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RESEARCH ARTICLE

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A STUDY ON LIGHT WEIGHT CONCRETE AND ITS PROPERTIES

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ABSTRACT

Concrete is a construction material composed of cement (commonly Portland cement) as well as other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water and chemical admixtures This chapter presents the detailed experimental programmed of this investigation. It includes materials and pumice stone used a detailed methodology of experimental programmed, mix proportions, specimen details, and test set up. The details of the tests conducted to ascertain the basic properties of constituent materials, the tests conducted on standard specimens and the experiments conducted using structural components are also explained. This project deals with the development of two types of lightweight concrete the one using lightweight aggregate (Pumice stone) and the other water floating type using zinc powder, aluminium powder. as an air entraining agent. This also shows the importance of water/cement ratio as in first type of concrete it relates to the smoothness of the surface and in second one it is a major factor which controls the expansion of concrete. This work presents the results of an experimental study investigating the effects pumice for light weight concrete on the mechanical properties of concrete. Experimental program consisted of compressive and tensile strength a test was carried out this study aims to investigate the compressive and tensile strength of light weight concrete, incorporated with zinc powder and aluminium powder at various dosages. For this, a drop weight test was performed on the 7 days and 28 days cured Plain and light weight concrete samples as per the testing procedure. The main aim of this experiment is to study the mechanical properties of light weight concrete of M15and M20 grade with zinc powder added to concrete in different proportions i.e. 0.4%, 0.5%,0.6. Aluminium powder added to concrete in different proportions 0.5%,1.0% and 1.5% with water cement ratio of 0.42.

Keywords: tensile strength, compressive strength, workability, permeability, weight.

I. INTRODUCTION

Concrete is a building material in the human history. It consists of cement, Coarse and Fine Aggregates and Water. It is no doubt that with the improvement of human civilization concrete will continue to be a governing construction material in the future. Aerated concrete is relatively homogeneous when compared to normal concrete, as it does not contain coarse aggregate phase, yet shows vast variation in its properties. The properties of aerated concrete depend on its microstructure (void±paste system) and composition, which are influenced by the type of binder used, methods of pore-formation and curing. Although aerated concrete was initially envisaged as a good insulation material, there has been renewed interest in its structural characteristics in view of its lighter weight, savings in material and potential for large scale utilisation of wastes like pulverised fuel ash. Aerated concrete is a highly thermally insulating concrete-based material used for both internal and external construction. Aerated concrete is well suited for urban areas with high rise buildings and those with high temperature variations. Pumice stone is a light weight materials by using pumice stone and chemical admixtures are zinc powder and aluminium powder to find out the mechanical properties of light weight concrete.

A. Structural properties of concrete

The studies have been conducted largely based on the structural properties of concrete and have been discussed below.

B. Compressive Strength

The compressive strength of concrete is one of the most important and useful properties of concrete. Strength is a measure of amount of stress acquired to fail a material. Concrete is strong in compression but weak in tension and the working stress theory for the concrete design also consider the concrete as a mostly suitable for bearing the compressive load ; that is why the compressive strength of the material is specified. Since the strength of concrete is a function of cement hydration process, which is relatively slow, traditionally the specification and the test for concrete strength are based on specimens cured under standard temperature humidity conditions for a period of 28 days.

Calculation:

Area of the specimen = 22500mm^2

Maximum load applied =…………………KN

Ultimate compressive load (N)

= Compressive strength (N/mm^2)

Cross section of specimen (mm^2)

= ---------------------------------KN

C. TENSILE STRENGHT

In normal structural design of members in flexure, the tensile strength of concrete is important to estimate the cracking loading. The absence of concrete is important in maintain the continuity in concrete structure for diminishing the corrosion of reinforced concrete for a liquid retaining structure.

Concrete as we know is relatively strong in compression and weak in tension in reinforced concrete members, little dependence is placed on the tensile strength of concrete since steel reinforced bars are provided to drying shrinkage, rusting of steel reinforcement, temperature gradients and many other reasons. Therefore, the knowledge of tensile strength of concrete is of importance. A concrete road slab is called upon to resist tensile stress from two principal sources wheel loads and volume change in the concrete. Wheel loads may cause high tensile stresses due to bending, when there is an inadequate sub grade support. Volume change, resulting from changes in temperature and moisture, may produce tensile stresses, due to warping and due to the movement of the slab along the sub grade. Stresses due to volume changes alone may be high. The longitudinal tensile stress in the bottom of the pavement, caused by restraint and temperature warping, frequently amounts to as much as 2.5MPa at certain periods of the year and the corresponding stress in the transverse direction is approximately 0.9MPa These stresses are additive to those produced by wheel loads on unsupported portions of the slab.

Tensile strength=2p/3.14dl

Fig: 1 split tensile strength

D. WORKABILIY

A theoretical water/cement ratio calculated from the considerations discussed above is not going to give an ideal situation for maximum strength. Hundred percent compaction of concrete is an important parameter for contributing to the maximum strength. Lack of compaction will results in air voids whose damaging effect on strength and durability is equally or more predominant then the presence of capillary cavities. To enable the concrete to be fully compacted with given effects, normally a higher water/cement ratio than that calculated by theoretical consideration may be required. That is to say the function of water is also to lubricate the concrete so that the concrete can be compacted with specified effort forth coming at the site of work. The lubrication required for handling concrete without segregation, for placing without loss of homogeneity, for compacting with the amount of efforts forth-coming and to finish it sufficiently easily, the presence of a certain quantity of water is of vital importance. The quality of concrete satisfying the above requirements is termed as workable concrete. The word "workability "or workable concrete signifies must wider and deeper meaning than the other terminology "consistency" often used loosely for workability. Consistency is a general term to indicate the degree of fluidity or the degree of mobility. A concrete which has high consistency and which is more moble, need not be of right workability for a particular job. Every job requires a particular workability. A concrete which is considered workable for mass concrete foundation is not workable for concrete to be used in roof constrictions, or even in roof construction , concrete considered workable when vibrator is used, is not workable when concrete is to be compacted by hand. Similarly a concrete considered workable when used in thick section is not workable when required to be used in thin sections. Therefore the word workability assumes full significance of the type of work, thickness of section; extend of reinforcement and mode of compaction.

E. LIGHT WEIGHT CONCRETE

This project deals with the development of light weight concrete using aluminum powder and zinc powder. Water floating type is the zinc power and the aluminum metal powder as an air entraining agent. This also shows the importance of water/cement ratio as in first type of concrete it relates to the smoothness of the surface and is second one it is a major factor which controls the expansion of concrete. All the test specimens were cubes of size in (150x150x150) mm cast in moulds made of steel. The cubes formed were kept for a time of 15 to 18 minute under normal room temperature conditions and moulds were removed. They were then subjected to steam curing and drying. Raw materials are mixed in the desired proportions. To achieve the possible mix design. A sample of 150x150x150 is prepared by mixing 174gm of aluminium powder and 346 gm.

TABLE I: Materials and Properties of chemical admixtures

Different type of chemical with %	Compressive strength N/mm^2		Tensile strength N/mm^2	
	7 D	28 D	7 D	28 D
Aluminium-0.4%	12.32	16.53	1.32	2.13
Aluminium-0.5%	11.40	15.30	1.21	1.82
Aluminium-0.6%	09.23	13.25	1.10	1.60
Zinc-0.5%	13.62	18.63	1.42	2.21
Zinc-1.0%	14.24	19.56	1.54	2.31
Zinc-1.5%	12.50	16.28	1.29	2.15

II. LITERATURE REVIEW

Kenneth S. Harmon [1] in this paper they give brief explanation about light weight concrete. Structural light weight aggregate is an important and versatile material in modern construction. It has many and varied applications including multi-storied building frames and floors, bridges, offshore oil platforms and pre-stressed or precast elements of all types. Many architect, engineers and contractors recognize the inherent economics and advantages offered by this material, as evidence by the many impressive light weight concrete structures found today throughout the world. Structural lightweight aggregate concrete solves weight and durability problems in buildings and exposed structures. Light weight concrete has strength comparable to the normal concrete. Structural light weight concrete offers design flexibility and substantial savings cost by providing: less dead load, improved seismic structural response, longer spans better fire ratings etc.

Hjh kamsaiah mohd, ismail (head) [2] this paper describes the behaviour of light weight concrete. Light weight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities such as naillabity and lessened the dead weight. It is lighter than the conventional concrete. The main specialties of light concrete are its low density and thermal conductivity.

P.C. Aitcin and Mehta P.K, et al (1990) [3] has investigated the influence of four coarse aggregate types available in Northern California on the compressive strength and elastic behavior of a very high strength concrete mixture. The four types of coarse aggregates used were Diabase, Limestone, Gravel, and Granite. The compressive of the concrete for different aggregates at the end of 28 days were 100 MPa (diabase), 97.3MPa (Limestone), 92.1MPa (Gravel) and 84.8MPa (Granite). The elastic moduli of the aggregates at the end of 28 days were 36.6 GPa (Diabase), 37.9 GPa (Limestone), 33.8 GPa (Gravel) and 31.7 GPa (Granite). From the strength and elastic moduli data the superior performance of diabase aggregate and limestone aggregate concretes compared to gravel aggregate and granite aggregate concretes is self-evident. However the highest compressive strength values and elastic modulus were not found in the same concrete; the diabase aggregate produced the concrete with highest compressive strength whereas the limestone aggregate that produced concrete with highest elastic modulus. It has been concluded that four different types of aggregates in a very high strength concrete mixture (0.275 W/C), compressive strength and elastic modulus of concrete were shown to be significantly influenced by the mineralogical characteristics of aggregates.

Francois de Larrard et al (1997) [4] has presented a compressive theory describing the influence of aggregate on the compressive strength of concrete. The distinction of the aggregate is made between the topological and mechanical aspects. The topological effect also called as confining effect, includes the effect of the volume and the maximum size of the aggregate, which are described by means of a single physical parameter, the maximum paste thickness (MPT). MPT is defined as mean distance between two adjacent coarse aggregates. The second type of effect concerns the bond between paste and aggregate (bond effect), and a limitation of the strength that originates in the intrinsic strength of the rock. The aim of the research is to understand the role of aggregate in the compressive strength of structural concrete, from which semi-empirical mathematical models can be derived and incorporated in software for computer aided mix design and quality control. It has been concluded that the paste has a certain compressive strength, depending on mixture proportioning parameters (W/C ratio), time and curing regime.

III. OBJECTIVE OF THE STUDY

The benefits of using mineral admixtures in cement are fairly established. They offer benefits with respect to the cost of manufacturing of cement because fly ash and silica fumes are by-products or waste materials replacing a part of OPC, hence fewer primary energy and raw materials are required in production of low cost concrete. This leads to more efforts towards the use of waste materials with lower environmental impact.

A. OBJECTIVE OF THE PRESENT INVESTIGATION

1. To estimate the compressive strength of concrete, using the compressive and tensile strength tests specimen for M20 grade of concrete with aluminum powder and zinc powder added to concrete in different proportions i.e. 0.4%, 0.5%, 0.6%, 0.5%, 1.0%, and 1.5% with water cement ratio of 0.42.
2. The experimental investigation has to be conducted on light weight concrete using compressive strength test.
3. Two different types of chemicals are to be used in the experimental investigation. Cubes size is 150x150x150.

IV. CONCREATE MIX DESIGN

TABLE II: Mix Proportion for M20 Grade Concrete

Water	Cement	Coarse aggregates	Fine aggregates
191.58	478.95	1237.99	529.207
0.4	1	2.33	1.104

Hence the mix is 1: 2.33: 1.10 (designed for M_{20})

V.EXPERIMENTAL INVESTIGATION

A.COMPRESSIVE STRENGTH

The compression tests on cubes were conducted according to Indian normal specifications (IS: 516 – 1959. compressive strength Francois DE Garrard et al (1997) has presented comprehensive theory describing the influence of mixture on the compressive strength of concrete. The distinction of the aggregate is made between the topological and mechanical aspects. The topological effect also called as confining effect, includes the effect of the volume and the maximum size of the aggregate, which are described by means of a single physical parameter, the maximum paste thickness (MPT). MPT is defined as mean distance between two adjacent coarse aggregates. The second type of effect concerns the bond between paste and aggregate (bond effect), and a limitation of the strength that originates in the intrinsic strength of the rock. The aim of the research is to understand the role of aggregate in the compressive strength of structural concrete, from which semi-empirical mathematical models can be derived and incorporated in software for computer aided mix design and quality control. It has been concluded that the paste has a certain compressive strength, depending on mixture proportioning parameters (W/C ratio), time and curing regime.

Fig 2: Compressive strength of cube

B. TENSILE STRENGHT

In normal structural design of members in flexure, the durability of concrete is very important to estimate the cracking loading. The absence of concrete is very important in maintain the continuity in concrete structure for decreasing the corrosion of concrete for a liquid holding structure.

Concrete as we all know is comparatively robust in compression and weak in tension in concrete members, very little dependence is placed on the durability of concrete since steel reinforced bars area unit provided to drying shrinkage, rust of steel reinforcement, temperature gradients and lots of other reasons. Therefore the data of durability of concrete is of importance. A concrete road block is termed upon to resist tensile stress from two principal sources wheel hundreds and volume modification within the concrete. Wheel hundreds could cause high tensile stresses attributable to bending, once there's an inadequate sub grade support volume modification, ensuing from changes in temperature and wet, could turn out tensile stresses, attributable to warp and attributable to the movement of the block on the sub grade. Stresses attributable to volume changes alone could also be high .The longitudinal tensile stress within the bottom of the pavement, caused by restraint and temperature warp, oft amounts to the maximum amount as two. 5MPa at sure periods of the year and therefore the corresponding stress within the transversal direction is approximately zero.9MPa these stresses are additive to those made by wheel hundreds on unsupported parts of the block.

Fig 3: spilt tensile strength

VI. TEST RESULTS

Results of this paper are as shown in bellow Figs.4to 9.

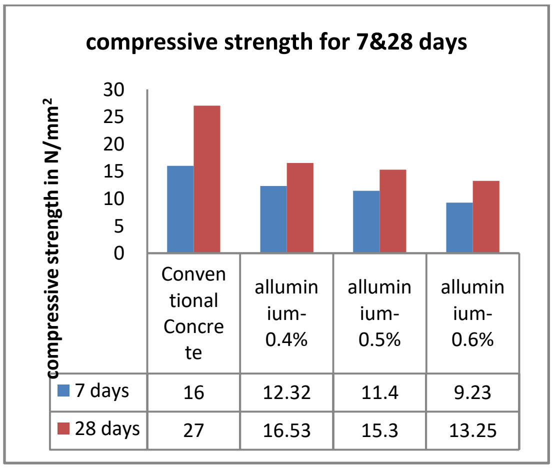

Fig 4: compressive strength of aluminium powder for 7 and 28 days

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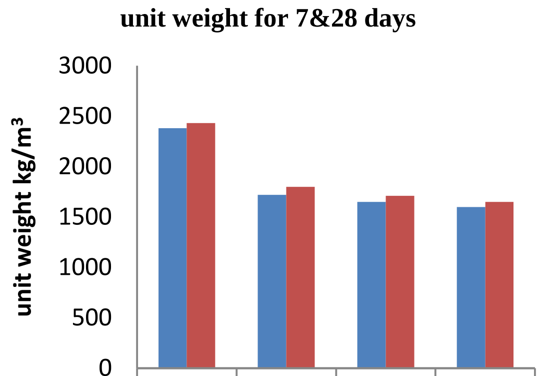
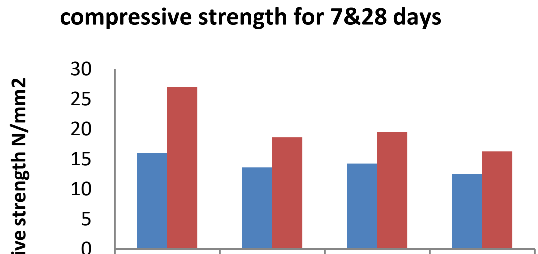


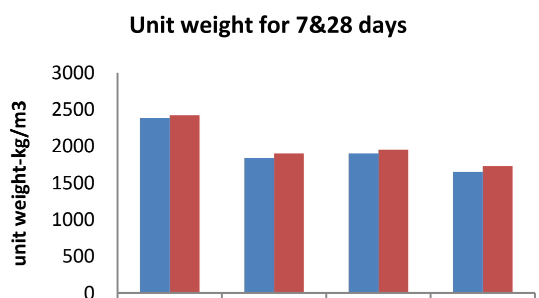
	Conventional Concrete	allumin ium-0.4%	allumin ium-0.5%	allumin ium-0.6%
7 days	2380	1720	1650	1600
28 days	2430	1800	1710	1650

Fig 5: unit weight of conventional & aluminium powder for 7 and 28 days



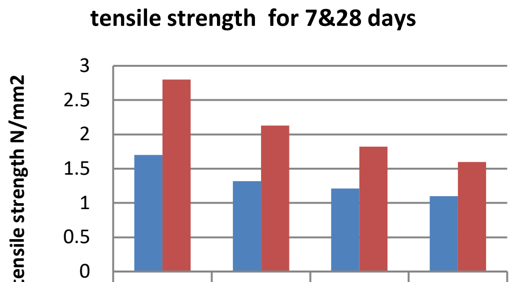
	Conventional Concrete	Zinc-0.5%	Zinc-1.0%	Zinc-1.5%
7 days	16	13.62	14.24	12.5
28 days	27	18.63	19.56	16.28

Fig 6: unit weight of zinc powder conventional for 7 and 28 days



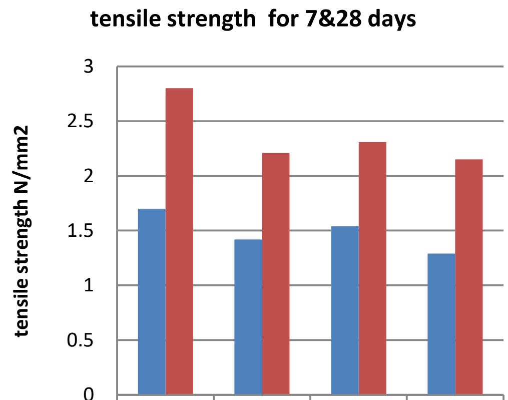
	Conventional Concrete	Zinc-0.5%	Zinc-1.0%	Zinc-1.5%
7 days	2380	1840	1900	1650
28 days	2420	1900	1950	1725

Fig 7: unit weight of zinc powder and conventional concrete for 7 &28 days



	Conventional Concrete	aluminium-0.4%%	aluminium-0.5%%	aluminium-0.6%%
7 days	1.7	1.32	1.21	1.1
28 days	2.8	2.13	1.82	1.6

Fig 8: tensile strength of aluminium and conventional concrete for 7 &28 days



	Conventional Concrete	zinc - 0.5%	zinc-1.0%	zinc-1.5%
7 days	1.7	1.42	1.54	1.29
28 days	2.8	2.21	2.31	2.15

Fig 9: tensile strength of zinc and conventional concrete for 7 &28 days

VII. AKNOLEDGEMENT

All authors are grateful to thank to the management of Visvodaya Engineering College, Kavali for the facility provided to complete the present study.

VIII. CONCLUSIONS

- Compressive strength obtained in Aluminium powder cubes and Zinc powder are quite high than ordinary concrete.
- Due to presence of chemical admixtures, the concrete is lighter weight compared to the conventional concrete.
- In compressive strength, the strength was observed and it is more than 4.21 times

than conventional concrete by adding of 0.4% of aluminium powder.

- In compressive strength, the strength was observed and it is more than 3.90 times than conventional concrete by adding of 0.5% of aluminium powder.
- In compressive strength, the strength was observed and it is more than 3.02 times than conventional concrete by adding of 0.6% of aluminium powder.
- In compressive strength, the strength was observed and it is more than 5.01 times than conventional concrete by adding of 0.5% of Zinc powder.
- In compressive strength, the strength was observed and it is more than 5.32 times than conventional concrete by adding of 1.0% of zinc powder.
- In compressive strength, the strength was observed and it is more than 3.78 times than conventional concrete by adding of 1.5% of aluminium powder.
- In tensile strength, the strength was observed and it is more than 0.8 times than conventional concrete by adding of 0.4% of aluminium powder.
- In tensile strength, the strength was observed and it is more than 0.61 times than conventional concrete by adding of 0.5% of aluminium powder.
- In tensile strength, the strength was observed and it is more than 0.50 times than conventional concrete by adding of 0.6% of aluminium powder.
- In tensile strength, the strength was observed and it is more than 0.79 times than conventional concrete by adding of 0.5% of zinc powder.
- In tensile strength, the strength was observed and it is more than 0.97 times than conventional concrete by adding of 1.0% of zinc powder.
- In tensile strength, the strength was observed and it is more than 0.86 times than conventional concrete by adding of 0.4% of zinc powder.
- By this project we know the light weight concrete is high strength compared to ordinary concrete
- As a Civil Engineer we have construct the constructions with most economically and with high strength.

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