PROPERTIES OF CONCRETE CONTAINING EGGSHELL POWDER AS PARTIAL CEMENT REPLACEMENT

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We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science in Civil Engineering.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Peningkatan kesan rumah hijau dan karbon dioksida oleh industri simen dan pembuangan sisa pepejal telah memberikan impak negatif kepada alam sekitar. Selain itu, pengambilan telur di Malaysia adalah sangat tinggi iaitu 300 biji setiap orang setiap tahun. Pembuangan kulit telur telah menghasilkan bau yang busuk dan boleh menarik cacing dan tikus kerana protein sangat tinggi dapat dijumpai di kulit telur. Pengunaan kulit telur sebagai bahan pengganti separa simen dalam penghasilan konkrit dapat mengurangkan kepergantungan kepada simen di samping mengurangkan pembuangan sisa pepejal. Kajian ini dijalankan untuk menyiasat ciri-ciri kulit telur, sifat mekanik dan prestasi ketahanan konkrit telur. Dua keadaan pengeringan telur yang berbeza digunakan sebagai pengganti simen separa yang kering dan kering oven. Ciri-ciri kulit telur diperiksa oleh X-Ray difraksi (XRD), X-Ray fluorescence (XRF), pengimbasan mikrokopel elektron (SEM) dan fourier transform spectroscopy inframerah (FTIR). Pada peringkat awal penyelidikan, campuran percubaan telah dijalankan untuk mengenal pasti nisbah air semen optimum. Spesimen konkrit dibancuh kepada (100 x 100 x 100) mm kiub, (100 x 100 x 500) mm rasuk dan (100 x 300 mm) mm. Kesan kaedah pengawetan iaitu pengawetan air dan pengawetan udara. Kekuatan mampatan, kekuatan lenturan dan kekuatan tegangan pemecahan spesimen konkrit telah diperiksa. Eksperimen tentang prestasi ketahanan spesimen konkrit adalah penyerapan air, serangan asid dan rintangan sulfat. Penemuan menunjukkan bahawa air menyembuhkan dengan 15% konkrit telur telur kering-oven mempunyai kekuatan mampatan tertinggi, kekuatan lenturan dan kekuatan tegangan yang berpecah. Pengawetan air menggalakkan proses penghidratan yang lebih baik yang memperbaiki struktur dalaman dan mempamerkan kadar penyerapan air yang lebih rendah. Oleh itu, penjagaan perlu diambil apabila persekitaran asid dan alkali sebagai kalsium adalah komponen utama untuk bertindak balas dengan larutan asid dan alkali. Akhirnya, kajian menunjukkan konkrit yang mengandungi kulit telur mempunyai potensi untuk digunakan sebagai aplikasi struktur.

ABSTRACT

The increasing of the greenhouse effect and carbon dioxide by the cement manufacturing industry as well as solid waste disposal have caused negative impact to the environment. Besides, the consumption of eggs in Malaysia is very high which is 300 eggs per person annually. Thus, the dumping of the eggshell at the site generates stinky smell and attracts worms and rat due to its high protein membrane of the eggs. Utilization of the eggshell as partial cement replacement in producing concrete would reduce the cement consumption and amount of waste disposed. Thus, this research was conducted to investigate the characteristics of eggshell, mechanical properties and durability performance of eggshell concrete. Two different drying conditions of eggshells were used as partial cement replacements which are air-dried and oven-dried. The characteristic of the eggshell was examined by X-Ray diffraction (XRD), X-Ray fluorescence (XRF), scanning electron microcopy (SEM) and fourier transform infrared spectroscopy (FTIR). At the early stage of the research, trial mix was conducted to identify the optimum water-cement ratio. A control specimen and eggshell concrete was cast into (100 x 100 x 100) mm cube, (100 x 100 x 500) mm beam and (dia. 100 x 300) mm. The effect of the curing method namely water curing and air curing. The compressive strength, flexural strength and splitting tensile strength of the concrete specimens have been examined. Experiments on the durability performance of the concrete specimens is water absorption. Besides, the eggshell concrete was placed in both acid solution and alkali solution to identify the performance eggshell concrete under aggressive solution. The findings show that the water curing with 15% of oven-dried eggshell concrete had the highest compressive strength, flexural strength and splitting tensile strength. Water curing promotes a better hydration process that improve the internal structures and exhibit lower water absorption. Thus, care should be taken when acid and alkali environment as calcium is the primary component to be react with the acid and alkali solution. Finally, the study showed that concrete that containing eggshell has the potential to be used as structural application.

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LIST OF SYMBOLS

Gt	Giga tons
°C	Degree Celsius
µm	Micrometre
mm	Millimetre
Kt	Kilotons
Kg	Kilogram
m	Metre
MPa	Megapascal
cm	Centimetre
kN	Kilonewtons
s	Second
f_c	Compressive strength
Σ	Submission
Θ	Angle
s	Standard deviation
v	Coefficient of variation
AO	Air-cured oven dried
WO	Water-cured oven dried
AA	Air-cured air dried
AO	Air-cured oven dried
pH	Potential hydrogen

LIST OF ABBREVIATIONS

FESEM	Field emission scanning electron microscope
FTIR	Fourier transform spectroscopy
SEM	Scanning electron microscope
XRD	X-ray diffraction
XRF	X-ray fluorescence
BS	British standard
ACI	American Concrete Institute
OPC	Ordinary Portland cement
ASTM	American society for testing and materials
LOI	Loss of ignition
A	Air-dried
O	Oven-dried
P	Point load
A	Average cross sectional area
N	Newton
f	Flexural strength
F	Maximum load at failure
L	Distance between
d	Lateral distance of cross-section
T	Splitting tensile strength

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