CHAPTER I
INTRODUCTION

1.1. Background

Concrete is one of the useful materials in construction industry which composed mixture of cement, coarse and fine aggregate, water, and additives (admixture) if necessary. It is very durable material and requiring little or no maintenance. Generally, the concrete that is widely used in the construction process is conventional concrete. In addition to the manufacturing process is relatively easy because it requires little or no maintenance, conventional concrete is also considered more economical and durable. However, in the process of conventional concrete casting often experience constraints due to the distance between reinforcement that are too tight. As a result, there is a separation between fine aggregate, cement, and water with coarse aggregates (segregation). Therefore, the improvement of concrete is needed.

One of the most outstanding advances in the concrete technology in the last decade is "Self-Compacting Concrete" (SCC). The self-compacting concrete is a comparatively new type of concrete that differs from the conventional vibrated concrete in that it contains a superplasticizer and a stabilizer, which contribute significantly to increasing the ease and rate of its flow. A self-compacting concrete can fill any part of formwork only under its own weight, without the need for compaction or external vibration. The concept of Self-Compacting Concrete (SCC) was proposed by Okamura from Japan in 1986 and spread to Europe through Holland and Sweden in the 1990s. It is a good alternative to conventional concretes in structural elements of complex and difficult shapes, e.g. very thin or curved members, in which the conventional concrete maybe difficult to compact, especially in the presence of congested reinforcement. Moreover, SCC offers many health and safety benefits. The elimination of vibratory compaction on site means that the workers are no longer exposed to vibration and providing a quieter working environment.

Despite its many advantages, such as good filling ability, passing ability and segregation resistance, normal SCCs are still prone to low durability and low tensile capacity in a similar manner to conventional vibrated concrete. Over the past few decades many researchers have explored ways of overcoming the drawbacks of conventional vibrated concretes. Most of the work done in this field is related to changing the constituents of the vibrated concrete to improve the interfacial bond between the mortar matrix and aggregates. The concretes so produced are the so-called Ultra High-Performance Concrete (UHPC)

UHPC is a kind of high-tech composite material which shows superb characteristics compared to other kind of concrete such as self-compactness, compressive strength higher than 100 MPa and exceptional durability performances. This new composite material consists of an optimized gradation of granular ingredients and water/binder ratio less than 20% in weight. This material offers variety of sustainable applications with respect to long-term cost and environmental aspects as an eco-efficient material. It enables the designers to have slim sections with higher strength, ductility and durability for applications such as bridge decks, shell structures and elements in high-rise structures even in aggressive environments.

An alternative in the advancement of concrete technology is to combine the important characteristics of the conventional vibrated UHPC and the SCC to produce Self-Compacting Ultra High-Performance Concretes (SCUHPC). The major disadvantage of UHPC, namely its low flow-ability and filling ability, is overcome by using a viscosity modifying admixture (VMA) or superplasticizer, while cement replacement materials (CRM) is used to overcome the drawbacks of the SCC, i.e. its low strength and durability.

The common CRM that usually use is silica fume. Silica fume is an ultrafine powder whose particle sizes are 50 to 100 times finer than cement and can fill up the voids created by the free water in the cement matrix. Chemically, it reacts with Calcium Hydroxide (CH) to produce additional Calcium Silicate Hydrate (CSH). The reaction between hydrated Portland cement compounds and Silica fume produces a very dense microstructure and thus improves the bond between the cement and the aggregates. The influence of silica fume content on the performance of SCUHPC is studied by Park *et al*. (2008), Duval and Kadri (1998) and Mazloom *et al*. (2004). They conclude that the workability and compressive strength of SCUHPC is dependent on silica fume content since the additional amount of silica fume decreases the water demand which, in turn, needs more superplasticizer to make the concrete mix workable. However, it is not entirely clear which amount of silica fume is optimal; although the literature is rich in reporting on silica fume.

The purpose of this research is to extend knowledge on the workability and compressive strength of Self-Compacting Ultra-High-Performance Concrete affected by different amounts of silica fume. For investigation, slump flow test, L-box test, and compressive strength test will be conducted.

1.2. Problem Statement

According to the background, the problem statements that will be discussed in this experiment are:

1. How does the effect of silica fume as cement replacement material with proportion of 0%, 5%, 10%, 15%, and 20% of cement in workability (passing ability and filling ability) of self-compacting concrete?
2. How does the effect of silica fume as cement replacement material with proportion of 0%, 5%, 10%, 15%, and 20% of cement in the compressive strength of self-compacting concrete at the age 7, 14, 21and 28 days?
3. Which amount of silica fume is optimum in the improvement of workability and compressive strength of Self-Compacting Ultra High Performance Concrete?

1.3. Problem Limitation

In order to focus on specific problem, author set several limitations such as:

1. Self-Compacting Ultra High Performance Concrete with silica fume as cement replacement material with proportion of 0%, 5%, 10%, 15%, and 20% of total cementitious material.

2. Self-Compacting Ultra High Performance Concrete with the addition of Superplasticizer with proportion that limited for 2% - 2.2% of total cementitious material.
3. Self-Compacting Ultra High Performance Concrete with 0.35 – 0.39 water/cement ratio.
4. Self-Compacting Ultra High Performance Concrete with coarse aggregate from Merapi Mountain with particle size <1.680 mm (pass no 12 sieve).
5. Self-Compacting Ultra High Performance Concrete with fine aggregate which is quartz sand from Bangka Belitung with particle size 0.3 mm – 0.8 mm.
6. Self-Compacting Ultra High Performance Concrete with quartz powder from Bangka Belitung with particle size 0.0074 mm
7. The test, which is going to do are: slump flow test and L-box test to check the workability of Self-Compacting Ultra High Performance Concrete in its fresh properties. For the hardened properties, the test that conducted is compressive strength test.

1.4. Objectives

The objectives of this final project are to design Self-Compacting Ultra High Performance Concrete mixture contain with silica fume, to know the effect silica fume on workability and compressive strength of Self-Compacting Ultra High Performance Concrete, and the optimum amount of silica fume that can improve the workability and compressive strength of Self-Compacting Ultra High Performance Concrete.

1.5. Final Project Originality

There are some topics about the effect of silica fume on the Self-Compacting Ultra High Performance Concrete. But, the topic about the optimum amount of silica fume that can improve the workability and compressive strength of Self-Compacting Ultra High Performance Concrete has never been used on any final project before.