

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

Experimental Investigation on Light Weight Concrete by Using Vermiculite and Air Entraining Agent

V.Esakkirani ¹, Ashok Kumaravel ²

P.G Student, Department of Civil Engineering, PSN Engineering College, Tirunelveli, Tamilnadu, India¹

PhD Scholar, Anna university, Chennai, Tamilnadu, India²

ABSTRACT: Concrete is the single most widely used building material throughout the world. Concrete is used in large amounts because it is only and extremely good building material. In many places of the world the temperature is rising day by day. These days due to constant sand mining the natural sand is depleting at an alarming rate. In this case fine aggregate is partially replacement of vermiculite. Use of vermiculite in concrete it will enhance the shrinkage and crack resistance, fire resistance and reduces environmental impact and also reduce the cost. In this present study, an attempt has been made to study the mechanical properties of M30 grade concrete with different percentages at a range of 40%, 50% and 60% as partially replacement with vermiculite to the total weight of fine aggregate along with mineral admixtures like Fly ash (FA) is replace with cement by 10% for all mixes.. Water cement ratio is 0.42. Water cement ratio is put constant for all trail mixtures. The main aim of the study is to make economical and eco-friendly concrete. This thesis investigates quantitatively the workability and strength of a concrete mix at 3-days, 7-days, and 28-days, age containing 0% -60% of fine aggregate as vermiculite and 0% - 10% of cementations materials as fly ash. These finding guide the practitioner in selecting fly ash and vermiculite contents to meet strength and workability requirements of a concrete mix.

KEY WORDS: fly ash, vermiculite, aluminum powder

I. INTRODUCTION

Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities such as lessened the dead weight. It is lighter than the conventional concrete. The use of lightweight concrete has been widely spread across many. The main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages are that there is a reduction of dead load, faster building rates in construction and lower haulage and handling costs.

In this research we use vermiculite in concrete, which enhances the shrinkage and crack resistance, fire resistance and reduces environmental impact and also reduces the cost. Important characteristics of a good quality aggregate include resistance to abrasion, resistance to freeze/thaw action, resistance to sulphates, correct shape and surface texture, proper gradation, density, and compressive strength. The main purpose of the research is to study the compressive strength of concrete using vermiculite as partial replacement. The main aim of this study is to make economical and eco-friendly concrete.

This research was based on the performance of aerated lightweight concrete. However, sufficient water cement ratio is vital to produce adequate cohesion between cement and water. Insufficient water can cause lack of cohesion between particles, thus loss in strength of concrete. Focused were on the performance of aerated lightweight concrete such as compressive strength tests, water absorption and density and supplementary tests and comparisons made with other types of lightweight concrete.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

II. RELATED WORKS

M.R.Divya et al., (2016) have study on M30 grade concrete using vermiculite as partial replacement with 40%, 50% and 60% to the total weight of fine aggregate. The aim of their project is to study the strength parameters such as compressive strength, split tensile & flexural strength of concrete. They study result shows the optimum strength in compare the strengths for different vermiculite percentage was observed to be 50%.

S Syed Abdul Rahman and Gijo K Babu (2016) In their study, structural light weight aggregate concrete was designed with the use of natural vermiculite aggregate that will provide an advantage of reducing dead weight of structure and to obtain a more reasonable structural light weight concrete by the use of vermiculite power as a partial replacement of fine aggregate with the cement content of 479kg/m³ in M30 grade and water cement ratio is 0.40. The proportion of 0%, 5% and 10%, as vermiculite replacement to fine aggregate. And lastly they concluded that the 10% replacement of vermiculite to fine aggregate well compared to control mix.

S.Sharmila and L.Vijayan (2016) Have study replacement of the fine aggregate with the material called vermiculite. It belongs to the family of light weight aggregates. The exfoliated vermiculite is used as a replacement of fine aggregate. This project is mostly related in places where the ecological temperature is very high. The Replacements were done in 5, 10 and 15% of fine aggregate. And finally conclude that the Vermiculite replaced concrete shows insignificant decrease in density up to 15% when compared to normal concrete. In spit tensile test no much variation in split tensile strength when compare to normal concrete.

Ramazan Demirboga et al (2003) a study was made by on the effects of expanded perlite aggregate, silica fume and fly ash on the thermal conductivity of light weight concrete .The silica fume and fly ash were added as replacement for cement by decreasing the cement weights in different ratios by weight. They observed the decrease in thermal conductivity with the increase of silica fume and fly ash as replacement of cement.

Hjh Kamsiah Mohd.Ismail et al (1999) have studied the behaviour of light weight concrete and performance of aerated light weight concrete such as Compressive strength tests, water absorption and density and comparisons made with other types of light weight concrete.

Celik Ozyildirim (2009) et al has studied the durability of structural light weight concrete which includes the physical and chemical aspects of durability, the effect of cracking and resistance of light weight aggregates to freezing and g.

III. MATERIALS USED

VERMICULITE

Vermiculite is a mica-like mineral mined around the world. Vermiculite is light and is also fire resistant. Vermiculite is light brown/grey/gold and white in colour and is a pebble like material ranging in size from 2 – 10 millimetres in diameter.

FLY ASH

Fine particles of ashes, dust, soot carried out from burning fuel (such as coal or oil) in furnace. The use of fly ash as a cement replacement material is very common.



ALUMINIUM POWDER

In this project the aluminum powder is used as the air entraining agent. Aluminium powder is usually used to obtain autoclaved aerated concrete by a chemical reaction generating a gas in fresh mortar, so that when it sets it

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

Contains a large number of gas bubbles. Aluminium powder, if breath in, is not particularly harmful and will only cause minor irritation.



FINE AGGREGATE

The sand used for the experimental programme was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. Properties of the fine aggregate used in the experimental work are tabulated in Table. The aggregates were sieved through a set of sieves to obtain sieve analysis and the same is presented in Table. The fine aggregates belonged to grading zone III.

Physical Properties of Fine Aggregate

S. No.	Characteristics	Value
1.	Specific gravity	2.46
2.	Bulk density	1.4 kg/m ³
3.	Fineness modulus	2.56 m ² /g
4.	Water absorption	0.85 %
5.	Grading Zone (Based on percentage passing 0.60 mm)	Zone III

COARSE AGGREGATE

The material which is retained on IS sieve no. 4.75 is termed as a coarse aggregate. The crushed stone is generally used as a coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 3831970.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019



Table 3.2.3 Physical Properties of Coarse Aggregate

S. No	Characteristics	Value
1	Type	Crushed
2	Specific Gravity	2.66
3	Total Water Absorption	0.56
4	Fineness Modulus	6.83

WATER

Generally, water that is suitable for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it is suspected that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent tap water is used for casting.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

IV. EXPERIMENTAL WORKS

A) MIX DESIGN PROPORTION

MIX DESIGN - M30 GRADE (IS 10262-2009)

(a) Grade designation	:	M30
(b) Type of Cement	:	PPC
(c) Maximum Nominal size of aggregate	:	20 mm
(d) Shape of CA	:	Angular
(e) Minimum cement content	:	320kg/m ³
(f) Maximum W/C ratio	:	0.45
(g) Workability slump	:	100 mm (slump)
(h) Exposure condition (as defined in IS: 456)	:	Severe
(i) Method of concrete placing	:	Hand placed
(j) Chemical admixture	:	Air entraining admixture
(k) Maximum cement content	:	450kg/m ³

FINAL MIX PROPORTION

Material	Quantity for per m ³
Cement	395 kg
Fine Aggregate	748 kg
Coarse Aggregate	1180 kg
Mineral Admixture	7.9 kg
Water	158 litres

V. RESULTS

1 Slump test

Test was conducted as per the IS 1199 – 1959. The vertical settlement of concrete is known as slump. Slump is measure indicating the workability of cement concrete. A concrete is said to be workable if it can be easily mixed, compacted and finished. A workable concrete should not show any segregation or bleeding.

A slump test apparatus consisting of slump cone which is in the form of a hollow frustum made of thin steel sheet and tamping rod. The slump cone is to be positioned over a base plate placed on a level surface. Concrete mix is prepared with suitable water cement ratio. The mix is then placed in the slump cone mould in 4 layers. Each of the layers are tamped 25 times using a tamping rod. After filling the slump cone till its top, the cone is levelled at the top. The cone is removed immediately by raising it slowly and carefully in the vertical direction. As soon as the concrete settlement comes to stop, measure the subsidence of concrete in mm, which will give the slump value. Slumps test is carried out for various mixes CM, M1, M2, M3 concrete.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019



Fig 6.1 Slump Test

Table 6.1 slump result

W/C ratio	CM	M1	M2	M3
0.28	100 mm	80 mm	50 mm	10 mm
0.3	120 mm	85 mm	60 mm	20 mm

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

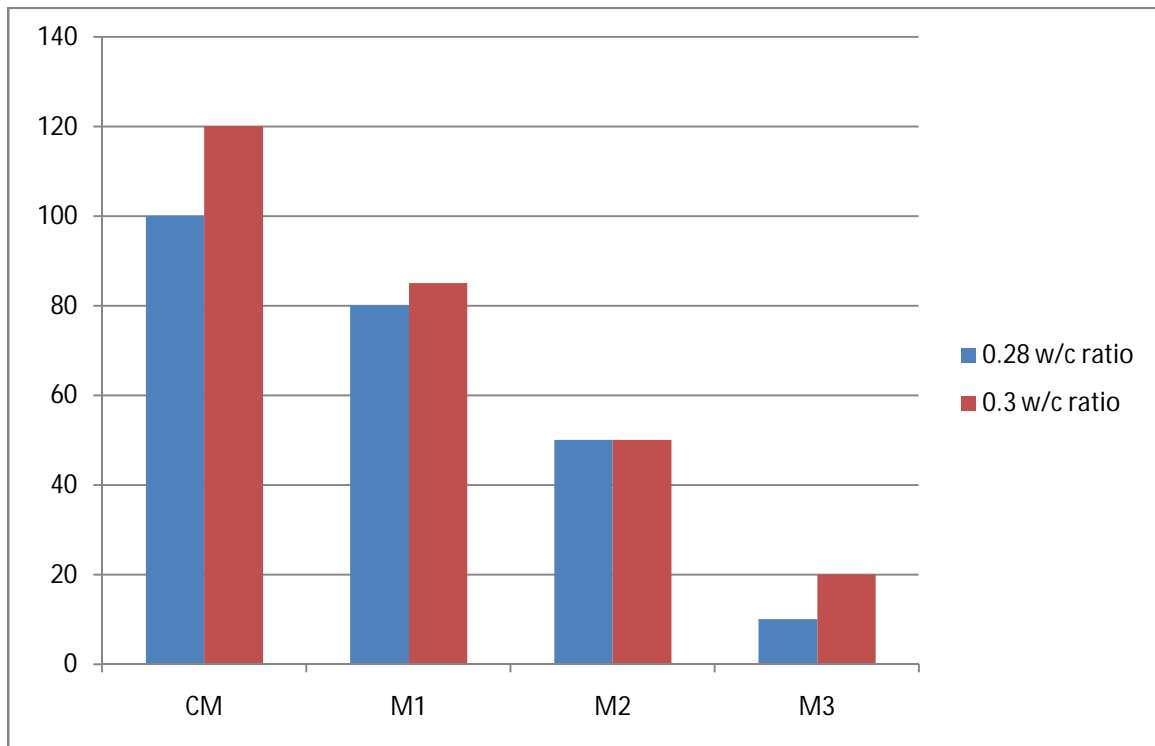


Fig 6.2 slump test results

Compressive strength of concrete

The test was conducted as per IS : 516- 1959. The compressive strength results obtained for various mixes CM, M1, M2, M3 for 7 days and 28 days.

Table 6.3.1 Compressive Strength Result for 7 days

Mix Name	Ultimate load at failure (kN)	Compressive Strength (N/mm ²)
CM	427	19.21
M1	360	16.45
M2	315	14.30
M3	270	12.41

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

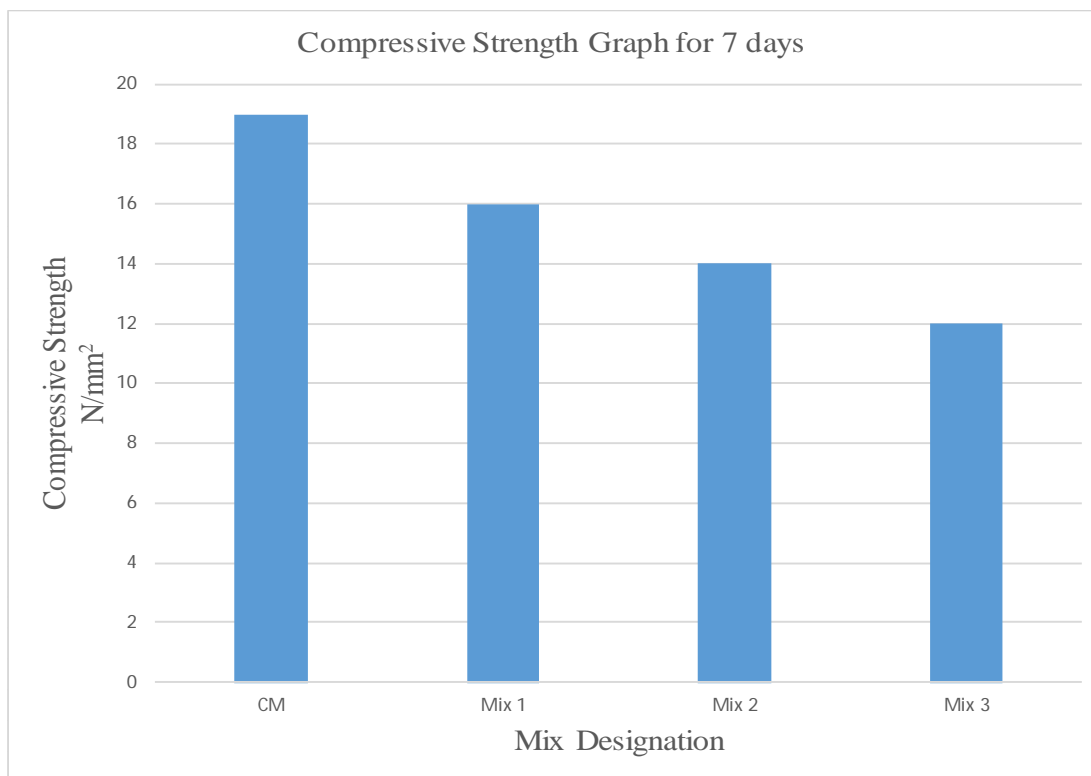


Table 6.3.2 Compressive Strength Result for 28 days

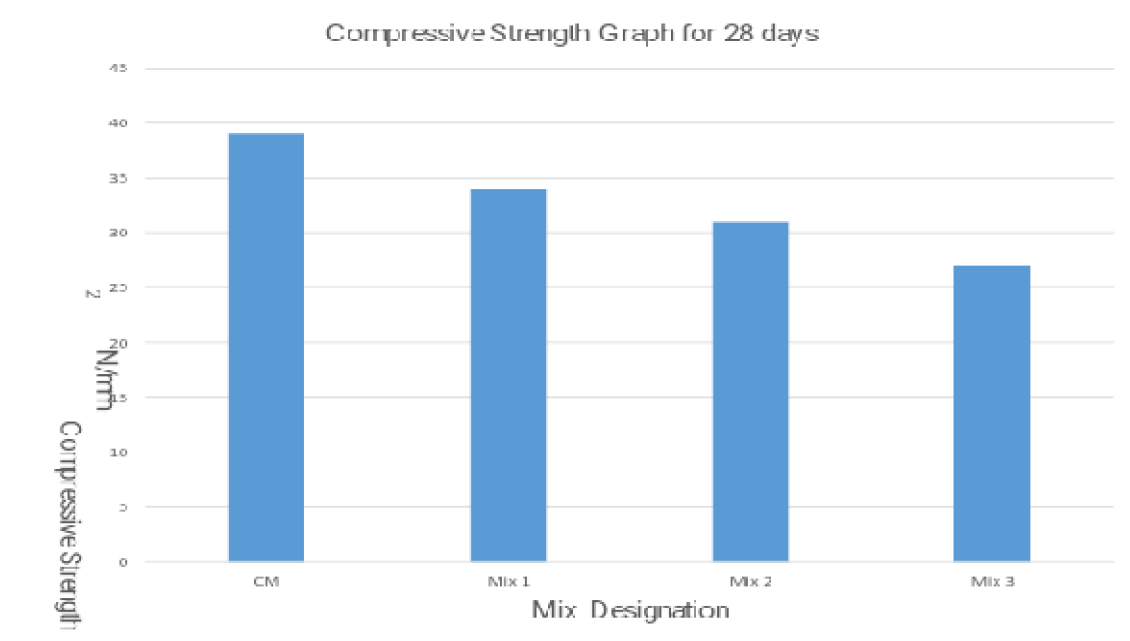
Mix Name	Ultimate load at failure (kN)	Compressive Strength (N/mm ²)
CM	877.5	39.58
M1	765	34.60
M2	697.5	31.14
M3	607.5	27.46

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019



Through the compressive strength of concrete decreases with increase of percentage of vermiculite, but with the replacement of fly ash at 10% to cement with replacement of vermiculite to fine aggregate and addition of Aluminium powder may be accepted and its giving required target mean strength.



International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

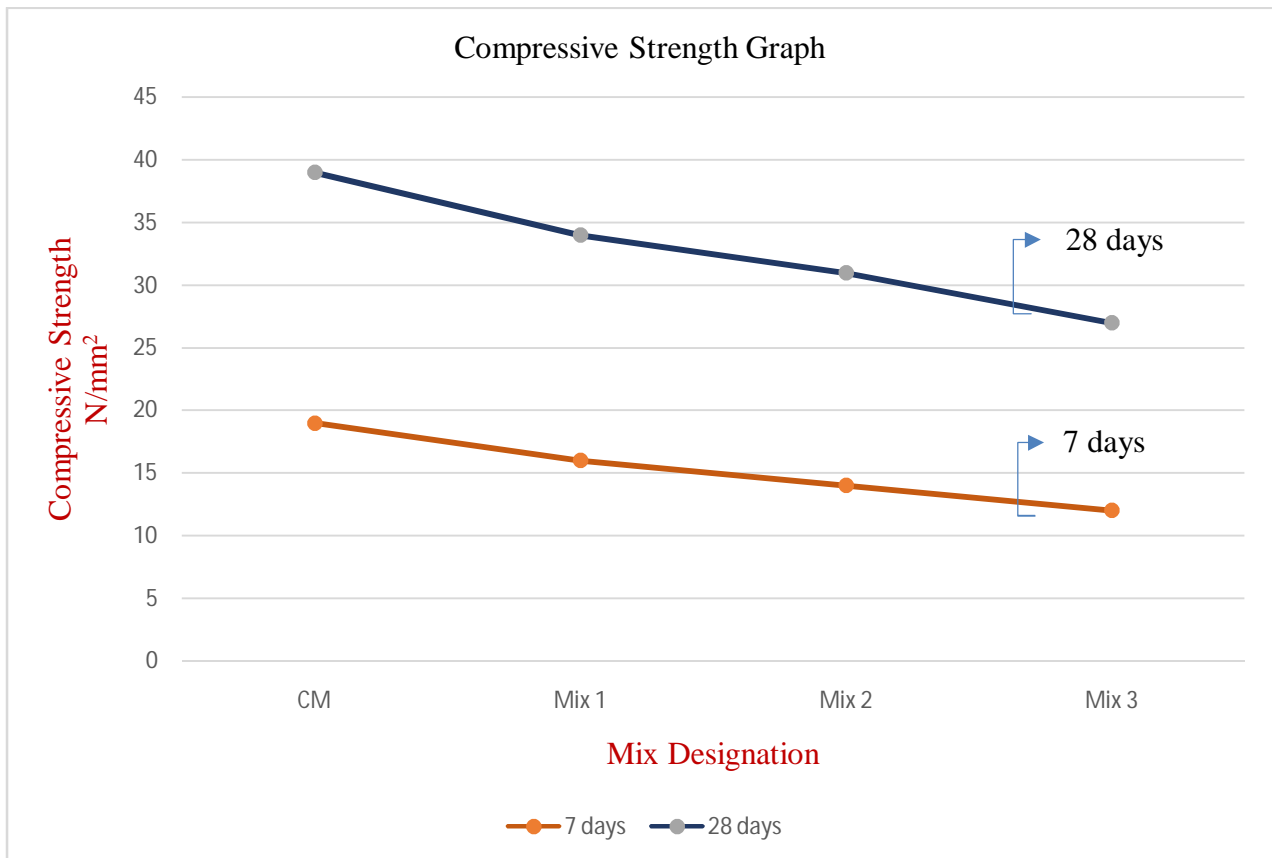


Fig. 6.3 Compressive strength graph for 7 & 28 days

DISCUSSION

Based on experimental results, the maximum compressive strength achieved for 7 day and 28 day is 16.45 N/mm² and 34.60 N/mm² at the replacement of 40% of fine aggregate (M1 mix) by vermiculite. The minimum compressive strength achieved for 7 day and 28 day is 12.41 N/mm² and 27.16 N/mm² at the replacement of 60% of fine aggregate (M2 mix) by vermiculite. Replacement of 50% of fine aggregate by vermiculite achieved the compressive strength of 14.30 N/mm² for 7 day and 31.14 N/mm².

FLEXURAL STRENGTH TEST

The flexural strength of concrete prism was determined based on IS 516-1959. Place the specimen in the machine in such a manner that the load is applied to the upper most surface as cast in the mould along two lines spaced 13.3cm a part. Apply load without shock and increase continuously at the rate of 180 kg/min and its increased until the sample fails. Measure the distance between the line of fracture and nearest support.

If $a > 13.3$ cm then

$$\text{Modulus of rupture } f_b = P * l / b * d^2$$

$$f_b = 3P * a / b * d^2$$

If $a < 13.3$

if $a < 11$, Discard the specimen

Where,

P= Maximum load applied to specimen in KN.

L= Supported length in mm.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

D= Depth of the specimen mm, and
A= Distance of the crack from the nearest support.



Fig 6.3.2 Testing of prism for flexural strength

TABLE 6.3.2 FLEXURAL STRENGTH RESULTS

Mix	% of vermiculite	% of fly ash	28 Days (MPa)
CM	0	0	4.68
M1	40	10	5.42
M2	50	10	5.62
M3	60	10	5.36

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

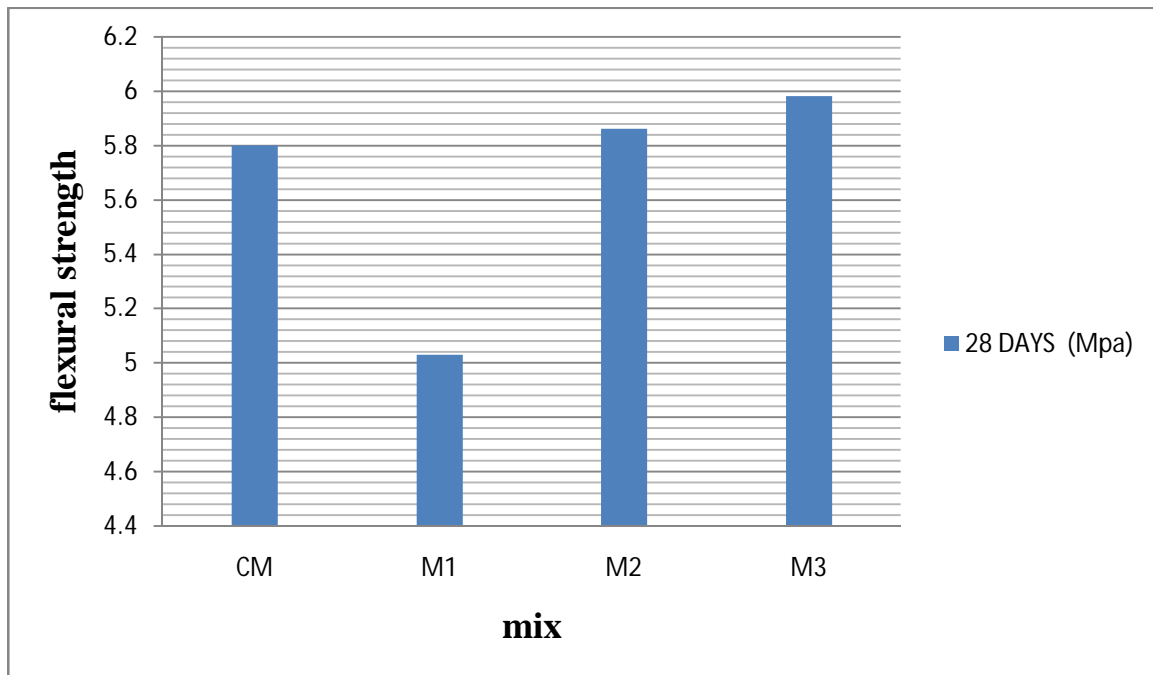


Fig 6.3.2 flexural strength of various mixes

SPLIT TENSILE STRENGTH OF CONCRETE

For the testing of split tensile strength of concrete cylinder would be tested in the compression testing machine for determining 7th and 28th day strength of concrete. The test was conducted as per IS: 5816:1999 guidelines. Specimens when received dry shall be kept in water for 24 h before they are taken testing. Unless other conditions are required for specific lab investigation specimen shall be tested immediately on removal from the water whilst they are still wet. The load shall be applied without shock and increased continuously at a nominal rate within the range 1.2 N/(mm*/min) to 2.4N (mm/min).

The tensile strength of the specimen was calculated by the following formula;

$$\text{Split tensile strength} = \frac{2P}{\pi ld}$$

Where,

P= Compressive load in KN

L= Length in mm

D= Diameter in mm

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019



Fig 6.3.3 Split tensile testing of cylinder

TABLE 6.3.3 SLPIT TENSILE TEST RESULTS

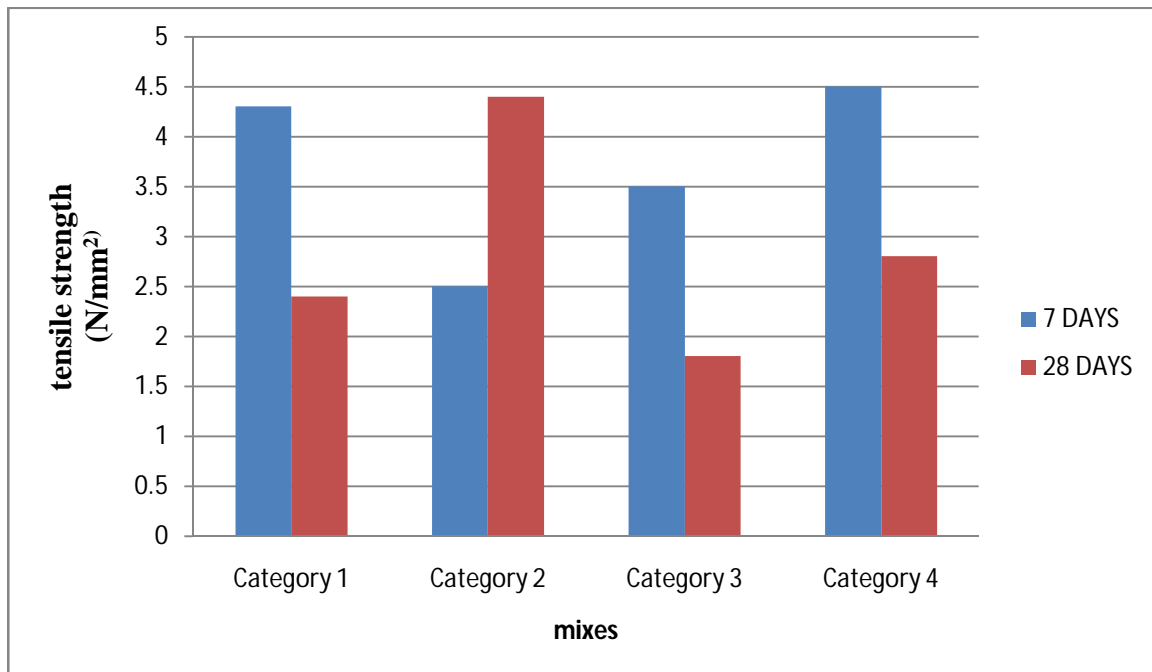
% OF VERMICULITE	7 DAY (N/mm ²)	28 DAY (N/mm ²)
CM	12.881	13.91
M1	12.71	13.58
M2	12.31	13.35
M3	12.06	13.2

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019



VI. CONCLUSION

As the results % of the vermiculite and the fly ash increases the compressive strength and split tensile strength. The split tensile strength of 28 days test of various vermiculite percentages shows the increases in strength of the concrete. Using the vermiculite and fly ash as the percentage of sand in concrete can reduce the cost of the materials in construction because the cost of the sand is high. The initial crack is delayed when compared with the beams compared with the beams of conventional concrete.

REFERENCES

1. DushyantRameshbhaiBhimani (2013) "Used Foundry Sand: Opportunities For development Of Eco-friendly Low Cost Concrete" Journal of Advanced Engineering Technology.
2. Dushyant R. Bhimani (2013) "A Study on Foundry Sand: Opportunities for Sustainable and Economical Concrete" Journal of Building Physics.
3. Dushyant R. Bhimani (2013) "Innovative Ideas for Manufacturing of the Green Concrete by Utilizing the Used Foundry Sand" Journal of Emerging Science and Engineering.
4. EknathP.Salokhe, D.B.Desai (2012) "Application of Foundry Waste Sand In Manufacture of Concrete" Journal of Mechanical and Civil Engineering.
5. Hind M.Ewadh, Noorezlin A. Basri (2012) "Effectiveness of Polystyrene Beads as Aggregate Replacement Material to Recycle Solid Waste" Journal of Scientific & Engineering Research.
6. Journal of the International Hemp Association. Vol. 1 (1994)–Vol. 6 (1999).
7. K.Rajeshkumar, N.Mahendran,R. Gobinath (2010) "Experimental Studies on Viability of Using Geosynthetics as Fibres in Concrete" International Journal Of Applied Engineering Research.
8. Manolia Abed Al-wahab Ali (2012) "The Possibility of Produce Self Compacted Polystyrene Concrete" Journal of Engineering and Development.
9. R. Sri Ravindrarajah (2005) "Adjusted Density High-strength Concrete Using Expanded Polystyrene Beads" International Conference on Concrete for Structures.
10. Shetty.M.S(2005), "Concrete Technology Theory and Practice" S.Chand& Co, Ltd., published in New Delhi.
11. TengkuFitriani L, Subhan(2006) "Lightweight High Strength Concrete With Expanded Polystyrene Beads" Journal Of Materials In Civil Engineering.
12. Youjiang Wang et al (2000) "Concrete Reinforcement With Recycled Fibers" Journal Of Materials In Civil Engineering.
13. IS 456- 000 "Plain and reinforced concrete code of practice".
14. IS 10262 - 009 "Recommended guidelines for concrete mi design".
15. Santa Monica green concrete guidelines