BEHAVIOR OF PUMICE LIGHTWEIGHT CONCRETE

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ABSTRACT

Lightweight concrete has many advantages compared to conventional concrete. The light weight concrete has density is about 300 to 1850Kg/m^3 which is less than the conventional concrete weight density of about 2200 to 2600 Kg/m^3. The lightweight concrete generally made with natural lightweight aggregates or artificial aggregates. In the present investigation the pumice aggregates are used to produce the concrete and to improve the performance of concrete, Bagasse ash (by-product of sugar cane industry) is used as partial replacement material for cement in concrete mix with varying proportions 0, 5, 10, 15 and 20%. Experimental studies are conducted in compression and split tension. The results indicate that the optimum percentage of bagasse ash for lightweight concrete mix is 15%. To establish the relation between split tensile and compressive strength, a regression model was deduced.

Key words: Bagasse ash, Compression, Pumice, Split tension

I. INTRODUCTION

The use of lightweight aggregate concrete has many advantages of dead load reduction, high thermal insulation; increase the progress of building and lowers haulage and handling cost. The self weight of building on the foundation is an important factor in design, especially in the case of low bearing capacity soils and high rise buildings. In multistoried buildings, the structural components such as beams and columns have to carry load of floors and walls. If floors and walls are made up of lightweight concrete, it leads to economy to the structure. The lightweight concrete is also lowers power consumption for extreme climatic conditions due to possessing property of low thermal conductivity. The lightweight concrete is produced with the help of lightweight aggregates, which are produced with the naturally available aggregates or artificially aggregates. In nature the available low density aggregates at many places over the globe are pumice, diatomite, scoria etc. and the artificially aggregates are produced with combinations of cinders, clinker & breeze, foamed slag and bloated clay. Now days many people are also using the rice husk, fly ash, slag, sludge waste, palm oil shell, shale slate and other industrial by products with and without introducing the air entraining agents. To improve the strength of light weight concrete the industry people are using the the good quality of cement along with the admixtures. This helps to improve bond strength between materials of concrete.
A resent past literature is presenting herein on lightweight concrete and bagasse ash concrete. Y.J.Kum et.al (2007) conducted tests on one way slabs to evaluate shear strength. The slabs were prepared with the

lightweight concrete. The results indicated that the behavior of lightweight aggregate concrete closely mimics the response of normal weight concrete at service loads but the ultimate load carrying capacity is lesser than the natural aggregate concrete. Adewuyi A.P and Adeoke T (2008) studied the behavior of periwinkle shells as coarse aggregate in concrete. The usage of periwinkle shells as lightweight aggregates, encouraging the compressive strength results. Xiao Ma and Qiuhua Rao (2012) produced the lightweight concrete with the help of inorganic polymers (cement based). They varied the binder polymer from 0 to 50% and the cube compressive, prism compressive and elastic modulus were decreased but the ratio between prism and cube compressive strengths were increased form 088 to 0.95. Sivakumar A and Gomati P (2012) were used the fly ash as light weight aggregate after making the pelletized aggregates. The results indicated that pelletized aggregates usage promises cost effective construction material for concrete. Lokesh.S et.al (2013) conducted the experimental work on lightweight concrete. The concrete made with high volume fly ash and a little quantity of silica fume. The fly ash used as replacement for cement. The results indicated that, the compressive, split and flexural strengths were increased. Bhaskar Desai.V and Sathyam.A (2014) studied the strength properties of lightweight concrete. The concrete was produced with cinder aggregates. In the concrete the natural aggregates were replaced with cinder aggregates. The replacement up to 75% is shown as the compressive strength is not affected the design compressive strength of natural aggregate concrete. Abdolkarim Abbasi and AminZargar (2013) conducted experimental work on concrete with combination of bagasse ash as pozzolana material. The results found that there are no effect on the setting time and absorbing water capacity and also found that it is cost effective material for concrete. Kawade.U.R et.al (2013) studied the effect of bagasse ash on strength of concrete. The study showed that replacement up to 15% is effective. Sivakumar et.al (2013) studied the morphology and chemical analysis of concrete prepared with sugarcane bagasse. The replacement level of 10% is more effective for concrete rather than the other replacements. Shafana.R et.al (2014) found the mechanical properties of sugarcane bagasse ash concrete and the results showed that 10% replacement is more effective for enhancement of mechanical properties. From the past literature it is noticed that no work has been carried out on lightweight concrete with combination of bagasse ash as pozzolana material. In the present experimental work pumice aggregates were used as lightweight aggregate and bagasse ash as partial substitute material for cement. Bagasse ash is an agricultural/industrial waste and it is by-product of sugarcane milling process in sugarcane factories. The sugarcane is a major crop growing in Mysore and Mandya district. There are around 8 sugar mill factories in and around Mysore and Mandya districts (Karnataka (state)) which extract sugarcane juice from around 30 lakh metric tons sugarcane yearly to produce sugar. Sugarcane bagasse (SCB) which is a voluminous by-product in the sugar mills obtained when juice is extracted from the sugarcane. For each 1 ton of sugarcane crushed, a sugar factory produces nearly 300kg of bagasse. The present experimental study is limited to evaluate compressive and split tensile strengths

II.EXPERIMENTAL PROGRAM

To evaluate compressive and split tensile strengths 30 cubes and 60 cylinders are cast and tested. The compressive strength test was conducted on cubes and cylinders. The split tensile strength test was conducted on cylinders. The strength tests were conducted at 7 and 28 days. As per Indian standards there is no mix design procedure for the lightweight concrete, hence few trail batches were done in the laboratory as per ACI 213 R-03 guide lines. From the trial mixes the optimum quantities per m^3 are cement 480Kg, Fine aggregate 865kg and coarse aggregate (pumice) 335 kg. The mix was provided with water cement ratio of 0.4.

III.MATERIAL USED

Cement: Ordinary Portland cement conforming to IS: 8112-1989 was used. The specific gravity of cement is observed as 3.05

Bagasse ash: The bagasse ash consists of specific gravity 2.15 and the specific surface area of 2475 cm^2/gram. The used bagasse ash was classified as Class F. The chemical properties are presented in table 1.

Table 1.Chemical Composition of Bagasse Ash (%)

SiO_2	Al_2O_3	Fe_2O_3	CaO	LOI
68.67	0.22	5.98	1.50	14.00

Fine Aggregate: Locally available sand was used and it is conformed to Zone II. The specific gravity and fineness modulus of sand is observed as 2.67 and 3.5.

Coarse aggregate: Pumice a natural lightweight aggregate was used as coarse aggregate. The properties are determined as per IS specification and the obtained test results depicted in table 2.

Table 2: Physical Properties of Pumice Aggregate

Specific Gravity	1.03
Bulk Density (kg/m^3)	
Loose	393.47
Compacted	457.65
Flakiness Index (%)	3.85
Elongation Index (%)	5.6
Water Absorption (%),	30

Water: Portable water used for the experimental work and it observed that it is free from organic matter

IV.TESTING OF SPECIMENS

The cubes and cylinders are tested in compression testing machine. The compression and split tensile tests were performed on the specimens as per IS specifications

V.ANALYSIS OF RESULTS

5.1 Compressive Strength

Compressive strength of concrete is important for designers to design structural elements. The compressive strength of concrete is related to other strength parameters of tensile, shear, bond, bearing strengths etc., so the compressive strength of concrete place major role in the construction industry/technology. In India, UK and European countries to evaluate the compressive strength of concrete cube specimens were used, whereas in USA, Canada Australia and New Zealand, cylinders were used. In the present experimental work both were used to determine the compressive strength of concrete. From the experimental work the obtained cube and cylinder compressive strength results for 7 and 28 days were presented in the Table 3 and Figure 1. From this table it is observed that as the bagasse ash content up to 15% is effective and later on the strengths were decreased and the maximum strength results are obtained at 15%. From this it is concluded that 15% replacement of cement with bagasse ash is optimum. The strength enhancement may be due to the reaction between the calcium hydroxide and the bagasse ash. Once the content of calcium hydroxide is exhausted in the mix and then the bagasse ash is present in the mix as inert material. It does not contribute the strength to the mix and also the mix is become weak due less quantity of the binding material.

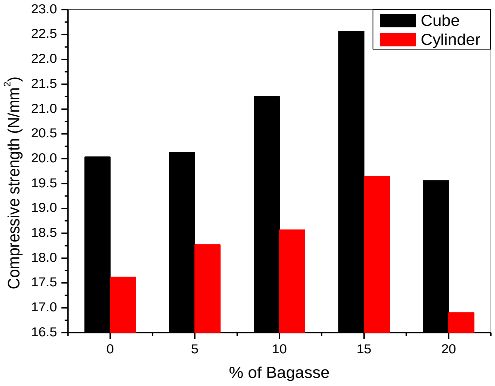

Fig.1: Compressive Strength Vs % of Bagasse Ash

5.2 Split tensile Strength

In general the tensile strength of concrete is not taken in to account in the design of concrete elements. But the knowledge of tensile strength of concrete is required when the elements subjected to transverse shear, torsion, and shrinkage and temperature effect. The tensile strength of concrete was also used while design of pre stressed and concrete structures, liquid retaining structures and run way slabs. Direct tensile strength of concrete is tedious to evaluate. Hence split tensile strength test is conducted to find the tensile strength of concrete. IS 5846:1999 specified the procedure to find the split tensile strength of concrete. In the present experimental work the split tensile strength is evaluated as per IS code and the results are presented in Table 3. From this table it is observed that the maximum strength is obtained at 15% of bagasse ash. The trend of the split tensile strength behaviour is similar to the compressive strength. IS 456 does not provide any relation to evaluate the split tensile strength of concrete. So in the present experimental work a regression model was deduced with a correlation value(R) as 0.885 and standard deviation of 0.176 and the same is presenting below.

$$f_{st}=1.50\sqrt{f_{ck}}$$

f_{st}= split tensile strength of concrete in N/mm2 at 28 days.

f_{ck} =cube compressive strength of concrete in N/mm2 at 28 days.

The performance of the model is presented in the Table 4 and Figure 2.From this table it is observed that the proposed model is well suited with the experimental work and the variation of the results observed as 4%.

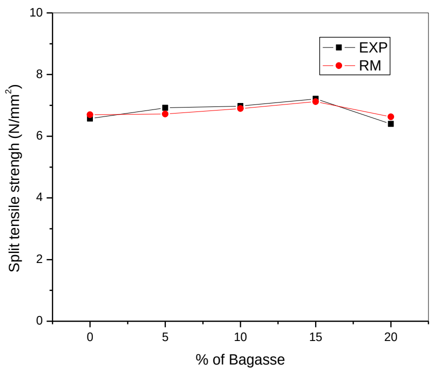

Fig.2: Performance of Regression Model

Table 3.Compressive and Split Tensile Strings of Bagasse Light Weight Aggregate Concrete

S.No	% of Bagasse ash	Cube compressive strength		Cylinder compressive strength		Split tensile strength	
		7 Days (N/mm^2)	28 Days (N/mm^2)	7 Days (N/mm^2)	28 Days (N/mm^2)	7 Days (N/mm^2)	28 Days (N/mm^2)
1	0	15.46	20.04	11.69	17.62	5.98	6.57
2	5	15.52	20.13	11.94	18.27	5.99	6.92
3	10	15.62	21.25	12.04	18.57	6.02	6.98
4	15	16.43	22.57	13.59	19.65	6.11	7.21
5	20	15.07	19.56	13.10	16.90	5.85	6.40

Table 4.Peroformance of Regression Model

S.No	% of Bagasseash	Cube compressive strength 28 Days (N/mm^2)	Experimental split tensile strength 28 Days (N/mm^2)	Split tensile strength based on Regression Model (RM)	Ratio of EXP/RM Split tensile strength
1	0	20.04	6.57	6.70	0.98
2	5	20.13	6.92	6.72	1.02
3	10	21.25	6.98	6.90	1.01
4	15	22.57	7.21	7.12	1.01
5	20	19.56	6.40	6.63	0.96

VI.CONCLUSIONS

From the experimental investigation, the following conclusion were drawn

1. The compressive and split tensile strength results indicated that 15% replacement of cement with bagasse ash shown better strengths when compared with conventional lightweight concrete.

2. It can be concluded that, bagasse ash is predominant up to 15% as substitute for cement to produce structural light weight concrete which can be used for practical applications.

3. The proposed regression model well suited with the experimental results

4. The variation of strength results with the regression model is 4%

5. The bagasse ash can be used as supplementary or pozzolanic material for concrete works.

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