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by

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THE DEVELOPMENT OF 'ECO-FRIENDLY' CONCRETE USING SILICA FUME WITH HIGH ECONOMIC VALUES

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FOONG KAH YEN

A Thesis

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DECLARATION OF THESIS

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DEDICATIONS

This Thesis is Dedicated

To

My Beloved Family, My Supervisor and Dear Friends

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ABSTRACT

The world's yearly cement production of 2 billion tons emits about 7% of carbon dioxide (CO_2) into the atmosphere. Producing a ton of Ordinary Portland Cement (OPC) produces a ton of CO_2. In concrete production, OPC should not only be considered as the main high strength contributor. Aggregate gradings and types of admixtures should be taken into serious consideration. Major concrete issues such as pre-structural deterioration, durability in marine environment and natural resources depletion should be concerned. Silica Fume (SF), the by-products of metal industries attracts the attention of many parties. SF abundance availability has become an environmental issue but being a potential high strength contributor has attracted many parties into applying its application into the concrete technology and construction industry. This research is to produce concrete that is high performance and high strength from 50MPa-80MPa having the 'Eco-Green' characteristics. The research was conducted using the Trial Laboratory Test method. X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) analyses were conducted to analyze the chemical compositions of OPC and SF. SF is then added 5% and 10% into 2 types of aggregate mixes namely 'Designed' and 'As-supplied' with fixed 0.5w/c. Excel worksheets were produced to determine the cement efficiency and cost effectiveness. It is concluded that by adding SF, the strength of concrete has increase by 15%-20%. With comparisons from other research, cement consumption is reduced by 15%-20%. CO_2 emissions were reduced by 15%-20%, energy efficient during production and have enhanced durability. This can be justified from Excel worksheets produced. OPC content is not the main contributor to the high strength of concrete. This is part of an effort to produce the ideal building material that delivers many positive traits.

Keywords: Carbon Dioxide (CO_2); 'eco-green'; Ordinary Portland cement (OPC); Silica Fume (SF); Trial Laboratory Test; X-Ray Diffraction (XRD)

ABSTRAK

Produksi tahunan simen sebanyak 2 billion ton dibuktikan membebaskan 7% gas karbon dioksida ke atmosfera. Satu ton simen yang dihasilkan akan membebaskan satu ton gas karbon dioksida. Dalam produksi konkrit, simen tidak harus dijadikan tumpuan utama untuk mencapai kekuatan tinggi. Keseimbangan kandungan aggregate dan jenis bahan kimia harus dititikberatkan. Isu-isu utama konkrit misalnya kerosakan pra-struktur, daya tahanan dalam kawasan pesisir dan kemerosotan sumber alam juga harus diutamakan. Silica Fume (SF) hasil sampingan industry pengilangan aloi telah menarik perhatian pelbagai pihak. Hasilnya yang banyak telah menjadi tumpuan isu persekitaran tetapi jika dipandang dari ciri-cirinya untuk menghasilkan konkrit berkekuatan tinggi telah menarik minat pelbagai pihak untuk diaplikasikan dalam teknologi konkrit dan pembinaan. Objektif utama penyelidikan ini adalah untuk menghasilkan konkrit yang berprestasi dan berkekuatan tinggi dalam lingkungan kuatan 50MPa-80MPa dengan ciri-ciri 'Eco-Green'. Kaedah ujian 'Trial Laboratory' telah digunakan. Ujian belauan sinar-x dan analisis pendarkilau sinar-x dijalankan untuk menganalisa komposisi kimia simen dan SF yang telah ditambahkan 5% dan 10% dalam dua jenis campuran konkrit iaitu 'Designed' dan 'As-supplied' dengan nisbah air simen tetap 0.5. Program computer asas telah dihasilkan dan digunakan untuk menentukan jumlah kepenggunaan simen dan kos. Kesimpulannya, dengan penambahan SF, kekuatan konkrit telah meningkat sebanyak 15%-20%. Dengan perbandingan penyelidikan, kandungan guna simen telah dikurangkan sebanyak 15%-20% selaras dengan kadar pembebasan gas karbon dioksida. Konkrit yang dihasilkan adalah berpatutan dan menjimtkan tenaga semasa produksi dengan adanya daya tahan yang baik dalam keadaan pedalaman dan persisir. Oleh itu kandungan simen dalam konkrit bukan fokus utama kekuatan tinggi dalam konkrit berkualiti tinggi. Penyelidikan ini adalah sebahagian usaha untuk menghasilkan bahan binaan yang ideal dan berpotensi.

Kata kunci: karbon dioksida; daya tahanan; 'eko-hijau'; beton prestasi tinggi; simen; Silica Fume (SF)

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LIST OF ABBREVIATIONS

OPC	Ordinary Portland cement
HPC	High Performance Concrete
HCP	Hydrated Cement Paste
SF	Silica Fume
w/c	Water to cement ratio
w/b	Water to binder ratio
CA	Coarse Aggregates
CO_2	Carbon Dioxide
FA	Fine Aggregates
SP	Superplasticizer
XRF	X-Ray Florescence
XRD	X-Ray Diffraction
SEM	Scanning Electron Microscopy
FESEM	Field Emission Scanning Electron Microscopy
etc	Et cetera
i.e.	In example
PCC	Portland Cement Concrete
SFC	Silica Fume Concrete
UD	'Undesigned'/ 'As-supplied' Mixes
CRM	Cement Replacing Material