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EXPERIMENTAL RESEARCH ON FOAM CONCRETE WITH PARTIAL REPLACEMENT OF SAND BY M-SAND

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ABSTRACT

Foamed concrete is a versatile material which consists primarily of a cement based mortar mixed with at least 20% volume of air. It is a non-load bearing structural element which has lower strength than conventional concrete. Foam concrete is mostly used in construction field and is also quite popular for other applications in the same field because of its light weight such as reduction of dead load, non-structural partitions. Because of its low strength, some materials are used to increase the strength of foam concrete.

A study on the effect of M-sand as replacement material in foam concrete blocks was conducted. This project was carried out to determine the compressive strength of foam concrete blocks by using M-sand as partial sand replacement material. This report presents the probability of the usage of M-sand as 0 %, 20 %, 40 %, 60%, 80% and 100% for sand in foam concrete. Mix design was formulated and developed for four different proportions of quarry dust in foam concrete. Tests were conducted on foam concrete blocks of size 150mm x 150mm x 150mm to study the compressive strength of concrete blocks made of M-sand and results were compared with the control specimen.

It was found that the compressive strength of foam concrete made of M-sand was nearly 43% more than the control specimen. Immediately under the load, a high compressive stress is induced. Therefore the load is applied through a packing of plywood strip, as a result the cube fails at the ultimate load. Based on the results of the experimental investigation, it is proposed that burnt clay bricks can be effectively replaced with foam concrete blocks. Finally cost benefit assessment was done to prove the economy of the foam concrete bricks and it is found cost effective.

I. INTRODUCTION

Foamed concrete is a material with a lot of practical aspects, a low weight and good thermal conductibility. Due to these good properties, the foamed concrete has been used so far mainly as a filling material. The applications in which the foamed concrete would be used as a load bearing material are until now scarce. The reason for that are the fairly low strength parameters. The parameters, which are possible to change during foam production are air, pressure and water to concentrate ratio. The key aspect in foams is density and drainage, as it was used as a parameter of stability of foams. The air pressure influences both the parameters. With high air pressure the density and drainage are low. The second aspect to regulate the drainage is the water to concentrate value. With the increase of water to concrete ratio the stability goes up, without big changes in foam density. Foam is a dispersion of a gas in liquid or in solid. Foam is produced as a result of distribution of gas in a liquid under the influence of foaming medium, such as soap, oil, or wetting agent. During the production, small bubbles are formed and are separated from liquid by a membrane. Clearly, there are several different types of foams with various applications. Therefore, there are several different industries, which use foam-like products.

1.1 Samples are

- Food industry
- Soap industry
- Industry of insulating materials
- Fire protection industry
- Industry for backfilling materials

II. FOAM GENERATOR

There are three main parameters to control the foam generator:

- Water flow
- Water to concentrate ratio
- Air pressure

2.1 Water Flow

The water flow is difficult to influence, hence provide valve between the water tube and the foam generator. From this work the average water flow inside of the HIF water supply system is known with an average flow.

2.2 Water to Concentrate Ratio

The amount of concentrate, which goes into the generator by means of a special pump, can be continuously adjusted by a controller. One test series regarding this parameter, taken care of the range which is given by the producer, therefore new tests have been done to get the information about the water to concentrate ratio out with the recommended range.

2.3 Air Pressure

A manometer controls the air pressure at the generator. According to Herbst, the air pressure is the best way to control density of the foam. It is relatively easy to vary the air pressure. To produce foams with different water to concentrate ratio and equal air pressure the manometer had to be readjusted

III. FOAMED CONCRETE MATERIALS

3.1 Foaming Agent

Foaming agents is also defined as air entraining agent. Air entraining agents are organic materials. When foaming agents added into the mix water it will produce discrete bubbles cavities which become incorporated in the cement paste. The properties of foamed concrete are critically dependent upon the quality of the foam.

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There are two types of foaming agent:

i). Synthetic-suitable for densities of 1000 kg/m^3 and above.

ii). Protein-suitable for densities from 400 kg/m^3 to 1600 kg/m^3.

3.2 Cement

Based on BS 12:1996, ordinary Portland cement is usually used as the main binder for foamed concrete. Portland cement is hydraulic cement when mixed in the proper proportions with water, will harden under water.

3.3 Water

Water is one of the important materials for the foamed concrete. The criterion of portability of water is not absolute. Water with pH 6 to 8 which is not tested saline or brackish is suitable for use. Natural water that is slightly acidic is harmless, but water containing humic or other organic acids may adversely affect the hardening of concrete. The present of algae in the mixing water will result in air entrainment with consequent loss of strength.

3.4 Fine Aggregate

Generally, the fine aggregate consists of natural sand, manufactured sand or combination of them. the fine aggregate for concrete that subjected wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any material that deleteriously reactive in cement to cause excessive expansion of mortar concrete.

IV. EXPERIMENTAL TEST ON FOAM

The concept for the experiments on the foam itself was to work with a constant water flow and run series of test on different values of water to concentrate ratio with a variation of the air pressure .Other tests about parameters like density or drainage were made to classify foams, but also to get some aspects about stability and indirect information about the bubble size distribution.

The test is classified into two types:

- Compressive strength test
- Tensile strength test

4.1 Compression Test (BS EN 12390-3, 2002)

The compression test was conducted by using compressive strength machine. The test was performed in accordance with BS EN 12390-3 (2002). An axial compressive load with a specified rate of loading was applied to 100mm cube until failure. The cubes were taken out from water tank and air-dried for two hours before the test was performed. Before testing, the dimension of the specimen was measured. This is done to determine the cross-sectional area of specimen for calculations. Followed by the measurement, the test specimen was placed at the center of the testing machine. The gradually applying load was given with the constant rate of loading of 0.02 mm/s until the specimen fails. The ultimate load carried by the specimen was recorded and compressive strength was calculated based on Equation occurred. INSTRON 5582 Testing Machine was used to conduct the compressive strength test on the cubes. Average value obtained from three cubes was then taken as cube compressive strength for each lightweight foamed concrete mix.

4.2 Mix Proportions

The mix proportion of the lightweight foamed concrete incorporated with POFA was determined based on trial and error method. Trial mixes with various w/c ratio were carried out. The optimum mix proportion was determined based on density and strength of lightweight foamed concrete incorporated with POFA.

4.3 Trial Mix

During the trial mix stage, three types of mix proportion, namely LFC with 100 % sand as filler (LFC-CM), 10 % POFA replacement as part of filler (LFC-PF10) and 20 % POFA replacement as part of filler (LFC-PF20). The water to cement mix ratio for each type of mix proportion was tried at the range of 0.52 to 0.60 for each mix with the increment of 0.02. Density for every mix was controlled to 1300 kg/m^3± 50 kg/m^3

4.4 Mixing Procedure

OPC, Sand and POFA were weighted and mixed in a concrete mixer until the dry mix was thoroughly mixed. After that, the water was weighed and added into the dry mix. The mix was mixed until the wet mix was uniformly mixed. Follow by that, an amount of foam was weighted and added into the wet mix repeatedly until the desired density, 1300 kg/m^3 ± 50 kg/m^3 was achieved. Lastly, inverted slump test was carried out before fresh lightweight foamed concrete was poured into the mould.

Fig. Shows the Mixed foam concrete for Density mesurement.

4.5 Curing

Curing condition is very important procedure in gaining the strength of lightweight foamed concrete. For this study, specimens were cured for 28days.

V. RESULT AND DISCUSSION

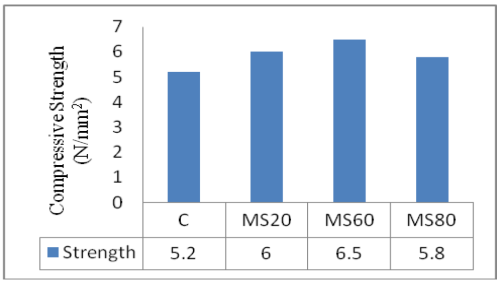

Fig. Shows the Compressive Strength of Foamed Concrete at 28 days

For control specimen concrete using 0% M-sand compressive strength is 5.2 N/mm^2. For 20%, and 60% of replacement of sand by M-sand the compressive strength is increased by 15.3% and 25% respectively. But for 80% replacement the compressive strength is reduced by 10.2% when compared to MS60 specimen.

5.1 Advantages of Foamed Concrete

- Foam concrete does not settle easily, hence requires no compaction.
- Lightweight - does not impose large loadings.
- Free flowing - spreads to fill all voids.
- Does not impose significant lateral loads.
- Reliable quality control - batches are easy to reproduce.
- Resistant to freeze-thaw cycle (1000 cycles of -18oC to +20oC).
- Low water absorption over time.
- Excellent fire resistant properties.
- Highly cost effective compared with other methods.
- Sufficiently strong and durable for most applications.
- Excellent sound and thermal insulation Easy to re-excavate

5.2 Applications of Foam Concrete

- Voids filling **eg.** storage tanks, pipelines, sewers, tunnels, culverts, subways, mine workings, cellars and basements, swimming pools, relining of pipes etc.
- Trench Reinstatement
- Road and Pavement Sub-Bases
- Bridge Abutments
- Construction Strengthening
- Emergency works – Structural support **eg.** basements, tunnels, bridges, roads.
- Thermal Insulation **eg.** roofing, walls, floors.
- Pre-cast blocks and panels **eg**. Tsunami Structures, light weight construction in tall buildings, Earthquake resistant structures.

VI. CONCLUSIONS

Foam concrete can be made as low density high strength concrete.They can be employed as high thermal insulation and light weight concrete.This type of concrete is boon for remote areas where sand alone is available. It can be used in garden structures where water percolation is high. When partial replacement of sand is done by M-sand, due to this, eco-friendly concrete can be achieved. 60% replacement of M.sand from the sand as the compressive strength increases upto 60% and decreases after that. The manufacturing and casting are fast and easy process. As the foam concrete is light weight, the brick work in walls can be replaced by the foam concrete since it reduces the dead load.

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REFERENCE

[1]. Aldridge, D., (2005), Introduction to Foamed Concrete What, Why, and How? *Use of Foamed Concrete in Construction*. London: Thomas Telford, 1005: 1-14.

[2]. Aldridge, D., Ansell, T., (2001), Foamed Concrete: Production and Equipment Design, Properties, Applications and Potential. Proceedings of One Day Seminar on Foamed Concrete: Properties, Applications and Latest Technology Developments. Lough borough University.

[3]. American Society for Testing and Materials (2005). Standard Specification for Portland Cement (ASTM C150 – 05)

[4]. American Society for Testing and Materials (2007). Standard Test Method for Flow of Hydraulic Cement Mortar (ASTM C1437-07).

[5]. American Society for Testing and Materials (2010). Standard Guide for Examination of Hardened Concrete Using Scanning Electron Microscopy (ASTM C1723-10).

[6]. Awal, A.S.M. and Hussin, M.W. (1997). Some Aspects of Durability Performances of Concrete Incorporating Palm Oil Fuel Ash,

[7]. Proceedings of 5th International Conference on Structural Failure, Durability and Retrofitting, Singapore, 210 – 217

[8]. Awal, A.S.M. (1998). A Study of Strength and Durability Performances of Concrete Containing Palm Oil Fuel Ash, PhD Thesis, Universiti Teknologi Malaysia.

[9]. British Standards Institution (1970). Testing hardened concrete–Part 5: Method of Testing Hardened Concrete for Other Than Strength. London: BS 1885-5:1970.

[10]. British Standards Institution (2001). Thermal Performance of Building Materials and Products. Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods. Dry and Moist Products of Medium and Low Thermal Resistance. London: BS EN 12664:2001.

[11]. Byun, K.J., Song, H.W., Park, S.S. (1998). Development of Structural Lightweight Foamed Concrete Using Polymer Foam Agent. *ICPIC-98: 9*

[12]. Eldagal, O.E.A. (2008). Study On The Behaviour of High Strength Palm Oil Fuel Ash (POFA) Concrete, Universitiy Malaysia.

[13]. Khalid.Ali. M.Gelim. (2011), Mechanical and physical properties of Fly Ash Foamed Concrete, University Tun Hussein Onn Malaysia (UTHM).