

DURABILITY OF ANCIENT MUDMORTAR IN EGYPT

Mohamed Abd El-Hady¹ and Mahmoud Algohary²

¹ Prof. of Conservation of Historical Buildings, Faculty of Archaeology, Egypt, elhady_esna@yahoo.com

² Demonstrator at dept. of conservation, Faculty of Archaeology, Egypt, Mahmoudalgohary2013@gmail.com

Abstract Mudmortars of different constituents widely used in the ancient Egyptian Earthen buildings from pharaonic periods till 11th century A.D.

This type of mortar consist of different unhomogeneous materials mainly clay mineral mixed with chopped straw, fine sand particles, powder of limestone.....etc.

Different samples of mudmortar have been collected from different historical buildings in Egypt specially from pharaonic tombs and Cairo historical wall from 11th century. These samples have been investigated by XRD, PLM and SEM with EDX.

The obtained results showed that the durability of mudmortars used in the historical buildings in Egypt considerably decreased due to the attack of severe deterioration factors which are discussed in this research.

Keywords Durability, clay mineral, additives, physio-chemical properties, Deterioration

1 Introduction

Different mortars (mud, gypsum, lime) have been used through the ages as binders in the purposes of construction.

Mudmortar is considered very common binding material for mud bricks used for building the archaeological buildings in the Middle East and in some rural regions before using the stone blocks in construction purposes since more than 8.000 years B.C

This mortar was easy to fabricate when compared with other building materials such as stones. It was therefore more economical particularly for large buildings such as palaces, castles, fortresses, houses ...etc. this mortar was a modular and regulized construction materials.

The ancient Egyptian used mud mortars for building their houses which were of semi-circular shape in the pre dynastic ages (figure). This type of mortar greatly developed with passing of time.

The excavations carried out in many archaeological sites in upper and Lower Egypt should that the ancient builders this primary mortar was used in the binding of the mud blocks used for constructing castles, fortresses, houses, palaces, pyramids and walls of the temples such as Karnak and Luxor temples dating back to old, middle and new kingdoms.

The palace of Akhnaten at Tell el Amarna, the ancient Egyptian capital in lower Egypt during new kingdom completely built of mud brick cemented with Mudmortar which was mixed with chopped straw. It was noticed that layers of a dry grasses and fragments of different dry plants were but under the layers of mud brick to increase the stability of these layers. Moreover wooden beams of different lengths were added in the walls between the layers of mud brick for reinforcement of these walls. This technique was applied in the Coptic, Greco-Roman and Islamic historical buildings in Egypt. (Figure)

The manufacture phases of Mudmortar and brick were illustrated on the surfaces of the walls of many pharaonic tombs mainly Rakh-me-re-tom from 18th dynasty which gives on indications about the importance of this technology in the ancient Egyptian society. The painted scenes show that some workers are carrying the raw materials and others are constructing the walls with mud brick with using Mudmortar. (figure)

The ancient builder usually used this mortar in the horizontal joints between mud bricks in a course.

Kemp has mentioned that the ancient builders had fabricated this type of mortars as close to the construction site as possible whereas bricks more often were produced at a greater distance from the construction site and transported at least a short distance as pictured in the brick –making scenes from the tomb of Rekhmi-Ra.

1.1 Composition of mud-mortar:

Soil materials are considered the most widely used materials for fabricating mud-mortar and mud-brick since Neolithic age, particularly in arid and semi-arid regions of the world. In Egypt soil materials were used for building purposes before the making of mud-brick was developed.

Suitable soil materials for building should contain four different materials:

Coarse sand (aggregate), fine sand, silt and clay. The aggregate is essential for providing strength. Silt and clay act as binders and plastic medium for cementing the other constituent of mud-mortar together.

Hughes 1988 has mentioned that soil materials with a high percentage of aggregate may be strong when become dry but are vulnerable to erosion from wind erosion or rain. On the other hand soil materials with high percentage in clay

may be much more resistant to erosion but less strong and seriously deteriorated by moisture infiltration.

Because of the abundance of clay and silt in the Egyptian soil materials the ancient builders could modified these materials by adding quantities of coarse sand or dried plants such as chopped-straw or hay and manure.

Chopped straw is considered very essential additive materials to the composition of mud mortar especially if the organic content of this mortar is high and the clay content is too low in this case it may be necessary to add chopped straw to the mixture of this mortar to make it strong and durable after dryness.

Mud mortar was commonly similar in composition to mud-bricks but with poor quantities of chopped straw temper.

The analytical studies of the mortars greatly developed in recent decades because of the need for information regarding the composition and characteristics of these mortars and other building materials used in the historical buildings especially after the advent of the more international charters for the conservation of historical materials and buildings like Venice Charter issued in 1964.

These information's are considered valuable and very specific guidelines for the design of repair materials and procedures, apart from being a source of general knowledge on the construction history. It also aid in a better understanding of the attribution of cultural and historical significance of the building materials that are very important for supporting statements of the development of conservation plans.

1.2 Experimental work:

In order to understand the mineral composition and physio-mechanical properties of mud mortars used in the construction of some historical buildings in Egypt and how these properties may have contributed to the present conditions of these buildings, various samples of mud mortars have been collected by well-trained experts and analyzed by different techniques such as:

XRD

PLM

SEM with EDX

The obtained results provide a basic record and information regarding the fabric of mud mortars and their inhomogeneous constituents, such as clay minerals, sand, gravels, crushed ceramic and chopped straw which was added to these constituents as a filler.

X-ray diffraction analyses:

Fine powdered samples of mud mortar collected from different archaeological buildings to be analysed with a diffractometer Bruker Axs D8 ADVANCE with the following conditions: generator settings 40kv and 40 ma. Fenditure divergence slit 1.0, RS 0.2mm, R=217mm.

This technique becomes very important for identifying the major, minor and trace components of mud mortar samples.

Mineralogical and Petrographic characterisation of the complex compositional structure of mud mortars is very effective analysis technique.