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Geognostic investigation on damage and deterioration evolution of soil and architectural materials of Mekaad Radwan, ottoman Cairo, Egypt (case study)

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Abstract

This study determines which factors play roles of deterioration in Mekaad Radwan. The study also makes it possible to know the real response of the masonry structure to the deformation imposed at the base of the foundation condition. The used methodology included the identification of the seismicity situation and the possible damage effects of the Cairo (1992) earthquake through discussion of situation before and after earthquake as well as the controlling factors, in addition to the analysis and determination of the types, geometry of the types, deformation and other deterioration patterns, using the direct observation and primitive monitoring evaluation.

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Keywords: Mekaad Radwan; Geognostic Investigation; Deterioration Evolution; seismicity situation; Architectural Materials;

1. Introduction

The Mekaad Radwan monument is situated in the neighborhood of Bab Ziweila in the historical Cairo. It was built in the early XVI century (1650 AD). 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. It is well known

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that any restoration work must be determined on the basis of a reliable geodiagosis that is the identification of the causes of failure, cracks, salinization and other phenomena of damage. Therefore it is necessary to perform a complete series of investigations on the monument before defining the restoration interventions for the different building elements, to evaluate their safety level in the present situation. The main problem in the present case study is that it consists of a complex structure and has suffered damages and deterioration in its history as result of different accumulated reasons, whose origin must be discovered and understood. The present study emphasized on the identification of the seismicity situation of the Greater Cairo and the possible damage effects of the October (1992) earthquake through discussion of situation before and after earthquake as well as the controlling factor, in addition to the analysis and determination of the types, geometry of the types, deformation and other deterioration patterns, e.g. loss of mortars using the direct observation and primitive monitoring evaluation.

2. Materials and Methodology

The collected materials from different building elements were described, mechanically and geotechnically analyzed. The mechanical analysis of the foundation of soil mater and microscopic investigation were carried out in the Geology department, Cairo University, while their mineralogical characteristics were analyzed by the XRD technique in Housing and Building Material National Research Center – Cairo. X-ray diffraction (XRD) was performed on powdered samples using a Philips (PW1840) diffractometer with Ni-filtered Cu-Kα radiation. The samples were scanned over the 0-60° 2θ intervals, at a scanning speed of 1.2° min-1. A quantitative estimate of the abundance of the mineral phases was derived from the XRD data, using the intensity of certain reflections and external standard mixtures of minerals compared to the (JCPDS standards of 1967); the detection limits of the method were ±1 w/w %.

3. Characteristics of foundation soil (Texture and Mineralogy)

The ground floor of Makaad Radwan building consists of a large storage room taking the whole building area. The building is based on the thick basement load bearing walls and pillars constituting the foundation structure. The foundation appears to be very shallow and the foundation soil is exposed in some parts of the floor and the soil appears to be welled by sub-soil water. The ascending moisture from the ground water causes dangerous deterioration problems not only for the whole foundation structure but also is up to six meters above the ground surface.

The soil foundation of some Islamic monuments at old Cairo has been the subject of several investigations carried out before and after the October 1992 earthquake. As shown in some previously studied bore holes with depth ranging between 7 and 20 meters, the subsoil are mainly formed of surface fill layer (3-4 meter thick) composed of the Nile flood silts and clay matrix mixed with fine to medium sand with traces of limestone fragments. The alluvial soil which is very heterogeneous in thickness (ranging from 5 to 20 meters) is commonly underling by Eocene limestone bed rock (Maamoun, 1979, Adham and Khalaf, 1992, Masuch, 1992 and Melegy, 2005).

The foundation soil underneath the studied building was mechanically and clay mineralogically analyzed. The results of the mechanical analysis indicated that the soil texture is mainly fine sandy clayey silt with 15% fine and very fine sand, 71% silt and about 14% clay. In this respect it is very similar to the matrix of the reworked heterogeneous fill layer that covering the Nile alluvial deposits. Occasionally, some fine limestone and gypsum fragments are observed within the foundation sub-soil. The foundation soil is highly wetted by slightly saline water. The clay minerals identification depends upon the XRD analysis of the clay fraction which constitutes of representative soil sample and its expose to glycolation and heat treatment. The XRD result reveal that the foundation soil clay contain predominantly smectite with small proportion of kaolinite that associated with few quartz, calcite and gypsum. This result may be coinciding with clay mineral content of Nile Delta that was previously examined (Rozenberg et al., 2002, Said 1981 and 1990). According to the presence of little clay component (about 14% of this sample), the foundation soil is generally considered as slightly expandable sandy silt deposits on wetting from the subsoil water.