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THE INVESTIGATION INTO QUANTIFYING OPTIMUM VISCOSITY OF SCC MIX DESIGN

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No portion of the work referred to the dissertation has been submitted in support of an application for another degree or qualification of this or any university of higher learning.

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(WILMI ANAK NYOKIEW)

Dedicate To

My Beloved Parent, Brothers, Sister, and Fiancee

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ABSTRACT

Self-compacting concrete (SCC) is known for its excellent deformability, high resistance to segregation and use without applying vibration in congested reinforced concrete structures. In cases of optimum flowability and viscosity, a high viscous paste is required to avoid the blockage of coarse aggregate when concrete flows through obstacle. Paste with high viscosity also prevents localized increases in the internal stress due to the approach of coarse aggregate particles. The method for achieving self-compatibility involved resistance to segregation between aggregate and mortar when the concrete flows. Twelve mixtures with water–cement ratio between 0.35 to 0.50 and water content 400 kg/m^3 to 600 kg/m^3 were designed in order to determine the optimum viscosity of SCC. The methods used in this study are T-500, slump flow and V-funnel flow test. The optimum viscosity of SCC in this study achieved when proportions of water-cement ratio is 0.40 to 0.45 and cement content 400 kg/m^3 to 500 kg/m^3.

Keywords: high fluidity concrete, self-compacting concrete, V-funnel time, flow time, viscosity

ABSTRAK

Self-compacting concrete (SCC) dikenali dengan sifat rintangan perubahan bentuk, daya kelikatan yang tinggi dan tanpa bantuan mesin gegar untuk membolehkan SCC memenuhi ruang di antara tetulang besi. Dalam aspek kebolehan-aliaran dan kelikatan yang optimum, simen yang cukup likat mampu mengelak sekatan batuan ketika pengaliran melalui celahan tetulang besi. Simen yang mempunyai sifat likat yang tinggi juga mengelak daripada tekanan dalaman akibat daripada batuan yang saling berlanggar antara satu dengan yang lain. Kaedah untuk memperoleh sifat kebolehpadatan melibatkan rintangan dalam pengasingan antara batu dan pasir dengan mortar ketika pengaliran konkrit. Sifat kebolehpadatan konkrit dapat dicapai dengan menghadkan kandungan batu dan pasir, nisbah air kepada simen yang rendah dan penggunaan *superplasticizer.* Dua belas sampel konkrit dengan nisbah air kepada simen antara 0.35 dan 0.50 dan kandungan simen antara 400 kg/m^3 dan 600 kg/m^3 telah direka untuk menentukan kelikatan SCC yang optimum. Kaedah-kaedah yang digunakan dalam kaji selidik ini ialah T-500, pengaliran kejatuhan dan pengaliran corong-V. SCC yang dicapai dalam kajian ini diperoleh apabila nisbah air kepada simen di antara 0.40 dan 0.45 dan kandungan simen di antara 400 kg/m^3 dan 500 kg/m^3.

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NOMENCLATURE

A	-	Aggregate
C	-	Cement (OPC)
D	-	Diamater
G	-	Coarse aggregate
G_{max}	-	Maximum size of aggregate
HRWR	-	High range water reducer
M	-	Mortar
MSA	-	Maximum size of coarse aggregate
R_c	-	Relative funnel speed
S	-	Fine aggregate(sand)
SCC	-	Self-compacting concrete
SP	-	Superplasticizer
SSD	-	Self-saturated dry
T500	-	Time taken in second to reach slump flow 500 mm
V_a	-	Volume of aggregate
V_c	-	Volume of cement
VEA	-	Viscosity enhancement admixture
V_m	-	Volume of mortar
V_s	-	Volume of sand
W	-	Water
w/c	-	Water-cement ratio

CHAPTER 1

INTRODUCTION

1.0 Introduction

Self-compacting or self-consolidating concrete (SCC) can be regarded as a high-performance concrete that exhibits a low resistance to flows under its own weight over a long distance without the need of using vibrators, and a moderate viscosity to maintain a homogeneous deformation through restricted sections while keeping the coarse aggregate homogenous in the mix. SCC is used to improve the productivity of casting congested sections and ensure the proper filling of restricted area with minimum or no consolidation.

Workability may describe as that property of the plastic concrete mixes which defines ease with which it can be placed and degree to which it resist segregation. There are five factors that may affect the workability of the SCC, which are consistency, amount of cement, properties of sand and coarse aggregate, and time and temperature. Workability requirements necessary to ensure self-compaction and the principles involved in proportioning such highly flowable concrete are discussed in Chapter Four. Field oriented test useful in evaluating the deformability and stability of SCC are presented. The performance of concrete mixes proportioned according to two main approaches needed to ensure high deformability, low risk of blockage during flow and proper stability are compared.

In this study, the condition of high fluidity fresh mix concrete is characterized by three criteria: slump flow, T-500 and V-funnel time (V-time). Twelve SCC proportions were prepared with varying w/c and cement constituent in order to achieve the target of optimum viscosity of fresh SCC properties. The suggested mixes with 1.5% of Type F SP satisfies the requirement of fresh properties of SCC will require 35 %, 40 %, 45 % and 50 % of water cement and cement constituent of 400 kg/m^3, 500 kg/m^3 and 600 kg/ m^3. mixes with both approaches were evaluated. The performance of each concrete was compared to that of a flowable concrete with 600 to 700 mm slump corresponding to 5 and 10 seconds of T-500 and V-funnel flow tests respectively.

1.2 History of Self-Compacting Concrete

SCC also called self-consolidating concrete and abbreviated as SCC is defined as concrete with ability that can be placed in all corners of the formwork causing no segregation without need for consolidating. SCC was pioneered in Japan approximately 20 years ago. Since then, the researches have been rapidly spreading into other areas of Asia, Europe, the South-Pacific region, and North America. SCC has been used in a number of precast component as well as cast-in place structures in many countries around the world.

The development of SCC is considered as a milestone achievement in concrete technology due to the following advantages; high performance in its fresh and hardened state (super flowability, high segregation resistance, excellent applicability for components and structures even with complicated shape and dense reinforcement, good interface zone, low permeability, and high strength and durability); economic efficiency (increased casting speed and reduced labor, energy, and cost of equipment); improved working and living environment (high consumption of industrial by-products and reduced noise and heath hazards); and enhancement towards automation of construction process.

Due to the possibility of producing a flowable yet viscous mix, a high performance self-compacting concrete was founded in Japan in the late 1980s. Since then, investigations on SCC have been carried out and self compacting concrete has been used in practical structures mainly by large scale construction companies. Investigations for establishing rational mix-design method and self compatibility testing methods have also been carried out from the view point of making SCC standard one. The methods used in this study are T-500, slump flow and V-funnel flow test.

1.3 Objective of Study

The objectives of this study are outlined as below:

i. To show and investigate the different proportion of different quantity of cementatious and water –cement ratio (w/c).

ii. To examine the best mix proportion of SCC based on the workability test.

iii. To find out the difference in workability of SCC with Ordinary Portland Cement (OPC) concrete.