Design of Light Weight Porous Concrete

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Abstract- *Concrete is widely noted to be most expensive constituents in the entire construction industry. Many research works has been carried out on concrete mixes which had encouraged the development of material with partial replacement of natural aggregate like pumice stone, thermocol beads, saw dust. For the construction of structures, the new sources that is produced from environmental waste is Natural aggregate which reduces the self weight and helps in constructing of larger precast units. light weight concrete plays a prominent role in reducing the density of concrete structures where reduction of self weight is an important factor which may increases thermal insulation by relating of structural response & serviceability. Light weight aggregate is of natural origin mostly volcanic tuff which acts as active pozzolonas when used as aggregates. In this study the strength and durability properties of M40 concrete by partial replacement of coarse aggregate with natural light weight aggregate pumice stone will be studied. The properties of conventional M40 concrete are compared with properties of concrete with light weight aggregate, produced by replacing coarse aggregate with pumice stone by 0%,10%,20%,30%,40% and 50%. The physical and mechanical properties of natural aggregate are evaluated. An optimum control mix is designed based on structural light weight concrete M40 using the light weight aggregate pumice stone as a partial replacement to coarse aggregate. For this purpose 6 sets were prepared in which each set comprises of 15 cubes, 3 cylinders and 3 beams. Slump test were carried out for each mix in the fresh state. The compressive strength of cubes (150mmX150mmX150mm), split tensile strength for cylinders (150mm diaX300mm height),flexural strength for (beams 500X100X100mm) tests will be carried out to determine the strength of concrete at 7and 28 days which were performed in the hardened state.*

Keywords- Natural light weight aggregate (pumice aggregate), coarse aggregate, cement, super plasticizer (gleninum sky 8630), fine aggregate

I. INTRODUCTION

The conventional cement concrete is a heavy material having a density of 2400 kg /m^3, and high thermal conductivity. The dead weight of the structure made up of this concrete is large compared to the imposed load to be carried, and a relatively small reduction in dead weight, particularly for members in flexure, e.g. in high-rise buildings, can save money and manpower considerably. The improvement in thermal Insulation is of great significance to the conservation of energy. The reduction in dead weight is normally achieved by cellular construction, by entraining large quantities of air, by using no-fines concrete and lightweight aggregates which are made lighter by introducing internal voids during the manufacturing process. The term no-fines indicates that the concrete is composed of cement and coarse aggregate (commonly 10 or 20 mm grading) only, the product has uniformly distributed voids. Suitable aggregates used are natural aggregates, blast-furnace slag. Clinker, foamed slag, sintered fly ash, expanded-clay, etc. Lightweight aggregate is a relatively new material. For the same crushing strength, the density of concrete made with such an aggregate can be as much as 35 per cent lower than the normal weight concrete. In addition to the reduced dead weight, the lower modulus of elasticity and adequate ductility of lightweight concrete may be advantageous in the seismic design of structures.

II. PROBLEM STATEMENT

The present day world is witnessing construction of very challenging and difficult civil engineering structures. Researchers all over the world are attempting to develop low density or lightweight concrete by using different admixtures in concrete up to certain proportions. This study deals with the development of Light weight Thirsty concrete by using Pumice stone.

III. LITERATURE REVIEW

3.1 Title - Manufacturing of High-strength Lightweight Aggregate Concrete using Blended Coarse Lightweight Aggregates.

Author - Muhammad Aslam" Payam Shafighb.c Mohammad Alizadeh Nomeli, Mohd Zamin Jumaat

Structural lightweight concrete plays an important role in the construction industry, especially for the high-rise buildings. It can only be produced using lightweight aggregates. Oil-palm-boiler clinker (OPBC) is a solid waste from the oil palm industry and could be used as lightweight aggregate in concrete mixture. However, the density of this lightweight aggregate is more than the density of the other types of natural and artificial lightweight aggregate. Therefore, the density of concrete was made of this lightweight aggregate is relatively high and is in the range of semi-lightweight concrete. In the current study, OPBC was partially substituted with a lighter lightweight aggregate namely oil palm shell (OPS) in a OPBC semi-lightweight concrete with high strength to further reduce the density of the concrete .

3.2 Title – Experimental study on lightweight aggregate concrete with Pumice stone ,steel fibre and fly ash as a partial replacement of coarse aggregate

Author - G. Ankamma Naidu , J. Keerthana , M. K.M. V. Ratnam

Publisher and Year - December 2015 | IJIRT | Volume 2 Issue 7 | ISSN: 2346002

In this study an attempt has been made to study the mechanical properties of a structural grade light weight concrete M30 using the light weight aggregate pumice stone as a partial replacement to coarse aggregate and mineral admixture materials like fly ash and steel fiber. For this purpose along with a control mix, 12 sets were prepared to study the compressive strength, tensile strength and flexural strength. Each set comprises of 3 cubes, 3 cylinders and 3 prisms. Slump test were carried out for each mix in the fresh state. 28,60 and 90 days compressive test, tensile strength and flexural strength tests were performed in the hardened state. The study is also extended for blending of concrete with different types of mineral admixtures. The test results showed an overall strength and weight reduction in various trails. The density of concrete is found to decrease with the increase in percentage replacement of natural aggregate by pumice aggregate.

3.3 Title – Enhancing the performance of porous concrete by utilizing the pumice aggregate.

Author – Hariyadi , Hiroki Tamai

Publisher and year - Procedia Engineering 125 (2015) 732 – 738

The purpose of this research is to evaluate the effect of varying proportion of volcanic pumice as an aggregate replacement (VP/A) and proportion of aggregate to cement (A/C) with a constant water to cement ratio (WCR) to the mechanical properties of volcanic pumice porous concrete, and to those porous concrete with normal aggregate as a control. The result shows that by using volcanic pumice the porosity increases and the modulus of elasticity decreases, even though slightly decreasing in strength is also found. However, it showed a possibility of volcanic pumice porous concrete as impact energy absorber structures.

utilizing volcanic pumice on porous concrete mixtures resulting in a high porosity (void content) and a low modulus of elasticity of porous concrete.Moreover, by using volcanic pumice a higher tensile strength (flexural strength) than that of ACI standard can be obtained. This volcanic pumice porous concrete is potential for future structure with adequate strength and good impact energy absorbing. In addition, for estimating the modulus of elasticity of porous concrete, ACI 318-08 developed equation (Ec = 0.043*W1.5*f'c0.5) can be used to rapidly estimate the modulus of elasticity of porous concrete, where it is necessary, due to experimental difficulties to measure it.

3.4 Title - The relationship between porosity and strength for porous concrete

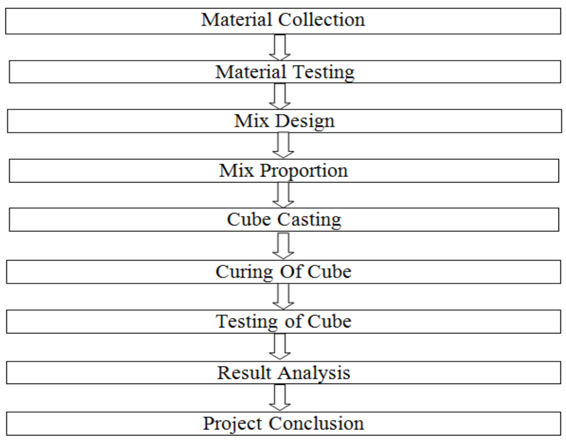
Author - C. Lian , Y. Zhuge , S. Beecham

Publisher and year - Construction and Building Materials 25 (2011) 4294–4298

In a previous experimental investigation , the compressive strength of porous concrete has been tested. This testing could be used as an index to characterize the mechanical capacity of porous concrete in this study. On the other hand, the pore structure of a porous material can be characterized by a number of parameters including pore size, pore connectivity, pore surface roughness and pore volume fraction (porosity). Of these, the porosity is regarded as the primary parameter of porous material microstructures . Normally the strength of a porous material is influenced by porosity, the other parameters listed above having less influence. Thus,in this study the porosity is chosen as an independent variable to relate to the material strength. The objective of this study is to establish a quantitative relationship between porosity and compressive strength of porous concrete.

The effective porosity of porous concrete has been measured. However, since the non-intrusive pores weaken the strength of concrete, the total porosity was estimated and then compared with the effective porosity. It has been demonstrated that the estimated total porosity has a good correlation with the measured effective porosity. This estimation method could be used when total porosity testing apparatus is not available. Existing equations relating compressive strength and porosity for cement-based materials were presented and a potential equation for porous concrete has been appraised by fitting to the experimental data. It has been shown that without extra knowledge of paste strength, the exponential function derived using experimental data resulted in a relatively low correlation coefficient.

IV. METHODOLOGY



V. SCOPE OF PROJECT WORK

Storm water management-:. As regulations further limit storm water runoff, it is becoming more expensive for property owners to develop real estate, due to the size and expense of the necessary drainage systems. Pervious concrete lowers the sites SCS Curve Number by retaining storm water on site. This allows the planner/designer to achieve pre-development storm water goals for pavement intense projects. Pervious concrete reduces the runoff from paved areas, which reduces the need for separate storm water retention ponds and allows the use of smaller capacity storm sewers. This allows property owners to develop a larger area of available property at a lower cost. Pervious concrete also naturally filters storm water and can reduce pollutant loads entering into streams, ponds and rivers. Pervious concrete functions like a storm water infiltration basin and allows the storm water to infiltrate the soil over a large area, thus facilitating recharge of precious groundwater supplies locally.[5] All of these benefits lead to more effective land use. Pervious concrete can also reduce the impact of development on trees. A pervious concrete pavement allows the transfer of both water and air to root systems allowing trees to flourish even in highly developed areas.

Improved thermal efficiency reduces the heating and cooling load in buildings

Concrete Pavement-: Pervious concrete pavement is a unique and effective means to address important environmental issues and support green, sustainable growth. By capturing stormwater and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater, reducing stormwater runoff

Sidewalk-: It is a method of paving vehicle and pedestrian pathways that allows for infiltration of fluids. In pavement design the base is the top portion of the roadway that pedestrians or vehicles come into contact with. The media used for the base of permeable paving may be porous to allow for fluids to flow through it or nonporous media that are spaced so that fluid may flow in between the crack may be used. In addition to reducing surface runoff, permeable paving can trap suspended solids therefore filtering pollutants from stormwater.

Pollution Treatment-: About 90% of the surface pollutants are carried off by the first ½-inch to 1-inch of rainfall (otherwise known as “first flush”). The permeability of a pervious concrete parking area allows the first-flush to pass through the pavement into the native soil beneath the pavement. The soil of the site then filters and treats the rainfall in the same manner as before the parking lot was constructed. The rainfall is spread over the entire parking area instead of concentrating it in one spot such as a conventional detention pond. As water has to pass through a greater distance through the soil layers to the water table than with treatment systems such as detention ponds or underground infiltration systems, the water purification is more effective.

Recharging Groundwater and Aquifer -: Pervious concrete parking areas allow rainfall to percolate back into the soil where it falls, and replenishes the aquifer naturally.

VI. SPECIMEN TESTING RESULTS

6.1 Compressive Test

The compressive strength is obtained after curing of 28 days at 28 days the compressive strength is………..Mpa it will increases in a long period of time and exceeds the compressive strength values of nominal concrete.

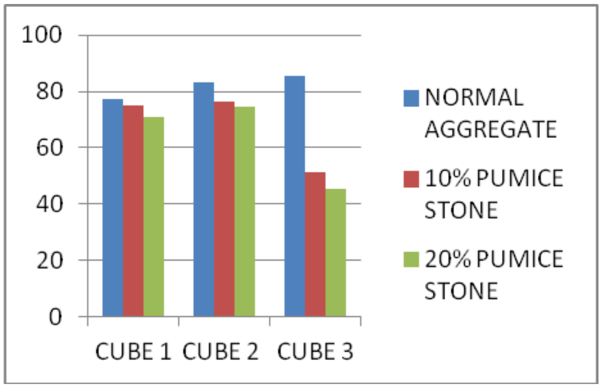


Figure 1: Compressive test on cubes

6.2 Split tensile Test

The compressive strength is obtained after curing of 28 days at 28 days the tensile strength is………..Mpa it will increases in a long period of time and exceeds the split tensile strength values of nominal concrete.

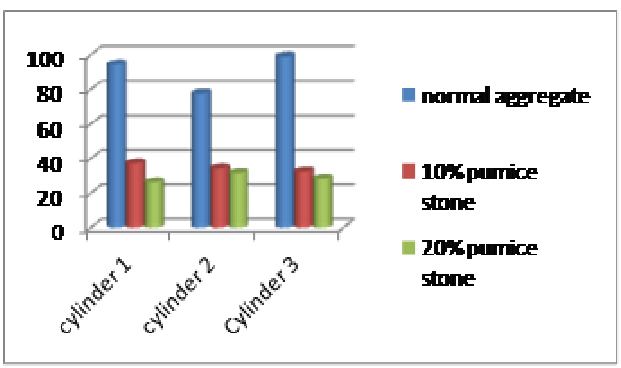


Figure 2: Tensile test on cylinders

VII. CONCLUSION

Concrete specimens show good results in light weight for 50% partial replacement of natural aggregate with pumice stone.

- The increasing percentage of pumice stones will show negative impact on strength of concrete (strength decreases).
- Generally Pumice stone absorbs more water compared to the nominal coarse aggregate, to overcome this problem additional usage of super plasticizes is added.
- For replacement of 20% of pumice stone gives optimum value beyond 20% the compressive strength value decreases.

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