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Strength Behavior of Pumice Stone Lightweight Concrete Beam in Contrast with Reinforced Concrete Beam

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Abstract*: The density of concrete less than that of nominal concrete achieved by any means is referred as Light weight concrete. Circulated air through Concrete, Light Weight Aggregate Concrete, Foamed Concrete are different types of Light weight concrete. In this research study, the density of the concrete has been reduced by replacing the coarse aggregate by the pumice stone as light weight coarse aggregate. The major advantage of this study is to reduce the risk of seismic damages of the structure by reducing the self weight of the structure. The decrease in dead load of structure because of the utilization of LWC additionally brings about reduction in the cross segment of other auxiliary individuals such as beam, column and foundation. The pumice stones have huge number of voids and have moderately higher warm protection than the ostensible aggregates. The objective of this research is to obtain light weight concrete having low unit weight and an optimum compressive strength. The Nominal concrete and the light weight concrete is prepared and the tests were led to decide the mechanical properties and compressive quality, its flexural capacity in beams

***Keywords* : *Flexure Strength Test, Light Weight Concrete, Pumice Stone, Reinforced Concrete Beam*.**

I. INTRODUCTION

The density of concrete less than that of nominal concrete achieved by any means is referred as Light weight concrete. Circulated air through Concrete, Light Weight Aggregate Concrete, Foamed Concrete are different types of Light weight concrete. In this research study, the density of the concrete has been reduced by replacing the coarse aggregate by the pumice stone as light weight coarse aggregate. The major advantage of this study is to reduce the risk of seismic damages of the structure by reducing the self weight of the structure. The decrease in dead load of structure because of the utilization of LWC additionally brings about reduction in the cross segment of other auxiliary individuals such as beam, column and foundation. The pumice stones have huge number of voids and have moderately higher warm protection than the ostensible aggregates. The objective of this research is to obtain light weight concrete having low unit weight and an optimum compressive strength. The Nominal concrete and the light weight concrete is prepared and the tests were led to decide the mechanical properties and compressive quality, its flexural capacity in beams.

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II. LIGHT WEIGHT CONCRETE

The density of the concrete material ranging between 300kg/m^3 and 1840kg/m^3 is alluded as Light Weight concrete. The benefits of LWC are decrease of dead weight, quicker construction and low in cost. The purpose behind picking lightweight concrete as a development material is winding up progressively significant as more consideration is being paid to vitality preservation and to the utilization of waste to supplant modest common sources. In current occasions, LWC structures are broadly utilized however to an a lot lesser degree contrasted with ostensible concrete. In real practice, LWC will be very beneficial since it provides improvements in the Superstructure such as wider shoulders and more lanes. LWC can also provide longer life with low maintenance. Though light weight concrete has good insulation and mechanical properties, further investigation need to be carried out on their structural behaviors for use as structural member[1].

Pumice is naturally a light weight rock commonly occurred in volcanic regions. It is having low specific gravity with high porosity and higher water absorption[2].

III. MATERIALS AND ITS PROPERTIES

This Based on the IS 4031 Codal provisions, the setting time of cement is found to be 37min and 365min as initial setting time and final setting time respectively having the specific gravity of 3.19. The modulus-fineness of fine aggregate is 2.75 having the specific gravity of 2.7 with water absorption of 0.9% is used as per IS 2836 Codal Provisions. The pumice coarse aggregate having fineness modulus of 7.21 with specific gravity of 0.85 is having the water absorption of 26.5%. The Impact value of coarse aggregate is found to be 33.7%. After obtaining the properties of materials the mix design is done as per IS 10262 and the mix ratio is designed as 1:1.5:2.5 with water to cement ratio of 0.5[3].

The properties of light weight concrete is very similar to nominal concrete and hence LWC can be used instead of standard concrete[4]. Based on the derived mix ratio, the concrete is prepared and certain tests are conducted on fresh concrete as per IS1199-1959 and the test results are provided in Table- I.

Table- I: Properties of Fresh Concrete

Test	Concrete	
	Nominal	*Light Weight*
Slump Value	18mm	28mm
Flow-ability	27%	32%
Dry Density	2450 kg/m^3	1650kg/m^3

IV. CASTING AND TESTING

A total of 12 cube specimens of size 150mm is casted, out of which 6 specimens are casted with nominal concrete and 6 specimens are casted with Light weight aggregate concrete. Out of 6 specimens in each, 3 specimens were tested on 7 days of curing and 3 specimens were tested on 28 days of curing. The Characteristic strength of the concrete is determined by compression testing machine. Table- II represents the compressive strength test results which are compared between Nominal concrete and the Light weight concrete.

Table- II: Compressive Strength Test Results

Trial	Concrete Strength			
	Nominal (N/mm^2)		*Light Weight (N/mm^2)*	
	7 Days	*28 Days*	*7 Days*	*28 Days*
1	24.8	47.5	17.0	30.3
2	24.2	47.5	15.4	31.7
3	25.6	48.5	16.7	30.0
Average	24.9	47.8	16.3	30.7

Similar to compressive strength test, the split tensile test has been conducted by casting 12 numbers of cylindrical specimens of 150mm diameter and 300 height. Table- III shows the test results of split tensile strength of Nominal concrete and light weight aggregate concrete.

Table- III: Split Tensile Strength Test Results

Trial	Concrete Strength			
	Nominal (N/mm^2)		*Light Weight (N/mm^2)*	
	7 Days	*28 Days*	*7 Days*	*28 Days*
1	1.4	1.9	0.9	1.1
2	1.2	2.2	1.1	1.3
3	1.3	1.9	1.0	1.2
Average	1.3	2.1	1.0	1.2

A Reinforced concrete beam is designed for a length of 1.8m having the width and depth of 0.2m and 0.15m respectively[5]. The steel bars used for casting of beams is chosen as Fe500 HYSD bars and the tensile strength of the steel is tested in Universal testing Machine and the yield strength and the ultimate strength is found to be 600N/mm2 and 660N/mm2. Based on the guidelines of IS 456, the design has been made and the reinforcement details are designed as providing 2 numbers of 10mm diameter bars at the top and 2 numbers of 10mm diameter bars at the bottom having a 2 legged stirrups using 8mm diameter bars at 100mm center to centre. Fig. 1 shows the details of reinforcement provided in the beam specimens.

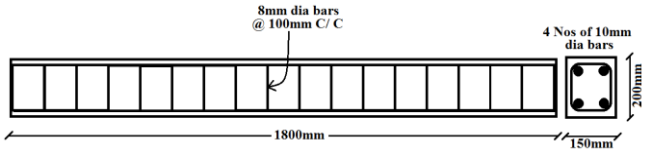

Fig. 1. Reinforcement details of Beam

The flexure test on Reinforced beam is conducted using loading frame of 100 Tonne capacity. The Loads and deflection are measured using proving ring and dial gauge. The unsupported length of 150mm is provided on either sides of the beam and the loads are applied under two point loading[6].

A total of 6 beams has been cast out of which 3 beams are casted using nominal concrete and 3 beams are casted using light weight aggregate concrete. The beam is casted using nominal concrete and it is tested after 28 days of curing. The test results are given in Table- IV.

Table- IV: Test Results of Nominal Concrete Beam

Beam	Nominal Concrete			
	Load (kN)	*Deflection (mm)*	*Strain @ top (mm)*	*Strain @ Bottom (mm)*
NC1	52	62	1.1	1.2
NC2	49	63	0.6	0.7
NC3	56	69	0.7	0.8

The Load Versus Deflection for the flexure strength of beam using two point loading for the Nominal mix concrete is plotted in Fig. 2.

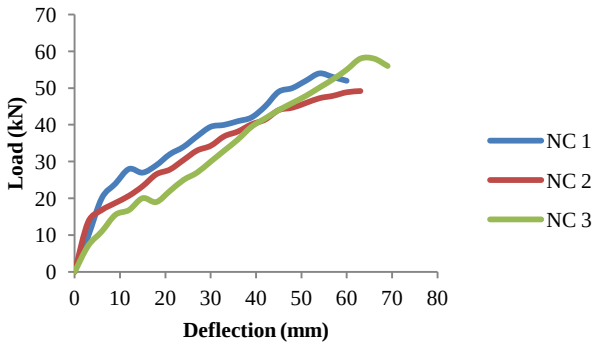

Fig. 2. Load vs Deflection of Nominal Concrete Beam

It has been observed that the average load taken by the beam is 52kN under flexure two point loading and the average deflection is found to be 65mm. The strain energy graph for the three beams specimens are figured as 2(a), 2(b) and 2(c) respectively.

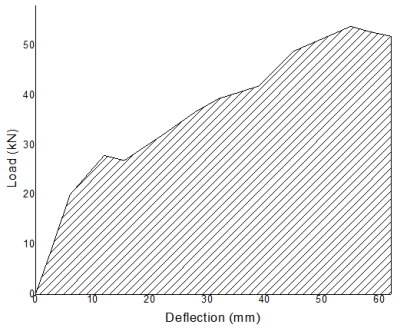

Fig. 2(a). Energy stored in NC1 is 2286.3kN-mm

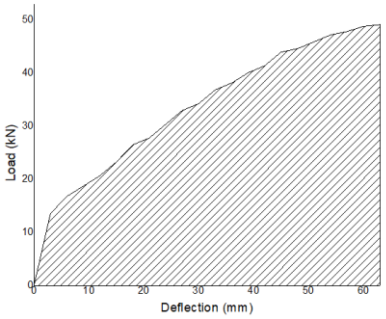

Fig. 2(b). Energy stored in NC2 is 2124.5kN-mm

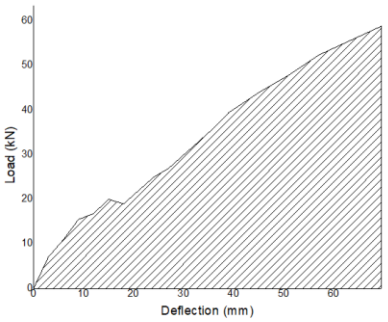

Fig. 2(c). Energy stored in NC3 is 2417kN-mm

The pumice light weight concrete beams are tested under two point loading with same unsupported length of 150mm and the details of load carried by the specimens, defection and the strain are provided in Table- V.

Table- V: Test Results of Light Weight Concrete Beam

Beam	Light Weight Concrete			
	Load (kN)	*Deflection (mm)*	*Strain @ top (mm)*	*Strain @ Bottom (mm)*
LWC1	33	39	0.2	0.33
LWC2	47	57	0.5	0.5
LWC3	37	69	0.2	0.6

The load versus deflection for the light weight aggregate beam specimens are provided in Fig. 3.

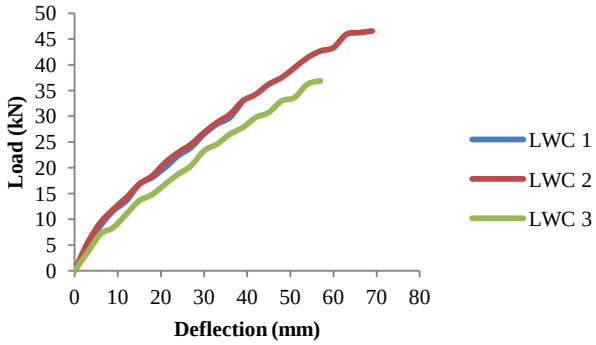

Fig. 3. Load vs Deflection of Lightweight Concrete Beam

The average load carried by the light weight pumice aggregate beam is determined as 39kN and the average deflection is observed as 55mm. The strain energy stored in the light weight concrete beams are figured as 3(a), 3(b) and 3(c).

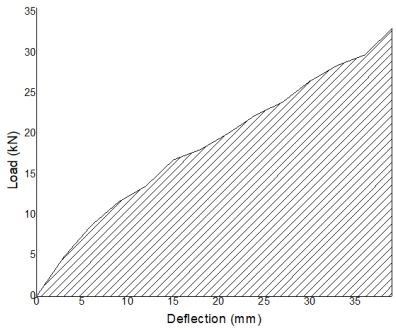

Fig. 3(a). Energy stored in LWC1 is 670.8kN-mm

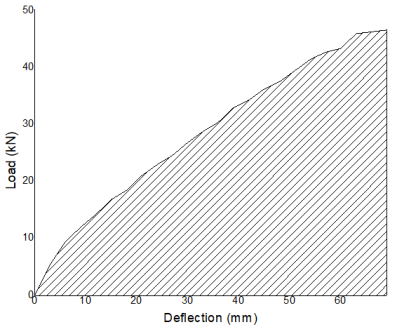

Fig. 3(a). Energy stored in LWC2 is 1505.5kN-mm

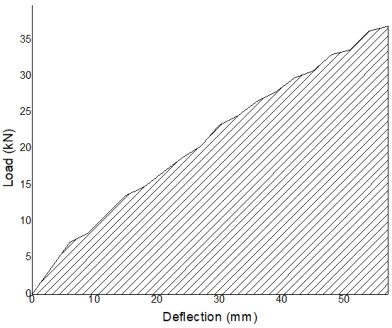

Fig. 3(a). Energy stored in LWC3 is 1776.2kN-mm

V. RESULT AND DISCUSSION

The experimental work has been winded up with the following results:

1) It has been observed that the light weight dry density of concrete is achieved as 1650kg/m^3 and the characteristic strength of concrete is 19N/mm^2. The cracks appeared in the concrete at the time of failure can be reduced and the load carrying capacity of the concrete can be increased by adding the fibres in the concrete.
2) The strength parameters of the light weight coarse aggregate is comparatively low when compared to the nominal aggregates. However the mechanical properties of the concrete can be improved by increasing the cement content or by adding Silica fume in the concrete.
3) The mechanical properties such as compressive strength and split tensile strength for the light weight concrete are 55% and 43% lower than those for nominal concrete respectively.
4) The flexural load carrying capacity of the light weight concrete beam is 75% of that nominal concrete beam and the deflection is found to be 15% less than that of nominal concrete.
5) The strain energy stored in the light weight flexure specimen is 26.5% less than that of conventional beam. The continuous use of nominal concrete can be altered by pumice stone aggregates in order to achieve sustainable development.

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R. Saravanakumar, Presently working as Assistant Professor in the Department of Civil Engineering in Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology. He is having 4 years of teaching experience. He has completed B.E Civil Engineering from Anna University in 2013 and M.E Structural Engineering from Anna University in 2015. He has published more than 8 International Journals. His research area is composite structures and Light weight concrete structures. He is a lifetime member professional bodies like ISTE, IAHS, ISEIS.

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