EFFECT OF GARNET WASTE ON THE PROPERTIES OF FOAMED CONCRETE

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ABSTRACT

The research is aimed to produce foamed concrete blocks viable for non-structural applications. This paper reports the studied effect of garnet waste on the properties of foamed concrete. Garnet waste was used to replace fine aggregates (sand) at different percentages (20%, 40%, 60%, 80% and 100%). The various mixes were checked for fresh properties (workability and plastic density of mortar and foamed concrete) and consequent compressive strength test was carried out on cube and block specimens. The results have shown increment in workability with respect to increase in garnet content. The best replacement producing the best compressive strength is that containing 20% spent garnet waste replacing fine aggregates (sand). The mix has added up to 15 % in cube compressive strength and 12% in block compressive strength. However, replacing 100% fine aggregates (sand) with spent garnet waste for foamed concrete is not possible due to probable chemical reaction between synthetic foaming agent and garnet waste disallowing proper bond between cement and garnet waste.

ABSTRAK

Penyelidikan ini bertujuan menghasilkan blok konkrit berbusa sesuai untuk penggunaan bukan struktur. Kesan bahan buangan ‘garnet’ kepada sifat-sifat konkrit berbusa dikaji. ‘Garnet’ digunakan sebagai pengganti batu baur halus pada peratus yang berbeza (20%, 40%, 60%, 80% dan 100%). Pelbagai campuran ini diuji kebolehkerjaan dan ketumpatan plastik bagi mortar dan konkrit berbusa manakala ujian kekuatan mampatan di jalankan kepada specimen kiub dan juga blok. Keputusan menunjukkan peningkatan kebolehkerjaan apabila terdapat pertambahan kandungan ‘garnet’. Campuran 20% ‘garnet’ menggantikan pasir menghasilkan kekuatan mampatan yang terbaik. Campuran ini juga berupaya meningkatkan kekuatan mampatan sehingga 15% kepada kiub dan 12% kepada blok. Bagaimanapun penggantian 100% batu baur halus dengan ‘garnet’ tidak dapat menghasilkan konkrit berbusa. Ini mungkin disebabkan tindakbalas kimia diantara agen busa sintetik dan ‘garnet’ yang tidak membolehkan ikatan sebenar antara simen dan garnet.

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LIST OF ABBREVIATIONS

BS	-	British standard
ASTM	-	American society of testing and materials
MS	-	Malaysian standard
NFC	-	Normal foamed concrete
MFC	-	Modified foamed concrete
MMHE	-	Malaysian Marine and Heavy Engineering
LWC	-	Lightweight concrete
C	-	Control mix
B1	-	20% spent garnet waste replacement by fine aggregate
B2	-	40% spent garnet waste replacement by fine aggregate
B3	-	60% spent garnet waste replacement by fine aggregate
B4	-	80% spent garnet waste replacement by fine aggregate
B5	-	100% spent garnet waste replacement by fine aggregate

LIST OF SYMBOLS

w/c	-	water to cement ratio
b/s	-	binder to sand ratio
^{o}C	-	degree celcius
ppm	-	parts per million
μm	-	micro meter
MPa	-	Mega-pascal
Psi	-	pounds per square inch
mm	-	milli-meter
ml	-	milli-liter
sec	-	seconds
min	-	minutes
kg	-	Kilogram
kg/m^3	-	Kilogram per meter cube
N	-	Newton
N/mm^2	-	Newton per millimeter square
kN/mm^2	-	Kilo newton per millimeter square
W/mK	-	watts per meter kelvin

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CHAPTER 1

INTRODUCTION

1.1 Background

For ages and eras, construction has been a premier component in the way of human advancement and how human life courses are been perceived. Rightly, it could be said that the contemporary world is at a construction age. Concrete however, is the largest and universally utilized construction material in all kinds of modern construction (M. S. Shetty 2005). By far, it remains the prime element in all civil engineering constructions and technology due to nothing more than the following sub structural properties. The mould capability and flexibility of it materials likewise the immense durability over compression as well as sighting of reinforcing and pre-stressing system which served to make up for it depressed durability over tension is contributing largely to its epidemic utilization.

Subsequent to the invention of concrete in the construction industry, it has been a prime course to advance this material in a feasible and a sustainable manner. Through this course, substantial innovations and improvements have been made. Foamed concrete been one of these ample developments, it dates back to the primitive years of concrete technology which was during the very early 1920's. However, the application of this material in actual construction was done about five decades thereafter its invention (M. H. Thakrele 2014). During its primitive period of application, it was employed as a void filling material likewise in ground related engineering applications.

Foamed concrete just as the name implies, is a porous concrete that is highly flow-able and self-compacting. This type of concrete possesses extraordinary properties, it is incredibly light in weight set against the conventional concrete. Its thermal insulating properties are exceptional (M. R. Jones and A. McCarthy 2005). Foamed concrete is an aerated like concrete that is mainly composed of cement, water, fine aggregates and a foaming agent. These constituents when blended together form a chemical reaction through which literally millions of equally sized bubbles are formed. These may be as a result of air or gas formation with the mortar mixture (A.A. Hilal et al. 2014). With properties like such, it has amassed the interest of many engineers for different engineering applications.

Having considered the growing demand of foamed concrete in the construction of lightweight structures, it has become a liability upon engineers and researchers to improve this material in such a way that it becomes environmentally sustainable without altering its strength and durability (M.I. Khan 2014). In the race to achieve this course, different types of waste materials have been used. It has also been a practice to inculcate Pozzolans into foamed concrete. These materials be it manmade admixtures or natural Pozzolans possess their own peculiar benefits to concrete (S.K. Lim et al. 2013). By far, it remains clear that the inculcation of Pozzolans in foamed concrete not just promotes sustainability but also improves and enhances the properties of foamed concrete.

1.2 Problem Statement

In the current construction industry, the primary employment of foamed concrete is for non-load bearing applications. According to (A.A. Hilal et al. 2014), the major factor preventing foamed concrete to be used as a load bearing material is the awfully low attainment of mechanical strength. Meanwhile, (H. Awang and M.H. Ahmad 2014) revealed that the generic cause for the increment in drying shrinkage of foamed concrete is nothing other than the excessive usage of cement and the emphatically low modulus of elasticity. The basis of this research study is to counter and improve the properties of foamed concrete using fine spent garnet waste with regards to the problems stated.

1.3 Aim

The aim of this research work is to evaluate the properties of foamed concrete modified with fine spent garnet waste, which may be suitable for non-structural applications.

1.4 Objectives

i. To produce modified foamed concrete (MFC) blocks using spent garnet waste as replacement for sand.
ii. To investigate and compare the fresh properties as well as strength development (Compressive) of modified foamed concrete (MFC) with that of Normal Foamed concrete (NFC).

1.5 Scope of Study

In order to define the precise focus of this research work, the very few boundaries need to be addressed. Some limitations are set in this research work in order to avert a wider scope of study resulting into unfocused research. These factors are listed below:

i. The study is limited to foamed concrete with density 1600 kg/m^3 only.
ii. The type of foaming agent to be used for producing foamed concrete will be an unstable synthetic based foaming agent.

iii. The mixing of (MFC) and (NFC) paste containing the synthetic based foaming agent will be done only using a pan concrete mixer.

iv. The optimum mix with highest compressive strength is determined after 7 days of curing inside water.

1.6 Significance of Study

Taking into consideration the growing concern on the issue of global worming, concrete technology researchers revealed that the substitution of cement in concrete lessens the amount of carbon (CO_2) emanation thereby depreciating the extent of greenhouse gas emission.

Furthermore, using foamed concrete can offers more to sustainability compared to other concrete types. Where it is possible to make concrete without coarse aggregates and to substitute sand either fully or partially with waste materials or by products (M. R. Jones and A. McCarthy 2005). Correspondingly, substituting sand with coarse spent garnet waste will also conserves energy and depreciates the amount of carbon emanation. It will contribute to the sustainability of the environment as well as reduce the rise in construction cost.

Taking into contemplation the findings of (M. R. Jones and A. McCarthy 2005) on the viability of applying foamed concrete as a load bearing structural material. Provided that foamed concrete can achieve strength of 25 Mpa. Partially judging, it may be used for structural applications. Additionally, the observations of (M.W. Hussin 2016) on the chemical compositions of spent garnet waste have shown that the material contains a considerable percentage of silicate and aluminate, which in turn bequeaths garnet waste with cementing properties. This research work however, employs the use of fine spent garnet waste, which will expectedly increase the workability, elasticity and strength parameters of foamed concrete and thereby contribute to the escalated demand for low weight constructions.

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