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Study on the Properties of Aerated Concrete Incorporating Fly Ash and Quarry Dust

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Abstract

The use of LWC (Lightweight concrete) has been a feature in the construction industry for centuries, but like other material the expectations of the performance have raised and now we are expecting a consistent, reliable material and predictable characteristics. The use of aluminum powder to make aerated concrete seems to be a viable option. This study deals with replacement of cement with fly ash and finding out an optimum ratio. This composition is then mixed with adequate aluminum powder to obtain an aerated concrete.

Keywords- LWC, Aluminium Powder, Fly Ash, Quarry Dust, Aerated Concrete

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I. INTRODUCTION

Structural LWC usually has a density below 1800kg/m3 where as a normal weight concrete has a density in the range of about 2400 kg/m3.Generally for the concrete to be used for structural purposes, it must have a minimum strength of 17 MPa. Light weight concrete generally has a porous structure by firing it in a rotary kiln, and it consist of shale or lime usually. Air-cooled blast furnace slag is also used to create a porous structure. There are other classes of non-structural LWC with lower density made with other aggregate materials and higher air voids in the cement paste matrix, such as in cellular concrete, so it is convenient to classify the various types of lightweight concrete by their method of production. Light weight concrete has an added advantage to normal concrete due to its ability to induce strength with lower weight.

II. ADVANTAGES

Longer unpropped sections can be put into use due to its reduced dead load. Considerable savings in labour and formwork material is possible this way. Lower haulage and handling costs is another advantage. The LWC due to its reduced dead loads, can be used in more complex designs. Usually haulage is limited by weight, hence large volume of LWC can be hauled economically. As the density decreases, thermal conductivity decreases thus providing more of an energy efficient space, which can isolate extreme climates.

III. DURABILITY

The ability of a material to withstand the effect of its environment may be termed as Durability such as chemical attack, physical stress, and mechanical assault. Light Weight concrete is more porous than the ordinary Portland cement and has no special resistance to chemical attack such as sulphate attack, spillage of corrosive liquid etc. hence it is not recommended for use below damp-course. A material may be termed as chemically durable when it is stable in presence of chemicals, usually enhanced with moisture content. Frost action, shrinkage and temperature stresses are generally thee physical stress. Cracking of LWC is generally by drying shrinkage.

IV. LITERATURE REVIEW

A. Comparison of Lightweight Concrete

Ameer et.al. (2015), uses two additives, silica fume and fly ash to replace Portland cement and Sand. The pre-formed concrete consists of a density ranging from 1300-1900kg/m^3. Comparison where done using consistency, mechanical properties and thermal properties. Foamed concrete mixes with high flow ability and strength was also manufactured. The Foamed concrete mixes had 28-day compressive strengths from 6 to 23 MPa. The mixes in this study showed higher strengths, higher tensile to compressive strength ratios and higher moduli of elasticity. [1]

B. Properties and Applications of Lightweight Concrete

Ali et.al. (2014), states the raw materials used in aerated concrete, types of agent, properties and applications. The production method is exhibited for each foamed and autoclaved concrete. This paper focuses on the porosity, permeability, compressive strength and splitting strength. [2]

C. Feasibility of using Aerated Concrete Block

Prakash et.al. (2013), studied the feasibility of using aerated concrete block as an alternative to the conventional masonry units. The paper focused on estimating physical, strength and elastic properties of Aerated concrete block units. They included Initial rate of absorption, density test, water absorption test etc. The present investigation has favoured to study all such properties. With the obtained results, it can be compared with the results of conventional masonry units. [3]

D. The Hardened and Durable Properties of Concrete using Quarry Dust

Sivakumar et.al. (2011), investigated the hardened and durable properties of concrete using quarry dust. Quarry dust can replace river sand thereby reducing cost. Experimental was also done on 100% replacement of sand with quarry dust. Cement mortar cube was studied with various proportions (CM 1:3, CM 1:2, and CM 1:1) of quarry dust. The addition of quarry dust for a ratio of 0.6 was found to enhance the compressive properties and elastic modulus. [4]

E. Strength of Concrete When Replacing Sand by Quarry Dust

Balamurugan et.al. (2013) replaced sand by quarry dust in steps of 10%. M20 and M25 grades of concrete were taken for study. The slump value is constant at 60mm. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained. It was found that maximum compressive strength is obtained at 50% replacement. [5]

F. High-Performance Aerated Concrete

Keun-Hyeok et.al. (2015) tested 16 concrete mixes to create a high-performance aerated concrete. The obtained high-performance aerated concrete was compared with the minimum requirements specified in ASTM C 1693. From the regression analyses of the test data, prediction models for dry density, compressive strength, stress–strain relationship, and thermal conductivity of aerated concrete were obtained. All concrete mixes tested showed enhanced workability and de foaming resistance, achieving self-compatibility performance. Mechanical properties prove that the developed high-performance aerated concrete can be used for practical application. [6]

G. Replacement of Sand with Quarry Dust an Economic Alternative

Lohani et.al. (2013) states that replacement of sand with quarry dust is an economic alternative. In countries like India, quarry dust replacement technology has become as an innovative development to civil engineering field. Design mix of M20 grade concrete was used. Replacement was done with 0%, 20%, 30%, 40%, and 50% of quarry dust. Slump test, flexural strength, compaction factor test, split tensile strength, compressive strength, modulus of elasticity, water absorption of hardened concrete. [7]

H. Use of Recycled Aggregates

Shi Cong et.al. (2007) suggested that use of high percentages of recycled aggregates in concrete is not so feasible. This paper tries to prove the same by using class F fly ash as a replacement. In this study, two series of concrete mixtures were prepared with water-to-cement ratios of 0.45 and 0.55. Fly ash was used as 0, 20, 50, and 100% by weight replacements of natural aggregate. As the recycled aggregate and the fly ash contents increased, the compressive strengths, tensile strengths, and static modulus of elasticity values of the concrete at all ages decreased. Further it decreased the resistance to chloride ion penetration and increased the drying shrinkage and creep of concrete. The best result was obtained in structural concrete is by incorporating 25–35% of fly ash as some of the drawbacks induced by the use of recycled aggregates in concrete could be minimized. [8]

I. Use of Bottom Ash as Portland cement Replacement

Watcharapong et.al. (2012) used bottom ash as Portland cement replacement to produce lightweight concrete (LWC). Portland cement type 1, river sand, bottom ash, Aluminium powder and calcium hydroxide (Ca (OH)) were the raw materials used in this study. BA was replaced at 0%, 10%, 20% and 30% by weight and Aluminium powder was added at 0.2% by weight. After the concrete were autoclaved for 6 h and left in air for 7 days compressive strength, flexural and thermal conductivity tests were then carried out. Due to the tobermorite formation the compressive strength and thermal conductivity boosted with increased BA content. [9]

V. MATERIALS USED

The cement used for this project work is Ordinary Portland Cement of 53 grade. The fine aggregate to be used in the study is manufactured sand. Fine sand conforming to IS specification is to be used in this study. Various tests were conducted on fine aggregate according to IS specifications. The fine aggregate indented to replace sand is Quarry dust. For the production of light weight concrete, sieved sand (600µm) is used and for the production of the aerated light weight mortar mix. Class F fly ash is preferred for the study. Aluminium powder provides the porous properties that is required t create a lightweight concrete. The

Aluminium powder used for the study is manufactured by NICE CHEMICALS Pvt Ltd, Kerala. The recommended super plasticizer is MasterGlenium SKY 8233

VI. CONCLUSIONS

From the literature review, approximate amount of fly ash, Quarry dust and Aluminium powder to be used was obtained. It is noted that the optimum amount of fly ash used to get a satisfactory result is around 25-35% by weight of cement. It can also be noted that aluminium powder replaced is around 0.2% which makes the concrete enough porous, maintaining a feasible strength. When recycled aggregates such as quarry dust is used, the maximum strength for concrete was obtained approximately at 50% replacement of fines by quarry dust. It is also noticed that as finer particles are introduced, the strength first increases and then decreases.

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