Faculty of Engineering

BEHAVIOR OF COMPOSITE SLAB CONSISTING OF FOAM CONCRETE AND NORMAL CONCRETE

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BEHAVIOR OF COMPOSITE SLAB CONSISTING OF FOAM CONCRETE AND NORMAL CONCRETE

LIM GEE ZHIONG

This project is submitted in partial fulfillment of
the requirements for the Degree of Bachelor of Engineering with
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To my beloved family

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ABSTRAK

Hari demi hari manusia memecah rekod dengan membina bangunan yang tertinggi di dunia, empangan yang terbesar dan lain-lain. Kesemua bangunan dan struktur gergasi ini yang tidak pernah dibayangi kemungkinan dapat dibina pada zaman dulu telah jadi kenyataan. Kebanyakan struktur-struktur ini dibina dengan menggunakan konkrit berbuih. Ini perlu dilakukan untuk memenuhi kriteria-kriteria yang perlu diikuti pada peringkat perancangan dan perekaan. Sebagaimana yang diketahui, konkrit ringan tidak mempunyai daya kekuatan yang tinggi dan walaupun konkrit biasa mempunyai daya kekuatan yang tinggi, namun ia mempunyai masalah terlampau berat untuk digunakan untuk membina struktur yang besar lagi tinggi. Laporan ini melaporkan kajian yang telah dilakukan untuk megkaji keberkesanan menyatukan kelebihan konkrit buih dan konkrit biasa sebagai satu jenis konkrit yang baru. Kajian dilakukan dengan tujuan menigkatkan daya kekuatan konkrit buih dan menurunkan jisim konkrit biasa. Pelbagai pengiraan dan pemerhatian telah dibuat untuk mengenal pasti parameter-parameter yang perlu diketahui untuk menaikkan taraf penggunaan konkrit jenis yang baru ini. Konkrit berbuih sememangnya dapat meningkatkan daya kekuatannya dengan menyebatikannya bersama konkrit biasa. Daya kekuatan konkrit biasa dapat dikekalkan dengan mempunyai jisim yang ringan.

ABSTRACT

In this new era, many mega structures have been built all around the world. Day by day human being keep on improving the structures that have been never thought that it will be possible to build in the past. Many mega structures are using lightweight concrete to fulfils some of the requirements during designing stage. However, due to some limitations; lightweight concrete do not have high strength in terms of compression or tension. Normal concrete has high compressive strength but it is not lightweight which contribute loading to the structure itself. The idea of combination of normal concrete and foam concrete is to produce a lightweight but strong structure. This study discusses the investigations done to behavior of composite consisting of normal concrete and foam concrete by identifying few parameters and the influence of these parameters on density and strength. The results were observed and studied for further analysis. It is found that the composite concrete consisting of normal and foam concrete is still able to perform well under the applied loading. The flexural and compressive strength of foam concrete can be improved by combining with normal concrete. Normal concrete can be called lightweight concrete while maintaining its high strength.

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mm	-	Millimeter
KN	-	Kilo Newton
m	-	Meter
kg	-	Kilogram
MPa	-	Mega Pascal
E	-	Modulus
°C	-	Celsius
%	-	Percent

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The use of the foamed concretes has in the past 10 years grown more rapidly than any other concrete product, with the current estimated UK market thought to be closely 1 million m^3 annually (Aldridge 2005). Foam concrete consists of cement, sand and foam only. It is well known of its lightweight characteristic than any other concrete in the market could not be achieved, but because of the lightweight, the compressive strength of the foamed concrete is lower than other normal concrete.

The compressive strength is the most important property of concrete. Normal concrete is strong in compression but weak and unreliable in tension. Reinforcement is required to resist tension due to moment. The tensile strength of concrete is only about 10 percent of the compressive strength. Because of this, nearly all reinforced concrete structures are designed on the assumption that the concrete does not resist any tensile forces. Reinforcement is designed to carry these tensile forces, which are transferred by bond between the interfaces of the two materials. Whenever tension occurs it is likely that cracking of the concrete will take place. This cracking, however, does not detract from the safety of the structure provided

there is good reinforcement bond to ensure that the cracks are retrained from opening so that the embedded steel continues to be protected from the corrosions. Although the tension problems of the concrete had been solved, but the reinforcement bars had gain more weight to the concrete. This is the main problem that will cause difficulties to the construction of a high rise buildings or mega structures that will be build on the water.

In thick concrete element, the compressive failure is generally initiated on the surface; inside concrete is confined and will display higher strength. It is proposed that a way cellular type of structure, where foam concrete moulding cells in normal concrete is to be explored. The resulting structure is less dense while retained same of the strength and durability requirements of the normal concrete. From this viewpoint, a laboratory study has been carried out in order to come out with a composite concrete that have both advantages of the foamed concrete and normal concrete. It was believed that by combining these advantages, many of the mega structures are impossible to be built on by this time can be built in the future.

1.2 Aim

The aim of this study is to explore the possibility of using a composite of foam concrete and normal concrete for lightweight construction.

1.3 Objectives

The objectives of this laboratory study are:

i) To find the flexural strength and compressive strength of a composite beam of foamed concrete and normal concrete.

ii) To propose a suitable lightweight composite concrete to replace the normal concrete.

1.4 Scope Outlines

i) In chapter 1 of this report a brief description of foam and normal concrete history are outlined. The aim and objectives of this study were clearly stated out. The main objective of this study is to improve the usage of foam-normal composite concrete.

ii) Chapter 2 of this report consist of collecting information from books, journals and internet regarding the researches that have been done by researchers on the properties of foam and normal concrete. A literature review is important as references when conducting this study.

iii) Chapter 3 of this report is describing the method of specimen preparation and specimens testing. This is the most important stage among all since the study will be proceeds based on what have stated out in methodology. Since this study is to study the behaviour of foam-normal composite concrete, thus the main tests that will be conducted in this study will be compressive strength test and flexural strength test.

iv) In Chapter 4, all the results gained from the experiment study will be state out in this stage. Discussions will be based on the result obtained from the test. Comment will be given in this stage.

v) Chapter 5 of this report is the final stage of this experiment study. Conclusion gained from the test and recommendations to improve the behaviour of foam-normal composite concrete will be state out in this stage.

CHAPTER 2

LITERATURE REVIEW

2.1 Properties of foam concrete

Foam concrete is an almost ageless and everlasting material not subject to the impact of time. It does not decompose and is as durable as rock. High compression resistance allows using produce with lower volumetric weight while construction, which increases the temperature lag of a wall. According to Ravinda and Moray (2005), due to foam concrete low density, foam concrete imposes little vertical stress on the substructure - a particularly important attribute in areas sensitive to settlement. Thus, foam concrete is a viable solution for reducing loading on burden soil and, in its hardened state, is less susceptible to differential settlement. Foam concrete is naturally self-levelling and self-compacting, filling the smallest voids, cavities and seams within the pouring area.

In excavations with poor soils that cannot be easily compacted, foam concrete forms a 100% compacted foundation over the soft sub-soil (Ravinda & Moray, 2005). Compaction of conventional, granular backfill against retaining structures or deep foundations can cause damage or movement to the adjacent structure. In these situations, foam concrete with its reduced lateral loading is a safe

solution. Effective stress is a measure of the stress on the soil skeleton and determines the ability of soil to resist settlement and shear stress. The principle of equilibrium states that when soils are excavated and replaced with foam concrete of a lighter density, the combined weight of the foam concrete and the new construction should be designed to be less than, or equal to the weight of the removed soil. In conforming to this principle the effective stress of the underlying soil remains unchanged from that existing prior to excavation and thus settlement of the construction is prevented.

Foam concrete forms a rigid, well-bonded body after hydrating. It is effectively a free-standing (monolithic) structure and once hardened, does not impose lateral loads on adjacent structures. The flowing and self-compacting attributes of foam concrete allow it to be constructed into any desired profiles through forming, stepping, or even machining successive lifts to shape.

Table 2.1: Typical properties of foamed concrete (Aldridge, 2005)

Dry Density, kg/m³	Compressive strength, N/mm²	Thermal conductivity, W/mk	Modulus Elasticity, kN/mm²	Drying Shrinkage, %
400	0.5-1.0	0.1	0.8-1.0	0.3-0.35
600	1.0-1.5	0.11	1.0-1.5	0.22-0.25
800	1.5-2.0	0.17-0.23	2.0-2.5	0.20-0.22
1000	2.5-3.0	0.23-0.30	2.5-3.0	0.18-0.15
1200	4.5-5.5	0.38-0.40	3.5-4.0	0.11-0.09
1400	6.0-8.0	0.50-0.55	5.0-6.0	0.09-0.07
1600	7.5-10.0	0.62-0.66	10.0-12.0	0.07-0.06

2.1.1 Effect of water–solids ratio on design density

Kunhanandan and Ramamurthy (2007) have proved that as the foam is added to the wet foam concrete mix, the consistency of the wet mix is very important to get the design density. It is observed that at lower water–solids ratios, i.e., at lower consistency, the density ratio is higher than unity. The mix is too stiff to mix properly thus causing the bubbles to break during mixing resulting in increased density. At higher water–solids ratios there is also an increase in density ratio as higher water contents make the slurry too thin to hold the bubbles resulting in segregation of the foam from the mix along with segregation of the mix itself thus causing an increase