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Experimental Investigation of Properties Of Structural Lightweight Aggregate Concrete

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Abstract- Concrete is a family of different material like binding material (cement+ fly ash), fine aggregate, coarse aggregate and water. Today construction cost is very high with using conventional materials due to unavailability of natural materials. This problem can be solved by total replacement of concrete with different material which is not convenient in terms of required properties. Due to this limitation of unavailability of material which plays the vital role of concrete we have only choice of partial replacement of concrete ingredients by waste materials. Over 3.3 billion tons of cement was consumed globally in 2010 based on survey of world coal association and also cement production emits CO2 in to the atmosphere which is harmful to the nature. If we can partially replace the cement with the material with desirable properties then we can save natural material and reduce emission of CO2 in to the atmosphere. This industrial waste dumping to the nearest site which spoils the land and atmosphere as well as it also affects aesthetics of urban environment so use of this waste material in concrete is cost effective as well as environment friendly way to disposal of waste. The numerical demonstrating based conjecture, thusly, is performed with the dynamic help of the advancement strategy which can do successfully assessing the compressive strength, the split elasticity, and the flexural strength with the guide of the perceived information esteems. The nature of the paper is the strength of pumice lightweight cement. With fractional supplanting of the sand with the quarry dust, the time and cost are limited minimized

Keywords - Binding material, CO2 etc.

I. INTRODUCTION

Concrete is a very strong and versatile mouldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate.

Concrete's versatility, durability, sustainability, and economy have made it the world's most widely used construction material. About four tons of concrete are produced per person per year worldwide and about 1.7 tons per person in the United States. The term concrete refers to a mixture of aggregates, usually sand, and either gravel or crushed stone, held together by a binder of cementitious paste. The paste is typically made up of Portland cement and water and may also contain supplementary cementing materials (SCMs), such as fly ash or slag cement, and chemical admixtures Understanding the fundamentals of concrete is necessary to produce quality concrete.

This publication covers the materials used in concrete and the essentials required to design and control concrete mixtures for a wide variety of structures.

1. General:
The point of the pumice lightweight cement is to add the quarry dust with the incomplete trade of sand for the flawlessness of strength and the minimization of the expense and time.

The High-performance Concrete might be suitably portrayed as that exceptional brand of solid, which meets with the particular products and unwavering quality imperatives that are not equipped for ongoing assessment normally by utilizing the customary materials and the regular blending, putting, and relieving techniques.

The solid is one of the broadly utilized development materials which by and large fall in line of the ordinary bath peril rate work bend. The dunk in the deadweight goes far in the lessening in the structure consumption. The work of the lightweight totals in solid offers a huge number of helpful highlights.

2. Types of Lightweight Concrete:
Lightweight concrete can be prepared either by injecting air in its composition or it can be achieved by omitting the finer sizes of the aggregate or even replacing them by a hollow, cellular or porous aggregate.

Particularly, lightweight concrete can be categorized into three groups:

- Absence fines concrete
- Foamed concrete
- Lightweight aggregate concrete

2.1 Absence Fines Concrete:
Absence Nonappearance fines cement can be characterized as lightweight cement made out of concrete and fine total. Consistently appropriated voids are shaped all through its mass. The principle qualities of this sort of lightweight cement is it keeps up its enormous voids and not framing laitance layers or concrete film when put on the divider. one illustration of Absence fines concrete. Nonattendance fines concrete normally utilized for both burden bearing and non-load bearing for outer dividers and segments. and hence debilitates the strength.

2.2 Foamed Concrete:
Frothed concrete doesn't contain coarse total, and can be viewed as a circulated air through mortar. Ordinarily, circulated air through cement is made by bringing air or different gas into a concrete slurry and fine sand. In business practice, the sand is supplanted by pummelled fuel debris or other siliceous material, and lime possibly utilized rather than concrete. There are two strategies to set up the circulated air through cement.

2.3 Lightweight Aggregate Concrete:
Permeable lightweight total of low explicit gravity is utilized in this lightweight cement rather than customary cement. The lightweight total can be regular, for example, pumice, scoria and those of volcanic birthplace and the fake total, for example, extended impact heater slag, vermiculite and clinker total. The primary trait of this lightweight total is its high porosity which brings about a low explicit gravity.

3. Objective:
The main objectives of this research are:

- To make the mixture compositions of grade of concrete M40 mix Concretes on the basis of their tensile and workability and also compressive test.
- Comparative experimental study of concreter M40 mix concrete in compressive, flexural test and also test of workability of concrete on replacement different percentage of sand and aggregate by sugarcane baggers ash, waste brick bats.
- To construct model the tensile actions of M40 grade of concrete with different combinations of waste material, on the basis of performed its properties test.
- To perform a study on its utilization in the engineering practice and to assess this utilization from engineering, technical and economical point of view.
- This workfare consists the complete perception of the growth M40 grade of Concrete, from its raw materials and its utilization in the engineering practice.

II. METHODOLOGY

The procedure viably utilized estimate the target work by methods for the powerful numerical displaying. The preparation and testing procedure is conveyed to find out the target capacity of the numerical model. The coarse aggregate (CA), fine aggregate (FA), concrete, water, silica seethe (SF), super plasticizer (SP), quarry dust (QD), load (KN), and extreme burden (KN) are the different critical boundaries that are utilized to prepare the numerical model by misusing 80% test information base and the lingering 20% ends up terribly occupied with validating the numerical model.

1. Properties of aggregate:

S. No.	Number Chemical contents	Percentage (%)
1	CaO	4.6
2	SiO2	59.2
3	Al2O3	16.6
4	Fe2O3	4.80
5	MgO	1.8
6	SO3	0.40
7	K2O	5.40
8	Na2O	5.60
9	Loss on ignition	1.60

Materials Used for Experimental Work. In the experimental work, the Ordinary Portland Cement is used. Normal river sand is used as fine aggregate with specific gravity of and the course aggregate used is the pumice lightweight aggregate of size 16mm.Themix design is based on the ACI method. The chemical properties of the pumice aggregate are presented in Table 1.Mix Proportion and Laboratory Testing Program. Eight types of concrete mixtures with different proportions of lightweight aggregate and quarry dust are offered. In addition to the above mixture concrete is mixed with silica fume in replacement of cement up to 10% and chemical admixture of SP430 is added at 2% to cement weight Cube Compressive Strength.

Fig 1. Vibration and costing of beam 150mmx150mmx150mm.

Fig 2. Compression testing machineor cube test.

III. MEASUREMENTS WITH FRESH CONCRETE

Quickly following blending, the solid was tried in the new state for four properties: the droop, temperature, unit weight, and air content. The consequences of these tests for each blend are summed up in Table 5.1. As examined in Chapter 4, in picking the segment extents for each blend, the droop objective was somewhere in the range of 1 and 2 inches (2.54 and 5.08 cm). Be that as it may, for the coconut shell blends and the sisal fibre blends, the droop estimations were essentially higher than the objective, going from 4.0 inches (10.2 cm) to 9.5 inches (24.1 cm).

The idea of the coconut shell aggregate may clarify the high droop in Mix 1 and 2. As indicated by Gunasekaran et al. (2012), coconut shell aggregate builds the functionality of cement because of its one smooth surface. Additionally, when assessing extents, an ostensible limit of ¾ inch (1.9 cm) was utilized to pick esteems from ACI 211.2-98.

This ended up having been a helpless portrayal of the aggregate, because the thickness of the coconut shell aggregate, albeit changed, never surpassed 3/16 inch (4.8 mm).

IV. GENERAL

The procedure of methods used for testing recycled concrete aggregate cement, coarse aggregates, fine aggregate es and concrete are given below the ratio of the density of a substance to the density of a reference substance. The reference substance is water for liquids or air for gases. The specific gravity of the solid is the ratio of its weight in air to the difference between its weight in air and its weight immersed in water. we are using M40 for that making mix design calculation are following.

1. Methodology:

The numbers of methodology are available. In this work used the following stages:

- **Cement:** Laboratory testing
- **Sand:** Silt Content, Specific gravity of sand, Sieve analysis
- **Aggregate:** Sieve analysis, Flakiness test**,** Crushing Test**,** Elongation Test
- **Mix Design**: M-30 Grade
- **Fresh concrete test:** like workability test slum cone test

2. Parameters for mix design M40:

- Grade Designation = M-40
- Type of cement = O.P.C-43 grade
- Brand of cement = Ultra tech
- Admixture = Fosroc (Conplast SP 430 G8M)
- Fine Aggregate = Zone-I
- Sp. Gravity Cement = 3.15
- Fine Aggregate = 2.61
- Coarse Aggregate (20mm) = 2.65
- Coarse Aggregate (10mm) = 2.66
- Minimum Cement (As per contract) = 400 kg/ m^3
- Maximum water cement ratio (As per contract) = 0.45

3. Coarse Aggregate:

Greatest size of aggregate is the standard strainer size (40mm, 25mm, 20mm, 12.5mm, 10mm) through which at any rate 90% of coarse aggregate will pass. Greatest size of aggregate influences the functionality and strength of cement.

Higher most extreme size of aggregate, which will have lower territory of contact with concrete mortar glue, will flop prior as a result of bond disappointment. Thus, for higher evaluations of cement (M40 and higher), it is favourable to utilize lower most extreme size of aggregate to forestall bond disappointment.

4. Mix Calculation for M40 grade of concrete

4.1 Target Mean Strength =

40 + (5 X 1.65) = 48.25 Mpa

4.2 Selection of water cement ratio: -

Assume water cement ratio = 0.4

4.3 Calculation of cement content:

Assume cement content 400 kg / m^3

(As per contract Minimum cement content 400 kg / m^3)

4.4 Calculation of water:

400 X 0.4 = 160 kg which is less than 186 kg (As per Table No. 4, IS: 10262) Hence o.k.

4.5 Calculation for C.A. & F.A.:

As per IS: 10262, Cl. No. 3.5.1

$$V = [W + (C/S_c) + (1/p).(f_a/S_{fa})] \times (1/1000) \quad V = [W + (C/S_c) + \{1/(1-p)\}.(ca/S_{ca})] \times (1/1000)$$

Where;

V= absolute volume of fresh concrete, which is equal to gross volume (m^3) minus the volume of entrapped air,

W= mass of water (kg) per m^3 of concrete,

C = mass of cement (kg) per m^3 of concrete,

S_c = specific gravity of cement,

p = Ratio of fine aggregate to total aggregate by absolute volume, (fa),

ca = total mass of fine aggregate and coarse aggregate (kg) per m^3 of Concrete respectively, and Sfa,

Sca = specific gravities of saturated surface dry fine aggregate and Coarse aggregate respectively.

As per IS-10262, for 20mm maximum size entrapped air is 2%.

Assume F.A. by % of volume of total aggregate = 36.5 %

0.98 = [160 + (400 / 3.15) + (1 / 0.365) (Fa / 2.61)] (1 /1000)

Fa = 660.2 kg Say Fa = 660 kg.

0.98 = [160 + (400 / 3.15) + (1 / 0.635) (Ca / 2.655)] (1 /1000)

Ca = 1168.37 kg.

Say Ca = 1168 kg.

Considering 20 mm: 10mm = 0.6: 0.4

20mm = 701 kg. 10mm = 467 kg.

Hence Mix details per m^3

Cement = 400 kg

Water = 160 kg

Fine aggregate = 660 kg

Coarse aggregate 20 mm = 701 kg

Coarse aggregate 10 mm = 467 kg

Admixture = 2.4 kg.

Water: cement: F.A.: C.A. = 0.4: 1: 1.65: 2.92

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V. GENERAL

According to is code 1199 and also is code 516 following test perform on cube and beam Samples from fresh concrete shall be taken as per IS: 1199 and cube and beam specimens shall be made, cured and tested at 28 days as per IS: 516. ... m of concrete.

Each sample shall comprise of 3 test specimens of beams and cubes. These shall be tested for 28 days strength. This Indian Standard was adopted by the Indian Standards Institution on 10 November 1959, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Building Division Council.

Testing plays an important role in controlling the quality of cement concrete work. Systematic testing of the raw materials, the fresh concrete and the hardened concrete is an inseparable part of any quality control programme for concrete which helps to achieve higher efficiency of the materials used and greater assurance of the performance of the concrete in regard to both strength and durability. The test methods used should be simple, direct and convenient to apply.

1. Compressive Strength:
The different mixes were moulded in cube of size 150 ×150×150mm for testing the compressive strength. Before moulding, the mould is thoroughly cleaned using a waste cloth and properly oiled along its faces.

Then the concrete was poured into the mould, compacted, and cured for 7 days and 28 days. After curing the cube is dried and tested in CTMand the compressive strength is found and listed in Table presents a comparison between equivalent cube compressive strength development from Trial mixes RP011 and RP033, overall, the results were variant with compressive strengths as high as 120MPa at 28 days.

Figure5.3 illustrates typical density observations throughout the testing period for Trial mix BB023. The reduction in density compared to normal strength concrete, typically between 2250 and 2350kg/m^3, is primarily due to (1).

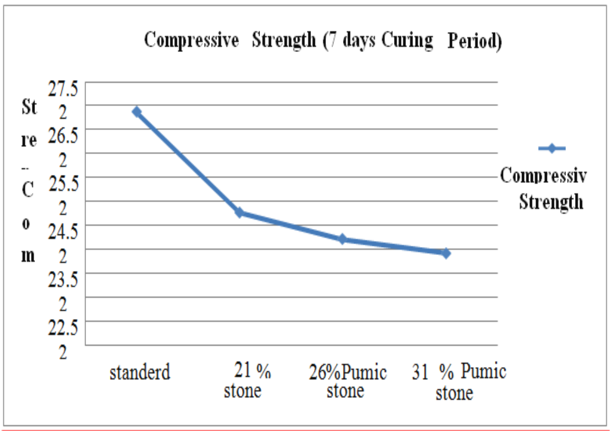

Fig 3. Replacement of fine aggregate by pumic stone different percentage on 7dyas.

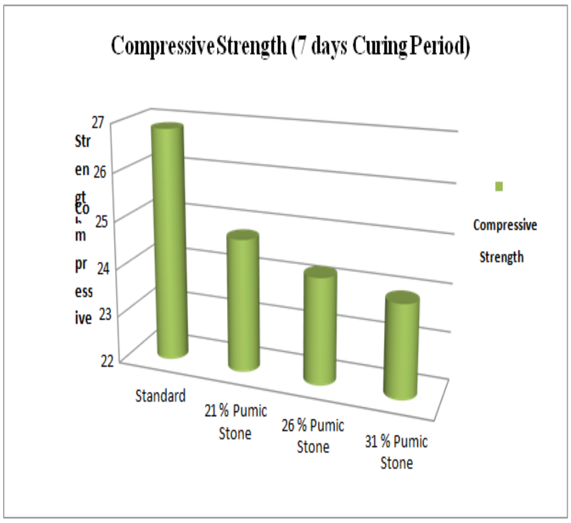

Fig 4. Illustrates typical density observations.

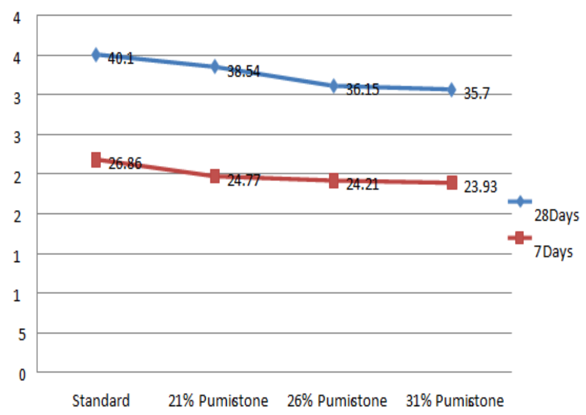

Fig 5. Replacement of fine aggregate by pumic stone different percentage on 7days & 28dyas.

2. Compressive Strength Vs Weight of Cube:

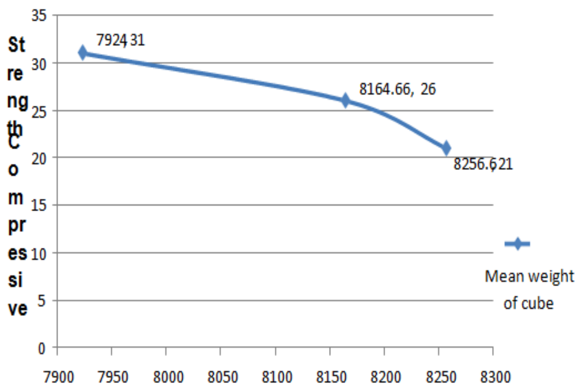

Fig 6. Mean weight of cube.

3. Flexural Strength concept:
For each mix, totally twelve number of prisms of size 100x100x500mm cast and tested in Flexural Testing Machine (FTM). The specimen of prism placed horizontally on the platform of the FTM. The ultimate load noted and calculated the flexural strength of corresponding specimen**.**

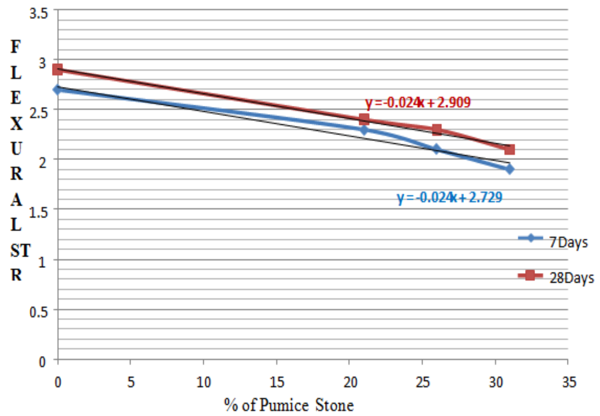

Fig 7. Graphically represent flexural strength of beam at different percentage.

4. 28 Days Flexural Strength Vs Weight of Cube:

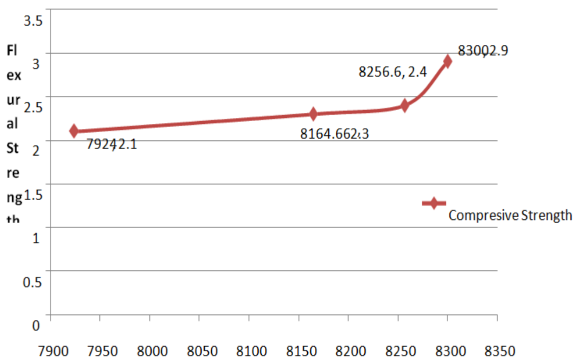

Fig 8. Mean Weight of cube on 28 day.

VI. CONCLUSION

Finally, present research was carried out to determine the mechanical properties of light weight concrete containing pumice aggregate. The objectives of the study were to study the effect of partial replacement of pumice aggregate with Fly Ash and Pumice stone on compressive strength of concrete. Specimens were prepared keeping w/c ratio 0.4 and by varying percentages of stone. After curing, the specimens were tested after 7 and 28 days for getting the value of compressive strength.

The statistical analysis was applied on results of compressive strength test. All the results were found statistically significant. From the experimental investigations, it can be concluded that: In addition to cylinder compressive strength samples, cubes (150*150mm) were also used for produced from which equivalent cubes. To ensure an accurate sample group was chosen the mean compressive strength was based.

- While the seven day mean equivalent cube compressive strength of RP01, RP02 and RP03 observed in 7 Days 23.93, 24.21, and 24.77 cube and 28 days compressive strength of 40.10, 38.58, 36.15 and 35.70Mpa significant variation was observed between the results, particularly in the equivalent cubes.
-
- Standard reference database, it was also observed that the phase is increasing in sample RP02 and RP03 which results in increase.
Further from the Flexural Strength test it was observed that optimum strength gain is RP11, RP12, RP13 and RP14is 2.6,2.3,2.1 and 1.9.

By comparing the peaks of samples with standard reference database, it was also observed that the phase is increasing in sample RP12 and RP11 which results in increase in flexural strength. Supplement with the results obtained from flexural strength.

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