Influence of Perlite and Glass Fiber on the Compresive, Split Tensile and Flexural Strength of Concrete Incorproting Glass Fiber

M.Rajendran, N.Lavanya

Abstract —Concrete is used most asconstructionmaterial than any material in the world. Concrete is used because it can be casted by anyone even in site itself. 60to80 percent aggregate occupies concrete volume and influence the concrete properties,mixproportions and economy. The properties likecompressive strength &fireresistance can be increased by adding perlite in concrete and it reduces weight crack resistance & environmental impact.The researchintention istoinvestigate the structural properties of of perlite-glassfiber concrete. 20%, 35% &50% of fine aggregate by weight is replaced by perlite. In additiontothat glass fiber material is added by 0.2%, 0.4% and 0.6%withrespect to the volume of the concrete in order to increasethetransverse rupture strength and the compressive strength considerably. Glass fiber is very good insulation to electricity andbetterresistance to chemical impact. The intentionof this study istoincrease strength and create environment-friendlyconcrete. Test result indicated that replacing fine aggregate of quantity 35% with perlite results in higher compressive strength and addition of 0.6% glass fiber has yielded higher flexural strength of M30 grade concrete.

Keywords— Perlite, Glass fiber, Compressive strength test,Split tensile test, Flexural strengthtest.

I. INTRODUCTION

Various structural members such as foundation, columns, beam, slabs, etc., employs concrete structures substantially. Many research study includes replacement of fine aggregates with various raw materials such as ferro chrome, manufacturing sand etc.,depending upon the availability, price of raw material. Compressive, split tensile, flexural strength and also modulus of elasticity increase was found under uni-axial loading [1], [2]. Increase in fiber above 1.5% decreases the workability of concrete, a major setback in property compared to Self curing concrete [3], [4].This research study reveals the use or replacement of fine aggregate with perlite. In this research study perlites were used as a replacing material for fine aggregate. Addition of perlite has increased

the compressive strength of concrete [5], [6]. The addition of fiber in concrete reduces the crack under different loading [7], [8], [9], [10]. Ductility of concrete found to be improved by addition of steel fibers [11]. The usage of Glass fiber found its serious advantage in increasing the flexural strength by bonding the material.

These properties made us to added perlite of 20%, 35%, and 50% by weight in place of fine aggregate in concrete and glass fiber is also integrated to study the increase in their flexural strength parameters.

The development in fiber concrete (FC) were early started in sixties. When concrete cracks, fibers starts arresting the cracks, and that increases the strength and ductility. The predominant modes of failure in FC are either by bond breakdown between fiber and material in the vicinity or by material failure.

In present investigation, M30 concrete grade is used. Mix design was done according to IS 10262: 2009. Based on the above practice, a concrete proportion with a characteristic target compressive strength is designed. Experimental investigations are pursued to find outmechanical properties which include splittensile strength, transverse rupture strength, and compressive strength of M30 concrete specimen. Minimum of three concrete specimens were tested for each trial mix. Thetests were conducted as per IS codalspecifications [12], [13], [14], [15].

II. MIX DESIGN OF M30 GRADE CONCRETE USING IS 10262:2009 [13].

A. Mixproportion of conventional concrete of M30 grade.

Cement	=	413kg/m^3
Fine aggregate	=	678 kg/m^3
Coarse aggregate	=	1238kg/m^3
Water	=	204kg/m^3

Revised Manuscript Received on 10 January 2019.

M.Rajendran, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India.

N.Lavanya, Department of Civil Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India.

VariousMixProportionOfM30GradeConcreteUsed

Mix No.	Unexpanded Perlite		Glass Fiber		C in kg/m^3	F A in kg/m^3	C A in kg/m^3
	percentage	in kg/m^3	percentage	in kg/m^3			
1	0	-	0	-	413	678	1238
2	20	135.6	0.2	0.826	413	542.4	1238
3	20	135.6	0.4	1.652	413	542.4	1238
4	20	135.6	0.6	2.478	413	542.4	1238
5	35	237.3	0.2	0.826	413	440.7	1238
6	35	237.3	0.4	1.652	413	440.7	1238
7	35	237.3	0.6	2.478	413	440.7	1238
8	50	339	0.2	0.826	413	339	1238
9	50	339	0.4	1.652	413	339	1238
10	50	339	0.6	2.478	413	339	1238

Table 1: Concrete mix proportion.

III. STRENGTH PROPERTIES

A. Compression tests forcubes

The cube of size150 mm X 150 mm X 150 mm was used to compute the compressive strength. The aggregates are bought to saturated surface dry condition before mixing. The tests was done atthe ageof7daysand28daysusing4T capacityHELICO compression testing machine referred to IS: 516-1959[14]. Uniform stress of 140kg/cm^2/min was applied on the specimen.

Loading were continued till the needle in dial gauge reversed its course of motion. The failureof the specimen was identified when the needle direction got reversed. The reading at that time wasnoted and that's the ultimate load. Ultimate load upon specimen's cross section area providesthe ultimate cube compressive strength [16], [17]. The typical test setup is shown in Figure 1.

$$\text{Compressive strength} = \text{Load} / \text{Area}(\text{N/mm}^2)$$

B. Split tensile test forcylinder

Concrete cylinder of size 150X300mm is casted. Aftera day, the specimens are removed from mould and placed inwater curing tank. After the curing of 7 and 28 days, three cylinders waretaken out and tested in universal testing machine.Ultimate load at which cylinder failedisnoted [16], [17].

Fig.1. Cube Compressiontesting

C. Rupturetest

Flexural strength is a measure of tensile strength of concrete. It is used to determine ability of the concrete structure in resisting bending failure and measuredby applying load on 100 x 100 x 500 mm concrete beams until it fails reaching its ultimate load. The flexural strength is articulated as Rupture Modulus (MR) and is found outby standard two-point loadingprocess [16], [17].

IV. TEST RESULTS AND DISCUSIONS

The concrete passing the fresh concrete test are then filledin the cubes and cylinder. The number of specimen castedis outlined in the programmed schedule. The results of the test which was performed once the curing was over are given in Table 2. Mix 1 represents the grade M30. The data given in the table 2, 3 and 4 are the average of three samples.

A. Cube compression test (M30 grade)

Mix	Average Cube Compressive Strength (N/mm^2)	
	7 days	28 days
1	21.04	30.05
2	27.17	38.81
3	26.12	37.31
4	22.67	32.39
5	25.29	36.13
6	27.77	39.67
7	25.29	36.13
8	26.12	37.31
9	25.45	36.36
10	24.74	35.34

Table 2 Cube compression test

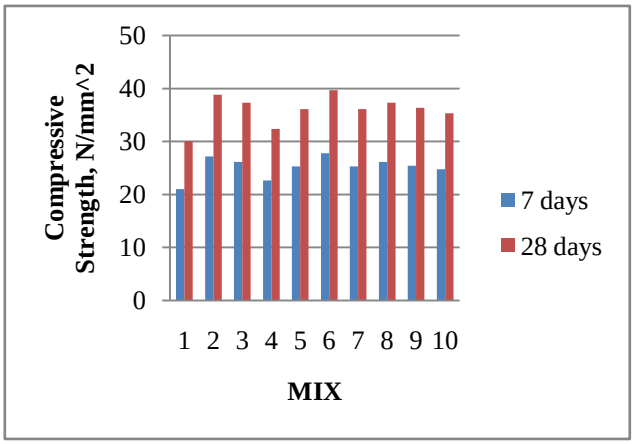

Fig.2. Cube compression test

Maximum increase in compressive strength of about 30 % has been observed for Mix 6 (35 % of perlite and 0.4% of glass fiber). The average results show that 35% replacement of fine aggregate by perlite shows 23.5% enhancement. However, the same is less for 20% and 50 % of perlite replacement.

B. Split tensile test (M30 grade)

Mix	Average Split Tensile Strength (N/mm^2)	
	7 days	28 days
1	1.96	2.8
2	2.23	3.19
3	2.14	3.06
4	2.4	3.43
5	2.67	3.81
6	2.78	3.97
7	2.5	3.57
8	2.5	3.57
9	2.4	3.43
10	2.42	3.46

Table 3 Split tensile test

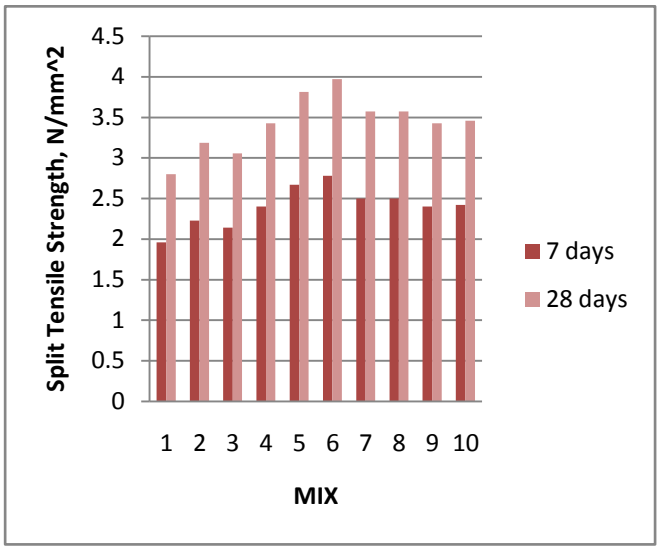

Fig.3.Split tensile test

The addition of 0.6% of glass fiber and replacement of fine aggregate by 35% perlite shows the best result of 42% increase in split tensile strength. On average, the result shows addition of 0.4% glass fiber give 35% increase in strength.

Increase in split tensile strength ware observed while percentages of fiber were increased, but after 0.4 % the decline in strength was observed. The test result shows that there is only 15 % and 24.5 % increase for 0.2% and 0.6% respectively.

C. Flexural strength test (M30)

Mix	Average Flexural Strength (N/mm^2)	
	7 days	28 days
1	3.77	5.39
2	6.78	9.69
3	6.84	9.77
4	6.84	9.77
5	6.06	8.66
6	6.00	8.57
7	7.26	10.37
8	6.16	8.80
9	6.74	9.63
10	6.87	9.81

Table 4. Flexural strength test

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

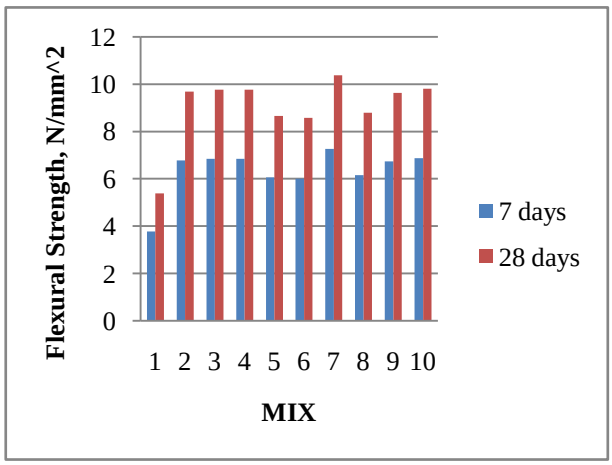

Fig.4. Flexural strength test

Though Mix 7 shows the maximum increase in flexural strength, on the average flexural strength only 0.2% addition of fiber give the best result. About 80% increase was found for 0.2% addition.

There is increase in the flexural strength for all 0.2%, 0.4%and 0.6% over control mix but there is decline in the average strength after 0.2% addition of fiber.

Even though there is increase in flexural strength for 0.4% and 0.6%, the uncertainty on its durability has to be answered in further studies. More addition of fiber decreases the durability of concrete [1], [2]. Result shows that for 0.2%addition of fiber, the quantity of perlite does not play any role in the flexural strength.

V. CONCLUSION

The present experimental investigation is performed with concrete by partial replacement of concrete's compressive and flexural strength and by adding Glass fiber .Totally per mix 6 numbers of cubes, 6 number of cylinder and 6 number of prism were tested. The test results show the following conclusions,

1. The concrete's compressive strength incorporated with perlite is comparatively high compared to conventional concrete.
2. In this project the perlite is replaced by 20%, 35%, 50% in addition to that glass fiber is added for 0.2%, 0.4%, 0.6% of total volume of binding material and from this it is found that 35% replacement by perlite and addition of 0.4% of glass fiber found to have compressive strength of 39.67 N/mm^2, split tensile strength of 3.97 N/mm^2.
3. Addition of 35% of perlite and 0.6% of glass fiber gives high flexural strength compared to other proportions.

REFERENCE

1. Shah, SurendraandRangan (1994), "Effect ofFiber addition on concrete strength", Indian Concrete Journal, Vol. 5, Issue 2-6, PP.13-21, 1994.
2. ACI Committee 544. 1982. "State-of-the-Art Report onFiber Reinforced Concrete (ACI544.1R-82)". ConcreteInternational, May, Vol. 4, No. 5, PP. 9-30.
3. Mohanraj A, Rajendran M, Ramesh A S, Mahalakshmi M, ManojPrabhakar S. "An Experimental Investigation of Eco-Friendly Self-Curing Concrete Incorporated with Polyenthylene Glycol" International Advanced Research Journal in Science, Engineering andTechnology, Volume 1, Issue 2, October 2014.
4. S.J.Sonule, G P Deskmukh "Study of Conventional Concrete, Fiber Reinforced Concrete, and Self Curing Concrete" International journal for research Trends and Innovation ISSN 2456-3315 Volume 2, Issue 8, 2017.
5. S. Shankarananth, B. Jaivignesh. "ExperimentalStudyon the use of Glass Powder, GGBS,& Perlite in Fly ash Brick". ISSN 2320-5407 International Journal of AdvancedResearch (2016), Volume 4, Issue 4, 1381-1387.
6. R.Yuvaraja, S.P.Palanisamy "Investigation on partialreplacement of fine aggregate with unexpanded perlite in concrete" International Journal of Civil Engineering andMaterial & Construction, Volume 3, Number 1(2015) PP. 29-43.
7. Nagarkar P, Tambe S, Pazare D, Study of fiberreinforced concrete; 1987.
8. SamanKhan*PP*, Roohul Abad Khan*PP*, Amadur Rahman Khan*PP*, MisbahulIslam*PP*, SamanNayal, "Mechanical properties of Polypropylene Fiber reinforced concrete for M 25 & M 30 mixes: A Comparative study" International Journal of ScientificEngineering and Applied Science (IJSEAS) - Volume-1, Issue-6, September 2015 ISSN: 2395-3470 .
9. Amit Rai et al Int. "Applications and Properties of Fiber Reinforced Concrete" Journal of EngineeringResearch and Applications www.ijera.com ISSN: 2248-9622, Vol. 4, Issue 5 (Version 1), May 2014, PP.123-131.
10. K.Srinivasa Rao, S.Rakeshkumar, A.Laxmi Narayana "Comparison of Performance of Standard ConcreteAnd Faber Reinforced Standard Concrete Exposed To Elevated Temperatures" American Journal of Engineering Research, Vol.2, No.3, PP.20-26.
11. Kavita SKene, Vikrant S Vairagade and Satish Sathawane "Experimental Study on Behavior of Steeland Glass Fiber Reinforced Concrete Composites" Bonfring International Journal of Industrial Engineering and Management Science, Vol. 2, No. 4, December 2012.
12. IS 383, "Indian Standard Specification for Coarse and Fine Aggregate for Natural Sources for Concrete", Bureau of Indian Standards, New Delhi, Second revision, Feb. 1997.
13. IS: 10262-2009, "Recommended guidelines for concrete mix design, Bureau of Indian standards", New Delhi, India.
14. IS: 2386 (part-III and IV)-1963, "Methods of testing for aggregate for concrete".
15. IS: 516-1959, "Indian standard methods of tests for strength of concrete", Bureau of Indian Standards, New Delhi, India.
16. M.S Shetty ,Concrete Technology: Theory and Practice, Third eidtion, 2008, S.Chand Publications.
17. A.M.Neville, J.J.Broke, Concrete Technology, Second edition, 2010.