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Study of Light Weight Fibre Reinforced Concrete by Partial Replacement of Coarse Aggregate with Pumice Stone

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Abstract: ***As the demand for the structural members application in the concrete industry is continuously increasing simultaneously many a times it is required to lower the density of concrete enabling light weight which helps in easy handling of the concrete and its members. In this research an experimental endeavour has been made to equate conventional concrete with light weight by partially substituting the coarse aggregate with the pumice stone aggregate in M30 grade mix design.***
Simultaneously small fibres of Recron3's Polypropylene have been applied to the concrete as a reinforcing medium to minimize shrinkage cracking and improve tensile properties. The coarse aggregate was substituted by the pumice aggregate in 10, 20, 30, 40, and 50 percent and fibres respectively in 0.5, 1, 1.5, 2 and 2.5 percent. The experiment is focused on strength parameters to determine the most favourable optimum percent with respect to conventional concrete.
Keywords**: OPC (Ordinary Portland Cement)1, FA (Fine Aggregate)2, CA (Coarse Aggregate) 3, fck (Characteristic Compressive Strength at 28days)4, Sp. Gr (Specific Gravity)5, WC (Water Content)6, W/C (Water Cement Ratio)7, S (Standard Deviation)8, Fck (Target Average Compressive Strength at 28days)9.

I. INTRODUCTION

Concrete is a composite mixture obtained by mixing of cement, sand, gravel and water in fixed proportions. Concrete is broadly utilized for structural and non-structural uses in broad varieties [2]. Usually regular concrete aggregates are natural stones which we get from various resources such as lime stone, granite etc. Owing to the growing usage of construction, natural sources and the environment are being unnecessarily exploited day by day [3]. The regular concrete has a high self-weight and varies in density between 2200 and 2600 kg/m³ [2]. The use of light weight concrete (1440-1840kg/m³) provides greater versatility in construction and considerable reduction in size, lower dead loads, enhanced cyclical load resistance, longer duration, narrower sections, smaller structural members and reduced self-weights [3]. The increasing market for concrete has contributed to the study of substitute content for aggregate usage and several trials have taken place into products such as Leca, Cinder, Pumice and other artificial aggregates.

Structural lightweight concrete used in modern architecture is an essential and durable resource. It provides various advantages of reducing dead weight, strong thermal insulation, improved building fire safety and reduced transport and handling costs. In the case of prefabricated and prestressed parts, lightweight concrete is more commonly used [4]. The weight reduction ranges between 25 percent and 35 percent relative to conventional concrete, but the performance is the same as normal concrete [1]. Light-weight concrete's fragility is heavily dependent on aggregates, particularly their density, typically the higher aggregate density raises material strength to the drawbacks of the above non-structural properties. The inclusion of reinforcement fibres to concrete matrix will solve this drawback [6]. Fibres are a thin, small structural medium with certain common properties. Different forms of fibres may be used in construction, from metal to organic.

A. Light Weight Concrete

The low-density concrete of reduced weight owing to inclusion of vast amounts of air voids in it is considered as light weight concrete. It is a concrete of density less (1440-1840 kg/m³) than (2200-2600 kg/m³) in mass. This is usually achieved by using either light weight aggregate or by injecting air or gas into the concrete.

B. Light Weight Aggregates

The replacement of conventional aggregates by porous cellular or light density aggregates decreases concrete density. Two forms of light weight aggregates are normal light weight aggregates as defined below:

1) *Natural Light Weight Aggregates*
a) Pumice stone.
b) Diatomite stone.
c) Scoria stone.
d) Volcanics cinders.
e) Sawdusts.
f) Rice husk.

2) *Artificial Light Weight Aggregates*
a) Artificial cinder.
b) Coke breeze.
c) Foam blast furnace slag.
d) Bloat clay.
e) Expanded shale and slate.
f) Sintered ash.
g) Exfoliated vermiculite crystal.
h) Granulated Blast furnace slag.

C. *Pumice Stone*

Pumice Stone is a lightweight natural material created by the fast cooling of volcanic molten lava. During the volcanic eruption, the pumice is produced mainly by volcanic eruption siliceous and is rich in volatile dissolved materials, particularly water vapor [3].
Pumice is the only rock floating in the water surface, eventually though it is waterlogged and sinks. Pumice and pumicites are used in the manufacturing of lightweight construction products. Therefore, nearly three quarters of pumice and pumicites are consumed every year [5]. Pumice stone is colourless pigment or light brown. Pumice stone is typically representative of silica (70%) and alumina (14%), iron oxide is usually 2.5% calcium oxide is 1% and sodium oxide is 9% [2].

II. LITERATURE REVIEW

A. *B. Subhan Ramji, M. Sri Lakshmi*

This study focuses on studies of lightweight concrete along with the application of glass fibres as a reinforcing material to strengthen and substitute cement with fly ash. The coarse aggregate was substituted by pumice stone aggregate at 5%, 10%, 15% & 20%, the optimum fly ash level constant at 5% and glass fibre at 1.5%. The research concluded that after the analysis of concrete compression, tensile and flexure characteristics, the coarse aggregate was substituted optimally with pumice stone at 5% [1].

B. *Rakesh Kumar Saini, Ashish Kumar Meena, Anurag Maheswari, Anil Godara*

This thesis concluded the volumetric substitution of the coarse aggregate by pumice in 8,16&24 percent, thereby minimizing concrete weight and testing the compression, tensile and flexural properties of the concrete. At 16% of the rough aggregate substitution with pumicite stone aggregate, the optimum results of the analysis were obtained. [2]

C. *Ashuvendrasingh*

This work carried out on M40 strength light weight concrete with use of recron 3s short fibres and replacement of coarse aggregate by pumice to make the concrete light weight, mineral admixture GGBS was also added. The optimum results were obtained at 20% GGBFS, 0.2% Recron 3s and 30% pumice stone aggregate. [3]

D. *Rajeswari S, Dr. Sunilaa George*

This research work carried out in M25grade of concrete mix and the properties of compression, tensile and flexure were studied. To make the concrete light weight material the coarse aggregate was replaced by pumice stone aggregate by 50%, 60%and70% and determined 60% optimum result in par with target mean strength. [4]

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E. A.M.N. Kashyap, G. Sasikala

This article addresses the compressive power of lightweight concrete by incorporating steel fibre. The concrete grade M30 and the substitution of coarse aggregates with pumice in 10 to 20% and the inclusion of 0.45 mm diameter and 35 mm long hooked end steel fibres were used. The study has obtained optimum results for 20 percent substitution of coarse aggregates with pumice and 1.5 percent application of steel fibre. [5]

F. Campione, N. Miraglia and M. Papia

This paper was intended to research concrete by the usage of clay aggregates as a substitute for the conventional coarse aggregate in comparison with pumice stone aggregates with the addition of hooked steel fibre. The compression, tensile and flexure properties of concrete were analyzed and the findings indicated that the clay aggregates performed 30 percent better than the pumice stone aggregate. [6]

G. G Venkateswarara, P Ravi Kishore, A S Kumar, M E K Yadav

This topic studies the characteristics of lightweight high strength fibre reinforced concrete, steel fibre was used for a percentage of 0.5,1,1.5,2.2.5,3 and 10, 20, 30, 40&50 percent of the coarse aggregate was substituted by pumice aggregate, and the compression, tensile and flexural measure for concrete was tested. The paper argues the best use of stainless-steel fibres between 1 and 20% pumice [7].

H. N. Sivalinga Rao, B.L.P. Swami, V. Bhaskar Desai, Y.RadhaRatna Kumari

This project was studied on M20 grade of concrete, coarse aggregate was replaced with pumice stone to make the concrete light and steel fibres were used as reinforcement. This project mainly studied the beam and slabs type of structural members. The optimum result concluded by this paper was 20% pumice aggregate and 1.5% steel fibres. [8]

I. G. Campione, N. Miraglia, & M. papia

This thesis in Italy examined the properties of the tensile, compression and flexure of the concrete, partly replacing the coarse aggregate with pumice material, and addition 0.5 mm in diameter hooked end steel fibres. The steel fibre was added 0.5, 1&2% [9].

J. Jianming Gao, a Wei Suqa & KeijiMorino

Experimented on high strength light weight concrete along with steel fibres of length 20, 25&30mm length addition. The coarse aggregate was replaced with clay aggregates and fibres were added in the 0.6,1,1.5&2% with the varying aspect ratios of fibres at 46,58&70. The optimum result of the research was concluded at 1.5% of 46aspect ratio of steel fibre. [10]

III. OBJECTIVES

A. To arbitrate the physical and mechanical properties of reinforced fibre light weight concrete.
B. To look for the alternative source for coarse aggregate and its mechanical characteristics.
C. The decrease density of the concrete to make it lightweight.
D. To research the impact of fibres in concrete and their failure.
E. The optimal outcomes for aggregate substitution and fibre inclusion to be inferred.

IV. MATERIALS

1) *Cement* is a concrete binding agent that adheres to other components through blending and tends to harden. The cement of OPC grade53 was used in the experiment.

Grade of Cement	53
Sp. Gr	3.14
Initial Setting Time	36 minutes
Fineness	7.8%

Table I Properties of Cement

2) Fine Aggregate the aggregate size, shape, colour, density all other factors have an influence on the concrete. In this experiment locally, available sand or fine aggregate was used.

Type	Zone II
Sp. Gr	2.54
Fineness Mod	3.5
Moisture absorption	1.4%

Table II Properties of Fine Aggregate

3) Coarse Aggregate the coarse aggregate is an inert material which gives the concrete volumetric form. In this experiment we used angular shaped crushed ballast stone aggregates of 20mm and down size.

Type	Natural crushed
Sp. Gr	2.65
Size	20mm& down
Moisture absorption	0.9%

Table III Properties of Coarse Aggregate

4) Water The concrete water must be clean of all impurities and salts which may damage the concrete or the properties of its component. In this experiment portable, clean water was used.
5) Pumice is a light weight material, crushed aggregate of pumice stone of size 20mm and down size were used in this project for partial replacement of coarse aggregate.

Sp. Gr	0.92
Moisture absorption	20.5%

Table IV Properties of Pumice

6) Recron 3S Polypropylene Fibre Short fibres were used as reinforcing material of 0.05mm diameter & 12mm length.
7) Chemical Admixture Conplast Sp430 with SP. Gr 1.22 at dosage of 0.4% of cement has been used to reduce the water content.

V. EXPERIMENTAL RESULTS

This chapter deals with the experimental results which are obtained by conducting experiments on specimens.

A. *Fresh Concrete*

Sl. No	Concrete	Slump (mm)
1	Normal Concrete	76
2	M1	71
3	M2	67
4	M3	65
5	M4	61
6	M5	56

Table V showing results of fresh concrete

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B. Mix Proportion Of Concrete Grade Table

Mix	Pumice	Recron 3S Polypropylene Fibre
Normal Concrete	0	0
M1	10%	0.5%
M2	20%	1.0%
M3	30%	1.5%
M4	40%	2.0%
M5	50%	2.5%

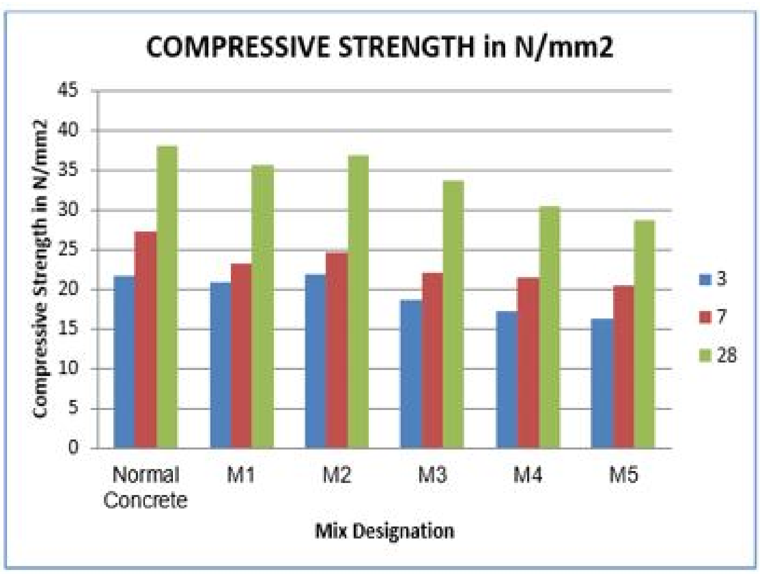
Table VI showing mix proportion of concrete

C. Hardened Concrete Check Results

1) Compressive Strength Check Test Results

	Curing			Mix
	3days	7days	28days	
Average Compressive strength (N/mm²)	21.60	27.22	38.18	Normal Concrete
	20.80	23.31	35.66	M1
	21.88	24.64	36.90	M2
	18.56	22.08	33.65	M3
	17.23	21.46	30.48	M4
	16.27	20.51	28.67	M5

Table VII showing compressive strength results

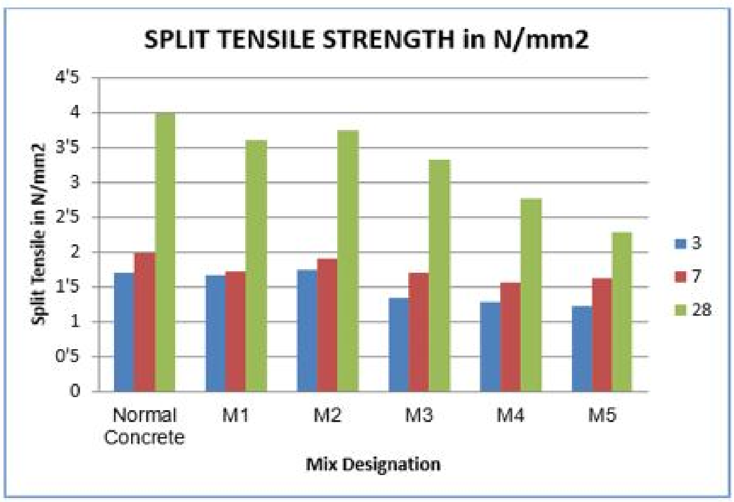


GRAPH 1 Compressive Strength

2) Split Tensile Strength Check Test

	Curing			Mix
	3days	7days	28days	
Average Split tensile strength (N/mm²)	1.71	1.99	3.98	Normal Concrete
	1.66	1.73	3.60	M1
	1.74	1.91	3.75	M2
	1.35	1.70	3.32	M3
	1.28	1.56	2.76	M4
	1.22	1.63	2.28	M5

Table VIII showing split tensile strength results

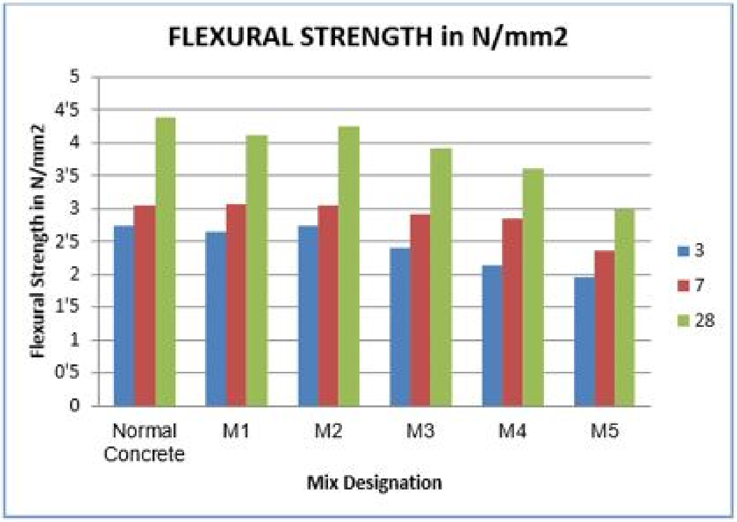


Graph 2 Split Tensile Strength

3) Flexure Strength Check Test Results

	Curing			Mix
	3days	7days	28days	
Average Flexural strength (N/mm²)	2.75	3.05	4.39	Normal Concrete
	2.65	3.08	4.13	M1
	2.73	3.06	4.25	M2
	2.40	2.93	3.92	M3
	2.14	2.85	3.60	M4
	1.96	2.36	2.98	M5

Table IX showing flexure strength results

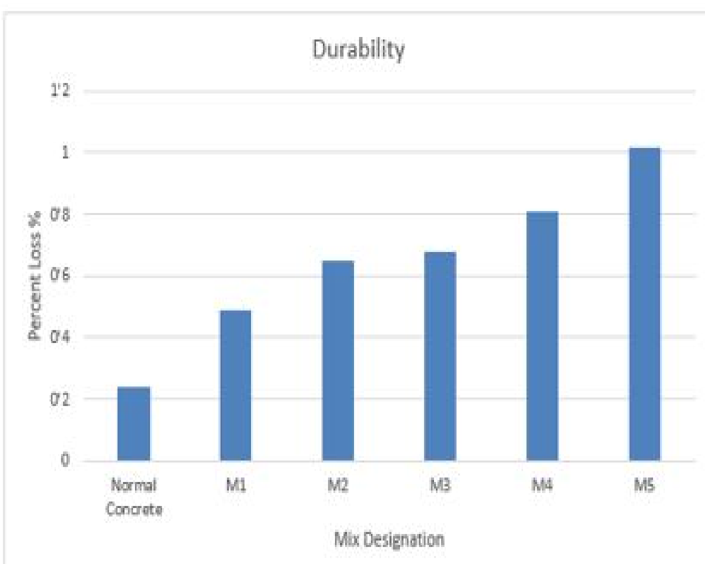


Graph 3 Flexural Strength

4) *Durability Test*

Concrete type	Initial wt. of specimen kg	Final wt. of specimen kg	Percent loss
Normal Concrete	9.20	9.17	0.24
M1	8.78	8.73	0.49
M2	8.37	8.31	0.65
M3	7.95	7.89	0.68
M4	7.54	7.47	0.81
M5	7.04	7.12	1.02

Table X showing durability test results



Graph 4 Durability Test

VI. CONCLUSIONS

A. The lowest density for modified concrete was found to be at 2112.29kg/m3 with comparison to the conventional concrete having 2726.81kg/m3 which shows reduction of 22.53%.

B. The optimum dosage of fibre content was found to be at 1% along with 20%replacement of coarse aggregate which shows satisfactory results.

C. The M2 mix in comparison with the conventional concrete did show 3.47% in compression, 6.13% in tensile and 3.29% in flexure strength parameters reduction.

D. It was observed that with the increase in quantity of pumice stone there was reduction in compression, tensile and flexural strength in concrete.

E. The optimum percent of utilization of pumice stone as substitute for coarse aggregate lies in range 0-30%.

F. The operational workability of the concrete fall with rise in percent of fibres and pumice aggregates.

G. Utilizing the pumice stone as coarse aggregates reduces the dependency on conventional aggregate and its depletion.

H. The coarse aggregate by pumice stone can be practised where it is cheaply available as transportation to far off places is highly uneconomical.

I. This variant of concrete can be utilized for low degree strength structural members such as that of light weight masonry blocks or for insulation of building members.

REFERENCES

[1] B. Subhan Ramji, M. Sri Lakshmi "AN EXPERIMENTAL STUDY ON GFRC BY PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH PUMICE STONE AND CEMENT WITH FLY ASH" International Journal of Latest Trends in Engineering and Technology Vol. (11) Issue (4), pp.053-061.

[2] Rakesh Kumar Saini, Anil Godara, Anurag Maheswari, Ashish Kumar Meena "Experimental Study on Light Weight Concrete with Pumice Stone as a Partial Substitute of Coarse Aggregate".

[3] Ashuvendrasingh "EXPERIMENTAL STUDY ON LIGHT WEIGHT FIBER CONCRETE USING PUMICE STONE AS FRAGMENTARY SUBSTITUTE OF COARSE AGGREGATE" International Research Journal of Engineering and Technology (IRJET)

[4] Rajeswari S, Dr. Sunilaa George "Volume 4 Issue 5, May 2016 Licensed Under Creative Commons Attribution CC BY International Journal of Scientific Engineering and Research (IJSER) "Experimental Study of Light Weight Concrete by Partial Replacement of Coarse Aggregate Using Pumice Aggregate".

[5] A.M.N.Kashyap, G.Sasikala "An Experimental Study on Compressive Strength of Steel Fibre Reinforced Light Weight Aggregate (Pumice Stone) Concrete" International Journal of Engineering Research and Development Volume 9, Issue 12 (February 2014).

[6] G.Campione, N. Miraglia and M. Papia "Mechanical properties of steel fibre reinforced lightweight concrete with pumice stone or expanded clay aggregates" Materials and Structures/Mat~riaux et Constructions, Vol. 34, May 2001, pp 201-210.

[7] G Venkateswarara, P Ravi Kishore, A S Kumar, M E K Yadav "Experimental Study on Strength Properties of Light Weight High Strength Fibre Reinforced Concrete with Partial Replacement of Coarse Aggregate with Pumice Stone" IJSART - Volume 4 Issue 12 –DECEMBER 2018.

[8] N. Sivalinga Rao, Y.RadhaRatna Kumari, V. Bhaskar Desai, B.L.P. Swami "Fibre Reinforced Light Weight Aggregate (Natural Pumice Stone) Concrete" International Journal of Scientific & Engineering Research Volume 4, Issue 5, May-2013.

[9] G.Campione, N. Miraglia and M. Papia "Experimental Investigation on light fibre reinforced concrete with hooked steel fibres" Materials and Structures/Mat~riaux et Constructions springer.link.

[10] Jianming Gao, Wei Suqa & Keiji Morino, Mechanical Properties of Steel Fiber-reinforced, High-strength, Lightweight Concrete Cement and Concrete Composites 19 (1997) 307-313 1997 Elsevier Science Ltd.

[11] IS 383-1970 "Specification for coarse and fine aggregates" Bureau of Indian standards.

[12] IS 456-2000 "Plain and Reinforced concrete code of practice".

[13] IS 10262:2009 "Recommended guidelines for Concrete mix design".

[14] IS 2386-1963 "Methods of test for aggregates of concrete, Part I, II, III&IV" Bureau of Indian Standards.

[15] ASTM C1247-14, Standard Test method for Durability.

[16] M.S Shetty, S chand "Concrete Technology" New delhi.