



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Structural Engineering

Using metakaolin and ground granulated blast furnace slag in production of geopolymer concrete

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Civil Engineering
(Structural Engineering)

by

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Bachelor of Science In Civil Engineering
(Structural Engineering)
Faculty of Engineering, El-Minia, 2016

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Statement

This thesis is submitted as partial fulfillment of Master of Science in Civil Engineering (Structural Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

Geopolymer concrete has shown a remarkable development as an alternative material to ordinary cement-based concrete. The GGBS and MK use an alumino-silicate powder as a total replacement for cement. The reaction between alumino-silicate and alkaline solution, to form a binding material has the same product resulting from the reaction of ordinary cement and water in concrete. The current thesis aims to produce the optimum mix of Geopolymer concrete under a different percentage of silicate (SiO_2), aluminum oxide (Al_2O_3), and calcium oxide (CaO) by using MK and GGBS. In the present study, seven different mixes were designed and prepared to study the influence of using MK and GGBS with a different percentage to produce geopolymer concrete. The metakaolin to GGBS ratios were 0%:100%, 20%:80%, 40%:60%, 50%:50%, 60%:40%, 80%:20%, and 100%:0% respectively, using the most efficient ratios of sodium oxide, solution modulus and water to binder ratio. Workability and mechanical properties have been tested for the tested mixtures using locally available aggregates. The specimens were cast and the compressive strength tests were carried out for 1, 3, 7, and 28 days while modulus of elasticity, split tensile test, bond strength and flexural strength were determined at 28 days. Also, two mixes were selected to study the effect of elevated temperature on the geopolymer concrete properties. The test specimens were subjected to ambient temperature and elevated temperatures; 300°C and 500°C for two hours before the testing procedure of GPC.

Results show that the specimens with a different percentage of the chemical composition of GGBS and MK (Al: Ca: Si, 1: 1.37: 1.84) respectively produced the highest 28-day compressive strength (52 MPa), that when using slag by 80% as a replacement of metakaolin into the mixture. Also, when the geopolymer concrete is exposed to elevated temperatures (300°C and 500°C) for two hours, the loss in the compressive strength of the geopolymer concrete specimen increases up to a range of 77% to 88%, the reasons for a higher strength loss in GP concrete are because most of the water in the geopolymer is expelled, and due to the reduction in bonding strength in Si-O-Al and Si-O-Si regions.

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