# INNOVATIVE TECHNIQUE FOR DESIGN OF BAKED CLAY BEAMS AND ITS USE IN BUILDINGS

*By*

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# BACKGROUND

# INTRODUCTION

Use of indigenous materials is an attractive option for low cost residential construction. Clay and pit sand are abundant in Pakistan. Clay is fine grained, natural, firm, earthy material that is plastic when wet at appropriate water content, hardens when dry and gains strength like a permanent solid when heated intensely.

Clay consists of hydrated silicates of aluminum. It is natural. non-toxic, easily available, recyclable, environment friendly and energy efficient. It is easy to work with and provides opportunities for creativity in developing variety of forms. It may be viewed as primitive, inferior and dirty but it does offer a viable option for use in low cost residential construction.

# This study aimed

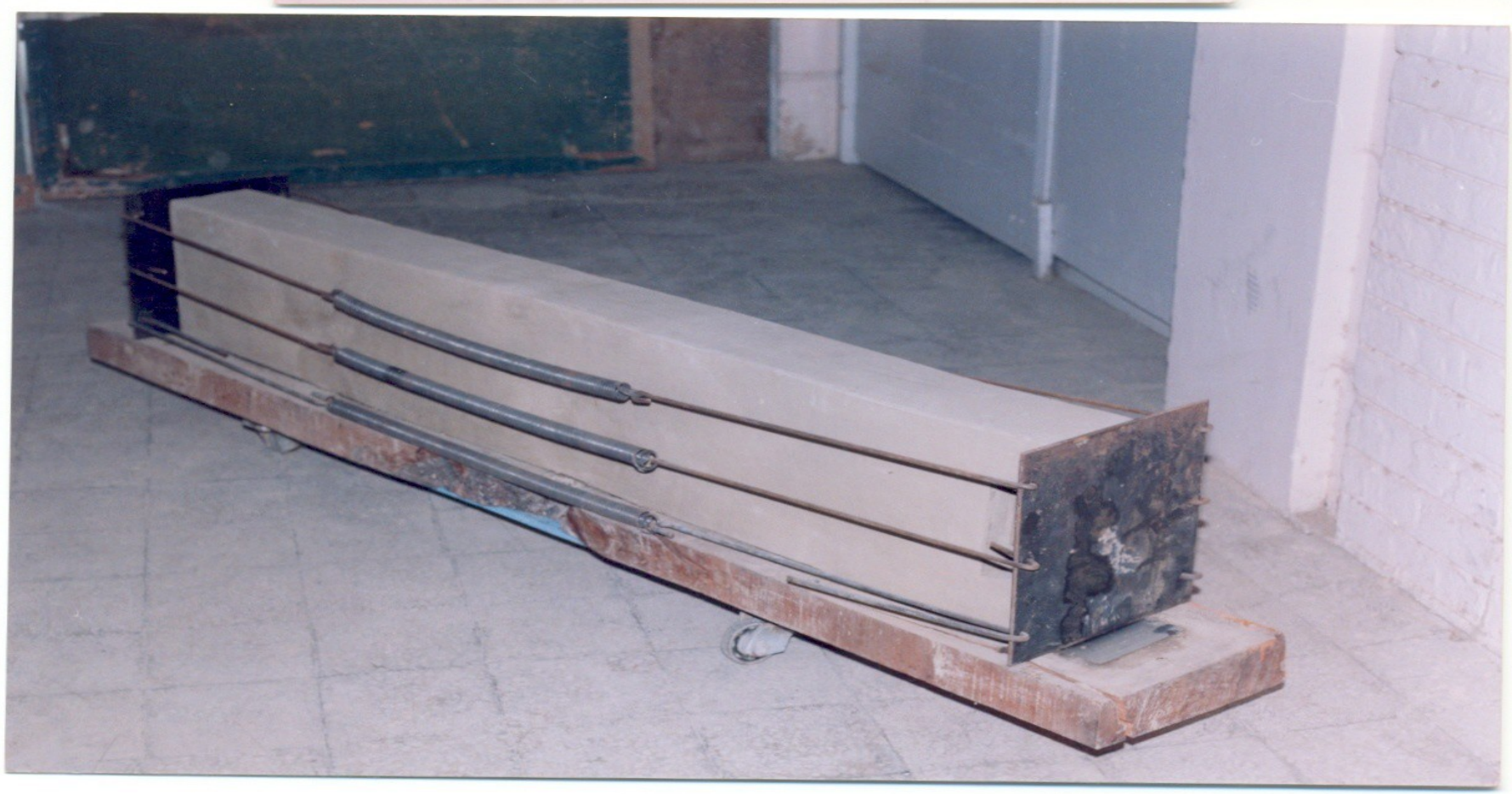
- **The structural properties**
- **The best composition**
- **The appropriate water content**
- **Extent of compaction**
- **Extent of shrinkage**

# Equipment and Instrumentation

- A large number of devices, equipment and machinery were required for this research but majority of items were not available. Therefore, the needed items were conceived, devised, designed and fabricated according to specific needs of various operations and they are such as…..

# STIFF STEEL MOULD

# RESTRAINING SYSTEM



# COMPACTION SYSTEM

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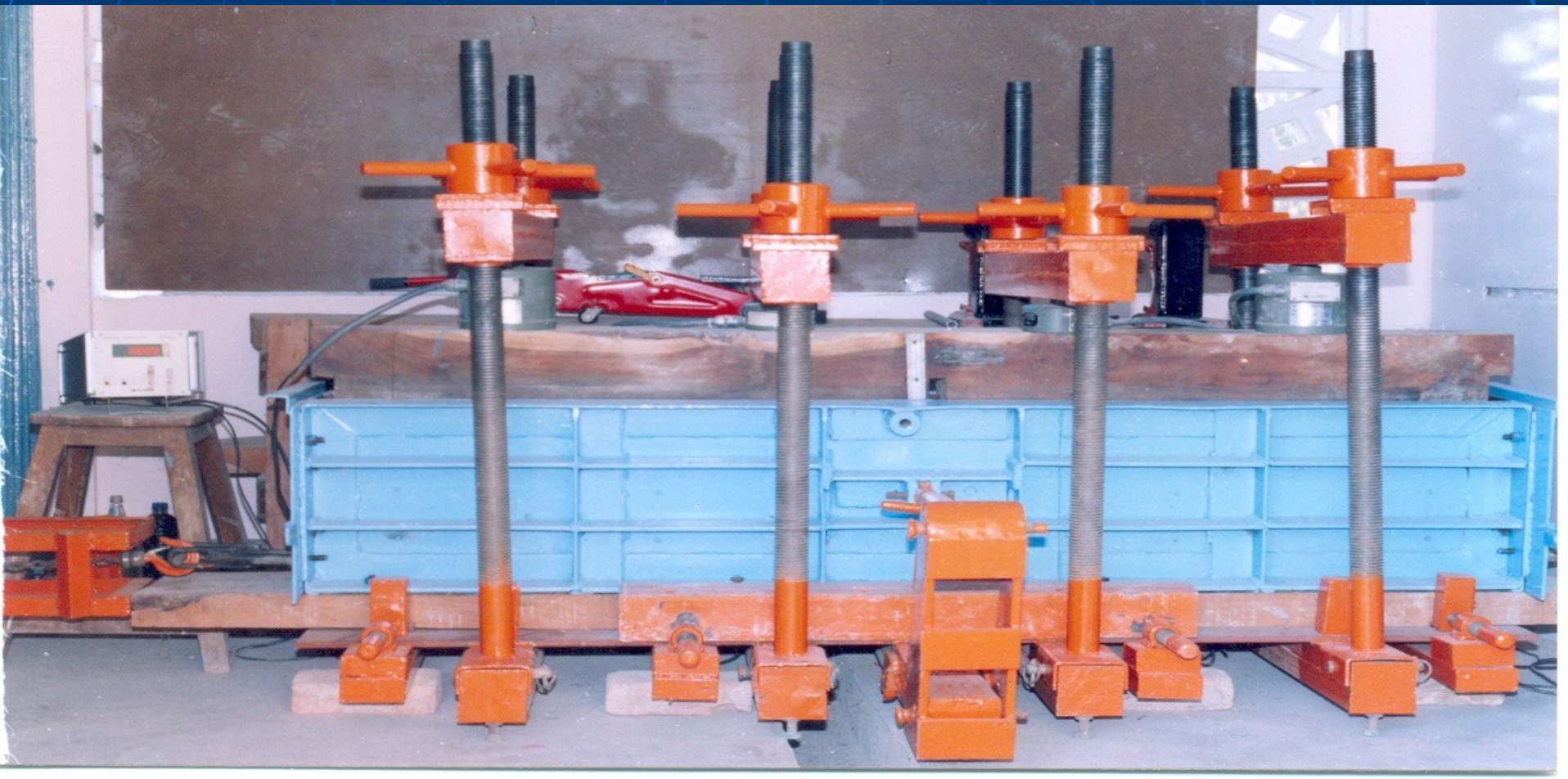


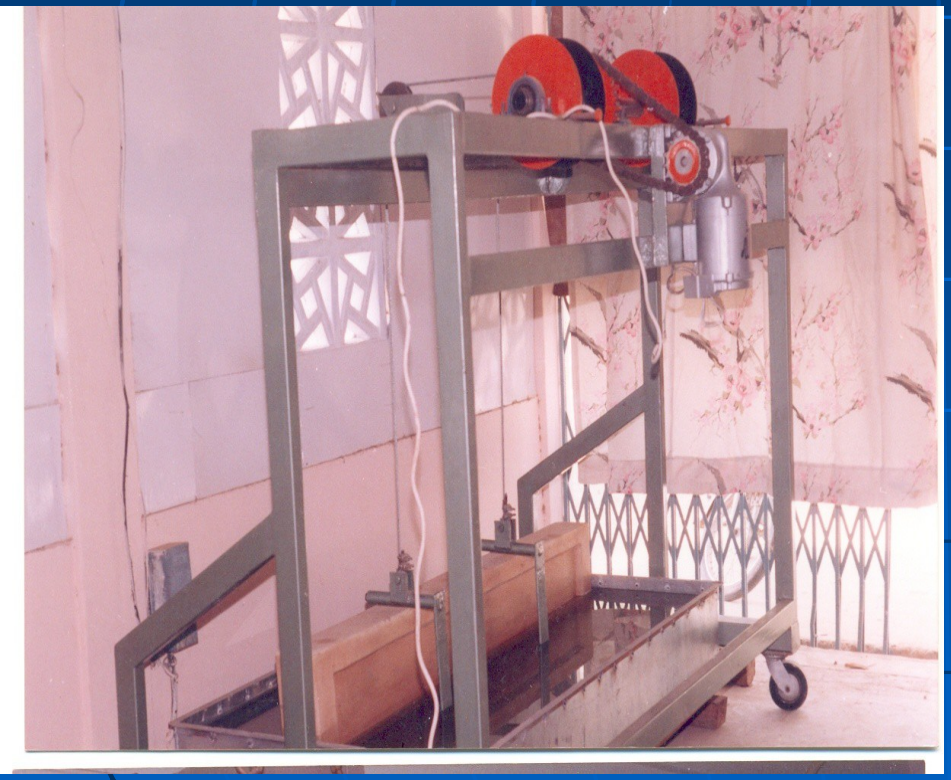
# TROLLY

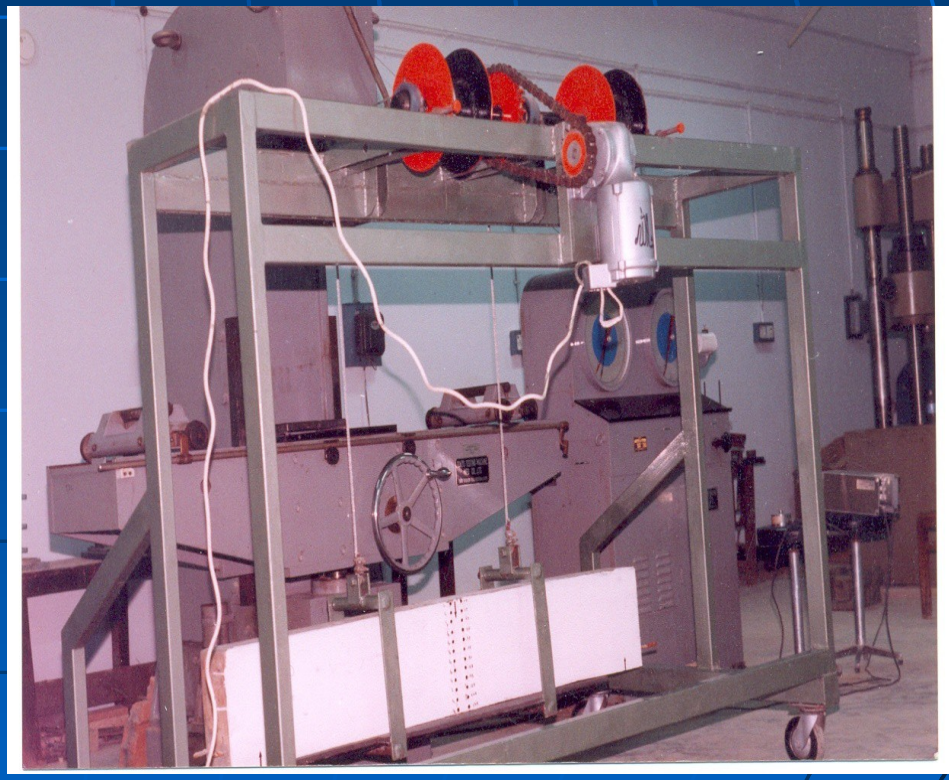
# PLATFORM LIFT

# GROUTING SYSTEM

# CURING TUB

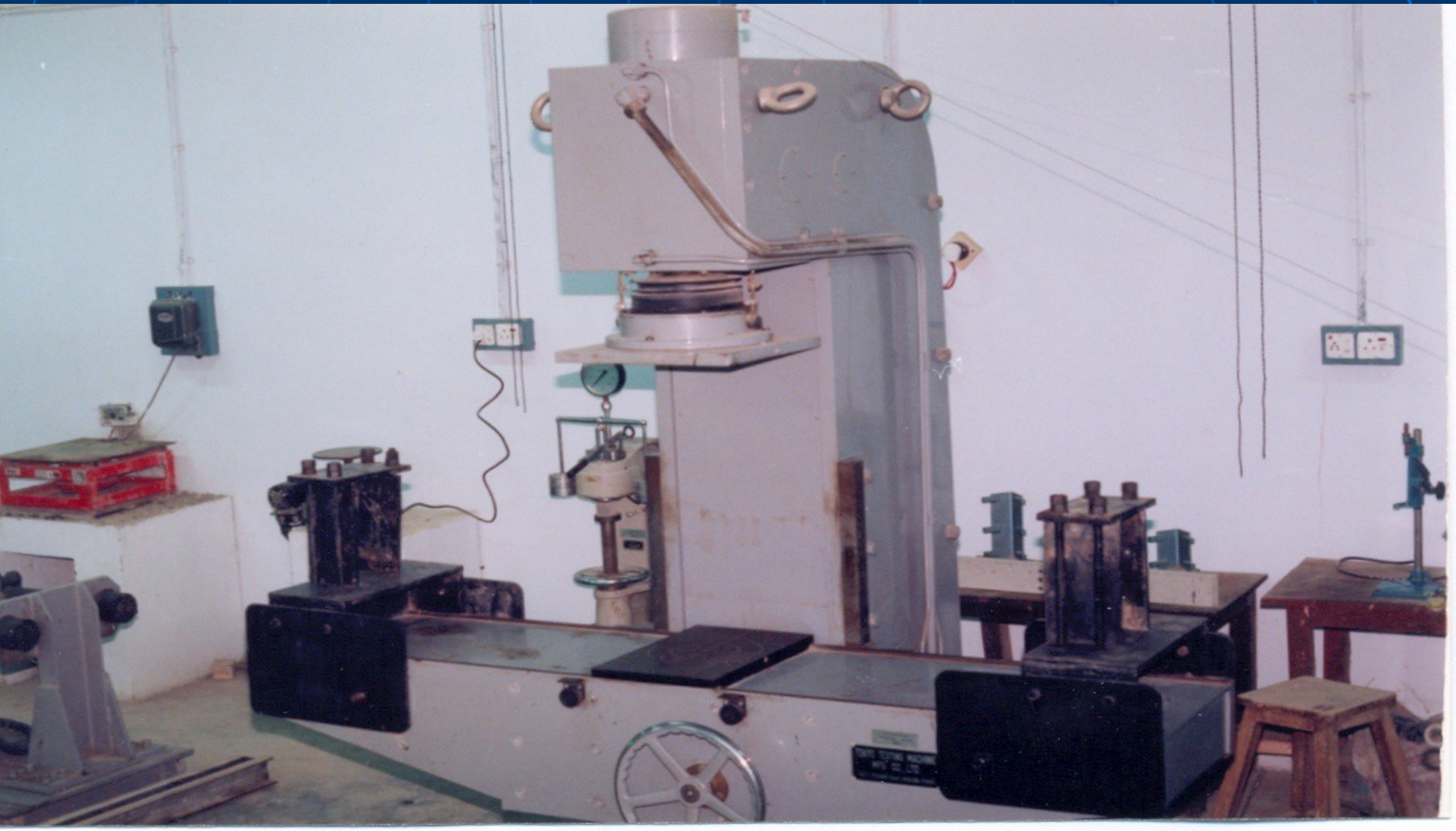
# MOBILE LIFT



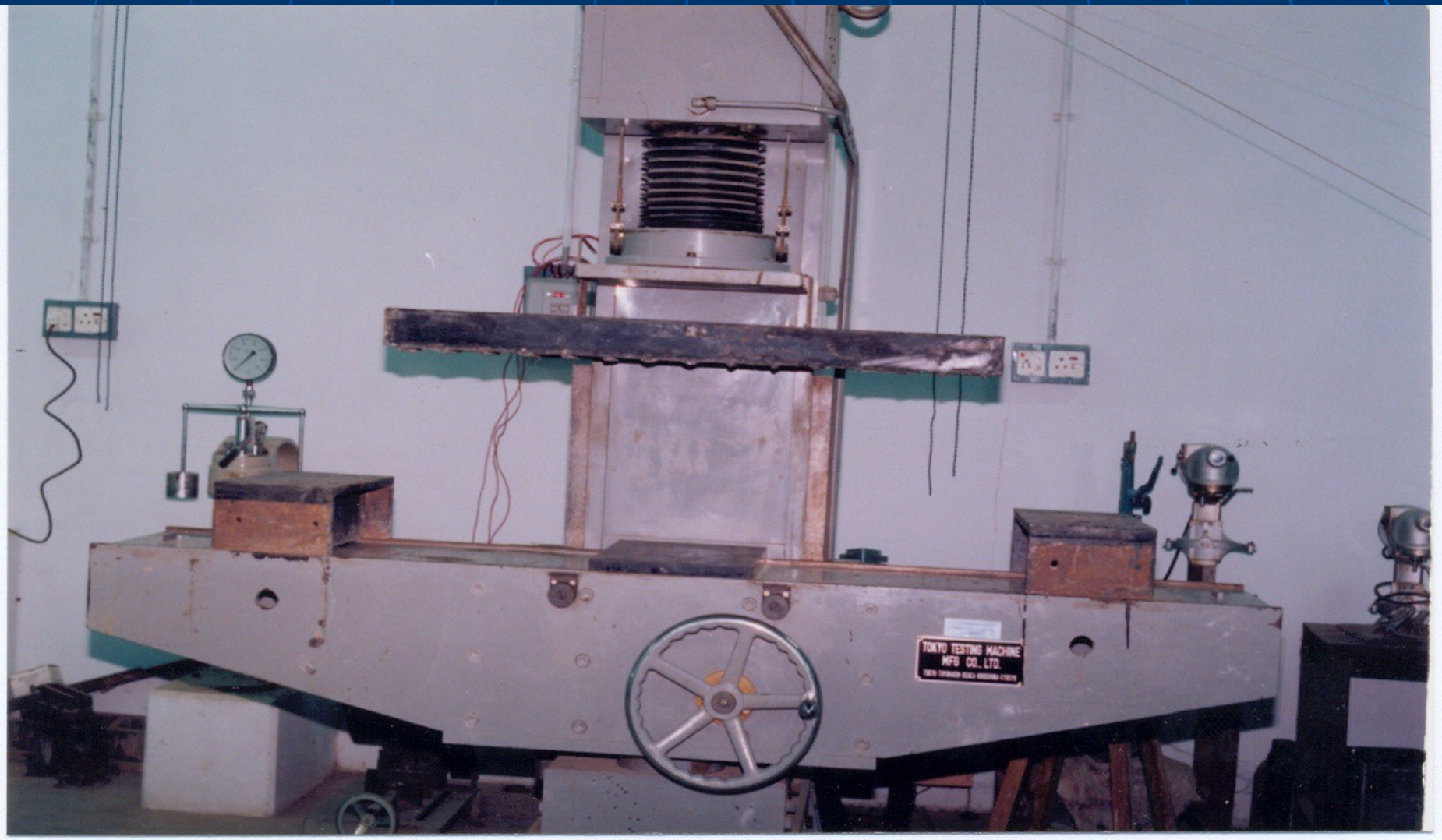


# PRECOMPRESSION SYSTEM

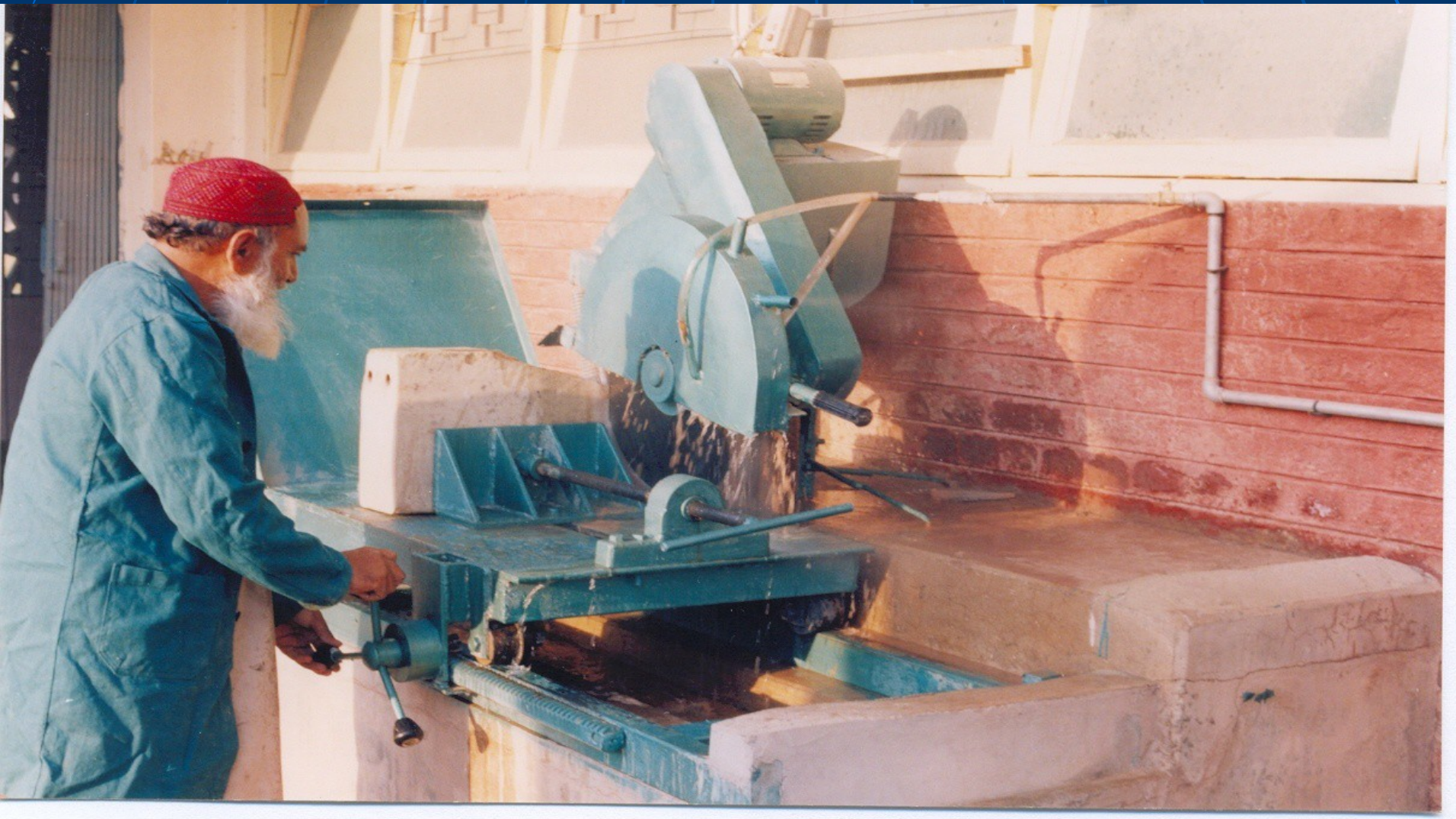
# END FIXITY ATTACHMENT



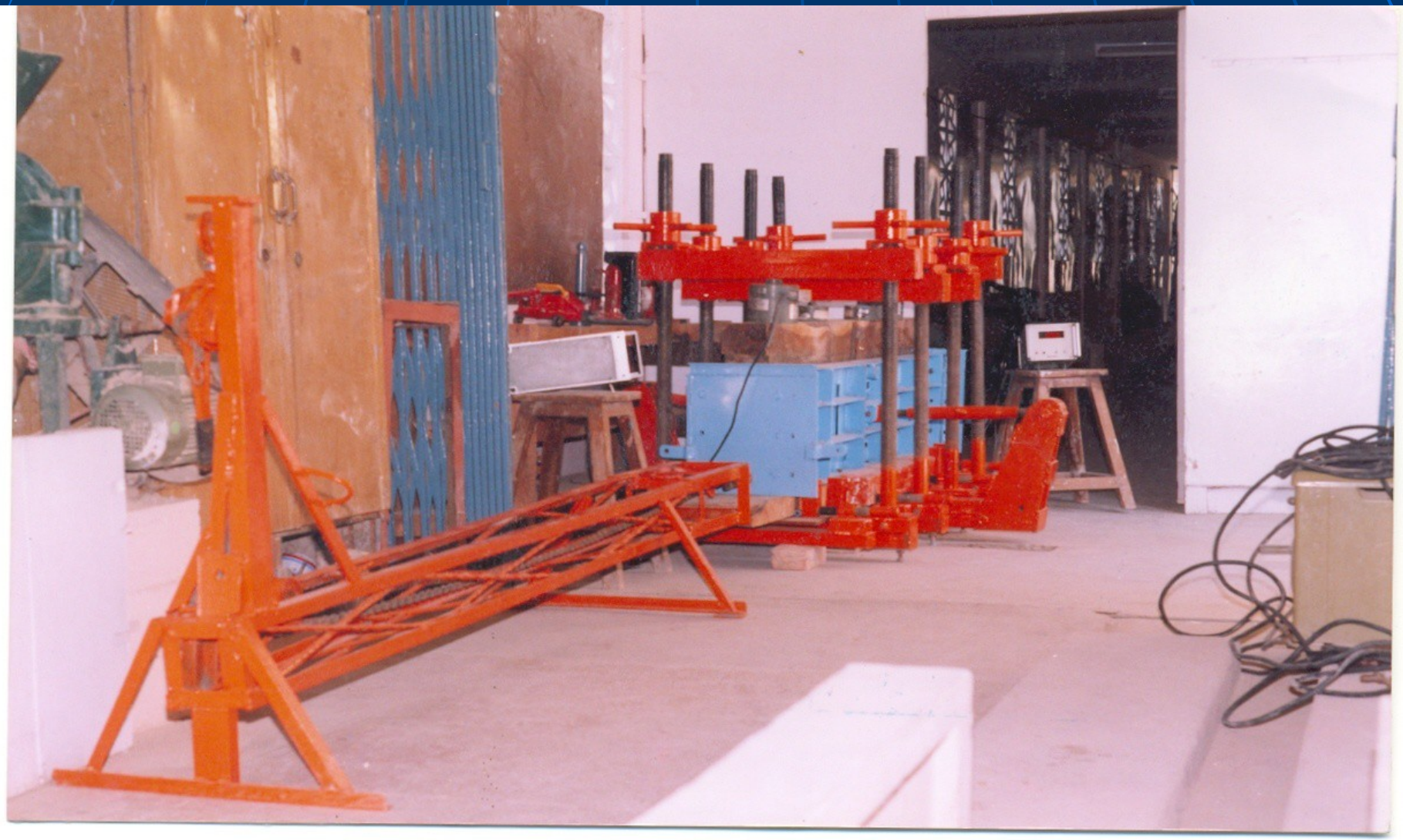
# U.D.L. SIMULATOR



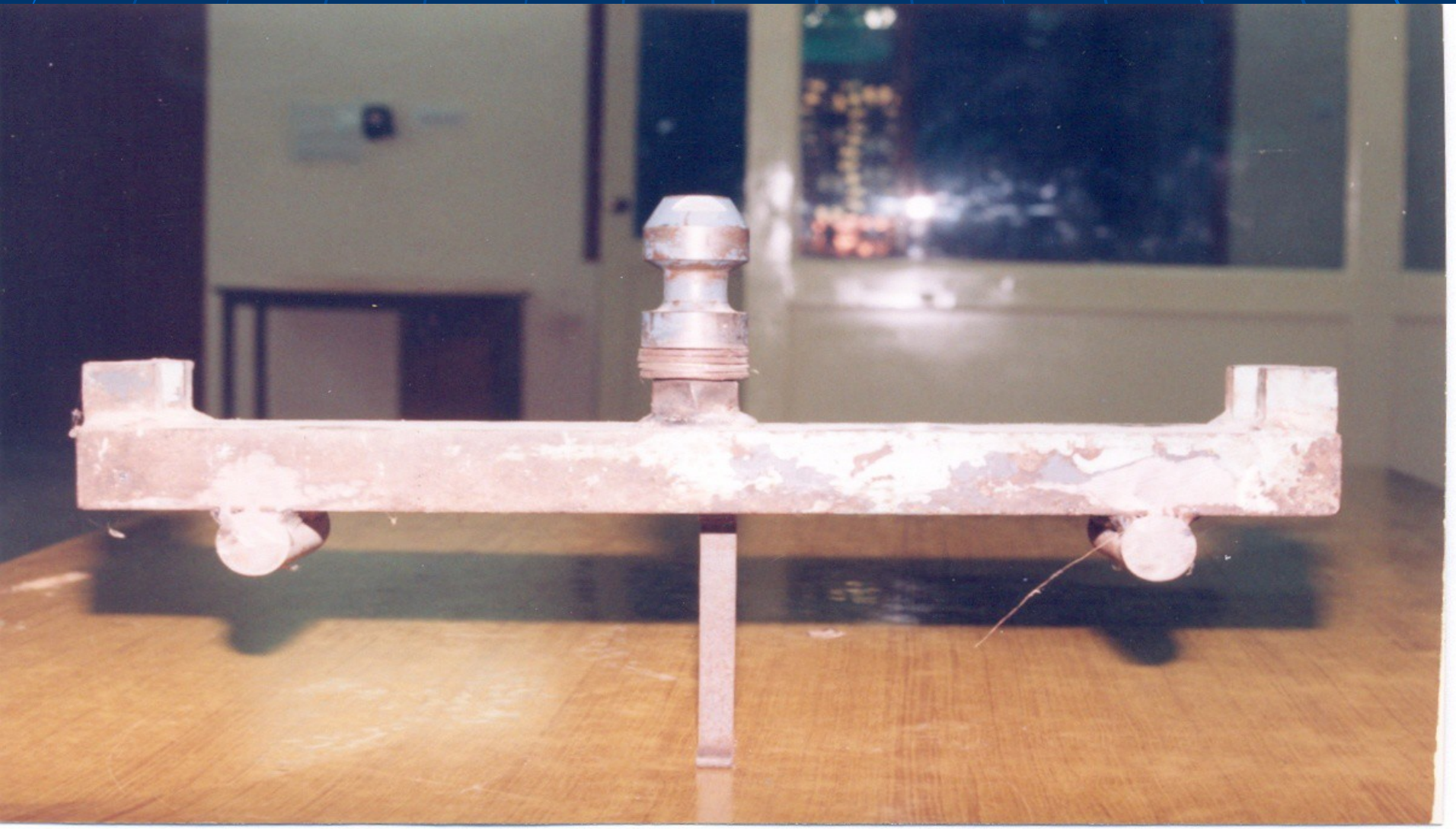
# BAKED CLAY SPECIMEN CUTTER



# PULLER SYSTEM



# TWO POINT LOAD ATTACHMENT



# KILN

# Thermocouple

# Standard Equipment used.

- Clay Drying Oven
- Pulverizer
- Load Cell
- Digital Display System
- Torsee Testing Machine
- Universal Load Testing Machine
- Dial-Gauges and Displacement Transducer
- Proving Ring

# MATERIALS

1. Clay and Pit-Sand
2. Mixing Water
3. Cement Slurry
4. Reinforcement
5. Concrete

It may be re-iterated here that the total research work has been divided into two series i.e. Preliminary Test Series and Main Test Series. The latter is further sub-divided into five phases. The effective span of all the beams was 1670 mm (65.75 inch). Apart from baked clay beams four concrete beams were also cast, cured and tested for the sake of comparison.

# Phase - I

First phase consisted of twenty three beams, out of which fourteen were rectangular and nine were I-shaped. All were reinforced with two bars.

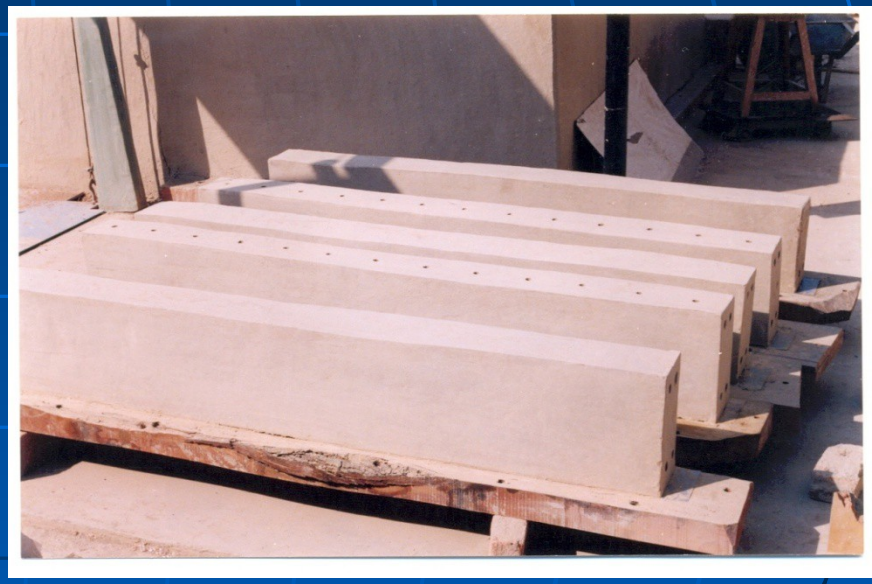
The beams were compacted by applying a compression of 3.5 $N/mm^2$. During first phase the beam panels were fired for a total period of 19 hours. In few cases after testing the beams, it was observed that the inner core of about one inch thickness was not properly baked.

## PHASE II

During this 2nd phase six beams were cast, baked, post-reinforced, grouted and tested. The major parameter was to increase of external compressive force applied on freshly cast beams for compaction from 3.5 $N/mm^2$ to 4.73 $N/mm^2$ and also the firing period from 19 hours to 22 hours. By increasing the firing period the problem was over come

# Phase III

The purpose of testing beams of phase III of Main Test Series was to check the behavior of baked clay beams with top steel and vertical steel. A compressive force of 4.75 $N/mm^2$ (690 psi) was applied for compaction.

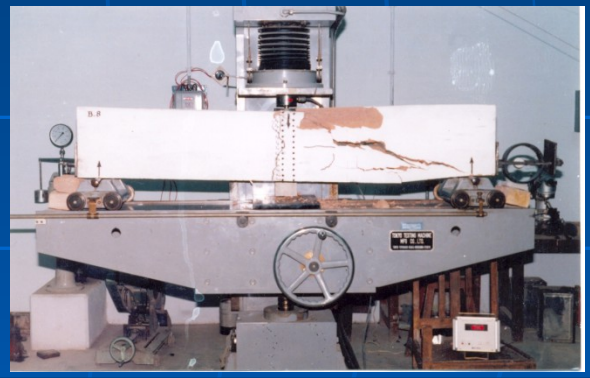


# Phase IV

In continuation with the work that has been done regarding suitability of replacement of concrete, more beams have been tested containing double longitudinal reinforcement as well as vertical reinforcement to emulate the real structural actions which occur in the buildings.

# Phase V

Infact in the advanced stage of experimental investigations the idea emanated to apply a certain intensity of compression on beam panels so that their shear strength could be improved without inserting the shear reinforcement



Although the actual ultimate condition could not be reached due to immature failure of the end connections anchorage system consisting of nuts and welding on threaded steel bars which were used to reinforce and apply pre-compression to the baked clay. However, from the results it appears that if the anchorage is to be properly designed and strengthened the system would definitely work and positive results could be achieved.

# CONCLUSIONS

Baked clay has shown very good crushing strength of 35.37 N/mm2 (5128 psi) which is reasonably good.

- An idea of using the most natural material i.e. clay requires no industrial processing except baking which is an established form of processing clay.
- Buildings must be erected cheaply but for a sufficiently long life and for generations to use them and the cost must be within the reach of common man.

- The major aim of this research is to make it possible in the plane of Pakistan for every rich and poor to afford a home of his own, which may resist the rigors of climate, environment and must not cause a hazard to at least the occupants.
- The human generation shall be best served if clay is used for roof over their heads.

- It was observed that best results could be achieved when the clay is 70% and Pit sand 30%.
- Poisson's ratio was found to be 0.173 as compared with that of concrete
- The modulus of elasticity for all tested beams was found to be 33.7 $kN/mm^2$
- Predominantly all the beams failed in shear and full flexure strength was not achieved

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# THANK YOU