1.1 General

The provision of good quality housing is recognized as an important responsibility, for the welfare of people in any country. For any such mass housing scheme, masonry is one of the important components and these masonry walls are usually made up of building blocks. These building blocks, technically known as masonry units, are available in variety, as natural, semi natural or artificial in their origin. Lot of work on these units has been done, especially on conventional brick, laterite, solid and hollow concrete blocks which are made of conventional raw materials, i.e. building materials based on natural resources. Some examples for these natural resources are the use of clay for making bricks, and river sand for making cement-sand blocks. The commercial exploitation of these resources often leads to various environmental problems. Extensive sand mining can lower the river-beds and allow salt-water intrusion in land. Therefore, the development of as many alternative
walling materials as possible will be of immense benefit to minimize the impact on the environment. One such walling material is earth as mud blocks. Earth as mud bricks, has been used in the construction of shelters for thousands of years and approximately 30% of the population still live in earthen structures.

1.2 History of Earthen Construction

A brief state-of art review is given by Walker et al. (2000). Mud wall construction is one of the oldest and remains one of the most widespread forms of wall construction. In the Middle East, for example, remains of adobe (sundried mud blocks) wall construction have been dated back to 8000 BC. Many of these ancient techniques, such as adobe and cob constructions, are still widely practiced in many countries today.

Unstabilised mud construction is associated with two major problems: (1) Loss of strength on saturation and (2) Erosion of soil due to the impact of rain. These problems can be handled by the techniques of soil stabilisation. Compressed earth block or stabilised mud block, as they are commonly called in India, represent, an example of alternative component for masonry construction produced by utilising natural soils, sand and other industrial waste products such as fly ash.

Although adobe blocks have long been tamped into slip form moulds, the dawn of compressed earth block technology is attributed to Francois Cointeraux, who developed a timber block press, based upon a
wine press, in Eighteenth century in France. However, it is only in the last so many years that compressed earth blocks have been widely adopted, largely due to the development of soil-cement block technology and invention of CINVA-RAM press in 1952 by Ramirez, a Chilean Engineer.

Mud wall construction in India has centuries of history and even now practiced in rural parts of India. The earliest Indian example of soil-cement buildings probably is to be seen in the refugee-housing programme in and around Karnal in Haryana state. 4000 buildings were constructed in 1948 using the concept of rammed earth soil-cement walls. A couple of problems like cracks and peeling off of cement plaster from the walls were noticed later. These problems may be attributed to inadequate stabilisation of fine-grained soils used for walls. Some of these houses are still in use with minor repairs and modifications. Development of Cinvaram block press in 1952 led to the concept of machine pressed stabilised mud blocks. Number of groups started working on stabilised mud block technology all over the world. The Ellson Block Master, a machine of South Africa origin was manufactured in Rajkot of Gujarat state during early seventies. This is heavier than Cinvaram, having the flexibility of interchangeable moulds. Some buildings were built using this machine in Gujarat, Kerala etc. Major impetus for stabilised mud blocks technology came after the formation of Centre for ASTRA (Application of Science and Technology to Rural Areas) in 1974 at IIISc, Bangalore.
Compressed soil masonry blocks, formed using moist soil compacted mechanically to improve physical characteristics, have gained popularity over the past so many years. Benefits of earth in this manner include improved strength and durability as compared to adobe while maintaining significantly low embodied energy levels than alternative materials. However problems arise from the material’s low tensile strength, brittle behaviour and deterioration in the presence of water. Stabilisation by a hydraulic binder such as cement or lime or a combination of the two can significantly improve water resistance and strength to some extent. Also natural fibres have been used in adobe and other traditional forms of earthen construction for many thousands of years, to reduce shrinkage cracking, to improve tensile strength, durability and improved ductility in tension. Apart from that, baking of composite bricks with natural fibres and grain, leaves a porous structure which consequently enhances thermal and acoustical insulation of the finished products. Theoretical models were also developed on composite soil blocks reinforced with fibres subjected to shear. In almost all the above studies, the fibres used are sisal fibres, coconut fibres, vegetable fibres, straw, palm fibre etc.

1.3 Motivation to this Study

During the last few years, there has been a growing interest in the use of earth as a modern construction material and also considered as a sustainable material. Some factors contributing to this new interest are the
energy crisis, resource depletion, increase in housing and habitat requirements day by day. At this context, for this mud blocks to be more widely applicable, a systematic study on physical and engineering properties is required. The present study aims at evolving few propositions regarding manufacturing of functionally efficient, structurally adequate and cost effective sustainable building blocks.

The motivation factors, which led to the present study, are listed as follows:

- Enormous amount of Plastic throw away.
- Soil by itself cannot stand reasonable loads as a masonry block.
- Natural materials tend towards dramatic depletion.
- Synthetic materials up heave drastically.
- Environmental issues.
- Energy aspects.
- Economic considerations.
- Social commitment.
- Technology based (Appropriate Technology).
- Rural & Mass Housing.
Chapter 1

1.4 Organisation of the Report

A general introduction of mud block and its classification, a brief history and motivation for the present study have been given in the preceding sections. A critical review of literature on earthen construction with special emphasis on mud blocks, its material, production, physical, mechanical and durability properties, applications and advantages is presented in Chapter 2. The need for the present study along with the objectives and scope are also brought out in this chapter.

Chapter 3 describes the characterisation of the materials used in the present study. Descriptions of the various experimental methods to find out the properties of mud blocks are also explained in Chapter 3. Chapter 4 presents the analysis of results of the experimental investigations covering wide range of compositional parameters to get a conclusive influence of these parameters on the strength of mud blocks and masonry. Analysis of the experimental study on the sorption and erosion characteristics is given in Chapter 5. The conclusions drew from the present research work and the scope for further studies are given in Chapter 6.

Test samples were prepared, for different composition of ingredients and relevant experiments were conducted. Cylindrical specimens were prepared for all the investigations, as these represent the worst condition of stresses. Apart from that, Light compaction tests have
been carried out to arrive at the OMC and the max dry density of samples. Hence, the specimens made on these moulds will be more relevant for the study. As masonry units are of blocks, a dismandable mould has been made and the Compressive strength tests have been performed. Interestingly the results are akin to that of the cylinders. There exists a definite ratio between the strengths of the two. Thus the Characteristic curves are drawn for cylinders and the modification factor for blocks has been mentioned in the relevant section (4.4). Tension and erosion tests have been done on cylinders alone. Split tension test has been done and the erosion resistance has been assessed by a spray test set up which is designed and devised to suit the cylindrical samples.

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