CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Concrete is one of the most commonly used materials in constructions. Concrete is a type of composite material for construction which generally composed of cement, course aggregates fine aggregates and water. Ordinary Portland Cement (OPC) is widely used as a binder for concrete mixing (Sarker et al., 2014). The emission of greenhouse gases such as carbon dioxide, CO$_2$ into atmosphere from the manufacturing of cement is contributed to the greenhouse effect issues (Ganesan et al., 2014).

Therefore, an alternative binder is emerged in order to take care on the greenhouse gases emissions’ issues. (Sarker et al., 2014). Research on geopolymer was initiated by Glukhovsky back in 1957. The development of a new binder material using inorganic materials is introduced by Joseph Davidovits in 1972 (Andri Kusbianter, 2012). There are several type of inorganic materials that can be used, for instance fly ash and steel fibre.

Although geopolymer concrete can be produced from a side variety of inorganic waste material, fly ash is considered one of the most effective geopolymer binders for concrete manufacturing. Fly ash based geopolymer concrete is a newly developed construction material which is more environmental friendly.

Fly ash is a coal combustion product which is the most prominent source material in geopolymer. The uses of fly ash are increasing throughout the years due to its amorphous alumina silica content and its availability is abundant around the world.
(Andri Kusbiantoro, 2012). The study shown that the total amount of fly ash produced in the world is relatively distinct from the OPC production. The production amount for fly ash is 480 million tons and for OPC is 3.3 billion tons respectively (Oss HGV. Cement United States Geological Survey: Mineral Commodity Summaries 2011). Fly ash based geopolymer utilizes the alkaline solution to activate alumina and silica precursors from the source material and form the binding material which is aluminousilicate-based.

Presence of self-healing agent contributes to the enhancement on the strength characteristic of the geopolymer concrete after high temperature exposure. There are several type of self-healing agent which can be used in geopolymer, such as: Poly Methyl Acrylate, silica gel, tung oil, silicone and bacterial solution (Tittelboom et al., 2013). Silica gel will be used for this research as a self-healing agent. It is a kind of combustion based self-healing agent.

1.2 PROBLEM STATEMENT

Research on fly ash based geopolymer is gradually increased throughout the years. There is a trend that geopolymer concrete will be replacing conventional concrete as it is more environmental friendly and more cost effective. The dependable characteristic of geopolymer shows that it has a relatively high strength compared to the ordinary concrete.

However, crack occurs most of the time in concrete after a certain period. It occurs more significantly especially after an exposure of high temperature (Kong et al., 2009). It occurs in geopolymer concrete as well. Strength characteristic of a geopolymer concrete is reduced after high temperature exposure because the propagation of cracks increased. The lifespan of a geopolymer structure is shortened and the weakened structure is not able to provide its designed service duration. At worst, it will lead to a structural failure with undesired casualties or deaths. Hence, in order to cater the problems, a proposal of combustion based self-healing agent, silica gel is used.
Structures like tunnel or concealed structures have the tendency that will expose to high temperature as the heat is trapped. It is not very convenient and the maintainer is exposed to high risks when maintenance is needed in such area with high temperature. Geopolymer structures with self-healing attribute will heal the cracks whenever exposed to high temperature for a certain period. It will be an alternative for the construction of concealed areas where the maintenance is not able to access at ease.

Geopolymer does not have autogenous healing. Hence, when it exposed to extremely high temperature, non-evaporable water will leave the geopolymer. It will trigger shrinkage where it leads to cracking. As the time goes on, it will lead to failure. If this problem occur in the structure, it will cause damages and become a disaster to the environment. This research proposed is to study the inclusion of silica gel as self-healing agent as it is expected to heal the cracks in geopolymer when exposed to extremely high temperature.

1.3 OBJECTIVE OF RESEARCH

The main objective of this research is to determine the suitability of silica gel as self-healing agent in geopolymer after exposed to extremely high temperature. This research is conducted along with the following sub-objectives:

- To obtain the compressive strength and porosity of geopolymer containing silica gel after extremely high temperature exposure.
- To identify the effective extremely high temperature for silica gel as self-healing agent in geopolymer.

1.4 SCOPE OF RESEARCH

In order to achieve all the research objectives, a series of scope of works are considered and taken into account. This research is limited to the following considerations. Fly ash used is originated from coal-fire power station, Manjung,