

Chapter 9

Comparison Between Ordinary Portland Cement and Geopolymer Concretes Against Sulphuric Acid Attack

ABSTRACT

This chapter covers a comparison between ordinary Portland cement (OPC) and geopolymer concretes against sulphuric acid attack. An intensive introduction to the topic is given. Lack of study about high strength of self-compacting geopolymer concrete (SCGC) against sulphuric acid attack is also one of the problems. In this research, slag and ceramics were used as replacement of OPC. The aim was to study the durability of SCGC against sulphuric acid attack which mainly incorporated ground granulated blast-furnace slag (GGBFS) and ceramics waste as a binder. Methodology of the experimental program, with emphasis on preparation of materials and mix design is described. Testing procedure of GSCC is given. Durability test for sulphuric acid resistance and cost analysis are briefly explained. In conclusion, the sulphuric acid solution had no effect on the strength of concrete and the weight after being immersed in sulphuric acid solution for 28 and 42 days.

INTRODUCTION

Naik and Kumar (2010) reported that higher demand for concrete from the construction field has almost peaked in every country of the world including Malaysia. Therefore, developing countries are searching for new solutions and have been focusing more and more to recycle and reuse waste products to generate sustainable construction materials.

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Ordinary Portland cement (OPC) production is considered a huge environmental problem because it requires large quantities of raw materials and fuel and contributes 8% of global CO₂ emissions (Scrivener and Olivier, 2012; Sanal, 2018). Furthermore, OPC is not a chemically stable material, as it deteriorates because of sulfate and sulfuric acid attacks as well due to elevated temperature exposure (Ariffin, 2013; Sanal et al., 2016). The use of pozzolans to replace part of OPC has become more attractive and important. Geopolymers (GP), the newly developed cement-free materials, are one alternative to overcome all the above-mentioned issues (Duxson, 2007).

Previous research study has shown that OPC concrete has a very low durability against sulphuric acid attack compared to geopolymer concrete (Shankar, 2012). Durability refers to the ability of concrete to resist deterioration from the environment or service to which it is exposed. Suitably proportioned concrete that is properly placed, finished, and cured can endure without significant distress throughout its service life (Taylor, 2013). This is because the penetration of sulfate ions in solution causes change in the chemical composition and microstructure of the concrete. These changes may vary in type or severity, but commonly include extensive cracking, expansion and loss of bond between the cement paste and the aggregates. Alteration of paste composition results in monosulfate phase which converts into ettringite and at later stages forms gypsum. The required additional calcium is provided by calcium hydroxide and calcium silicate hydrate present in the cement paste. The effect of these changes leads to an overall loss of concrete strength (Ferraris, 2006).

In addition, geopolymer binders have been reported as being acid resistant and thus are promising alternatives for sewer pipe manufacture compared to OPC concrete (Song, 2005). A lack of needed literature study about high strength self-compacting geopolymer concrete against sulphuric acid attack is also one of the problems.

In this research, slag and ceramics were used as replacement to OPC. Slag contained high calcium, which is suitable for aggressive environment (Islam, 2010), while the ceramic containing high silica can make the concrete more durable with more binder gel (Paratibha, 2015). There is also pressure to provide a better quality concrete to the construction sector which preserves natural resources and air quality. It is expected that this self-compacting geopolymer concrete (SCGC) can solve all the issues described in OPC (Srinivas, 2015).

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