EFFECT OF SILICA FUME TO THE STRENGTH AND PERMEABILITY OF HIGH PERFORMANCE GROUND GRANULATED BLASTFURNACE SLAG CONCRETE

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

JUDUL: EFFECT OF SILICA FUME TO THE STRENGTH AND PERMEABILITY OF HIGH PERFORMANCE GROUND GRANULATED BLASTFURNACE SLAG CONCRETE

SESI PENGAJIAN: 2005/2006

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EFFECT OF SILICA FUME TO THE STRENGTH AND PERMEABILITY OF HIGH PERFORMANCE GROUND GRANULATED BLASTFURNACE SLAG CONCRETE

AZLI SHAH BIN ALI BASHAH

A project report submitted in partial fulfillment of the requirements for the award of the degree of Master of Engineering (Civil – Structure)

Faculty of Civil Engineering
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MAY 2006

I declare that this entitled **"Effect Of Silica Fume To The Strength And Permeability Of High Performance Ground Granulated Blastfurnace Slag Concrete"** is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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TO MY BELOVED PARENT,

HAJI ALI BASHAH BIN YUSOFF

AND

HAJJAH NAEMAH ZAITUN BTE ABDUL HAMID

ACKNOWLEDGEMENT

In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Associate Professor Dr. A. Aziz Saim, for encouragement, guidance, and friendship. I am also very thankful to Ir. Rahmat Bin Abdul Rahman from *Persatuan Jurutera Islam Malaysia* and Ir. Y.C. Lee from Buildcon Concrete Sdn Bhd for their guidance, advices and motivation. Without their continued support and interest, this thesis would not have been the same as presented here.

I am also indebted to University Teknologi Malaysia (UTM) for the laboratory works of my Master study. Librarians at UTM also deserve special thanks for their assistance in supplying the relevant literatures.

My sincere appreciation also extends to my friends Ir. Che Husni Ahmad (Consultant), Ir. Musfa Mohamed, Ir.. Abdul Kadir Ahyat(Consultant), En. Fairuz Hussin, En. Sharul Othman who have provided assistance at various occasions.

Lastly, I also reserve special thanks to my beloved wife and my sons Sidi Muhammad Yusoff, Sidi Zainul Abideen and Sidi Iqbal Shah for their commitment, encouragement and patient while preparing this thesis and the continued support.

ABSTRACT

A durable concrete is one that has the ability to withstand the damaging effects of the environment and of its service conditions without undue deterioration and excessive unforeseen maintenance over the design life of a structure. The used of high performance concrete is an alternative in producing high – strength concrete, durable and construction friendly. This paper study the effect of silica fume to the properties of high performance ground granulated blastfurnace slag concrete to reveal the potential outmost. It was found by compressive strength test, that high-strength concrete can be achieved. At the age of 28 days, concretes containing 5, 7.5, and 10% silica fume gave compressive strengths of 65.6, 64.6, and 67.1 Mpa, respectively. At aged 56 days concrete containing 10% of silica fume had the highest strength. However the concrete containing 5% of silica fume had low permeability thus may enhance the durability.

ABSTRAK.

Konkrit yang tahan lasak adalah kebolehan konkrit tersebut daripada mengalami kerosakan akibat dari kesan alam sekitar dan kemerosotan semasa perkhidmatan serta penyelenggaran yang kurang sepanjang hayat rekabentuk sesuatu struktur. Penggunaan konkrit berprestasi tinggi digunakan sebagai bahan alternatif untuk menghasilkan konkrit yang tahan lasak, berkekuatan tinggi dan memudahkan kerja pembinaan. Sehubungan itu kajian kesan bahan tambah silika peluwap terhadap sifat konkrit sangga relaubagas berbutir untuk mendedahkan potensi yang wujud. Dalam kajian ini melalui ujian mampatan, konkrit berkekuatan tinggi boleh dicapai. Pada konkrit berusia 28 hari yang mengandungi 5, 7.5 dan 10 % silika peluwap mencapai kekuatan mampatan 65.6, 64.6 dan 67.1 Mpa. Manakala konkrit pada usia 56 hari yang mengandungi 10% silika peluwap mencapai kekuatan yang paling tinggi. Walaubagaimanapun konkrit yang mengandungi 5% silika peluwap mempunyai ketelapan yang rendah dan secara tidak lansung ianya menambah nilai ketahanlasakan.

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LIST OF SYMBOLS

BS	-	British Standard
HPC	-	High Performance Concrete
ACI	-	American Concrete Institute
w/c	-	water/cement
Mpa	-	Mega pascal
ISAT	-	Initial Surface Absorption Test
C-S-H	-	Calcium Silicate Hydrates
AASHTO	-	American Association of State Highway and Transportation Officials
MS	-	Malaysian Standard
OPC	-	Ordinary Portland Cement
C_3A	-	Tricalcium Aluminate
Psi	-	Pound/square inch
GGBS	-	Ground Blastfurnace Slag Cements
SF	-	Silica Fume
ASTM	-	American Society for Testing And Materials
S.O.	-	Superintendent Officer
UTM	-	University Technology Malaysia
JKR	-	Jabatan Kerja Raya
mm	-	millimeter
N/mm^2	-	newton per millimetres square
ml/m2/s	-	milliliters per square metre per second
SiO_2	-	Silicon Dioxide
Ca(OH)	-	Calcium Hydroxide
FM	-	Figgs Method
m^2/kg	-	metre square per kilogram
>	-	More than
<	-	Less than

CHAPTER 1

INTRODUCTION

1.1 Foreword

Most conventional concrete structures deteriorate rapidly and require costly repairs before their expected service life is reached. Four major types of environmental distress affect concrete structures. They are corrosion of the reinforcement, alkali-aggregate reactivity, freeze-thaw deterioration, and attack by sulfates (Ozyildirim, 1998). In each case, water or chemical solutions may penetrate the concrete and initiate or accelerate damages. By using high-performance concrete (HPC), durability and are enhanced strength, resulting in long-lasting and economical structure (Lerning and Ahmed, 1993).

American Concrete Institute(ACI) defined high performance concrete as: “High performance concrete (HPC) defined as concrete which meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing and curing practices”

The high performance concrete mixes designed for low permeability resist this infiltration of aggressive liquids and, therefore, are more durable. One important issue need to be addressed in the use of high performance concrete are the development of the mixes.

Low-permeability concretes are made with a low (0.45 and less) water-cementations material ratio (w/cm). Pozzolanic material such as fly ash, silica fume, or slag be used as cementation materials. These modifications to the mixes results in higher compressive strengths than conventional concretes, above 41 Mpa (6,000 psi). The initial economic benefit arises from the ability to use fewer borepiles, colums, beams resulting in lower costs in materials, labour, transportation, and construction. The structural benefits include increased rigitidy because of the increased elastic modulus and increased concrete strength that raise the allowable design stresses (Lane, S.N, and Podolny, W. 1993). This project paper emphasis will be directed mainly to the applications of ground granulated blastfurnace slag and silica fume.

1.2 Objectives

i) To develop the concrete mix and study the effect of silica fume between the matrix which consist of ground granulated blastfurnace slag with gradually added percentage f silica fume with minimum cube strength of 60 Mpa.

ii) To develop concrete early age strength of more than 1 Mpa within 24 hour.

ii) To test concrete mix for compressive strength and preliminary study on permeability by Initial Surface Absorption Test (ISAT).

1.3 Scope of study

This study focuses on investigating the properties of the proposal concrete mix of high performance concrete. Among the properties investigated for such designed mixes are compressive strength, and permeability for durability while maintaining the high workability.