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Alternative lime based grouts used in re-pointing of deteriorated ancient mortars and their structural effects on composite unreinforced masonry walls of Mekaad Radwan, ottoman Cairo, Egypt (Case study)

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Abstract

Mortars and plasters of Mekaad Radwan are badly affected by decay hazards, therefore; they were studied by means of XRD and polarized microscope to detect their chemical composition, physical and petrographic properties, in addition to identify their characteristics. The analyses revealed gypsum mixed with lime as dominant component with some aggregates of sand particles, sodium chloride was detected in all the studied samples. Standardized alternative mortars were prepared, exposed to artificial aging and tested in order to select the most suitable type to replace the old mortars and plasters at Mekaad Radwan.

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Keywords: Mekaad Radwan; building materials; XRD; polarized microscope; alternative mortars; lime based grouts; re-pointing

1. Introduction

Mekaad Radwan is situated in the neighborhood of Bab Ziweila in the historical Cairo (fig. 1a, b). It was built in the 17th century (1650 AD). The Mekaad Radwan monumental building consists of three storeys: the ground floor, the opened floor (the Mekaad room), and the housing top floor (the roof). The building is made of timber and masonry load bearing walls. The floors and ceilings are supported by timber beams, whereas the window and door openings are strengthened by timber or stone lintels. The facades of the building are composed of non-plastered walls made of

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large well-edged parallelepiped and/or cubed limestone blocks with regular horizontal and rare vertical mortar joints. The internal mason load bearing walls are mostly thick and plastered by lime-gypsum mortars. The building is affected by severe deterioration phenomena and patterns of damage which occurred during the time. These deterioration and damages are mainly due to foundation problems, subsoil water and also to the earthquake that affected the whole of Greater Cairo in October 1992.

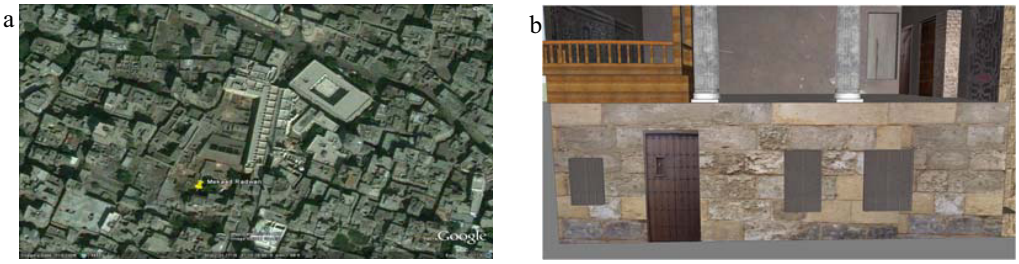

Fig. 1 (a) site of the case study; (b) front façade of the case study.

The plasters and mortars of the Mekaad walls were subjected to loss and cracking due to internal and external reasons. The internal reasons are concerning with petrographic characteristic of the building stone and bricks as well as the type and composition of the mortars and plasters used. The external reasons may be relate to the construction deficiency, exterior salt invasion or differential settlement and subsidence as well as the earthquake affects.

Physical and mechanical characterizations are important requirements for the development of compatible mortars. However, for ancient mortars they are sometimes impossible to evaluate due to the difficulty to do rigorous determinations with irregular, friable specimens, cutting standard-sized test samples or sampling from an ancient wall of high aesthetic value. The tests that are most often performed are compressive resistance, water absorption and porosity (Candeias, A.E., Nogueira, P., & Mirão, J., et al., 2004).

2. Materials and Methodology

Several samples were collected from ancient mortars and plasters as well as from recent plasters that were used during the last restoration upon either limestone blocks or the red bricks (table, 1). However, some physical characteristics are impossible to evaluate due to the difficulty to do rigorous determination with irregular, friable specimens cutting standard sized test sample that could be collected from very soft ancient mortar.

Table 1. The specific locations of the collected mortar and plaster samples.

Type	Symbol	Specific location
Mortar samples	MBM	Binding mortar between red bricks
	LSM	Binding mortar between limestone blocks
	ZLSP	Binding mortar between zigzag limestone blocks
	MME	Collating mortar of the mosaics
Plaster samples	MBP	Plaster upon the red brick
	LSP	Plaster upon the limestone blocks

Preliminary morphological observation of the raw surface and polished thin section of the samples were carried out using Zies optical light microscopy. Thin sections of the samples were examined using polarized transmitted light microscopy model Nikon opti photo x23 equipped with photo camera S23, under 10x and 20x magnification in plane-polarized light. X-ray diffraction (XRD) was performed on powdered samples of the core and glaze materials in addition to the mortar used to adhere the tiles into the walls, using a Philips (PW1840) diffractometer with Ni-filtered