Ain Shams University
Faculty of Science
Geology Department

PETROGRAPHIC EVALUATION AND PHYSICO-MECHANICAL PROPOERTIES OF CONCRETE MADE WITH DIFFERENT KINDS OF NATURAL AGGREGATES

Thesis submitted to award Ph.D in Science (Geology)

By
Mohamed Ezzat Taha
M.Sc. in Geology (2011)

To

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ABSTRACT

Concrete is a rapidly continuously changing system, starting from its mixing to its placement. The strength, durability, and dimensional stability of concrete have been recognized as the three fundamental parameters for a good concrete. This research aims to shed highlight on the role of petrographic evaluation of aggregates and experimental concretes subjected to the influence of induced physical (heat) and chemical (alkali attack) deteriorations, with the aid of basic scientific methods in diagnosing concrete problems, in a trial to solve possible associated durability issues.

This research involves assessment of Wadi Abu-Saiyala dolomite, Widan El-Faras basalts, and Homra El-Girigab granite aggregates to test their suitability in concrete industry. Further, for this purpose casting three experimental concretes with arbitrary mix design 1: 2 : 4 (cement: fine aggregate: coarse aggregate, w/c 0.55), and further water curing and subjecting to the influence of elevated temperatures (300^{o}, 600^{o}, and 800^{o}C) with duration of two hours, and alkali attack (1.25% Na_2O equivalent of cement) on concrete prisms for a whole year were carried out. These water cured and influenced concretes are evaluated for their performance; visually, mineralogically, physically, chemically, mechanically, and petrographically using transmitted (thin sections) and reflected microscopes (fluorescent slabs), with detailed micro structural investigations conducted on polished concrete sections using SEM (BSE).

The assessment of different kinds of aggregates; physically, chemically and mechanically revealed that all the used aggregates are considered suitable for concrete purposes. The petrographical investigation performed according to ASTM C295 (2013), disclosed that the examined dolomite is distinguished in two lithofacies; dolosparstone and dolomicrosparstone, the examined basalts show occasional altered grains, and the examined red granites partially contain seritized potash feldspars.

The results of physico-mechanical investigations on water cured concretes; disclosed that they are categorized as normal weight concrete, and that the concretes casted with dolomite and granite aggregates is comparatively performed good, while the concrete casted with basalt aggregates is comparatively performed badly. The petrographic evaluation of concretes cured in water for 28 days and 12 months examined under transmitted and reflected light, indicated that the chemical interaction which is shown in dolomite aggregates, while the mechanical interactionis shown in basalts and granite aggregates is

largely responsible for the concrete performance. Further, the petrographical evaluations and SEM investigations revealed probable signs of deterioration, occurring in concrete casted with basalt aggregates, owning to swelling of clay minerals encountered in basaltic matrix.

The alkali attacked concretes, were evaluated petrographically and investigated using SEM, for possible occurrence of alkali aggregate reactions (AAR) confirming to ASTM C1293 (2008) and ASTM C856 (2013), revealed that some dolomite grains showed alkali carbonate reaction (ACR), resulting from dedolomitization occurring along peripheries of dolomite grains. Whereas some reactive basalts and granite grains showed expansive alkali silica reaction (ASR), resulting from partial dissolution of their mineral components, and deposition of the reaction products (alkali silica gel) in cracks and voids.

The heated concretes evaluated physically, mechanically, petrographically, and micro structurally, using SEM (BSE), revealed that the mineralogic composition, chemical transformations (dehydration of cement paste, decarboxylation of portlandite, dehydroxylation of clay minerals, and decarbonation of dolomite), textural properties (intercrystalline cracks and cleavage planes), thermal incompatibility, thermal conductivity, and thermal expansion occurring in cement paste and aggregates, are the key factors controlling the performance of concrete subjected to elevated temperatures.

In order to obtain a good performing and durable concrete, which can withstand physical and chemical deteriorations, appropriate aggregate should be used; avoiding alterations, mineral disorders, textural defects, and large thermal incompatibility, between the used aggregates and cement paste in concrete.

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