International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Experimental Study of Light Weight Concrete using Perlite

Annie Sweetlin.J.P[1], Boologanageswari.S[2], Madhu.S[3], Priyanka.B[4], Rekha.S[5]

[1]*Assistant Professor, Department of Civil Engineering, Velammal College of Engineering and Technology, Madurai, Tamil Nadu, India*

[2,3,4,5]*UG Student, Department of Civil Engineering, Velammal College of Engineering and Technology, Madurai, Tamil Nadu, India*

Abstract - Structural Low Density Aggregate Concrete has an ability to reduce the self-weight of the structure as well as reduces the risk of earthquake damages to a structure because earthquake forces are proportional to mass of the structure. For structural application of lightweight concrete, the density is more important than the strength. A low density for the same strength level reduces the self-weight, foundation size and construction costs. In this study, structural lightweight aggregate concrete was designed with natural Perlite aggregate that will provide an advantage of reducing dead weight of structure also compared the strength of normal concrete with perlite concrete by fully replacing coarse aggregate with perlite by varying the water cement ratio in perlite concrete. The investigations were carried out using several tests which include compressive test, split tensile test. By analyzing the test results the perlite concrete can be effectively used in non-load bearing walls and in-fill walls and the dead load of the structure can be effectively reduced.

Keywords: ***Low density concrete, Perlite aggregate, Self –weight reduction, Compressive strength analysis, Tensile strength analysis***

1.INTRODUCTION

Concrete is a mixture of fine and coarse aggregate bonded together with cement mortar that hardens over time. Portland cement is most commonly used for making concrete. Concrete is used in the construction of various structures like beams, columns, slabs, foundation and other load bearing elements. There are many types of Non Cementious materials exists by using different binding aggregate like asphalt concrete in combination with a bitumen binder**.**

The term light weight concrete according to ACI is also known as Light density concrete. It is defined as the concrete which is made with light weight coarse aggregate and normal weight fine aggregate with possibly some light weight fine aggregate. This concrete is of density less than 1950 kg/m^3 . The aggregate used here has high porosity, small apparent density, more water absorption and low strength. Structural Light Weight Aggregate are typically expanded shale, Clay or slate materials fired in a rotary kiln to develop a porous structure.

1.1 Objectives

The following are the objectives

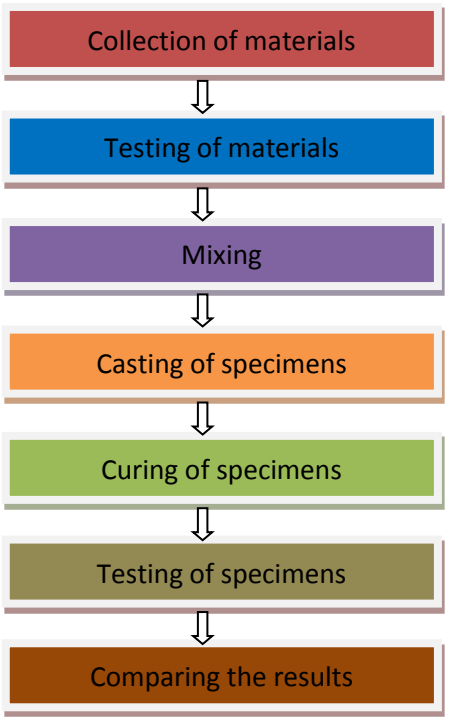
- To reduce the self weight of the structure by producing structurally light weight aggregate concrete with the help of perlite as coarse aggregate.
- To compare the conventional concrete with structurally light weight aggregate concrete by fully replacing coarse aggregate as perlite with different water content of 0.45% and 0.5 %
- The investigations are to be carried out using tests which include compressive test and split tensile test.

2. LITERATURE REVIEW

Bhuvaneshwari. K *et al.* (2017) studied that the structural light weight concrete when designed with natural perlite aggregate provides an advantage of reducing the dead weight of the structure and also the strength of normal concrete with perlite concrete by partially replacing perlite with sand as a percentage of 5%, 10%, 15%, 20% and 25% in normal concrete mix. The result shows that the Compressive strength increased by 1.85%, Split Tensile strength increased by 10.46% and Flexural strength by 10.20% through the optimum replacement of 10% of sand by Perlite.

Dinesh. A *et al.* (2016) This study states that in the design of Concrete Structures, Light weight concrete plays a prominent role in reducing the density and to increase the thermal insulation. Structural light weight aggregate concrete was designed with the use of Perlite aggregate, Vermiculite aggregate and expanded clay aggregate. With respect to Compressive strength and Split tensile strength they concluded that the replacement of Vermiculite and Perlite aggregate by 50% of weight of aggregate increases strength with increase in age of concrete and obtain early strength.

3. METHODOLOGY



4. EXPERIMENTAL PROCEDURE

4.1 Collection of Materials

The materials needed for the project are Ordinary Portland cement of 53 grade,20mm sized coarse aggregate, fine aggregates passing through IS 4.36mm sieve and perlite aggregate of size 10mm and water. The cement, fine and coarse aggregate is collected from factory nearby. The perlite which was imported from Bangalore to kochadai-madurai.

4.2 Material Properties

4.2.1 Cement

Table-1: Properties of Cement

Properties	Result
Initial setting time	45 minutes
Final setting time	466 minutes
Specific gravity	3.15
Fineness	8%
Consistency	30%

4.2.2 Fine Aggregates

Table-2: Properties of Fine Aggregates

Properties	Result
Grading zone	Zone III
Water absorption	2.2
Specific gravity	2.44
Fineness modulus	2.7

4.2.3 Coarse Aggregates

Table-3: Properties of Coarse Aggregates

Properties	Result
Water absorption	0.5%
Specific gravity	2.98
Fineness modulus	3.44

4.2.4 Perlite Aggregate

Table-4: Properties of Perlite Aggregates

Properties	Result
Size	10mm
Water absorption	1.5%
Specific gravity	0.15
Color	White
Fineness modulus	5.17

4.3 Mix Design

Mix design for M25 concrete was determined from IS 10262-2009 and according to the properties of cement,

fine and coarse aggregates are mixed with respective water cement ratio.
The mix proportion for 1m^3 of conventional concrete,

Water: Cement: Fine aggregate: Coarse aggregate

208 : 41 : 721.35 : 1098.39

The mix proportion for 1m^3 of perlite concrete,

Water: Cement: Fine aggregate: Perlite aggregate

208 : 41 : 721.35 : 655.77

4.4 Casting of Specimens

After mixing, the conventional concrete mix and perlite concrete mix with different water cement ratio are filled in cubic and cylindrical moulds for testing. The specimens are demoulded after 24 hours for curing and the curing is done for 28 days in the curing tank.

Fig -1: Casting of concrete

4.5 Curing of Specimens

The curing procedure used here is water curing. The mould is dismantled and the cubes are taken out and placed in the curing tank for 28 days, so that the concrete could attain its full strength.

Fig -2: Curing of concrete

5. TESTING OF CONCRETE

5.1 Compressive Strength

After 7 and 28 days of curing, cube specimens were removed from the curing tank and cleaned to wipe off the surface water. Cubes were tested at the specified age using compression testing machine as shown in Figure. The maximum load to failure at which the specimen breaks and the pointer starts moving back was noted. The test was repeated for three specimens and the average value was taken as the mean strength.The conventional concrete and the structurally light weight aggregate concrete has been tested .The Structurally light weight perlite concrete of series 1 (water content ratio 0.4) and series 2 (water content 0.5) is tested after 7days for its compressive strength.

Fig -3: Cube Testing

5.2 Split Tensile Strength

The tensile strength for continuously moist cured lightweight concretes was correlated mainly with the compressive strength and may be considered equal to that of equal compressive strength normal weight concrete. The tensile strength of lightweight concretes which undergoes drying is more relevant in respect to behavior of concrete in structures. In drying of the concrete, moisture losses progress at a slow rate into the interior of concrete members, which results in the probable development of tensile stresses on the exterior faces and balances compressive stresses in still moist interior Zones. Hence the tensile resistance to external load of dried lightweight concrete would be reduced from that indicated by continuously moist cured concrete. The splitting tensile strength of all-lightweight concretes varies from approximately 100-70 percentage to that of normal weight reference concrete when comparisons are made equal to compressive strength of the cylinder specimen.

Fig -4: Cylinder Testing

6. RESULT AND DISCUSSIONS

6.1 Compressive Strength Test Results

Table-5: Load at Failure in Compression

Trial No.	7 days Compressive load (KN)		28 days Compressive load (KN)	
	CC	PC	CC	PC
1	418.50	179.55	612.31	282.00
2	331.42	185.63	659.43	311.85
3	352.57	197.10	752.51	338.85
Average	367.50	187.42	674.75	310.90

Table-6: Compressive Stress Results

Trial No.	7 days Compressive Stress (N/mm^2)		28 days Compressive Stress (N/mm^2)	
	CC	PC	CC	PC
1	18.60	7.98	27.30	12.54
2	14.73	8.25	29.29	13.86
3	15.67	8.76	33.42	15.06
Average	16.33	8.33	30.00	13.82

6.2 Split Tensile Test Results

Table-7: Load at Failure in Tension

Trial No.	7 days Tensile load (KN)		28 days Tensile load (KN)	
	CC	PC	CC	PC
1	60.08	25.44	76.16	44.89
2	37.11	17.85	70.33	40.82
3	30.04	20.85	66.09	35.87
Average	42.41	21.38	70.86	40.52

Table-6: Tensile Stress Results

Trial No.	7 days Tensile stress (N/mm^2)		28 days Tensile Stress (N/mm^2)	
	CC	PC	CC	PC
1	3.40	1.44	4.31	2.54
2	2.10	1.01	3.98	2.31
3	1.70	1.18	3.74	2.03
Average	2.40	1.21	4.01	2.29

6.3 Comparison of Compressive Strength

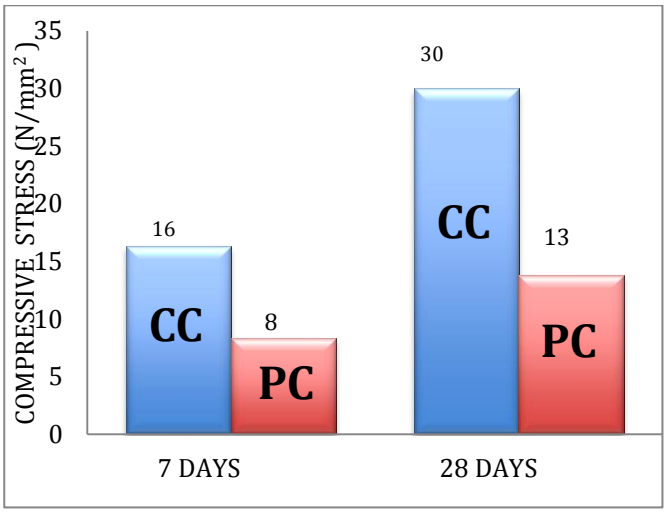


Chart-1: Comparison of Compressive Stresses

Chart-1 shows the comparison between the structurally light weight perlite concrete and the conventional concrete at 7 and 28 days shows minimum variation in their compressive strength. The compressive strength of perlite concrete increased from 8.33Mpa at 7th day to 13.82 Mpa at 28th day which is increased by 65.9%.Wheareas the compressive strength of conventional concrete increased from 16.33 Mpa at 7th day to 30 Mpa at 28th day which is increased by 83.71%.

6.4 Comparison of Tensile Strength

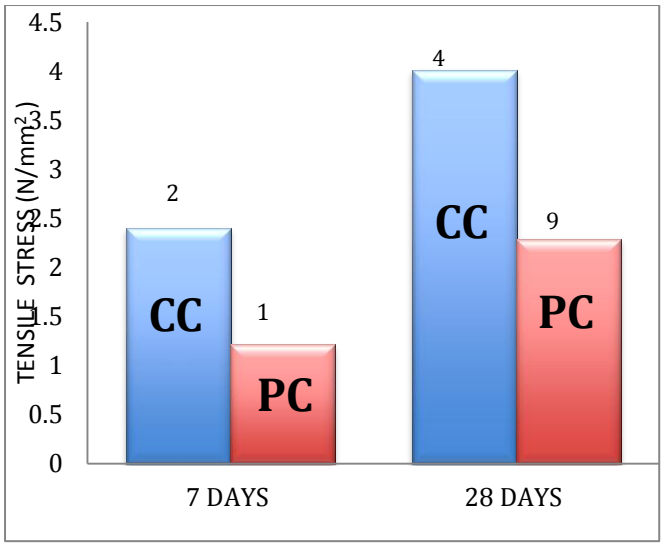


Chart-2: Comparison Of Tensile Stresses

Chart-2 shows the comparison between the structurally light weight perlite concrete and the conventional concrete at 7 and 28 days shows minimum variation in their tensile strength. The tensile strength of perlite concrete increased from 1.21Mpa at 7th day to 2.29 Mpa at 28th day which is increased by 89.25%,Wheareas the compressive strength of conventional concrete increased from 2.4 Mpa at 7th day to 4.01 Mpa at 28th day which is increased by 67.08%.

7. CONCLUSIONS

1) Thence, based on the test results acquired, it can be inferred that, The perlite concrete using natural perlite as coarse aggregate reduces the self weight of the concrete blocks to a considerable quantity compared to normal conventional concrete.

2) This type of light weight concrete is used in earthquake prone areas to resist the seismic forces.

3) Through the comparison study, the percentage difference in compressive strength of conventional concrete and perlite concrete is 46.06% and the percentage difference in tensile strength of conventional concrete and perlite concrete is 57.10%.

4) The compressive strength and tensile strength of perlite concrete is compared with conventional concrete which is of same water cement ratio and the strength of the perlite concrete is greatly reduced but the density achieved by perlite concrete is relatively low hence, it can be the vital replacement of concrete in non load bearing walls, light weight roof decks, floor fills and in-fill walls by which the structural dead load of the building can be effectively reduced.

REFERENCES

[1] Bhuvaneshwar, Dhanalakshmi and Kaleeswari(2017) 'Experimental study on light weight concrete using perlite' – International Research Journal of Engineering and Technology.

[2] Dinesh, Padmanaban and Maruthachalam (2016) 'Study on Mechanical Properties of low density concrete with partial replacement of coarse aggregate'- International Journal of Earth science and Engineering.

[3] Prekshi Khanna, Archana Manoj Mukulam, Varun Teja and Meena(2018 'Study on Durability Properties of perlite incorporated concrete' – International Journal of Civil Engineering and Technology.

[4] Purandara, Udayakumar and Gopinatha Nayak(2018) 'Elevated temperature performance of expanded perlite aggregate cement mortar as a protective cover for concrete' - International Research Journal of Engineering and Technology.

[5] Mathawee Sriwattanapong, Theerawat sinsiri and Saksith Pantawee(2013) 'Study of light weigth concrete admixed with perlite' – International Journal of Civil Engineering and Technology.

[6] Malek Jedidi, Omrane Beneddou and Chokri Soussi(2015) 'Effect of expanded perlite aggregate dosage on properties of lightweight concrete' – Jordan Journal of Civil Engineering.

[7] Khonsari, Eslami and Anvari(2010) 'Effects of expanded perlite aggregate on the mechanical behaviour of lightweight concrete' – International Journal of Civil Engineering and Technology.

[8] Indian Standards 10262:2009, Code Of Practice For 'concrete mix proportioning – guidelines (first revision)' – Bureau Of Indian Standards.

[9] Indian Standards 456:2000, Code Of Practice For 'Plain And Reinforced Concrete (Fourth Revision)' – Bureau Of Indian Standards.