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Effect of Partially Replace of Cement with Alccofine, Metakolin and Coarse Aggregate with Bamboo in Concrete

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Abstract: ***The production of cement for concrete releases a significant amount of carbon dioxide (CO2) into the atmosphere, which is a major cause of global warming and the greenhouse effect. As a result, the construction industry must come up with a different material for cement. A ton of Strengthening Cementitious Materials (SCM) like silica exhaust, fly debris, Alccofine, powder of slag and so on. have previously been identified and successfully utilized as a partial substitute for cement in the production of concrete. Certain materials of mineral origin are also added to concrete to enhance their strength and durability properties of concrete materials such as Metakaolin and other by Alccofine. The partial replacement of aggregates is need for the future generation of concrete structures for the environment supportable. The depletion of the natural resources gets exhausted. We have think over the alternate replacement of the materials. In present work the partial replacement of the Metakaolin, Alccofine with the Cement and the Coarse aggregates is partially replaced by the Bamboo. Optimum value of strength in compression, split tensile and flexure came at MK and AF 14% replacement of the Metakaolin, Alccofine with the Cement and the Coarse aggregates is partially replaced by the 18% Bamboo. The workability of mixture increases and after that there is decrease in the workability of the concrete when we increase the percentage of Metakaolin, Alccofine with the Cement and the Coarse aggregates is partially replaced by the Bamboo. A series of experiment were carried out to measure the compressive strength, split tensile strength and flexural strength of the concrete. The results showed that the compressive strength, split tensile strength and flexural strength increases with the adding of the Metakaolin, Alccofine with the Cement and the Coarse aggregates is partially replaced by the Bamboo in concrete.***

Keywords: MK (Metakaolin), AF (Alccofine), workability, compressive strength, Split Tensile strength, Flexural strength.

I. INTRODUCTION

Concrete is a composite synthetic material made from cement, coarse aggregate and fine aggregate or sand, water. The consumption of concrete from global society is after the utilisation of water in world. Coarse aggregate is most essential ingredient in concrete which is used as a compaction material in higher volume ratio. Now a days natural aggregate has become pricey, So there is a strict need to reduce the high cost of coarse aggregate and fine aggregate in order to provide the low cost of structure, researchers are always consider the use of some locally available materials for the partial replacement of coarse and fine aggregate in construction works. Bamboo is one of the generally utilized construction materials since old circumstances or era because of its high strength, seismic resistance, less cost , low weight attain ability etc. Metakaolin is used as an alternative. Metakaolin is produced by calcination of kaolinite (soil mineral) at a temperature of 650-800ºC. It has pozzolanic properties. This reduces the size of the pores by turning the fine particles in the cement paste into integral pores. The world's most extensively used man-made construction material is concrete. The production of cement for concrete releases a significant amount of carbon dioxide (CO2) into the atmosphere, which is a major cause of global warming and the greenhouse effect. As a result, the construction industry must come up with a different material for cement. A ton of Strengthening Cementitious Materials (SCM) like silica exhaust, fly debris, Alccofine, powder of slag and so on. have previously been identified and successfully utilized as a partial substitute for cement in the production of concrete.

A. Alccofine

Alccofine or Ultra-fine slag is more advanced form of GGBS in which slag is further grind to less than 20 micron. As a result of it, the specific surface area is increased dramatically to 3000 - 5000 m2/kg. Particle shape of this ultrafine slag or alccofine is spherical which is due to its ball bearing effect which gives increased workability ,& reduce water content.

The Pozzolanic reaction increases due to its increase in specific surface area. In this alccofine the content of silica is found to be more than 80% as a result it acts as a good pozzolanic material. Bleeding and Segregation is not observed hence it is good impermeable material which in turns increases its durability. A joint-venture of Ambuja cement ltd and Alcon group Goa produces the ultrafine slag with a brand name Alccofine. It is manufactured in highly controlled conditions with very special equipments to produce exact optimized particle size distribution which provides unique property to alccofine. Alccofine 1101 and Alccofine 1203 are two types of Alccofine with high calcium silicate and low calcium silicate respectively. Alccofine 1200 series is of 1201, 1202, 1203 which represents its fine, micro fine, ultrafine particle size respectively. Alccofine 1203 is slag based SCM (supplementary cementitious material) having ultra fineness with optimized particle size distribution , whereas Alccofine 1101 is a micro finer cementitious grouting material for rock anchoring and soil stabilization.

B. Metakaolin

Metakaolin is used as an alternative. Metakaolin is produced by calcination of kaolinite (soil mineral) at a temperature of 650-800ºC. It has pozzolanic properties. This reduces the size of the pores by turning the fine particles in the cement paste into integral pores. Metakaolin is not a by-product which means its engineering values are well regulated. Therefore, the use of metakaolin should promise some advantages over other cement replacement materials. Properties of cement with metakaolin are justifiable In this case; studies are needed to study the performance of concrete using metakaolin. The main components of concrete, on the other hand, are aggregates, which are usually naturally occurring. Metakaolin is innovative clay product developed in resents years it can be used as partial replacement of cement in mortar as well as in concrete therefore it has been studied widely in resents years. Despites of studies, still many known's with the uses of metakaolin. Study is needed to determine the contribution of metakaolin in concrete. It was reported that the Metakaolin showed improved engineering properties of concrete by filling voids spaces between cements results in more impermeable concrete due to lesser size than cement particles is ranging from 1 to 2 microns and its is off white in the color its specific gravity is generally 2.6.

C. Bamboo Chips

Bamboo pieces with size of varying length from 2 to 4 cm, breadth from 1 to 2 cm, and thickness of 1 cm is can be used as a partial replacement of coarse aggregate at the replacement levels Of 0%, 4%, 8%, 12% , 16% , 20% and 24%. The physical properties of all these materials were tested as per IS 383-1970. The failures of bamboos are very less in seismic zones as there tension of the energy is maximum about the joints. The Cellulose appear in the bamboo is the main source of mechanical properties of bamboo, which is very good in buckling but due to its low strength and not being straight it may not be as good as steel

II. LITERATURE REVIEW

Tushar Shirke, Ajay Shinde, Yogesh Thorat, Amit Kawade, Aakash Gadekar 2016 study on concrete properties by partial replacement of cement by fly ash & Alccofine. They conclude that 20% of Alccofine and Fly ash replacement found to be the optimum amount in order to get favourable strength. Replacement of Alccofine and Fly ash is Eco-friendly, economical.

Abhishek Sachdeva, Gobind Khurana 2016 Studied the Effect of cement and fine aggregate replacement with Alccofine and Bottom ash on mechanical properties of concrete. They works on M-40 Grade of concrete. The conclude that Workability of the concrete mix containing 40% bottom ash as a partial replacement of fine aggregate is increased with the increase in the percentage of cement replacement by Alccofine upto 15% after which it decreased. Due to its unique chemical chemistry and particle size distribution, Alccofine results in the formation of dense pore structure, which results in improved workability and strength at all ages.

G.R.Vijay Shankar 2013 In this paper describes the studies made to ascertain the properties of HPC M40 grade concrete by using Metakaolin as partial cement replacement (0, 2.5,5,7.5,10,12.5 & 15 %) and Quarry dust as partial fine aggregate replacement (0,10,20,30,&40), to determine the compressive and tensile strength experimentally. Conclusion of this is by replacing 10% of cement with Metakaolin and 30% of sand with Quarry Dust with 3% Super Plasticizers Compressive strength and workability of concrete is optimum.

Dr.K.Srinivasu1 2016 research is to study partial replacement of MK with cement to check strength of Mortar and concrete and to improved mechanical properties and durability properties. Conclusion of his study is that Cement replacement with MK 20% in content gave maximum enhancement in pore refinement of pastes and compressive strength and workability reduces when MK addition goes beyond 30% as cement replacement**.**

Sabarish Godavarthy 2020 this research is to study to investigate permanence properties of concrete in terms of initial water absorption, final water absorption and confrontation to acid attack by partially replacement from 0% to 30% of MK with cement.

Conclusion of his study is that both initial and final water absorptions of the MK-modified concrete have been improved when MK content was increased up to 10% advantageously. And, also weight loss was decreased when MK content varied from 0% to 30%**.**

A.Manimaran 2017 They conduct their test on M-40 concrete with partial replacement of coarse aggregate by bamboo and fine aggregate by quarry dust.The percentage of bamboo added by volume basis was 0, 5%, 10%, 15%, 20%, and 25% as replacement of coarse aggregate used in concrete. Similarly the percentage of quarry dust added by weight was 0, 15%, 20% and 25%, respectively the fine aggregate replacement in concrete. Compressive strength, Split tensile strength, Flexural strength test. They concluded that Based on mechanical strength results the optimum partial replacement of coarse aggregate with bamboo and fine aggregate with quarry dust 15%.

Bibhab Kumar Das 2018 in this research Bamboo as an Alternative to Coarse Aggregate. They worked on M-25 concrete for partial and full replacement of coarse aggregate with bamboo chips. They conclude that Though bamboo can take considerable amount of stress, though their strength rivals steel, yet their mechanical property and strength is not fully utilized when they were used with composite concrete. If, by some means, the mechanical and full strength could be used, then definitely the resulting strength of the concrete cubes could be upgraded.

III. MATERIALS

A. Cement

Cement is a fine grey powder that has adhesive and cohesive properties in the presence of water. Portland cement is hydraulic cement that hardens in water to form a water-resistant compound. These consist of two basic ingredients namely argillaceous and calcareous. This mixture is blended, grounded and fused in kiln at 14000ºC and a product clinker is formed. After that the clinker is cooled and grounded to get cement. .

The cement of 43 Grade is the most popular Grade of Cement which has low heat of hydration and provides long life strength of Concrete Structures. Ordinary Portland cement of grade- 43 conforming to Indian Standard IS: 8112- 1989 has been used in the present study.

B. Coarse Aggregates

The graded coarse aggregate is described by its nominal size i.e. 40mm, 20 mm, 16 mm and 10 mm. Crushed stone aggregates of nominal size 20 mm and 10 mm in the proportion of 50:50 were used throughout the experimental study. The aggregates were washed to remove dust and dirt to surface dry condition.

The properties of coarse aggregates such as specific gravity, bulk density and fineness modulus were determined. It was set in accordance with the 1963 Indian Standard Setting IS: 2386 (Part 3).

C. Fine Aggregates

Sand is an extremely useful and most important material in the construction work but its importance lies in its quality so while purchasing it one has to be very careful. Sand which is required to be used in the construction purpose must be clean, free from impurities and waste stones.

Sieve analysis of the fine aggregate was carried out in the laboratory as per IS 383- 1970. Firstly the sand has been sieved through the sieve of 4.75 mm to remove any particle greater than 4.75 mm sieve and after that sand was sieved through the sieve of 75 micron size to make it free from clay lumps and other foreign matter and then it was thoroughly washed and air dried in the laboratory before being used for casting the required concrete mix. Depending upon the particle size distribution IS 383- 1970 has divided fine aggregate in IV different zones. Sand is generally composed of silica particles and gets deposited by the weathering action on sand stone. Sand is also classified as: Fine Sand (0.075mm to 0.425 mm), Medium Sand (0.425mm to 2 mm) and Coarse Sand (2.0mm to4.75 mm). Different type of tests conducted on sand is water absorption, specific gravity , fineness modulus and bulk density.

D. Alccofine

Alccofine or Ultra-fine slag is more advanced form of GGBS in which slag is further grind to less than 20 micron. As a result of it, the specific surface area is increased dramatically to 3000 - 5000 m2/kg. Particle shape of this ultrafine slag or alccofine is spherical which is due to its ball bearing effect which gives increased workability ,& reduce water content.

Table no. 1 : Properties of Alccofine

Fineness	Specific gravity	Bulk density	Particle size		
			D10	D50	D90
>12000cm^2/kg	2.9	700-800kg/m	1.5µ	5µ	9µ
Chemical Properties					
CaO	SO_3	SiO_2	Al_2O_3	Fe_2O_3	MgO
61-64%	2-2.40%	21-23%	5-5.60%	3.8-4.40%	0.8-1.40%

E. Metakaolin

Metakaolin is used as an alternative. Metakaolin is produced by calcination of kaolinite (soil mineral) at a temperature of 650-800ºC. It has pozzolanic properties. This reduces the size of the pores by turning the fine particles in the cement paste into integral pores. Metakaolin is not a by-product which means its engineering values are well regulated

Table no. 2 : Properties of Metakaolin

Chemical composition	Cement %	Metakaolin %
Silica (SiO2)	34	54.3
Alumina Al_2O_3	5.5	38.3
Calcium oxide CaO	63	0.39
Ferric oxide Calcium oxide (Fe_2O_3)	4.4	4.28
Magnesium oxide (MgO)	1.26	0.08
Potassium oxide (K_2O)	0.48	0.50
Sulphuric anhydride (SO_4)	1.92	0.22
LOI	1.3	0.68
Specific gravity	3.15	2.5
Physical Form	Fine Powder	Powder
Colour	Grey	Off white

F. Bamboo Pieces

The physical properties of all these materials were tested as per IS 383-1970. The failures of bamboos are very less in seismic zones as there tension of the energy is maximum about the joints. The Cellulose appear in the bamboo is the main source of mechanical properties of bamboo, which is very good in buckling but due to its low strength and not being straight it may not be as good as steel.

Table no. 3 : Properties of bamboo

Parameters	Values	Parameters	Values
Average weight	0.625 kg/m	Safe working stress in shear	115 to 180 kg/cm^2
Modulus of rupture	610 to 1600 kg/cm^2	Bond stress	5.6 kg/cm^2
Modulus of elasticity	1.5 to 2.0 x 10^5 kg/cm^2	Bending Strength, Fb	20.27 N/mm^2
Ultimate compressive stress	794 to 864 kg/cm^2	Compressive Strength, Fc	7.86 N/mm^2
Safe working stress in compression	105 kg/cm^2	Tensile Strength, Ft	14.96 N/mm^2
Safe working stress in tension	160 to 350 kg/cm^2	Longitudinal Shear Strength	1.41 N/mm^2

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IV. METHODOLOGY

A. Mixing Concrete

All the ingredients of concrete are mixed together however this mix should be homogenous and uniform in color and consistency. The mixing can either be done by hand or with the use of mixer.

B. Mixing Concrete

Thorough mixing of the materials is essential to produce uniform concrete. The mixing should make sure that the mass become homogeneous, uniform in consistency and colour. There are two methods adopting for mixing concrete one is hand mixing and other is machine mixing.

C. Curing

Before removing the mould, it is dried for 24 hours, and then specimens are placed in a water tank made to cure specimens. The specimens must be marked for identification so that there must not be any error. The specimens are removed from the tank and dried before putting in the testing machine. The specimens are kept in the tank for 7,14,28 days.

D. Workability Test

It can be used in site as well as in lab. This test is not applicable for very low and very high workability concrete. It consists of a mould that is in the form of frustum having top diameter of 10cm, bottom diameter of 20cm and height of 30cm. The concrete to be tested if fitted in the mould in four layers. The each is compacted 25 times with the help of tamping rod. After the mould is completely filled it is lifted immediately in the vertically upward direction which causes the concrete to subside.

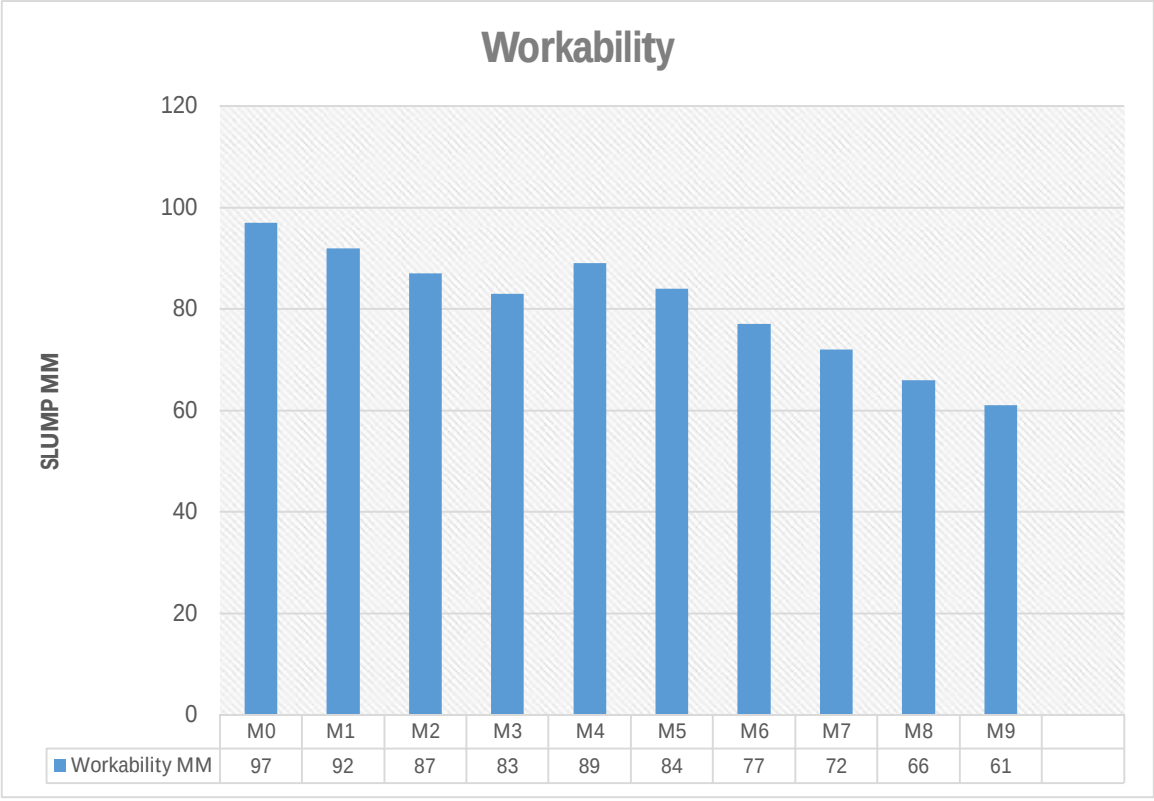


Fig -1: SLUMP CONE TEST

E. Compressive Strength Test

Then fresh concrete is filled in mould in 4 layers and after filling each layer tamping should be done 35 times in case of cube and 25 times in case of cylinder by using standard tamping rod. Once the mould is filled then leveled top surface of concrete with trowel. After the day the mould will removed and specimen are dropped in the curing tank under standard temperature of 27±2° c. After 7,14 days and 28 days in this research.

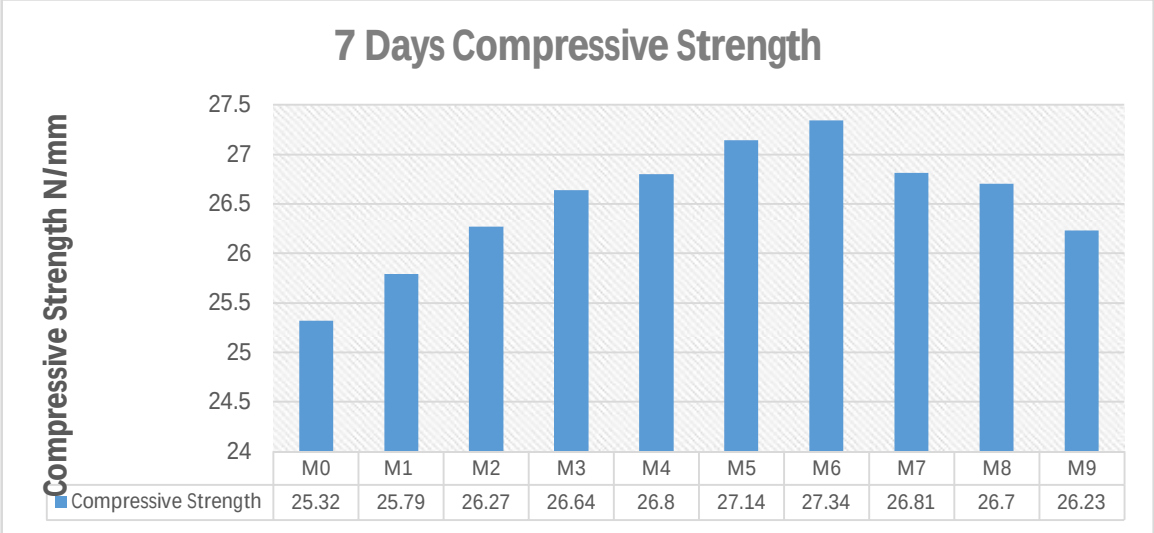


Fig -4: COMPRESSIVE STRENGTH TEST 7

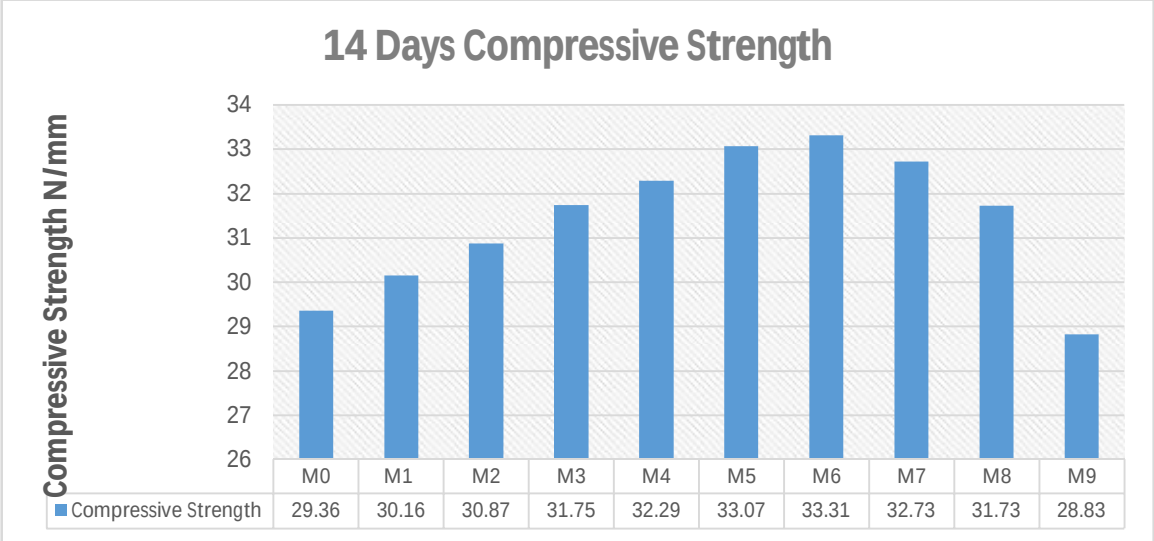


Fig -2: COMPRESSIVE STRENGTH TEST 14

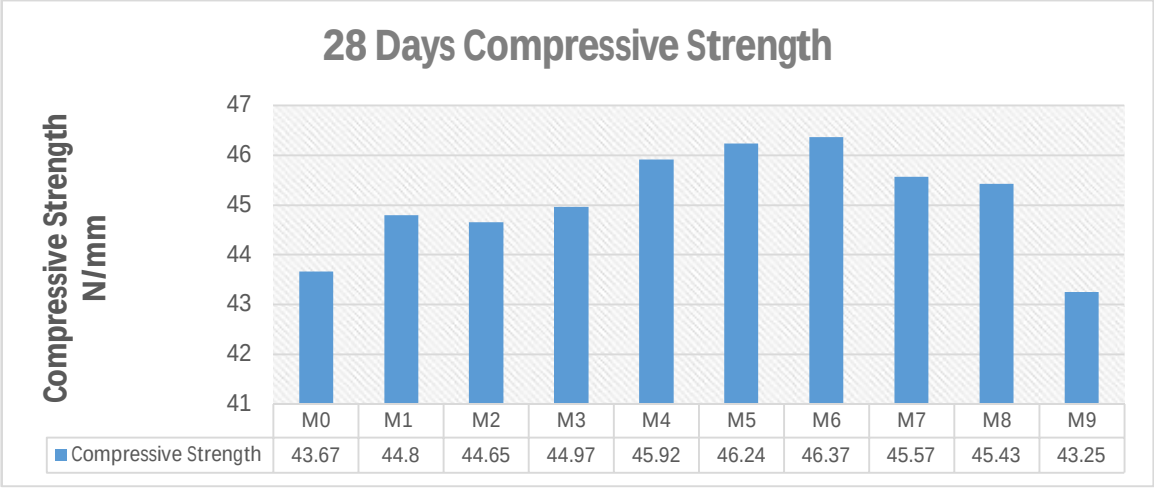


Fig -3: COMPRESSIVE STRENGTH TEST 28

F. Split Tensile Strength Test

The specimen used for this test is cylindrical and its dimension is 150 mm in diameter and 300mm in length. The instrument used for this testing is universal testing machine. The fresh concrete is prepared in according to the required grades and respective mix proportion. The fresh concrete is filled in mould in layers and each layer is tamping with standard tamping rod with 25 blows for each layer. After the day the mould is removed and specimen is placed in the curing tank for 7,14 days and 28 days in this research at the temperature 27+ 2°c. Then draw the line on the specimen.

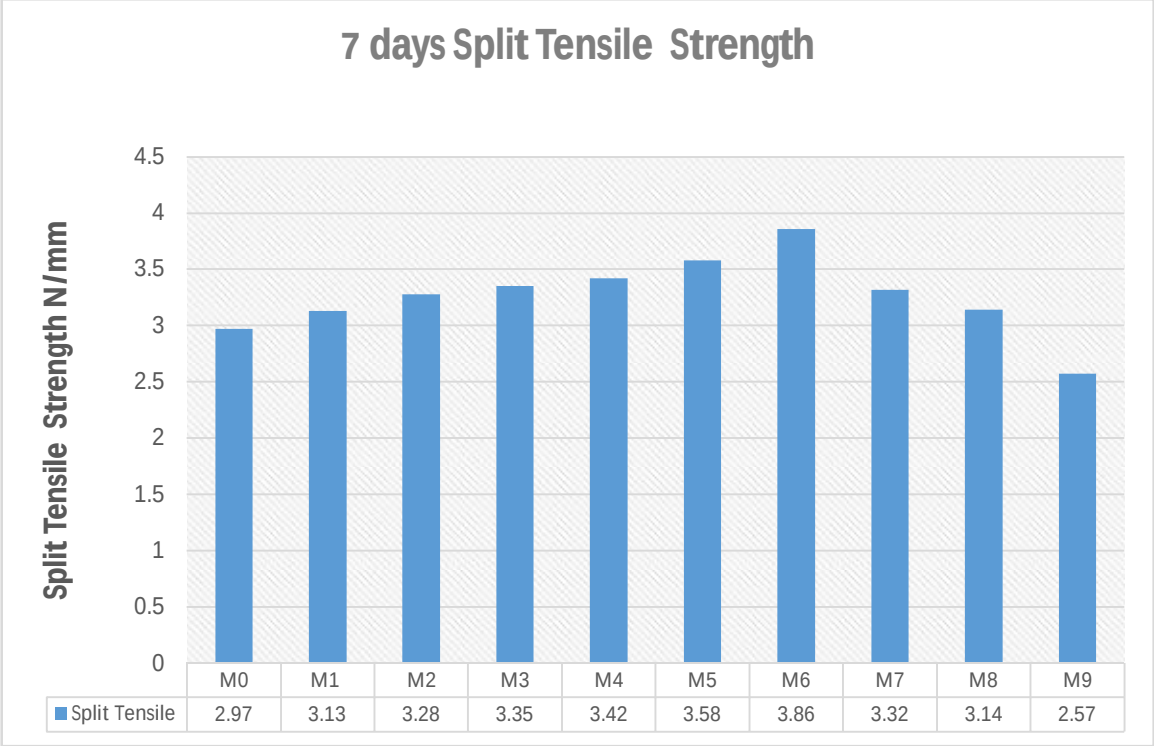


Fig -4: SPLIT TENSILE STRENGTH TEST 7

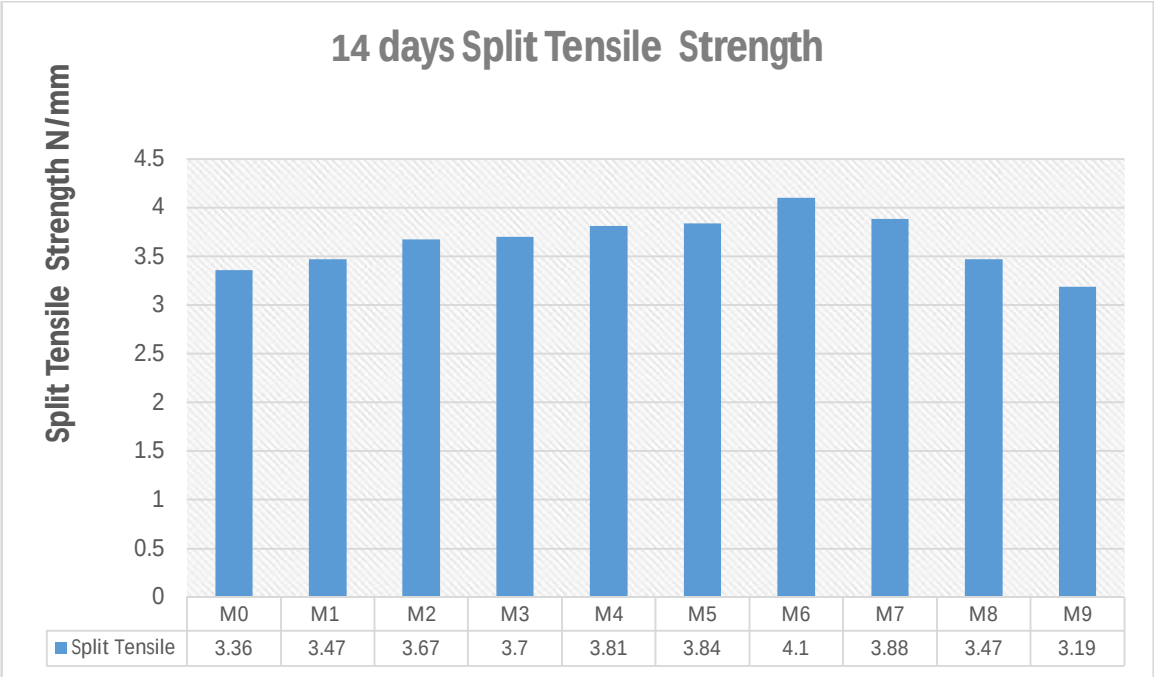


Fig -5: SPLIT TENSILE STRENGTH TEST 14

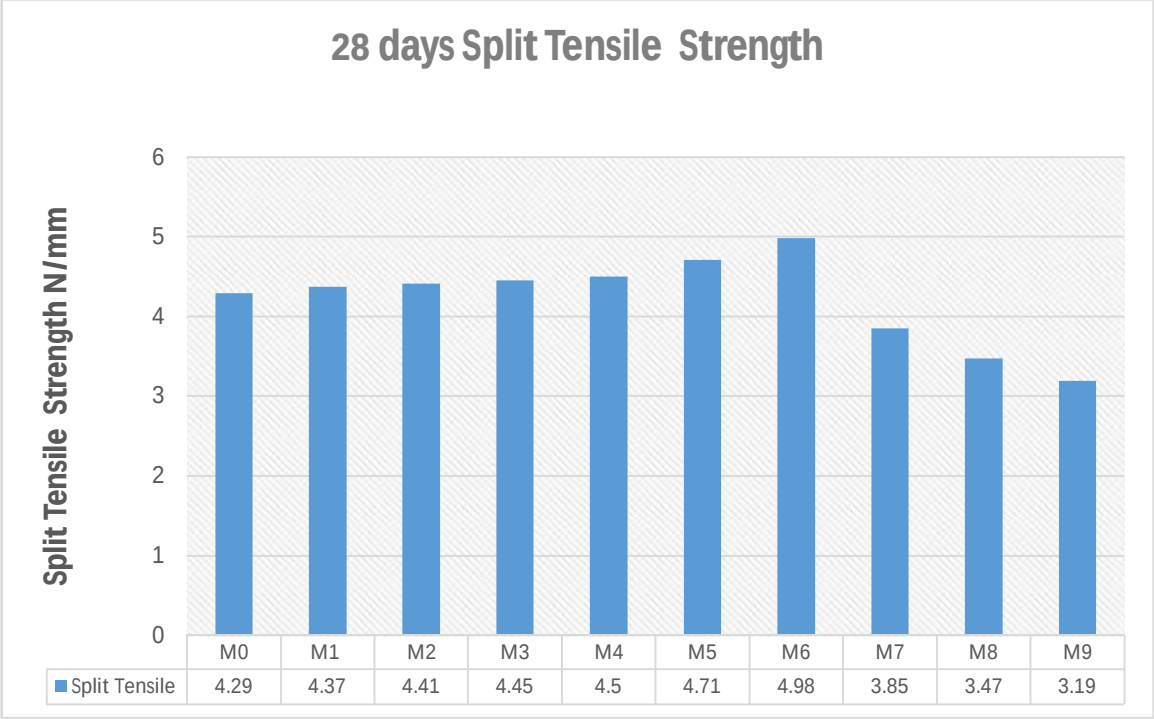


Fig -6: SPLIT TENSILE STRENGTH TEST 28

G. Flexural Strength Test

The concrete is prepared at required rate of mass element the mould is filled with concrete in layers and blows 25 times with standard tamping rod. After the day or we can say 24 hours the mould is removed and specimen placed in the water tank for curing at a temperature of 27 + 2 C. Depending upon the requirement the test specimen is removed from the water tank and wipe it properly for 7,14 and 28 days for testing.

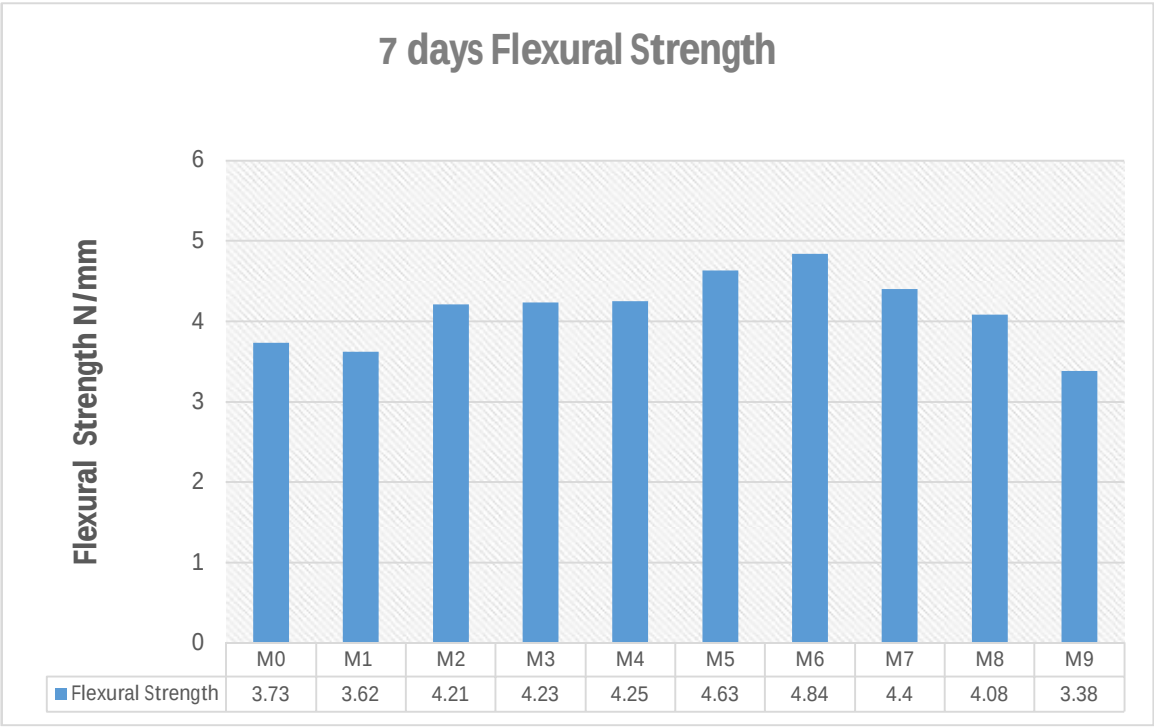


Fig -7: FLEXURAL STRENGTH TEST 7

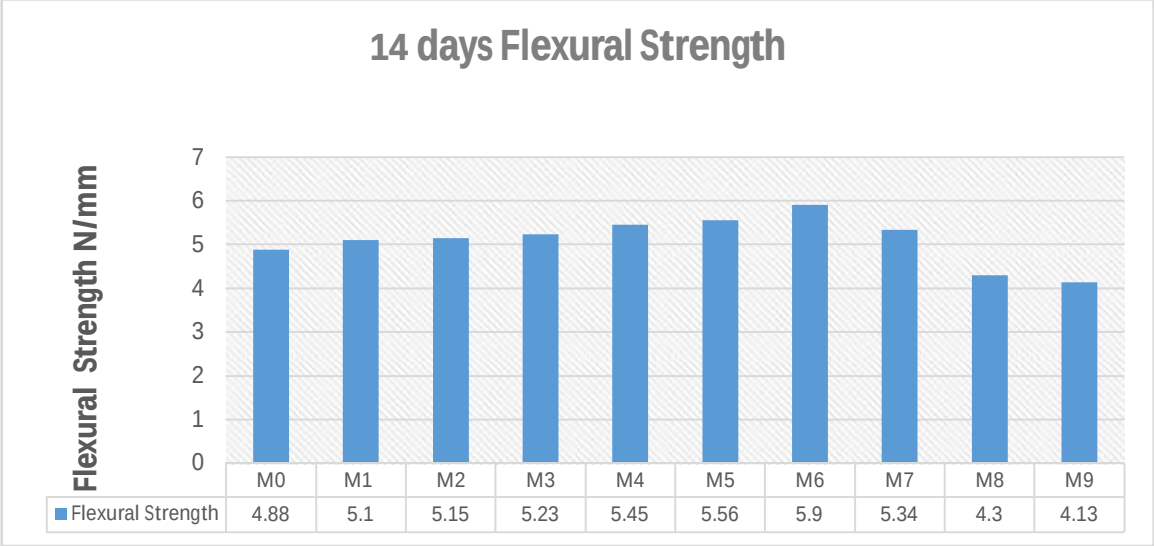


Fig -8: FLEXURAL STRENGTH TEST 14

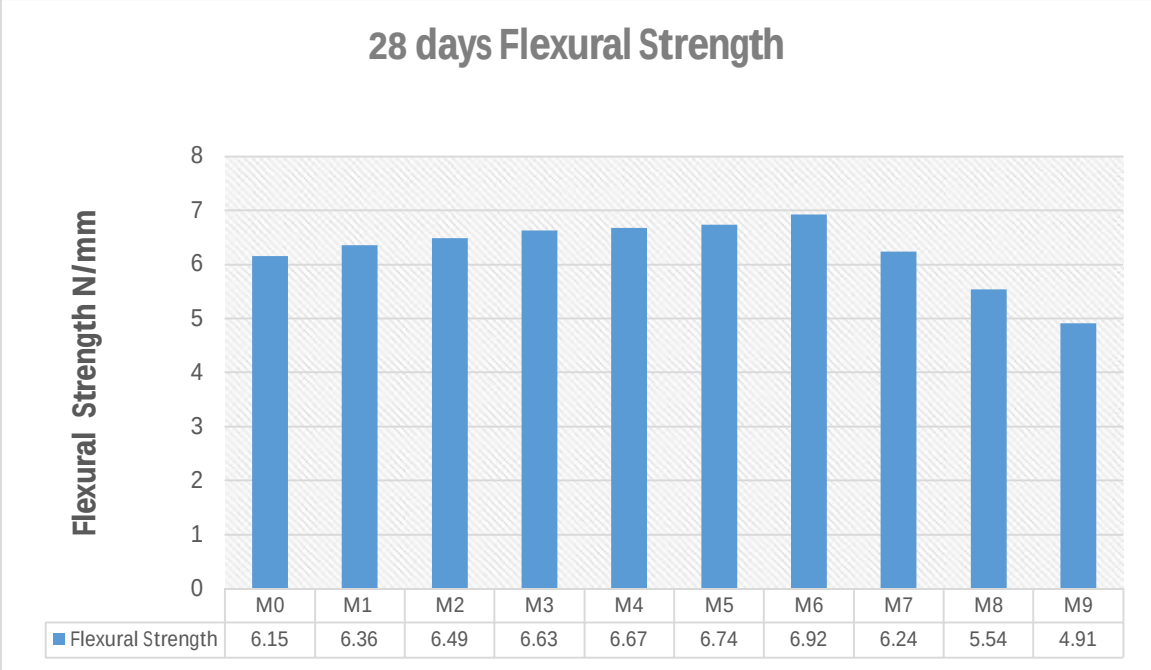


Fig -9: FLEXURAL STRENGTH TEST 28

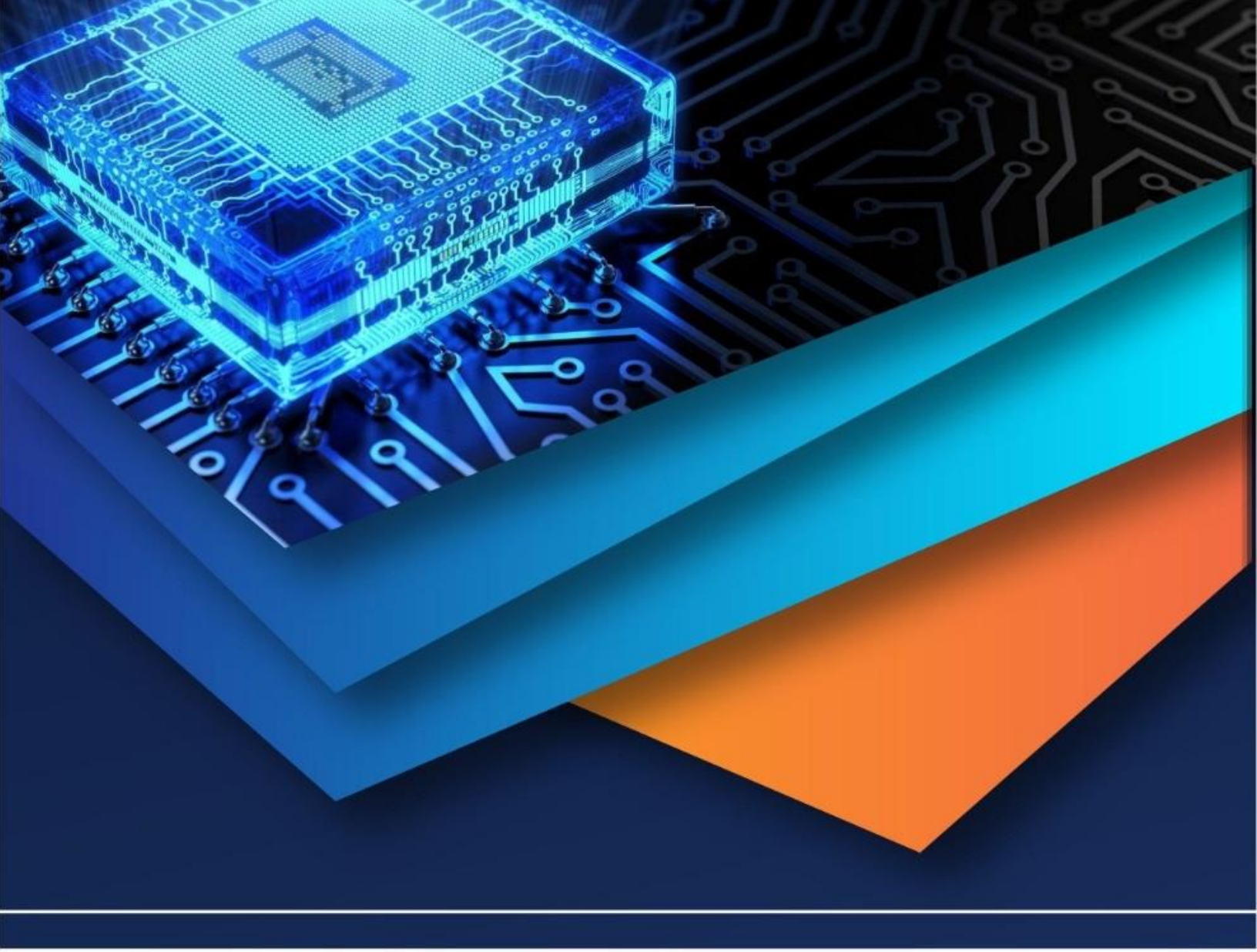
V. CONCLUSION

1) By replacing the cement with the replacement of Alcofine & Metakaolin with cement and Bamboo pieces replacing with coarse aggregate strengths get increased, also the replacement can be taken into consideration up to certain percentage workability factors gets enhanced as well.
2) The cost factor can be decreased by using replacement of Alcofine & Metakaolin with cement and Bamboo pieces replacing with coarse aggregate, as cement cost is increasing day by day and replacement is much needed to make concrete economical.
3) In case of compressive strength test conducted on cubes of size 150 x 150 x 150 mm, the compressive strength increases up to certain replacement and later on starts to get decreased as well.
4) The compressive strength of the concrete on comparing with conventional concrete gets increased till replacement of 14% Alcofine & Metakaolin with cement and 18% Bamboo pieces replacing with coarse aggregate was used. The strength obtained at 7^{th} day is 27.34 N/mm^2.

5) After 14 days of curing, the maximum compressive strength obtained was 33.31 N/mm^2 for same replacements and addition.
6) After 28 days of curing, maximum compressive strength obtained was 46.37 N/mm^2.
7) In case of compressive strength, the optimum percentage that was noticed, was at replacement of 14% Alcofine & Metakaolin with cement and 18% Bamboo pieces replacing with coarse aggregate.
8) The flexural strength of the concrete on comparing with conventional concrete gets increased till replacement of 14% Alcofine & Metakaolin with cement and 18% Bamboo pieces replacing with coarse aggregate was used. The maximum strength obtained at 7th day is 4.84 N/mm^2.
9) After 14 days of curing, the maximum flexural strength obtained was 5.90 N/mm^2 for same replacements and addition.
10) After 28 days of curing, maximum flexural strength obtained was 6.92 N/mm^2.
11) In case of flexural strength, the optimum percentage that was noticed, was at replacement of 14% Alcofine & Metakaolin with cement and 18% Bamboo pieces replacing with coarse aggregate.
12) After 7 days of curing, the maximum tensile strength obtained was 3.86 N/mm^2 for same replacements and addition.
13) After 14 days of curing, the maximum tensile strength obtained was 4.10 N/mm^2 for same replacements and addition
14) After 28 days of curing, maximum tensile strength obtained was 4.98 N/mm^2.
15) In case of tensile strength, the optimum percentage that was noticed, was at replacement of 14% Alcofine & Metakaolin with cement and 18% Bamboo pieces replacing with coarse aggregate.

REFERENCES

[1] Ansari U.S, 2015 works on High Performance Concrete with Partial Replacement of Cement by ALCCOFINE & Fly Ash.
[2] Tushar Shirke, “A study on concrete properties by partial replacement of cement by fly ash & AF”. International journal of engineering sciences & management.
[3] Abhishek Sachdeva, Studied the “Effect of cement and fine aggregate replacement with AF and Bottom ash on mechanical properties of concrete”. International Journal of Engineering Trends and Technology (IJETT) – Volume 32 Number 4- February 2016
[4] AdomAsamoah Mark and AfrifaOwusu Russell, “Comparative Study of Bamboo Reinforced Concrete Beams Using Different Stirrup Materials for Rural Construction”, International Journal of Civil and Structural Engineering, 2011, Vol- 2.
[5] Agbode, U.N., and Joel, G.K., “Quarry Dust Concrete”, Engineering Science and Technology; An International Journal, Vol-2, 2001, pp 67 – 71.
[6] Anithaselvasofia.S.D, , “Experimental Investigation of Quarry Dust Concrete with Chemical Admixture”, International Journal of Latest research in Science and Technology, ..
[7] A.V.S.Sai Kumar, Krishna Rao B., “A Study on Strength of Concrete with Partial Replacement of Cement with Quarry Dust”, International Journal of Innovative Research in Science, Engineering and Technology, ..
[8] Ayub, T, 2013. Durability of concrete with different mineral admixtures: a review. Int. J. Civ. Environ. Eng. 7 (8).
[9] Bamonte P (2010), “Thermal and Mechanical Properties at High Temperature of a Very High-Strength Durable Concrete”,Journal of Materials in Civil Engineering,ASCE, pp. 545-555.
[10] Beulah M (2012), “Effect of Replacement of Cement by Metakalion on the Properties of High Performance Concrete Subjected to Hydrochloric Acid Attack”, IJERA, Vol. 2, Issue 6, pp. 033-038.



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