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Performance of Light Weight Concrete Made With Pumice Stone as Coarse Aggregate with or Without Admixture into the Composition

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Abstract
Light weight concrete is introduced rapidly into the construction industry due to wide spread advantage of precast and prestressingelements. It is made up of naturally available light weight aggregates, Pumice is notable one of the most common and the oldest of naturally occurring aggregates utilized lightweight coarse aggregates used for the production of concrete for construction industry. At present investigation, pumice is used as a coarse aggregate at 0, 50 and 100% replacing natural coarse aggregate and study the performance of the light weight concrete with or without admixture in fresh condition and hardened state. Slump and compaction factor values are declining with respect to conventional concrete and strength values are increased with respect to conventional when the composition added with aluminum admixture.

Keywords: *Pumice stone, light weight concrete (LWC), light weight aggregate (LWA)and Performance.*

I. INTRODUCTION

Concrete is a one of the durable construction material and it has long service life because of its characteristics. As per the statistical report, In India, total concrete consumption will be expected to 470 and 580 million tons in the year 2017 and 2022. Structural light weight concrete is being used in construction due to its lower density, poor thermal conductivity, low durability and mechanical properties.It has low density ranges from 300 to 1800 kg/m3, compared with normal weight concrete as 2200 to 2600 Kg/m3. Pumice stone is notably one of the most common and oldest naturally occurring aggregate utilized lightweight coarse aggregates used for the production of concrete for construction industry. It acts as good filler which is non-crystalline, non-toxic and non-hazardous.Strength results of LWC were met the requirements of structural light weight concrete (SLWC) [1]. By addition of Vermiculite into the LWC, Compressive strength decreased and gained its values by addition of super plasticizer into the composition [2]. Based on the experimental results, it was concluded that the optimum percentage of bagasse ash is 15% into the light weight aggregate concrete and Strength results were decreased with increase of replacement of bagasse ash then declined [3]. Water absorption of OPBS (oil Palm Boiler Clinker) concrete increased linearly due to LWA, hence ideal replacement level is 20-40% by volume [4]. Pumice Aggregates met the physical properties of concrete aggregates and can effectively used into the light weight concrete but bulk density of light weight aggregate was within the allowable rage and it was close to the maximum [5]. Density and strength characteristics of concrete replacing cement by fly ash and coarse aggregate by coconut shell was decreased [6].20% replacement of coarse aggregate by Light weight aggregate carried out for instigation, Density and compressive strength of the light weight concrete was decreased as the percentage increased[7].

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Optimum replacement of Pumice stone was 20% into the concrete composition, spherical shape of pumice was significantly improved properties of fresh concrete and strength values are reduced due to the increase of pumice [8]. All Strength values were reduced with 100% replacement of Pumice Stone as Coarse aggregate and it is also concluded that the permeability was reduced up to 30% of replacement by Pumice [9]. The Optimum dosage of expanded polystyrene beads was 40% into the composition and its density was 19 kn/m3. Nearly 20% of density was reduced for this dosage [10]. Coarse aggregate was replaced by Cinder and Leca, due to this density and strength were reduces to 8.9 to 6.45 Kg [11].Workability of lightweight concrete was not good as it compared with ordinary conventional concrete. This Lightweight concrete has low thermal conductivity and it has an ability to absorb sound, hence it can be used for acoustic structures [12]. Pumice stone was used as light weight aggregate into the composition of lightweight concrete and it can be used for high strength concrete as long as the fracture was through the aggregate [13]. Pumice stone and Vermiculite was used as Light weight aggregate for CA and FA and Aluminum Powder as air entraining agent into the concrete composition, Strength of the concrete was increased by addition of steel fiber [14]. Structural Light weight concrete was produced with expanded clay and Perlite to produce poor workability and compressive strength was low compared with conventional concrete [15].Better results observed pumice stone as FA than CA Into the concrete composition. Optimum results obtained with 10% of Pumice stone used as FA into the composition [16]. With increase of Aluminium powder content into the composition influenced the strength properties be decreased [17].By the Addition of Aluminium powder in M40 grade concrete enhanced the properties like compressive and split tensile strengths[18].By addition more than 2% of Al powder reduces the compressive strength and density drastically[19]. Present study focused on behavior of fresh concrete and strength properties of light weight concrete with pumice as coarse aggregate.

II. MATERIALS:

Following Materials were used into the making of concrete composition

A. Cement

Basically it is bonding material, Penna 53 grade Cement was used into the composition and tested the properties according to the IS 12269--2013, these test results are tabulated in Table-1

Table No: 1 Properties of Penna Cement (53 Grade)

Test		units	Results obtained	Suggested values as per IS 12269-1987
Fineness		%	3	Less than 10
Normal consistency		%	32	--
Setting times	Initial	min	50	min.30
	Final	min	480	max.600
Specific gravity		-	3.12	3.15

B. Fine Aggregate

For present study, fine aggregate was procured from River Penna and used the fraction passing through IS 4.75mm. Test r*esults are tabulated in the following Table2*

C.*Coarse Aggregate*

Machine crushed Granite aggregate was procured from Ramampuram and for better impermeability well graded aggregates of two fractions were used into the composition as 20 and 12.5 mm. Test Results were within the range specified in IS 383-1970.

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Table No 2: Properties of Fine aggregate

Description	Value
Aggregate Crushing value	24%
Aggregate impact value	20.84%
Specific gravity	1.06
Fineness modulus	2.3
Bulk Density	
Loose Kg/m3	395
Dense Kg/m3	455
Elongation Index (%)	3.75
Flakiness Index (%)	4.82
Water Absorption (%)	2.8

Test Parameter	Results Obtained	According to IS: 2386-Part-4 – 1963
Specific Gravity	2.63	2.6-2.85
Water Absorption	1.62%	-
Bulking of Sand	3%	Zone-2

D. Water

Local source of water was used into the concrete mixing and curing. Tests were conducted on it and was concluded as a potable water and free from any impurities.

E. Pumice Stone

Pumice stone is a natural lightweight aggregate, which formed by the sudden cooling of molten volcanic matter. It has high vesicular rough texture and it may not contain any crystals. It was procured with a size of 50mm and makes it into convenient sizes into 20 and 12.5 mm by crushing. Properties of Pumice stone is tabulated in Table 3. Fig 1 and 2 are showing the pumice stone and Aluminium powder.

F. Admixture

By using finely powdered aluminium with the slurry and made to react with calcium hydroxide liberated during the hydration process, large quantity of hydrogen gas is liberated. Usually Al powder used in 0.2 to 0.5% into the composition but in the new composition added 2% and studied its effect on all properties of LWAC

Table 3: Properties of Pumice Stone

Fig 1: Pumice Stone

Fig 2:Aluminium Powder

III. Objectives

The objectives of the Present study is

- Study the mechanical properties of all ingredients of concrete and Pumice Stone.
- Study the behavior of density of LWC
- To determine the behavior of fresh concrete with or without admixture of a LWC
- Strength properties of LWC

IV. Experimental Procedure

Prepared M30 grade mixed proportion (W: C: FA: CA) as 0.45: 1: 1.7:2.37) of based on the mechanical properties of the above ingredients of the concrete. During the mixing for manufacturing of new concrete LWC by replacing CA with Pumice stone at 0, 50 and 100%.Total three types of concrete mixes have

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been used in production concrete as per details given below.

Mix 1: Cement + Sand + Natural coarse aggregate of 100% +water (LWAC 0)

Mix 2: Cement + Sand + Natural coarse aggregate of 50% + Pumice stone as CA of 50% + water+ 2% Al admixture (LWAC 50)

Mix 3: Cement + Sand + Natural coarse aggregate of 0% + Pumice stone as CA of 100% + water+ 2% Al admixture (LWAC 100)

In each mix, six specimens were proposed to cast and tested the behavior of fresh concrete using slump cone and compaction factor tests. Compressive strength of concrete is studied by casting cube specimens.

A. Fresh concrete

To study the behavior of fresh concrete according to the IS 1199-1959, workability of concrete depends on the water cement ratio and the water absorption capacity of the aggregate aggregate characteristics (shape and size distribution and texture), cementitious content and age (level of hydration) and can be modified by adding chemical, like super plasticizer.

i. Slump cone

Unsupported fresh concrete flows to the sides and a sinking in height would be observed after lifting of cone and its vertical settlement is known as slump value. Slump value is representing the behavior of fresh concrete.

ii. Compaction factor

This test is a more precise and sensitive than slump cone test and all other workability tests. This test is determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height of 20.3 cm between the upper and lower hoppers. Medium compaction factor is 0.92 and good one is more than 0.95.

B. Compressive strength

According to the IS 516-1959' Cubical specimens were cast of size 150x150x150mm and substituted natural coarse aggregate with pumice stone at 0,50 and 100%. into the composition. Totally 6 specimens were cast at each replacement level and average value is determines at each level.

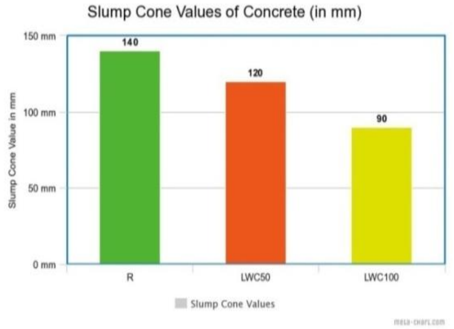
V. Results and Discussions

A. Workability of LWAC.

Pumice stone has rough texture and it absorbs more water content during the mixing, due to this reason slump values are declined. This is due to the higher water absorption capacity of pumice stone. Basically, the main composition of the pumice stone is volcanic ash. As the percentage replacement increases to 100%, slump values were varied from 140mm to 90 mm. Difference of variation with respect is 35%, this is due to the water absorption and specific gravity. Similar trend was observed on compaction factor also, it varied from 0.909 to 0.928 and its variation is 21%.

Table No 6: Test Results For Slump Cone Test& Compaction Factor Test Values For Concrete

S. No	%of Pumice Stone added	Slump cone value(mm)	Compaction factor value
1	0%	140	0.909
2	50%	120	0.912
3	100%	90	0.928



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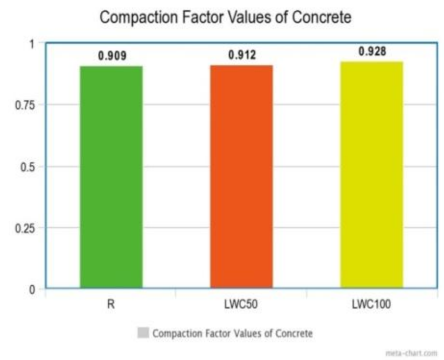

Fig 3: Slump Cone and Compaction Factor Test values of Concrete

B. Compressive strength of LWAC

Strength of the LWAC under compression is one of the prominent test for assessing the strength of the concrete. Following tables are presenting the weight of the sample and average compressive strength after 7 and 28 days with or with admixtures.

Table 4: Compressive strength of LWAC with admixture (0% Pumice stone)

S. No	% of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. of Days	Load (KN)	Strength (N/mm^2)	Average Strength (N/mm^2)
		Initial	Final	Initial	Final				
1	1:1.7:2.37:0:0.45	8190	8328	23.797	24.198	7	810	36.00	36.74
2	1:1.7:2.37:0:0.45	8289	8422	24.085	24.470		860	38.22	
3	1:1.7:2.37:0:0.45	8177	8324	23.760	24.187		810	36.00	
4	1:1.7:2.37:0:0.45	8292	8445	24.093	24.538	28	1190	52.89	53.11
5	1:1.7:2.37:0:0.45	8264	8428	24.012	24.490		1170	52.00	
6	1:1.7:2.37:0:0.45	8126	8272	23.612	24.035		1240	55.11	

Table 5: Compressive strength of LWAC with admixture (50% Pumice stone)

S. No	% of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. of Days	Load (KN)	Strength (N/mm^2)	Average Strength (N/mm^2)
		Initial	Final	Initial	Final				
1	1:1.7:1.185:1.185:0.45	5883	6208	17.094	18.038	7	420	18.67	18.96
2	1:1.7:1.185:1.185:0.45	5940	6255	17.259	18.087		380	16.89	
3	1:1.7:1.185:1.185:0.45	5836	6138	16.957	17.835		480	21.33	
4	1:1.7:1.185:1.185:0.45	5712	6050	16.597	17.579	28	670	29.78	29.63
5	1:1.7:1.185:1.185:0.45	5818	6216	16.905	18.062		650	28.89	
6	1:1.7:1.185:1.185:0.45	5996	6318	17.422	18.358		680	30.22	

Table 6: Compressive strength of LWAC with admixture (100% Pumice stone)

S. No	% Of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. of Days	Load (KN)	Strength (N/mm^2)	Average Strength (N/mm^2)
		Initial	Final	Initial	Final				

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1	1:1.7:0:2.37:0.45	4790	5158	13.918	14.987	7	280	12.44	12.15
2	1:1.7:0:2.37:0.45	4831	5186	14.037	15.068		290	12.89	
3	1:1.7:0:2.37:0.45	5109	5227	14.845	15.188		250	11.11	
4	1:1.7:0:2.37:0.45	5016	5533	14.574	16.077	28	450	20.00	20.00
5	1:1.7:0:2.37:0.45	5009	5468	14.554	15.888		420	18.67	
6	1:1.7:0:2.37:0.45	5117	5602	14.868	16.277		480	21.33	

As a result of analysis, density of specimens was decreased as the percentage of pumice increases into the composition. Pumice stone has less specific gravity of 1.06 and more water absorption capacity because of its characteristics. The ITZ of the LWAC composition is week due to the insufficient water content in the mix and specific gravity of Pumice stone.Strength of the LWAC with admixture was reduced drastically and percentage of variation with respect to conventional concrete was48 and 67% for 7 days and 44 and 62% for 28 days. Following tables are presenting the compressive behavior of LWAC without Al as admixture into the composition.

Table 7: Compressive strength of LWAC without admixture (0% Pumice stone)

S. No	% of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. of Days	Load (KN)	Strength (N/mm^2)	Average Strength (N/mm^2)
		Initial	Final	Initial	Final				
1	1:1.7:2.37:0:0.45	8112	8335	23.570	24.218	7	720	31.99	32.58
2	1:1.7:2.37:0:0.45	8189	8372	23.794	24.326		750	33.33	
3	1:1.7:2.37:0:0.45	8177	8324	23.76	24.186		730	32.41	
4	1:1.7:2.37:0:0.45	8192	8348	23.803	24.256	28	1080	47.99	49.89
5	1:1.7:2.37:0:0.45	8164	8328	23.722	24.198		1120	49.28	
6	1:1.7:2.37:0:0.45	8126	8372	23.611	24.326		1180	52.39	

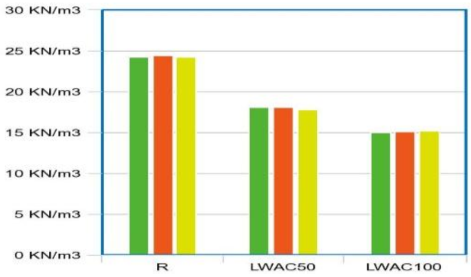
Table 8:Compressive strength of LWAC without admixture (50% Pumice stone)

S. No	% of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. Of Days	Load (KN)	Strength (N/mm^2)	Average Strength (N/mm^2)
		Initial	Final	Initial	Final				
1	1:1.7:1.185:1.185:0.45	6709	6779	19.494	19.697	7	380	16.89	15.22
2	1:1.7:1.185:1.185:0.45	7012	7110	20.374	20.659		340	15.11	
3	1:1.7:1.185:1.185:0.45	6353	6420	18.459	18.654		310	13.78	
4	1:1.7:1.185:1.185:0.45	6940	7039	20.165	20.453		340	15.11	
5	1:1.7:1.185:1.185:0.45	7210	7304	20.95	21.223	28	560	24.89	24.45
6	1:1.7:1.185:1.185:0.45	6750	6809	19.613	19.784		540	24.00	

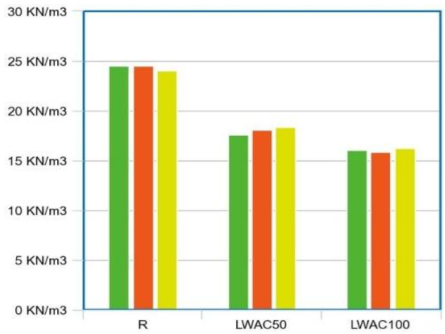
Table 9: Compressive strength of LWAC without admixture (100% Pumice stone)

S. No	% of Replacement [C:FA:CA:PA:W]	Weights (gms)		Unit Weight (KN/m^3)		No. Of Days	Load (KN)	Strength (N/mm)	Average Strength
		Initial	Final	Initial	Final				

									(N/mm^2)
1	1.1.7:0:1.1:0.45	5545	5592	16.112	16.248	7	250	11.11	11.22
2	1.1.7:0:1.1:0.45	5657	5711	16.437	16.594		220	9.78	
3	1.1.7:0:1.1:0.45	5750	5802	16.707	16.858		260	11.56	
4	1.1.7:0:1:0.45	5562	5623	16.161	16.338	28	280	12.44	
5	1.1.7:0:1.1:0.45	5690	5870	16.533	17.056		380	16.72	16.13
6	1.1.7:0:1.1:0.45	5709	5895	16.588	17.129		350	15.54	

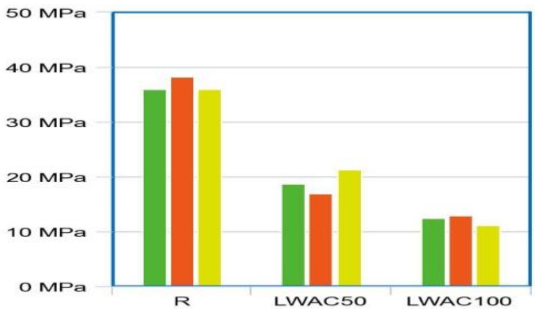


(a) 7 Days age of Concrete

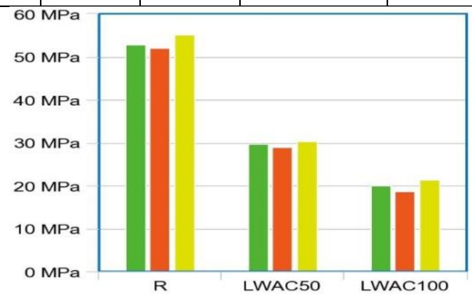


(b) 28 Days age of Concrete

Fig 4: Unit Weights of Concrete in KN/m^3 with admixtures

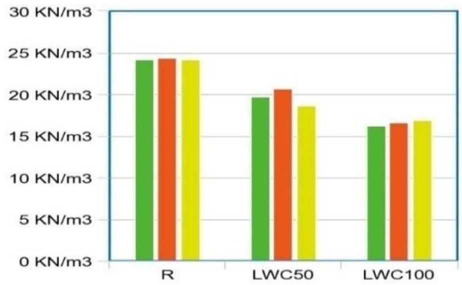


(a) 7 Days age of Concrete

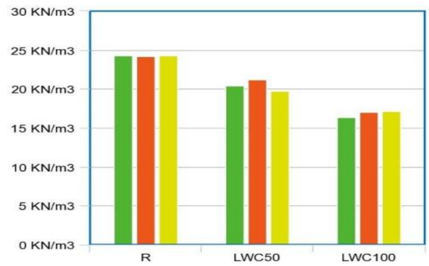


(b) 28 Days age of Concrete

Fig 5: Compressive Strength of Concrete in MPa with admixtures

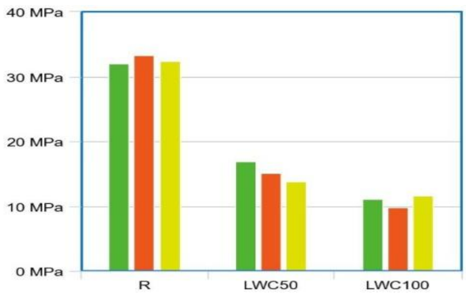


(a) 7 Days age of Concrete

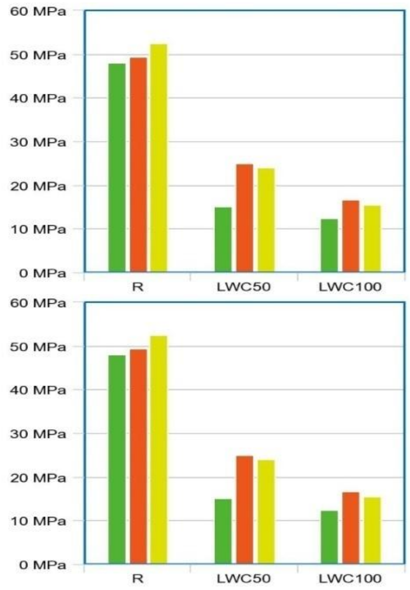


(b) 28 Days age of Concrete

Fig 6: Unit Weights of Concrete in KN/m^3 without admixtures



(a) 7 Days age of Concrete



(b) 28 Days age of Concrete

Fig 7: Compressive Strength of Concrete in MPa without admixtures

By the observation of the results, without addition of admixture, strength results are decreased by increasing the pumice percentage in the composition. Percentage of variation with respect to conventional concrete was 53 and 66% for 7 days and 50 and 68% for 28 days. By the addition of admixture into composition will enhance the strength values.

VI. Conclusions

- Mechanical properties of the Pumice aggregate (LWA) are lower than the conventional aggregates according to the IS383-1970.
- Density of concrete with new composition with or without admixture is decreased due to the specific gravity of pumice aggregate (LWA).
- Workability of LWAC is decreased as increase of LWA percentage into the composition.
- Compressive strength of the LWAC is more with admixture as compared to without admixture.
- By addition of Admixture into the composition strength values are increased and the values are varies from 8 to 24%.

By the addition of 50 and 100% pumice aggregate into the composition has low strength as even compared with targeted mean strength but it better to use into the light weight structural elements.

V. REFERENCES

[1] T. Parhizkar, M.Najimi and A.R Pourkhorshidi: "Application of Pumice Aggregate in Structural Light Weight Concrete", Asian Journal of Civil Engineering, Vol-13, Issue 1, 2012, pp 43-54.

[2] S.Syed Abdul Rahman and Gijo K Babu: "An Experimental Investigation on Light Weight Cement Concrete Using Vermiculite Minerals", International Journal of Innovative Research in Science, Engineering and Technology, Vol-5, Issue 2, 2016, pp 2389-2392.

[3] VenkataRamana: "Behavior of Pumice Light Weight Concrete", International jopurnal of Advanced Research in Science and Engineering, Vol4, Issue1, 2015, pp 368-374.

[4] Mohammad Aslam et.al: "Manufacturing of High-Strength Light Weight Aggregate Concrete Using Blended Coarse Light Weight Aggregate", Journal of Building Engineering, Vol 13, 2017, pp 53-62.

[5] ShankoAyelaAbera and DrNaresh Kumar: "A Study on Properties of Light Weight Aggregates Produced from Pumice ", International Journal of Innovative Research, Ideas and Innovations in Technology, Vol3, Issue 6, 2017, pp 525-531.

[6] A. Dhanalakshmi and A.Poonkuzhali: "Behavioural Study on Light Concrete", International Journal of Science and Research, Vol 5, Issue 11, 2016, pp 1521-1524.

January - February 2020
ISSN: 0193 - 4120 Page No. 01 - 11

[7] Lakhmi Kumar Minapu, MKMV Ratnam and DrRangaraju: "Experimental Study on Light Weight Aggregate Concrete with Pumice stone, Silica Fume and Fly ash as Partial Replacement of Coarse Aggregate", International Journal of Innovative Research in Science, Engineering and Technology, Vol3, Issue12,2014,pp 18130-18138.
[8] N. Ramanajaneyulu, M.V.SeshagiriRao and V.Bhaskar Desai: "Behavior of Self Compacting Concrete Partial Replacement of Coarse Aggregate with Pumice Lightweight Aggregate ", International Journal of Recent Technology and Engineering, Vol7 Issue 6, 2019, pp 434-440.
[9] R.Rajesh Kumar and M.Venkatadinesh: "Mechanical Properties of M25 Grade Concrete Made with Pumice as a Partial Replacement of Coarse aggregate", International Journal of Engineering Science Invention, Vol7 Issue 8, 2018, pp42-52.
[10] RamKumar P, Anjan B, and Arjun V: "Assesment of Lightweight Concrete Using Expanded Polystyrene Beads", International Journal of Innovative Technology and Exploring Engineering, Vol 8, Issue 8, 2019, pp 234-237.
[11] Anil Kumar R and DrP.Prakash: "Mechanical Properties of Structural Light Weight Concrete By Blending Cinder &LECA" International Advanced Research Journal in Science, Engineering and Technology, Vol 2, Issue 10, 2015, pp 64-67.
[12] .DivyaBhavana: "Study of Light Weight Concrete", International Journal of Civil Engineering and Technology, Vol 8, Issue 4, 2017, pp 1223-1230.
[13] Radhakrishna, PrithvirajPadachuri and Abhishek P.V: "Re-Proportioning of Lightweight Concrete with Pumice as Coarse Aggregate by Law of Mixtures", International Journal of Engineering Sciences Research, Vol 2, Issue 4, 2011, pp 281-290.
[14] GowthamaPrasanth et.al; "Experimental Investigation of Floating Slab with Incorporated Pumice Stone and Vermiculite", International Journal of Innovative Research in Technology, Vol 3, Issue 5, 2016, pp 223-230.
[15] CenkKarakurt and UgurOzen; " Influence of Natural Light weight Aggregtes on the Properties of Concrete", International journal of Turkish Chemical Society, Vol 1, Issue 2, 2017, pp 51-58.
[16] N. Bhavana and C.H.Rambabu; " Study of Mechanical Properties of Light Weight Aggregate Concrete Using Pumice Stone, Ceramic Tile and CLC Light weight Bricks", International Research journal of Engineering and Technology, Vol 04, Issue 06, 2017, pp 3071-3079.
[17] RanaShabbar, Paul Nedwell, Mohammad Al-Tee and Zhangjian Wu: " Effect of Different AluminiumPowderContent on the Behavior of Aerated Concrete: Experimental and Finite Element Validation", International journal of Materials, Mechanics and Manufacturing, Vol 6, Issue 2, April 2018, pp 155-158.
[18] JeetendraAhirwar and Antara Banerjee: "To Check the Suitability of Aluminium Powder and Khangar in Concrete", International Journal of Current Research, Vol 9, Issue 7, July 2017, pp 53470-53474.
[19] Balaji B and Satyakumar N: "High Strength light weight Concrete", International Journal of Technological Research in Engineering", Vol3, Issue 8, April 2018, pp 1637-1639.
[20] Corresponding Author : Prof V.Giridhar
[21] Mail Id : drgiridhar@ksrmce.ac.in