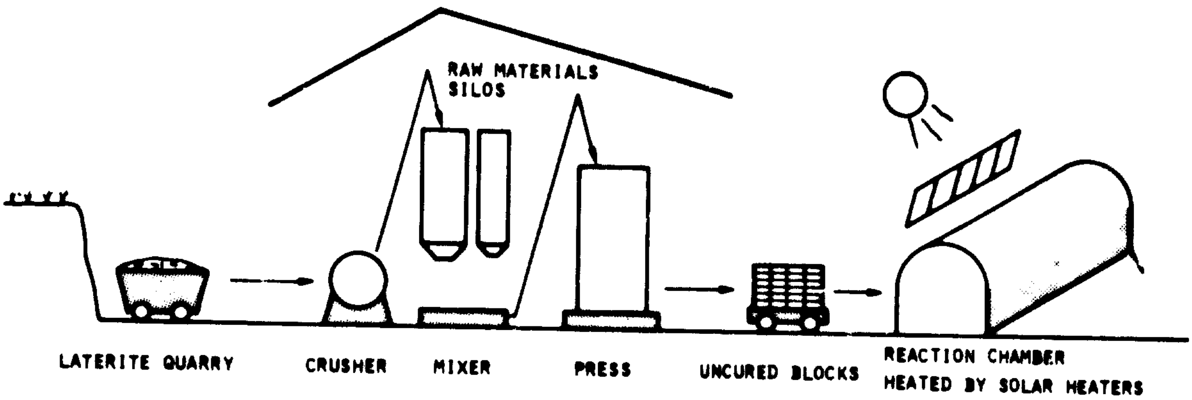
FACTORIES CAN BE DESIGNED FOR DIFFERENT LEVELS OF INDUSTRIALIZATION. SCHEMATIC FLOW-SHEETS FOR THREE TYPES OF LATOREX FACTORIES ARE SHOWN IN FIG. 1.

IN THE FOLLOWING WE WILL DESCRIBE THE MOST IMPORTANT MACHINERY IN SUCH A FACTORY.

A. MOBILE BLOCK PRESS, PRIMITIVE CRUSHING, MIXING AND CURING



B. STATIONARY ROTARY PRESS, MORE INDUSTRIALIZED CRUSHING, MIXING AND CURING



C. STATIONARY AUTOMATIC PRESS, FULLY AUTOMATIC PRODUCTION

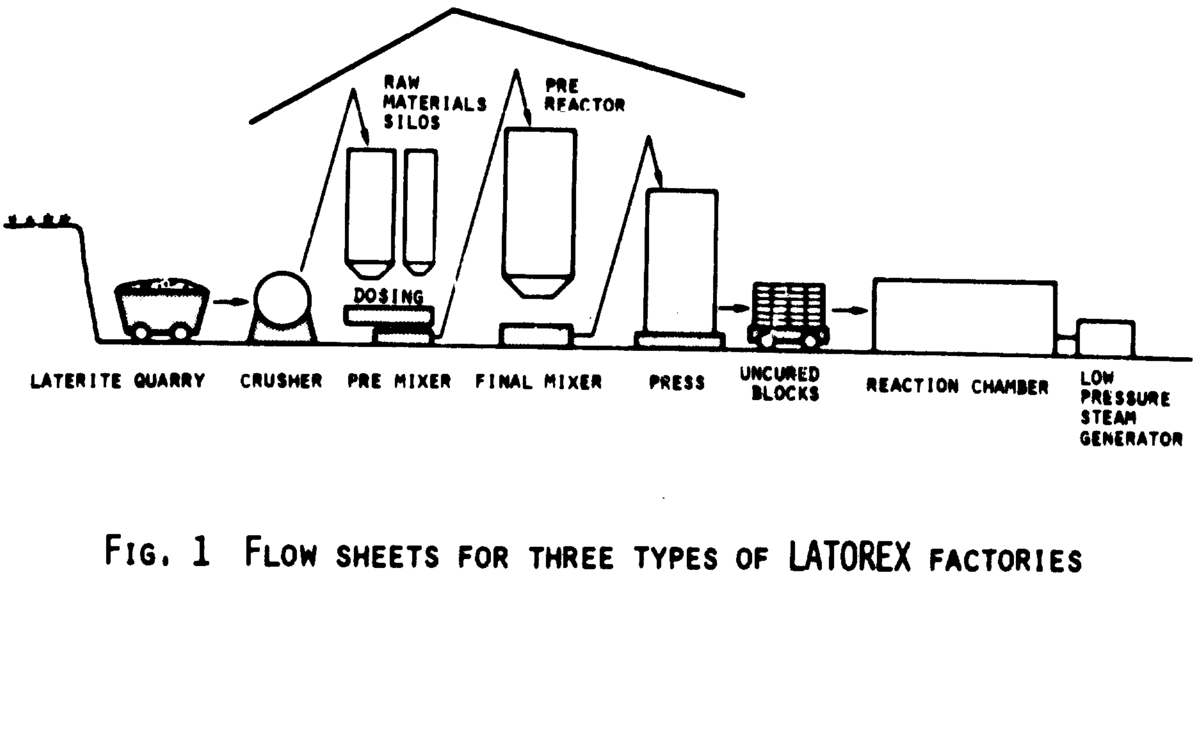


FIG. 1 FLOW SHEETS FOR THREE TYPES OF LATOREX FACTORIES

THE ESSENTIAL EQUIPMENT IN A LATOREX FACTORY IS THE BLOCK PRESS WHICH CAN BE MOBILE OR STATIONARY.

MOST DEVELOPING COUNTRIES MUST IMPORT THE BLOCK PRESSES.

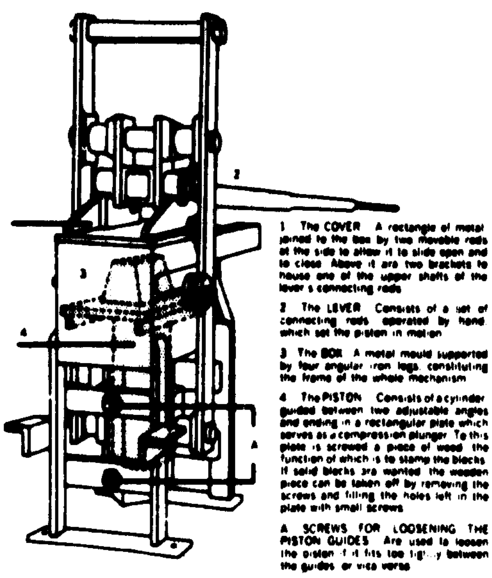


FIG. 2 CINVA-RAM MANUAL PRESS DEVELOPED BY THE INTER-AMERICAN HOUSING AND PLANNING CENTER, COLUMBIA.

FIG. 2 SHOWS A CINVA MANUAL PRESS FOR PRIMITIVE PRODUCTION OF BRICKS. THIS TYPE OF PRESS CAN BE USED UNDER EXTREMELY PRIMITIVE CONDITIONS. THE PRICE OF THE CINVA PRESS IS A FEW HUNDRED US.$.

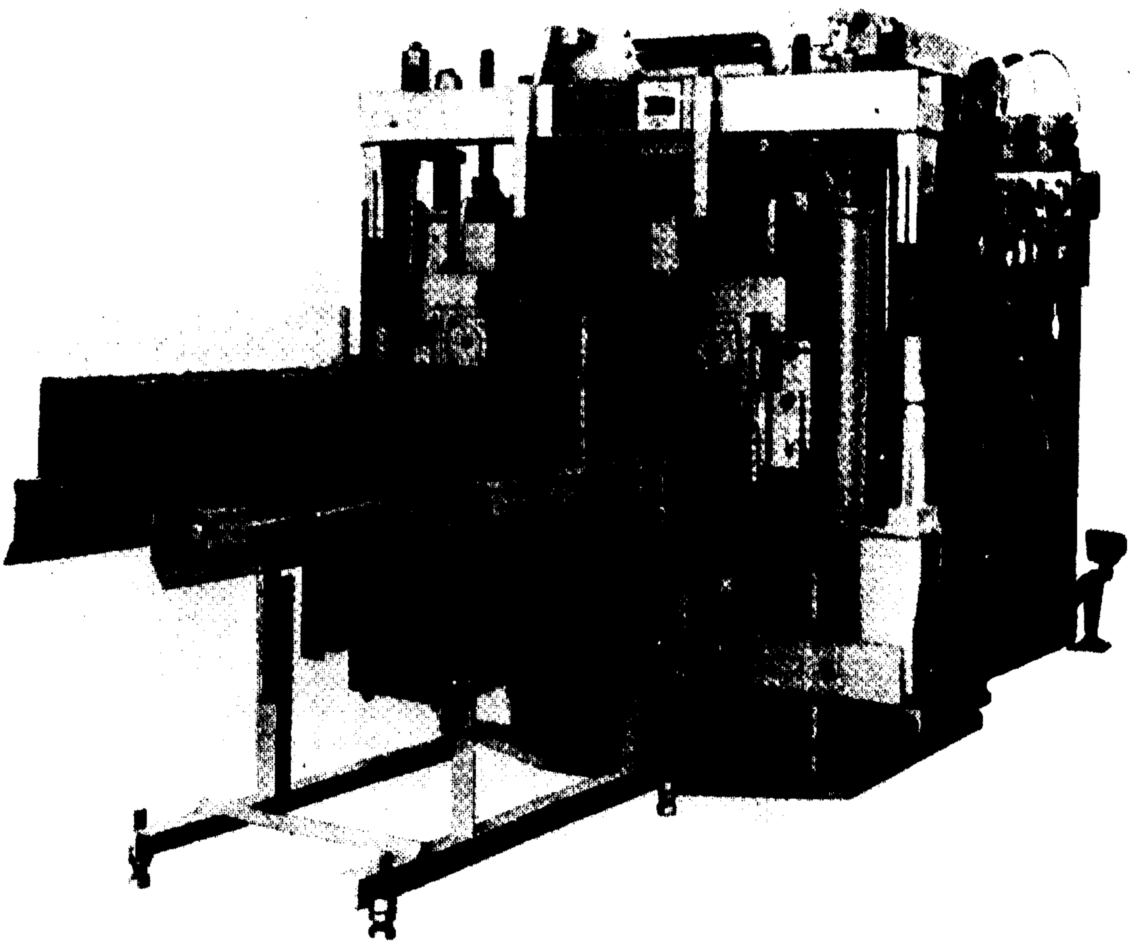


FIG. 3 HYDRAULIC VIBRATION PRESS. (BESSER).

FIG. 3 SHOWS A HYDRAULIC VIBRATION PRESS, PRODUCING TWO HOLLOW BLOCKS PER STROKE. A PRESS OF THIS TYPE CAN BE USED IN A MOBILE PRODUCTION PLANT. THE WEIGHT OF THE PRESS SHOWN IS 7 TONS. IT PRODUCES APPROXIMATELY 600 BLOCKS PER HOUR, AND THE PRICE IS ABOUT US$ 50.000.

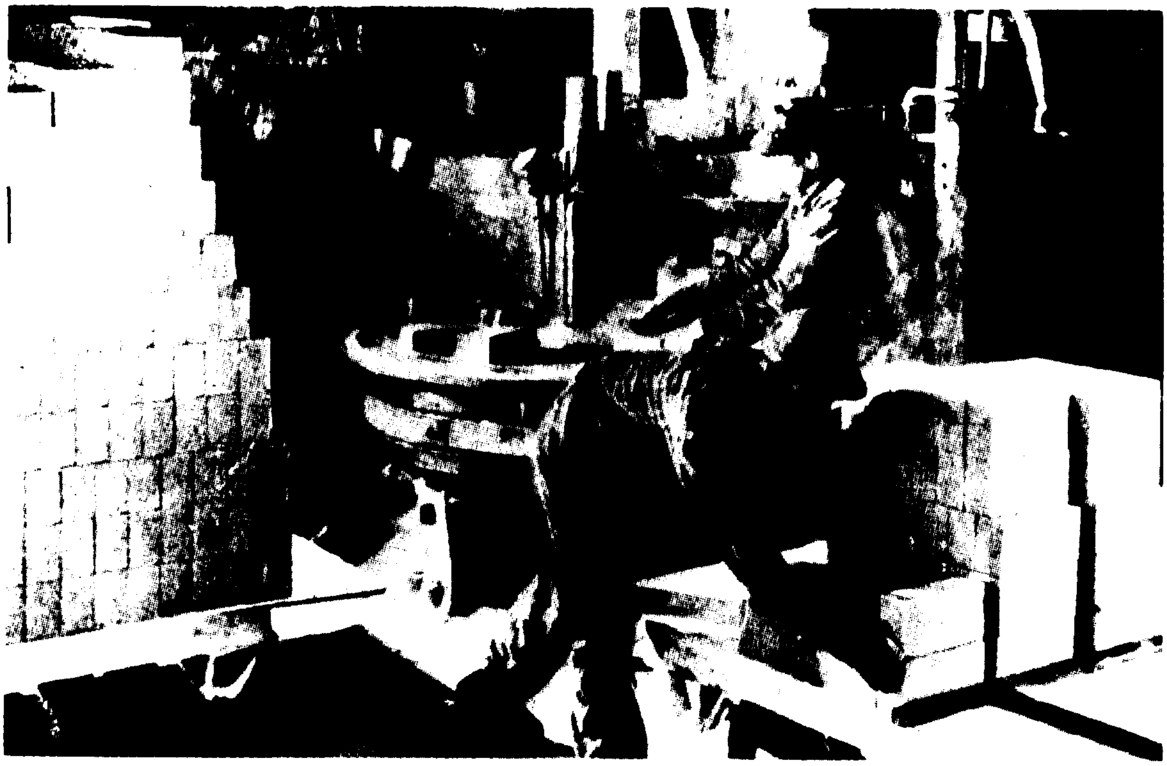


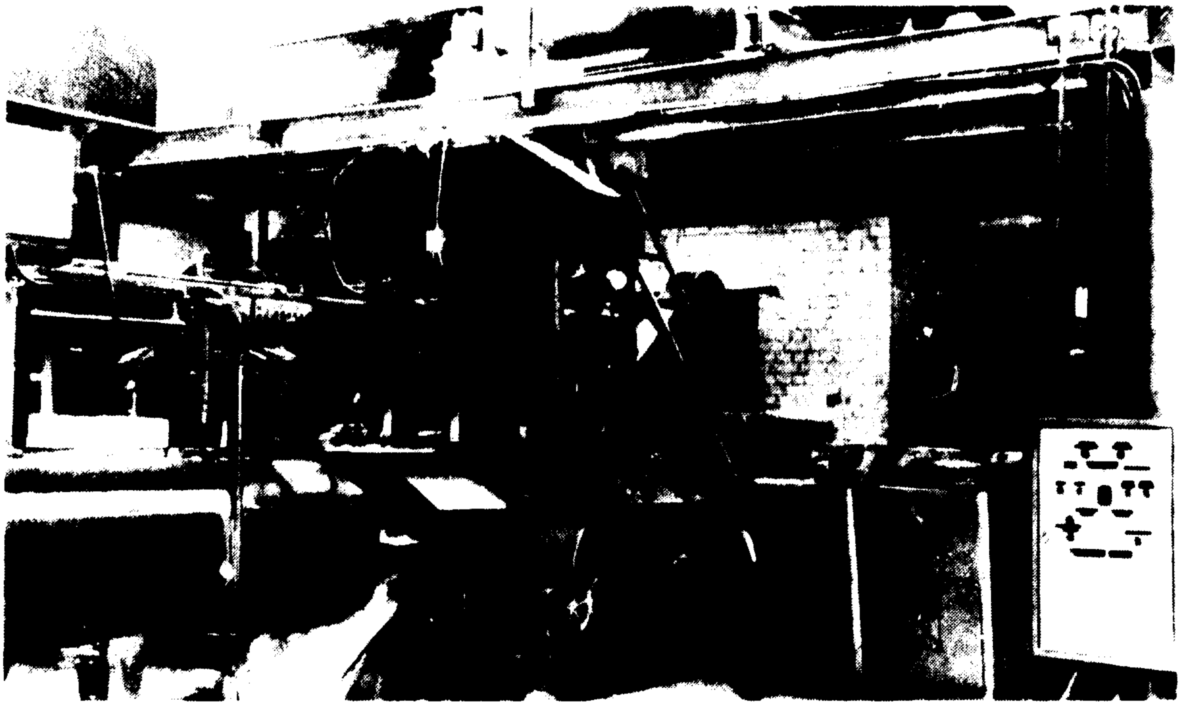
FIG. 4 ROTORY TABLE PRESS.

FIG. 4 SHOWS THE CONVENTIONAL ROTARY TABLE PRESS WHICH HAS BEEN USED FOR MANY YEARS IN THE SAND-LIME BRICK PRODUCTION. THE BRICKS ARE PRESSED BY MECHANICALLY MOVED PISTONS, AND THE MOULDS ARE ARRANGED ON A ROTATING TABLE MAKING SIMULTANEOUS PRESSING AND REMOVAL OF BRICKS POSSIBLE. THIS TYPE OF PRESS IS SUITABLE FOR A STATIONARY BUT NOT FULLY AUTOMIZED PRODUCTION OF LATOREX BUILDING ELEMENTS.

A ROTARY TABLE PRESS PRODUCES FROM 1000 TO 3000 STANDARD SIZE BRICKS PER HOUR. IT REQUIRES FROM TWO TO FOUR WORKERS TO OPERATE THE PRESS. THE COST OF A ROTARY TABLE PRESS IS SOMEWHAT LESS THAN THE COST OF THE AUTOMATIC PRESS DESCRIBED BELOW, BUT SECOND HAND ROTARY TABLE PRESSES ARE AVAILABLE AT REASONABLE TERMS FROM EUROPEAN SAND-LIME BRICK MANUFACTURERS.

FIG. 5 SHOWS A FULLY AUTOMATIC PRESS OF A TYPE NOW USED BY MOST EUROPEAN SAND-LIME BRICK AND BLOCK MANUFACTURERS. IT IS USUALLY COMBINED WITH AN AUTOMATIC STACKING MACHINE AS SHOWN IN FIG. 6.

THE COST OF A FULLY AUTOMATIC PRESS PRODUCING 4-5000 STANDARD-SIZE BRICKS PER HOUR OR 1000-3000 HOLLOW BLOCKS PER HOUR IS APPROXIMATELY US.$ 200.000.



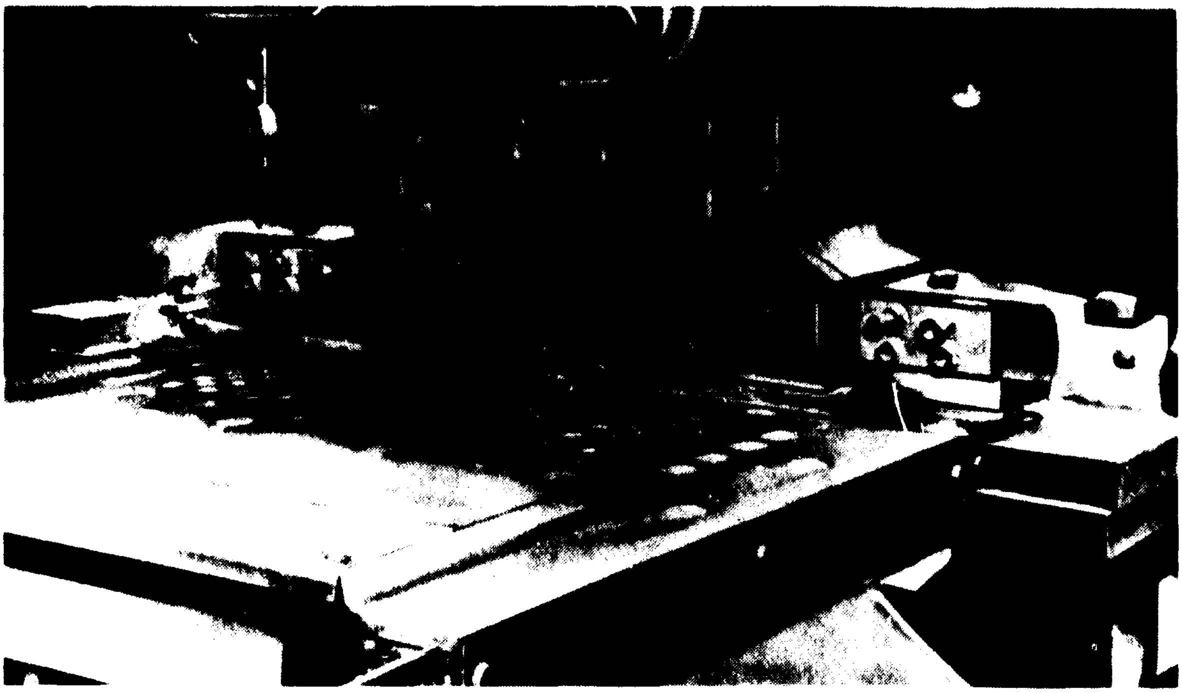


FIG. 5 A FULLY AUTOMATIC PRESS USED IN THE SAND-LIME BLOCK INDUSTRY CAN BE USED FOR PRODUCTION OF LATOREX. THE PRESS SHOWN IS AN ATLAS MODEL.

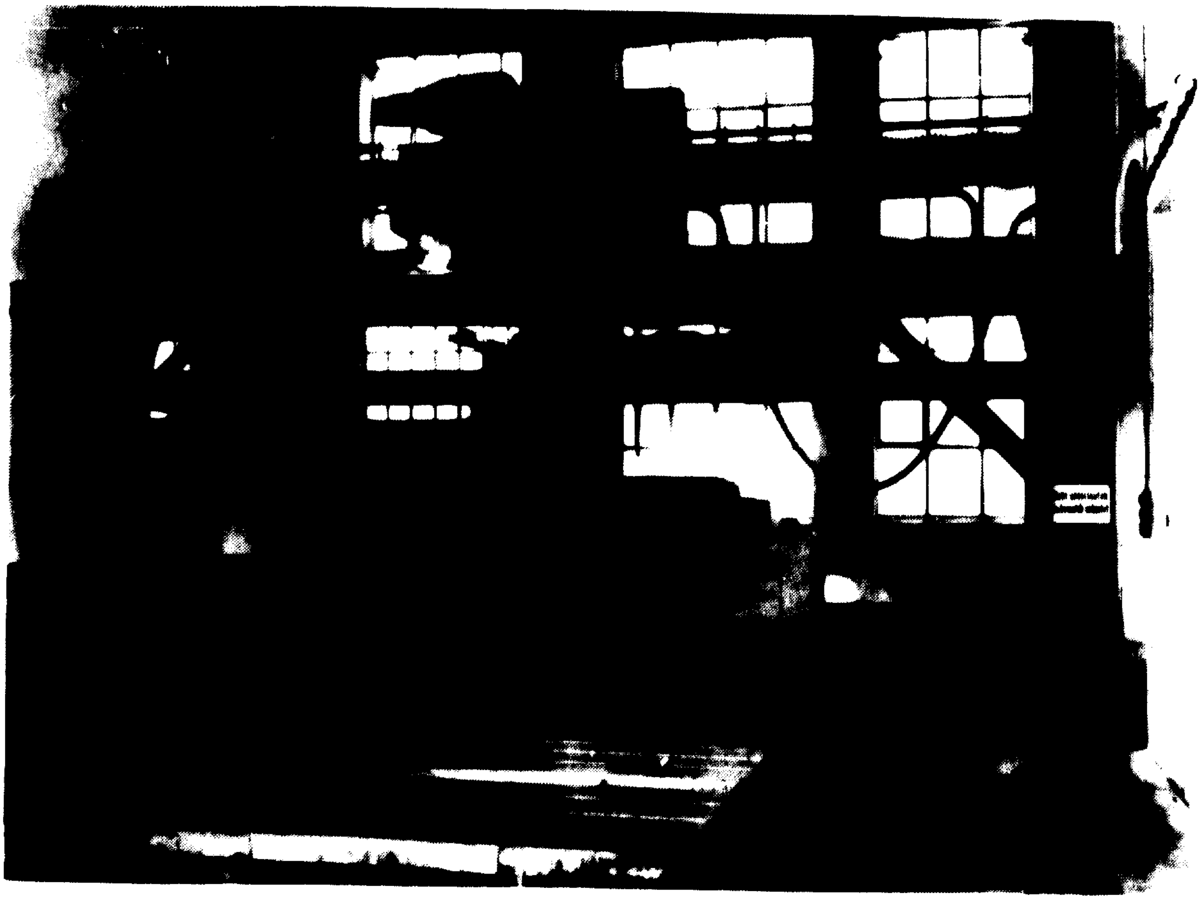


FIG. 6 AUTOMATIC STACKING EQUIPMENT (ATLAS).

THE LATERITE SHOULD BE OF BEACH SAND FINENESS AND MIXED WITH THE ADDITIVE BEFORE PRESSING.

ANY LUMPS IN THE LATERITE SHOULD BE CRUSHED BEFORE MIXING.

A SUITABLE HAMMER MILL CRUSHER IS SHOWN IN FIG. 7.

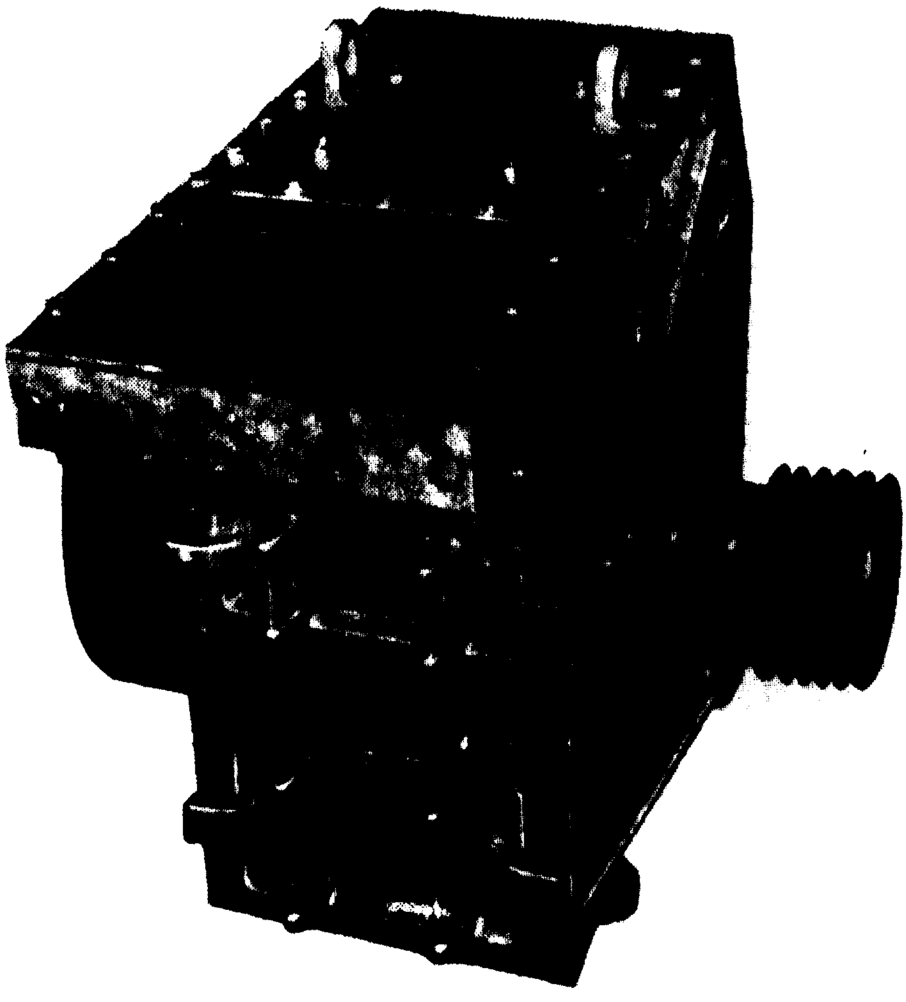


FIG. 7A HAMMER MILL FOR CRUSHING OF LATERITE (FUCHS).

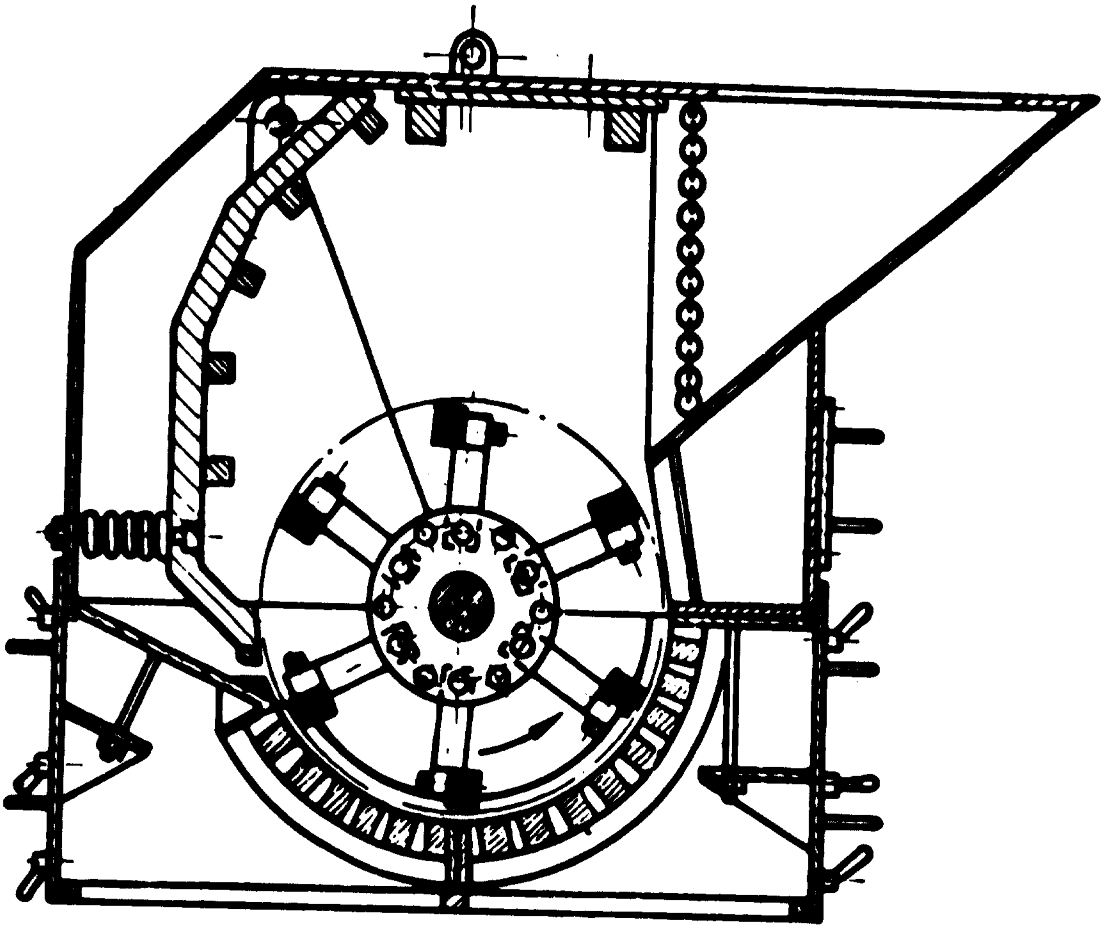


FIG. 7B CROSS SECTION OF HAMMER MILL.(FUCHS).

THE MILL HAS A ROTOR DIAMETER OF 50 CM AND A HAMMER WIDTH OF 35 CM. THE WEIGHT IS 1200 KG AND THE CRUSHER COSTS APPROXIMATELY US.$ 9,000. SMALLER MILLS ARE ALSO AVAILABLE.

MIXING CAN BE DONE BY HAND, BUT IN MOST CASES A MECHANICAL MIXER LIKE THE DOUBLE SHAFT MIXER SHOWN IN FIG. 8 IS RECOMMENDED. (APP.PRICE US.$ 6,000).

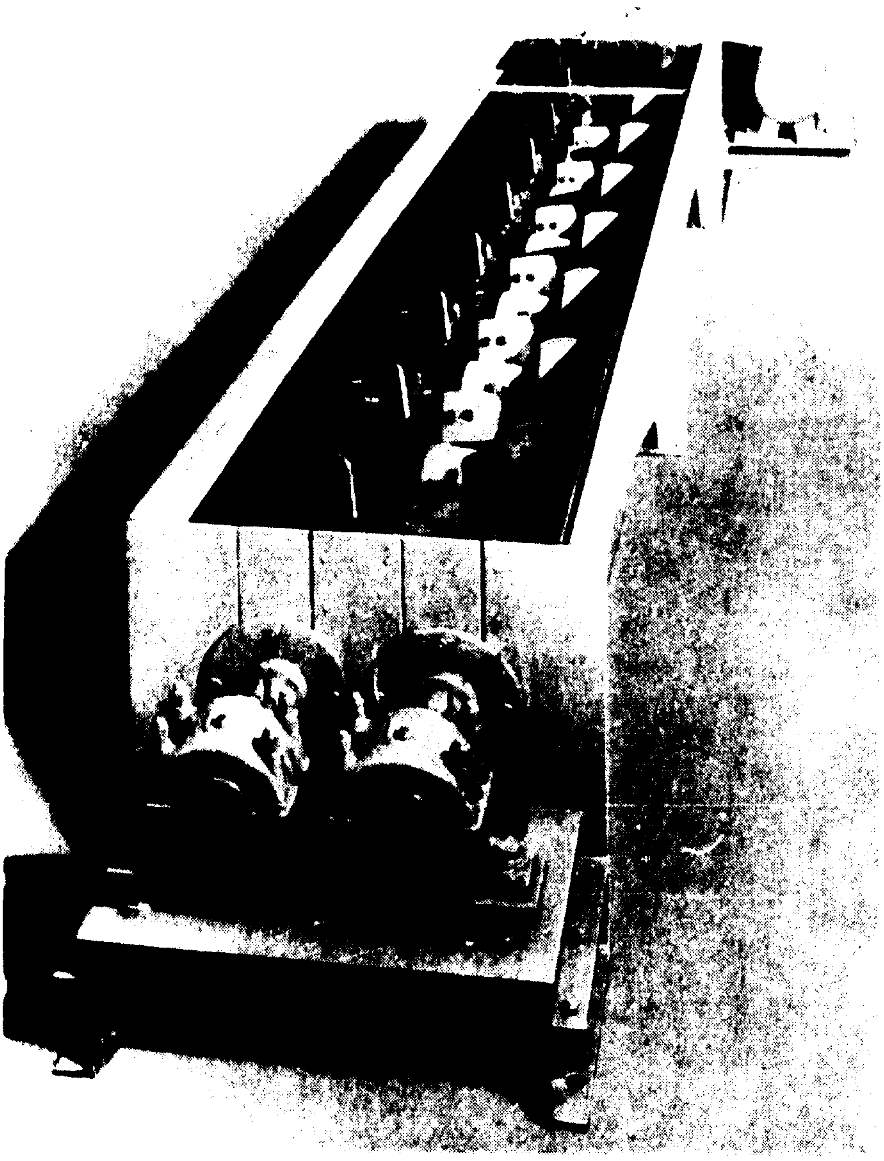


FIG. 8 DOUBLE SHAFT MIXER (ATLAS).

THE REACTIONS BETWEEN THE MINERALS IN THE PRESSED BLOCK TAKE PLACE IN A SIMPLE REACTION CHAMBER HEATED BY SUN OR HOT WATER. HIGH PRESSURE STEAM CHAMBERS ARE NOT REQUIRED. THIS IS IN CONTRAST TO THE SAND-LIME BRICK PRODUCTION WHERE HIGH PRESSURE STEAM CHAMBER AUTOCLAVES ARE NECESSARY FOR THE HARDENING PROCESS TO PROCEED. EASY CURING AND LOW ENERGY CONSUMPTION ARE SOME OF THE ADVANTAGES OF LATOREX: IN SAND-LIME BRICK PRODUCTION 10-15 ATMOSPHERES OF STEAM PRESSURE ARE REQUIRED TO PRODUCE BRICKS OF THE SAME QUALITY AS LATOREX. SOLAR HEAT MAY BE UTILIZED TO CURE THE LATOREX UNITS.

LATOREX UNITS ARE RED OR REDDISH-BROWN AND THE SURFACE IS SMOOTH AND UNIFORM. WALLS BUILT FROM LATOREX DO NOT REQUIRE ANY FURTHER SURFACE TREATMENT. ADHESION TO MORTAR IS EXCELLENT.

TABLE 1 SHOWS EXAMPLES OF COMPRESSIVE STRENGTH VALUES OBTAINED FOR LATOREX PRODUCED FROM RAW MATERIALS FROM VARIOUS PARTS OF THE WORLD AS COMPARED TO TYPICAL VALUES FOR TRADITIONAL MATERIALS.

PHYSICAL PROPERTIES SUCH AS DURABILITY, SHRINKAGE, EFFLORESCENCE AND FROST RESISTANCE HAVE BEEN DETERMINED FOR LATOREX WITH COMPLETELY SATISFACTORY RESULTS.

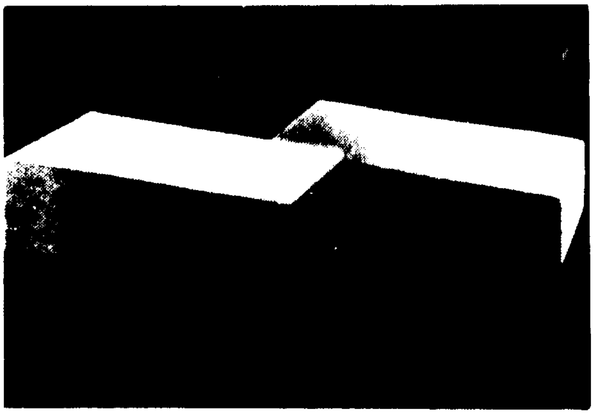
TABLE 1

COMPRESSIVE STRENGTH OF LATOREX COMPARED TO OTHER BUILDING MATERIALS

LATOREX:

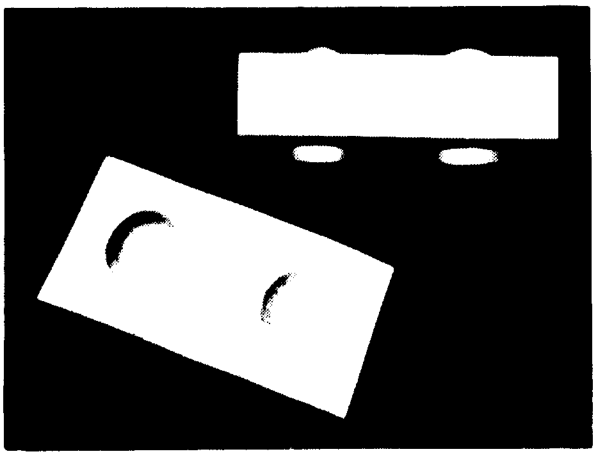
ORIGIN OF LATERITE	CURING TEMPERATURE	TIME OF CURING	COMPRESSIVE STRENGTH
ACCRA, GHANA	97°C	3 HOURS	75 KG/CM²
	-	6 -	120 -
	-	10 -	155 -
	-	24 -	275 -
	-	30 -	275 -
	80°C	1 DAY	110 -
	-	2 DAYS	200 -
	60°C	1 DAY	75 -
	-	7 DAYS	115 -
	40°C	3 DAYS	35 -
KEREGE, TANZANIA	97°C	1 DAY	121 -
NAIROBI, KENYA	97°C	1 DAY	335 -
THAILAND	97°C	1 DAY	206 -
SAND-LIME BRICKS			150-250-
CLAY BRICKS			150-450-
CONCRETE BLOCKS			150-300-
AERATED CONCRETE BLOCKS			20-60 -

A RESULT OF THE COMPRESSION MOULDING TECHNIQUE IS THE UNIFORM DIMENSIONS OF FINISHED LATOREX UNITS, WHICH MAKE IT POSSIBLE TO DESIGN BLOCKS WITH SPECIAL JOINING LOCKS AS DESCRIBED BELOW. FIG. 9 SHOWS EXAMPLES OF VARIOUS TYPES OF BRICKS AND BLOCKS WHICH CAN BE PRODUCED BY THE LATOREX TECHNIQUE.



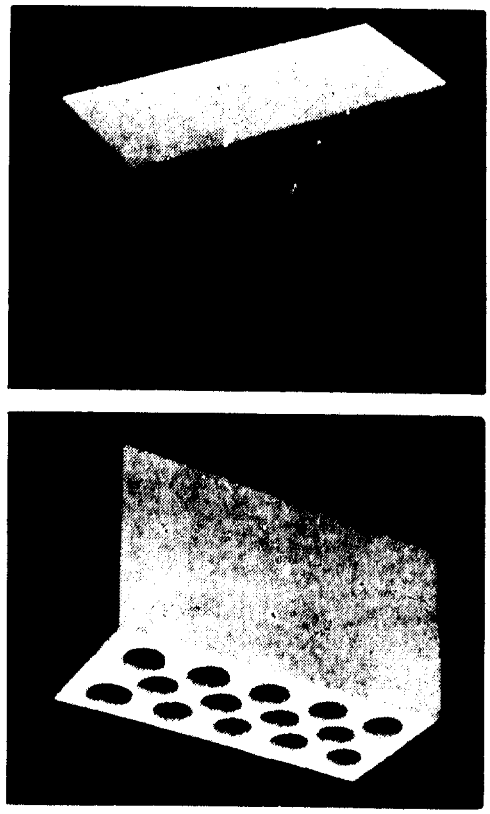
BRICK FOR TRADITIONAL BRICK LAYING.
L=240, B=115, H=71 MM
WEIGHT 4 KG.

SPLIT BRICKS WITH ROCK-LIKE SURFACE.

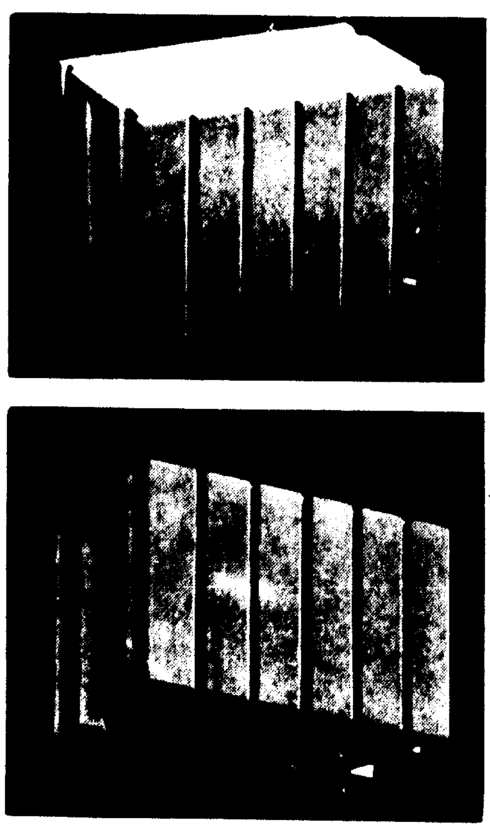


SOLID BLOCK FOR MORTAR-FREE BUILDING. THE SEMI-SPHERICAL LOCKS ENSURE THE CONSTRUCTION OF RIGID CORNERS AND SELF-ALIGNMENT AND SHEAR STRENGTH OF WALLS
L=398, B=198, H=98 MM
WEIGHT CIRCA 17 KG.

FIG. 9A MODELS OF LATOREX BUILDING UNITS.

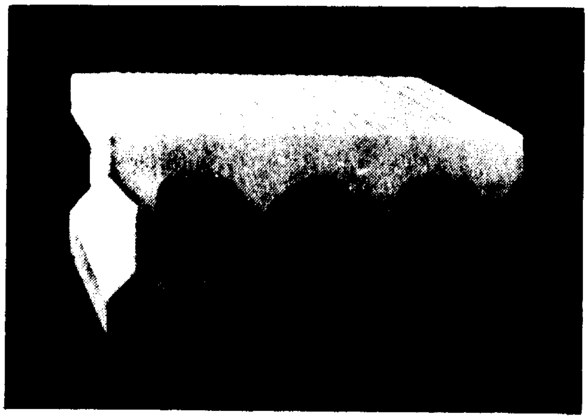


PERFORATED BLOCK
L=240, B=115, H=113 MM
WEIGHT CIRCA 4 KG

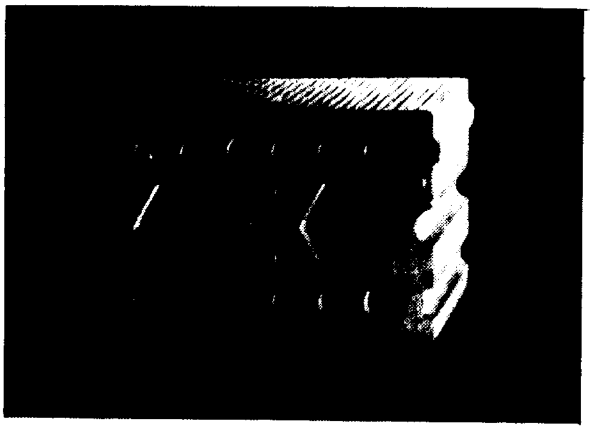


HOLLOW BLOCK WITH GROOVES
FOR EASY HANDLING
L=365, B=240, H=238 MM
WEIGHT CIRCA 30 KG

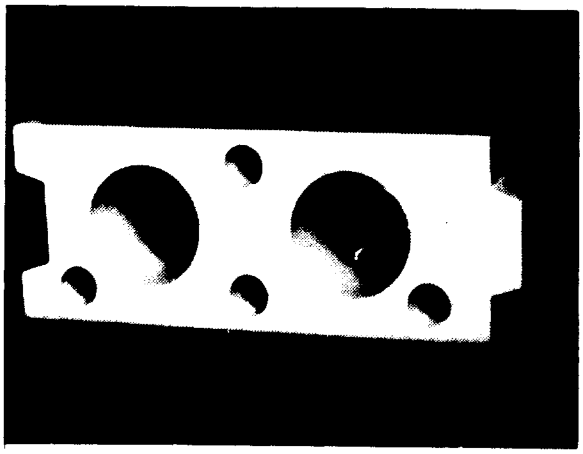
FIG. 9B MODELS OF LATOREX BUILDING UNITS.



HOLLOW BLOCK.
L=435, B=214, H=240 MM
WEIGHT CIRCA 35 KG.



HOLLOW BLOCK FOR USE WITHOUT MORTAR. CONCRETE REINFORCEMENT CAN BE PLACED IN THE BIG HOLES.
L=375, B=250, H=255 MM
WEIGHT CIRCA 35 KG.



HOLLOW BLOCK FOR LONG-SPAN FLOOR AND ROOF ELEMENTS. THE BLOCKS ARE BONDED TOGETHER TO BEAMS BY PRESTRESSED BARS. THE BARS ARE PLACED IN THE SMALL HOLES AND BONDED TO THE BLOCKS BY GROUTING.
L=500, B=200, H=200 MM
WEIGHT CIRCA 40 KG.

FIG. 9C MODELS OF LATOREX BUILDING UNITS.

It is difficult to quote an exact figure for investment costs of a complete LATOREX factory.

Equipment must be selected with due regard to the local conditions, the raw materials, labour conditions, etc.

The investment for a complete, automated plant would probably be in the range US.$ 400,000-600,000.

A semi-automated or labour intensive factory would be much less expensive.

BUILDING WITH LATOREX ELEMENTS

IT IS POSSIBLE TO DESIGN BUILDING UNITS SUITABLE FOR A VARIETY OF PURPOSES ON THE BASIS OF LATOREX.

MOST BUILDING SYSTEMS FOR LOW-COST, LOW-RISE HOUSING ARE BASED ON SMALL UNITS SUCH AS BRICKS OR BLOCKS WHICH USUALLY ARE SET IN MORTAR. IN MANY CASES A MORTAR-FREE SYSTEM WHICH CAN BE ERECTED WITHOUT ANY KIND OF SKILL WOULD BE PREFERABLE. AS THE SPECIFIC WEIGHT OF LATOREX IS 2.0 KG/CM^2, A HEAVY BLOCK COULD BE USED FOR ERECTION OF MORTAR-FREE GRAVITATION MASONRY WALLS. AS LATOREX BLOCKS CAN BE PRODUCED TO UNIFORM DIMENSIONS, THEY CAN BE PROVIDED WITH SPHERICAL LOCKS AS SHOWN IN FIG. 10. THIS WILL ENSURE THE CONSTRUCTION OF RIGID CORNERS AND SELF-ALIGNMENT OF WALLS. IF MONOLITHIC WALLS ARE REQUIRED, THE BLOCKS MAY BE GLUED TOGETHER.

HOLLOW BLOCKS FOR MULTI-STOREY CONSTRUCTION CAN ALSO BE PRODUCED FROM LATOREX AS SHOWN IN FIGS. 9 AND 11.

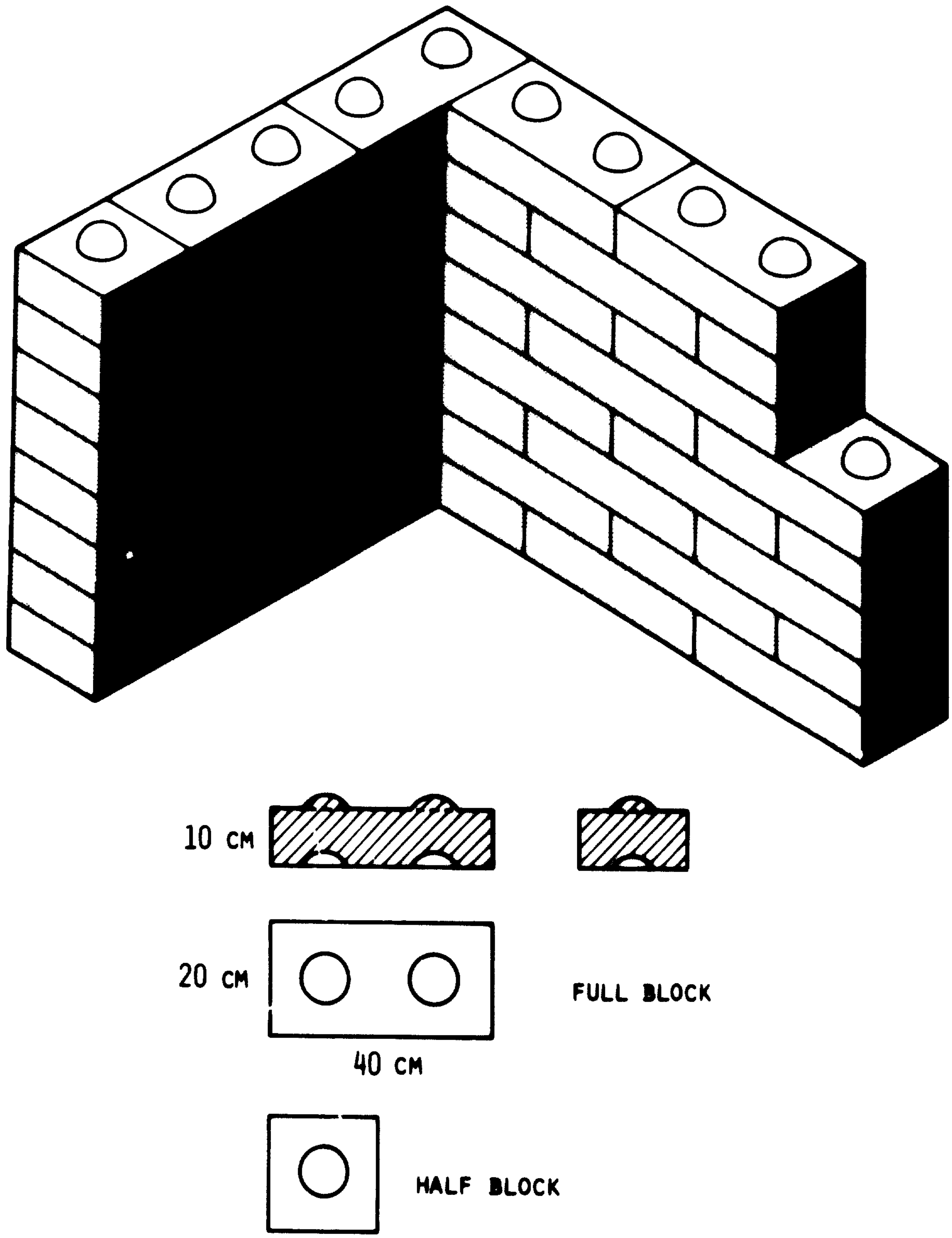


FIG.10 MORTAR-FREE GRAVITATION WALLS CAN BE BUILD WITH TWO STANDARD SIZES LATOREX BUILDING BLOCKS.

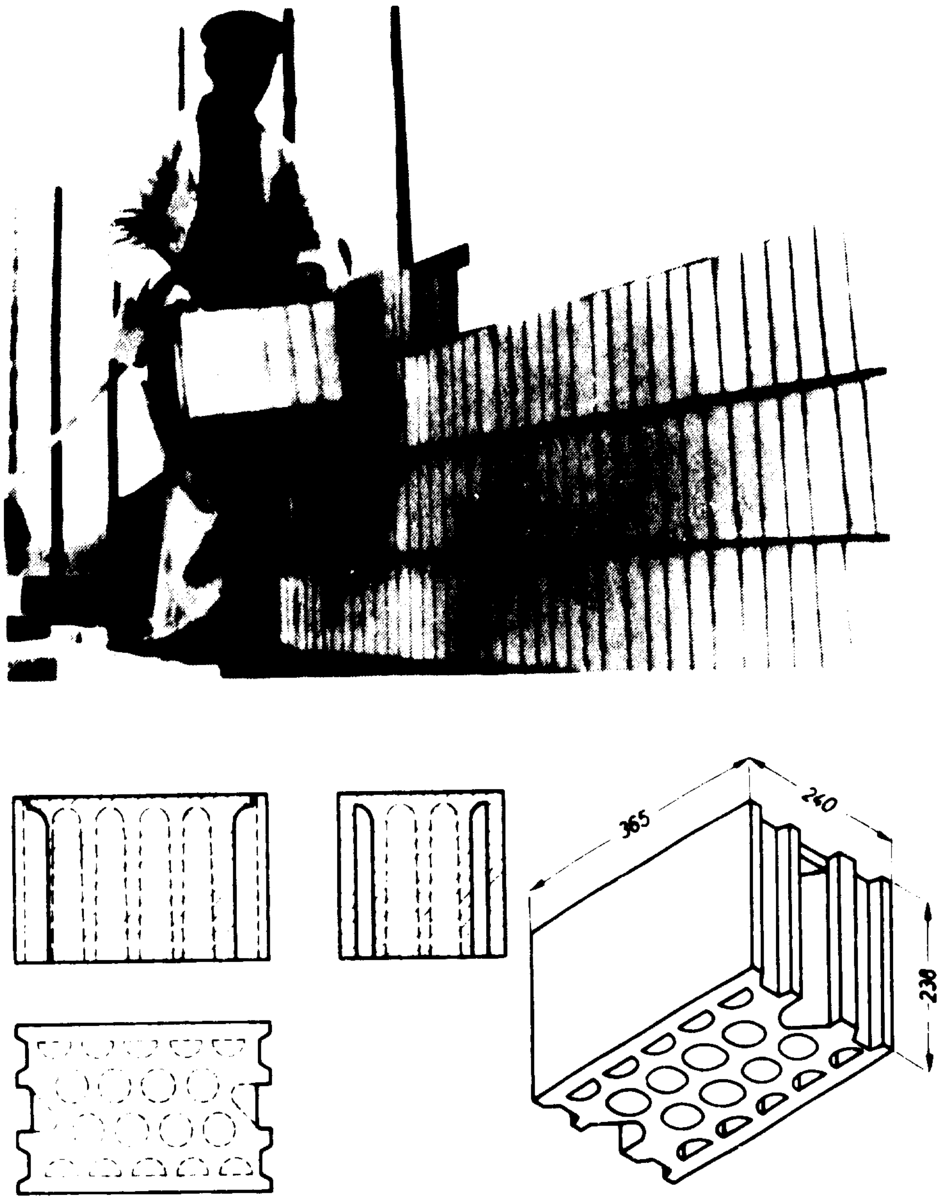


FIG. 11 BLOCKS LIKE THE GERMAN SAND-LIME BLOCK TYPE KSHBL 24A (DIN 106) CAN BE PRODUCED BY THE LATOREX METHOD. THE BLOCK HAS GROOVES FOR EASY HANDLING AND SMOOTH UPPER SURFACE FOR PLACING OF MORTAR. LATOREX BLOCKS SUITABLE FOR TRADITIONAL MASONRY WALL CONSTRUCTION ARE SHOWN IN FIG. 9.

SUMMARY

THE LATOREX BUILDING SYSTEM

BUILDING WITH LATERITE BLOCKS

THE PAPER INTRODUCES A NEW LOW-COST BUILDING MATERIAL, LATOREX.

THE PRODUCTION METHOD IS DESCRIBED. ANY KIND OF LATERITE OR LATERITIC SOIL CAN BE MIXED WITH AN INEXPENSIVE ADDITIVE, PRESSED INTO BLOCK SHAPE AND CURED IN PLASTIC TENTS HEATED BY SUN OR HOT WATER.

FLOW SHEETS FOR LABOUR INTENSIVE AS WELL AS FULLY AUTOMATED PRODUCTION PLANTS ARE SHOWN. EQUIPMENT IS DISCUSSED IN DETAIL. APPROXIMATE COSTS OF EQUIPMENT ARE STATED.

PROPERTIES OF LATOREX ARE COMPARED WITH PROPERTIES OF OTHER MATERIALS.

THE PAPER CONTAINS EXAMPLES OF VARIOUS BLOCK UNITS AND A SYSTEM FOR LOW-COST, LOW-RISE BUILDINGS BASED ON THE LATOREX METHOD.

NOTE

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