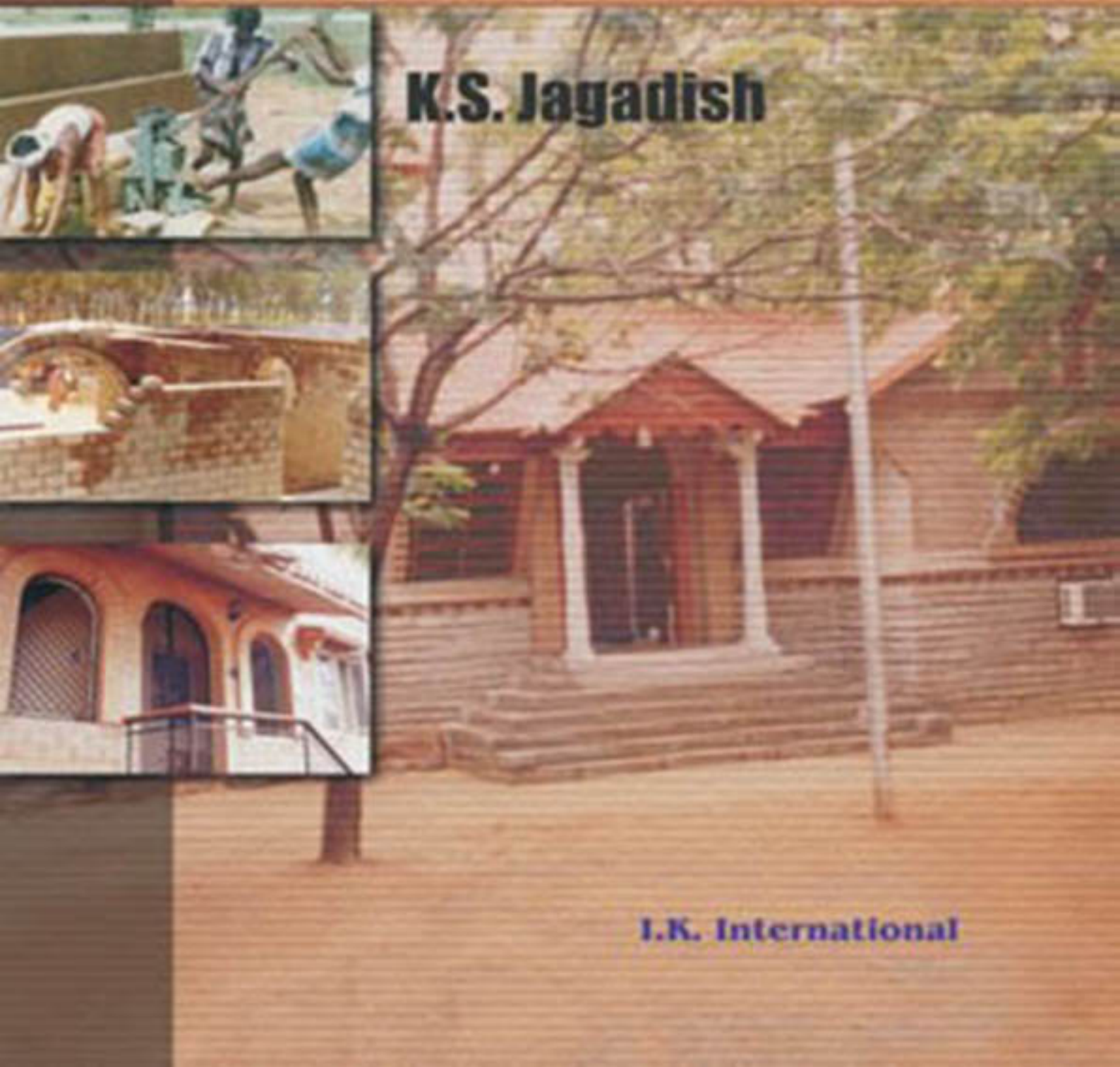
Building with Stabilized Mud



K.S. Jagadish

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Dedicated to the Memory of
Late Professor Amulya Reddy

Contents

Preface

Building Construction using stabilized mud (soil) has been in vogue in different parts of the world for nearly six decades. However, the desirable practices have not been placed on a firm footing due to sporadic nature of the constructions. The situation in conflicted due to the highly variable nature of soil as a construction material. This stands monograph is an attempt to summarise the best practices for the use of stabilized mud. It is essentially based on the experiences at ASTRA (Application of Science and Technology to Rural Areas) and Dept. of Civil Engineering, Indian Institute of Science, for more than three decades. The author would like to place or record. The valuable support given by his associates, Prof. B.V. Venkatarama Reddy, Dr. M.R. Yogananda, Subhas C. Basu, N. Krishna, K.S. Gumarti and Sharada R. Hubli, without which this monograph could not have been written. He is also indebted to the orchitich Anuradha Krishna, Gitanjali, Prasanna Rao, Ganesh and Bhookhan, whole enthusiastic expousal of stabilized mud has been an immerse encouragement. The support of engineers like Kanikoraj, Ramapresad, Dinesh, Lokesh Jayofrokach and Roghuram has been invaluable.

It is hoped that this booklet will be a useful guide to practitioners of mud construction and to Architect and Engineers with an interest sustainable construction. The author would also like to place on record this insfiring guidance and encouragement given by the late Prof. Amulya Reddy who was tower of strength to the ASTRA group during its formative years.

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1

Introduction

1.1 General

Human society has been using mud for shelter since the days of Egyptian and Mesopotamian cultures. Although, Harappa and Mohenjodaro are known for the use of burnt bricks, use of unburnt mud bricks was also prevalent. The use of mud has its advantages: its local availability and ease of processing makes it the most energy efficient building material. It also has quite a few disadvantages. Exposure to rain can severely affect the durability of a mud wall. Use of mud walls increases the chance of termite infestation and deterioration of timber in houses. Again, over the years, mud houses have come to symbolize poverty and even the poor are not happy about using mud for walls. They aspire for a more durable material like brick or concrete.

1.2 Why build with mud?

It is now useful to explore if the disadvantages of mud can be remedied so that the benefit of using mud can be mobilized at least partially. It is easy to recognize that mud is the most abundant building material known to our civilization and it is available in

a majority of locations. There are however, arguments, which disfavour the use of mud for buildings, saying that it often leads to loss of valuable topsoil. It must be pointed out here that far greater quantities of soil are lost to the sea by soil erosion and prevention of such erosion can easily provide all the mud needed for houses. Use of mud for wall construction in place of brick or concrete is hence, cost-effective and energy efficient.

1.3 To Stabilize or not to

The experience of last 3 decades shows that properly stabilized mud competes favorably with bricks or concrete blocks. This now begs the question: is it always necessary to use stabilized mud or can we use unstabilized mud even in the modern context? It is now clear that if one wants to build two or more storeyed buildings, stabilization of soil becomes essential to attain adequate compressive strength. If one is contemplating single storeyed buildings with moderate spans, use of unstabilized mud can indeed be an option. Prevention of wall erosion can be achieved either by better building design or by simple surface treatments. Such an approach will also bring down costs substantially.

2

Selection of Materials

2.1 Soils and their Characteristics

Soil is a generic term for the end product of the weathering process of rocks. Soil characteristics can vary widely depending on the nature of the parent rock and the type of climatic influences at a particular site. Soils, further, consist mainly of three types of particles.

a) Sand

Sand is nothing but grains of quartz varying in size from 0.075 mm to 2.0 mm. It is hard and chemically inert.

b) Silt

Silt particles are also grains of quartz but are much finer than sand. They range in size from 0.002 mm to 0.075 mm.

c) Clay

Clay particles are finer than 0.002 mm. Chemically, they are products of weathering of felspar and can vary in chemical

composition and physical characteristics from site to site. In general, they can be regarded as complex alumino silicates consisting of alternating sheets of alumina and silica. Depending on the arrangements, three types of clays are common: Kaolinite, Montmorillonite and Illite. The physical characteristics of clays are very much dependent on the presence of moisture. They have a tendency to absorb significant amounts of moisture. Clay is generally hard and strong when it is dry. It becomes very soft, however, on absorption of water. It is the 'clay' that imparts specific physical and chemical characteristics to a soil. Clay is responsible for the several useful applications of soils. Firstly, clay is essential for all agricultural practices. Its property of holding moisture and nutrients makes it indispensable for plant growth. Soils are useful in building construction due to the properties of clay as a binder. Again, when clay is burnt at high temperatures it hardens leading to production of pottery and bricks and tiles. Clay is also an important ingredient in the production of cement. The properties of a soil are, in general, governed by the type and amount of clay present in it. Clays generally expand on saturation and contract on drying. This characteristic is displayed to a great degree by soils which contain 'montmorillonite' clay. Black cotton soil is a typical soil with montmorillonite clay. Such soils are also known as expansive soils.

Besides sand, silt and clay soils often contain other minerals like iron oxide and salts like calcium and magnesium carbonate, in smaller quantities. Organic matter, from the decomposition of leaf litter or manure is also present in soils in very small quantities.

Soils are often used in traditional housing for wall construction. Such walls are quite strong when they are dry due to the adhesive property of clays. However, these walls are vulnerable to the effects of rain impact. Prolonged exposure to rain often leads to an erosion of the wall surface. Complete saturation of such walls can also lead to their collapse. Water leaking from the roof can often lead to such situations. Human civilization has always been

searching for a material which is relatively more durable than mud when exposed to rain impact. Whenever stone is easily available it has been used for construction. In other locations, burnt brick has evolved as a durable building material. Burnt brick, on the other hand, needs thermal energy for its production. This thermal energy has to come either from coal or from firewood or other biomass. Use of coal or firewood has an environmental implication and there is a need to reduce the energy requirement in the production of a stable building material.

2.2 The Stabilized Mud Block

Since, mud (soil) is the most widely distributed resource for building construction it is useful to explore ways of 'stabilizing mud' without employing an energy intensive technique like brick burning. 'Stabilized mud' may now be defined as, mud which does not soften due to the action of water, by the use of a small quantity of a binding agent. Cement, lime, cement and lime, lime and pozzolana, bitumen and organic binders are some of the typical 'stabilizers' which can be used to produce a 'stabilized mud block'. The performance of a soil based building block depends to a considerable extent on its density. Low density blocks are rather porous and will not have good strength. It is hence necessary to densify a soil while making a stabilized block, besides adding the stabilizer. For this purpose, the soil has to be subjected to adequate pressure at suitable moisture content. This process is known as 'compaction'. The compaction can be done inside a machine mould to produce a standard sized 'mud block'. Alternatively, the soil can be directly compacted in a wall using a movable mould in what is known as 'rammed earth' construction. As a rule, it is desirable to produce a 'stabilized mud' with a dry density of 1.80 to 1.85 gm/cc.

Thus, the process of stabilized mud block (SMB) making has two steps: firstly, the right type of soil has to be mixed with a

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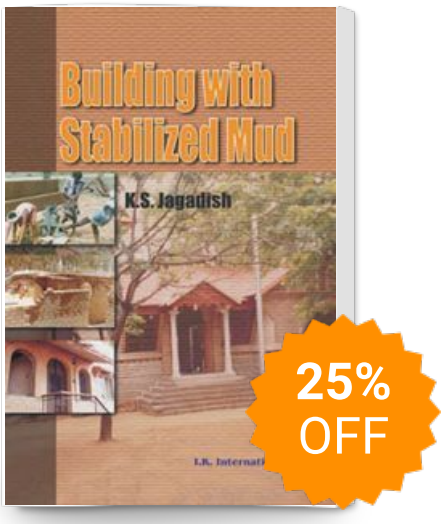

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