TO INVESTIGATE THE BEHAVIOR OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH TOBACCO WASTE ASH AND SUGARCANE BAGASSE ASH

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Abstract - The growth in population has placed an enormous need for more and more infrastructure and it keeps growing. The outcome of this demand is the increase in production of cement. Massive amount of waste materials and by-products are produced by manufacturing enterprises such as silica fumes, rice husk ash, and mineral slag and so on. As a result, waste management has become a huge problem for our environment. The wastes that are of economic importance are bagasse, molasses, and filter press mud. Bagasse is the fibrous residue remaining after the extraction of the cane juice from sugarcane. Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose, and 25% of lignin. In a lot of sugarcane industries, the bagasse generated is usually used as fuel while also reducing its volume for disposal. One of the residues from a cigarette factory is the Tobacco stem, and it is easy to collect as its production is concentrated in cigarette factories. This has led to a serious waste of resources and environmental problems as more than 95 % of the tobacco stems end up in landfills or incineration. Tobacco waste ash (TWA) is produced by burning these unwanted tobacco stems. The research work here deals with the partial replacement of cement by mass with SBA and TWA in combination in percentages of 6%, 12%, 18%, 24%, 30%, and 36%. The percentage replacements for RHA and TWA are 3%, 6%, 9%, 12%, 15% and 18% respectively. After mixing, casting and curing the characteristic strength of this new concrete are compared with conventional concrete of M40 grade. The experimental investigations are carried out for compressive strength, split tensile strength and flexural strength for curing period of 7, 14 and 28 days. The experimental results show that the for a combined replacement percentage of 27%, which includes 18% SBA and 9% TWA, the values of compressive strength, flexural strength and split tensile strength were higher when compared to other replacement percentages.

Keywords: SBA (sugarcane bagasse ash), TWA (Tobacco waste ash), Compressive strength, Flexural strength and Split tensile strength.

1. INTRODUCTION

Concrete is the most versatile building material composed of coarse aggregate, sand, cement, and water. The mixture of all the ingredients of concrete are mixed in a ratio which then can be poured into any shape and size of mould that on hardening produces a mass like solid stone solid, further the strength of hardened solid mass can be increased by adding admixtures. The mineral admixtures which are used to partially replace cement can be natural or artificial depending on the use of the concrete. The admixtures which are used can be industrial wastes or by-products which can lead the industry to be eco friendlier and sustainable. For decades industrial by-products and wastes, such as, silica fume, fly ash and ground granulated blast furnace slag have been successfully used as mineral admixture in concrete technology. The performance of the addition of mineral additives can be divided in physical and chemical parts. In order understand the physical part of this behaviour one has to only look at the shrinking of size of the voids in the interference between cement and the aggregate. Chemical composition of the mineral admixture in order to be used in cement and concrete should constitute of these main compounds SiO_2, Al_2O_3 and Fe_2O_3 in greater percentage. The action of these additives depends on the presence of minerals and oxides in weakly crystalline or amorphous state.

1.1 SUGARCANE BAGASSE ASH

Sugarcane bagasse ash is a solid waste generated from the sugar manufacturing industry. India produced 342.56 million tonnes of sugarcane in the year 2011-12, making it one of the world's biggest cane producers. The sugar manufacturing process generates sugarcane trash, bagasse, bagasse fly ash, press mud, and spent wash [14, 26, 27]. The wastes that are of economic importance are bagasse, molasses, and filter press mud. Bagasse is the fibrous residue remaining after the extraction of the cane juice from sugarcane. Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose, and 25% of lignin. In a lot of sugarcane industries, the bagasse generated is usually used as fuel while also reducing its volume for disposal. This residual ash generated from burning or incineration is called bagasse ash inclusive of both bottom and fly ashes. In most modern plants, the bottom ash gets mixed with fly ash in the water channel that comes from the gas washer. This waste is typically disposed of into pits and is also applied on land as soil amendment in some areas.

Fig -1 Sugarcane bagasse ash

1.2 TOBACCO WASTE ASH

One of the residues from a cigarette factory is the Tobacco stem, and it is easy to collect as its production is concentrated in cigarette factories. This has led to a serious waste of resources and environmental problems as more than 95 % of the tobacco stems end up in landfills or incineration. Thus there is a need to dispose this residue in a way which is environmental friendly. Tobacco waste ash is produced by burning these unwanted tobacco stems. Tobacco waste ash displays properties such as fineness, amorphous form and high silica content and thus needs to be investigated with its potential to show high pozzolanic activity. The ashes are not pozzolanic material, they have pozzolanic activity, but this activity is less than that in pozzolanic material. The ashes exhibit the "filler effect", which is composed of two phenomena, the nucleation and packing effects that primarily depend on the fineness of the materials. The nucleation effect occurs when the small particles are spread in blended cement paste, leading to an enhanced hydration reaction, while the packing effect occurs when the voids in pastes are filled with fine particles. Tobacco waste ash is not a pozzolanic material but it has been known to display some pozzolanic activities.

Fig -2 TOBACCO WASTE ASH

2. LITERATURE REVIEW

(Naveen Kumar A, Vivekananthan, Chithra 2019) In a paper entitled "Study the Effects of Tobacco Waste Ash and Waste Glass Powder as a partial replacement of cement on Strength Characteristics of Concrete" partial replacement of cement with tobacco waste ash and waste glass powder was done. The replacement with tobacco waste ash was done in the percentage of 5, 7.5, 10 and 12.5 while the replacement with waste glass powder was done in the percentage of 5, 10, 15 and 20. The tests which were done on the specimen included compressive strength, flexural strength and split tensile. The results of these test showed that he compressive and split tensile tests values of the specimens increases by adding at 10% of Waste glass powder and 10% of tobacco waste ash , whereas flexural strength test values increases at the 12.5% of waste glass powder and 12.5 % of tobacco waste ash. The author finally concluded that the presence of silica from the glass waste powder increased the strength of concrete it further made the concrete more durable and also increased its toughness. The use of tobacco waste ash made the concrete more workable thus reducing the amount of water required.

(S.celikten, M. Canbaz 2017) In a paper entitled "A Study on the Usage of Tobacco Waste Ash as a Mineral Admixture in Concrete Technology" studied the effects of partial replacement of cement with tobacco waste ash. The tobacco waste ash was taken from two sources and the tests were carried out on each of the specimen of the two tobacco waste ash. The partial replacement was done in the percentage of 10, 15 and 20 by weight. The mortar samples were then tested. The tests that were done included compressive strength and flexural strength test. From the results of these tests unit weight, ultrasound pulse velocity, dynamic modulus of elastic values of the mortar specimen was calculated. There was seen a decrease in the values of these results as the percentage of tobacco waste ash was increased. On comparing the values of the specimen with the control specimen there was a decrease in both compressive and flexural strength, though in the case of compressive strength the decrease was more. Thus the author came to the conclusion that with the partial replacement of 10 percent cement with tobacco waste ash there are ecological and economic benefits.

(Rafael Fragozo, Sergio Vesga 2018) In a paper entitled "Tobacco waste ash: a promising supplementary cementitious material" studied the use of tobacco waste ash as a cementitious material. The experiment were done at various percentage of replacement and at the end of which the author came to the conclusion that the compressive strength of the specimen increased when there was a partial replacement of cement at 10 percent. The experiments achieved a compressive strength more than 51 percent of the control specimen. The author states that this improvement in compressive strength is due to the "filler effect" and the pozzolanic activity occasioned by 10 percent replacement of cement.

Jayminkumar A. Patel1, Dr. D. B. Raijiwala 2015 There in this analysis the ecological and environmental effect of cement is considered as of much concernas it generates a lot of carbon dioxide also on the other hand sugarcane baggase ash is serious issue of land fills. In this study SCBA isused in M25 grade of concrete by replacing cement 5% by weight and compare with normal M25 grade of concrete to squared the possibility of SCBA in concrete. This analysis reveals that SCBA can be used as partial replacement of cement".

R.Srinivasan 2010 "In this paper, Bagasse ash has been partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. Fresh concrete tests slump cone test were done also test on the hardened state concrete like compressive strength, flexural strength and modulus of elasticity split tensile strength at 7 and 28 days was obtained. There was an increase in the strength of the concrete reveals the study.

Sumrerng Rukzon(2011) This cement is considered as of much concerns it generates a lot of carbon dioxide also on the other hand sugarcane bagasse ash is serious issue of landfills. It suggest SCBA as a pozzolanic material for generating high strength cement concrete. Cement is partially replaced with SCBA in percentages 10%, 20% and 30% of BA respectively. The study reveals the addition of SCBA up to 30% replacement can increases the resistance to chloride penetration. Also the use of 10% of BA produced concrete with good strength and low porosity. For producing high strength concrete SCBA can be used up to 30%.

3. Material

3.1 CEMENT

In this research work the cement that was used was the ordinary Portland cement of 43 grade. The cement used in this research was purchased from a local cement store and the cement was Khyber cement, which is being manufactured by Khyber Cement Private Limited.

3.2 FINE AGGREGATES

The fine aggregate which was used in this research was purchased from Jammu and Kashmir. Fine aggregate are the fillers of the concrete, these occupy most of the volume in a concrete mix formulae. The composition, shape, size and other properties of fine aggregate influence the concrete. The properties of concrete which are influenced by fine aggregate are the shrinkage, elastic modulus, abrasion resistance as well as mixing proportions and hardening properties. Fine aggregate are divided into zones which are zone 1, zone 2, zone 3 and zone 4 as per IS: 383-1970.

3.3 COARSE AGGREGATES

The coarse aggregate which is used in this research was purchased from grinding mil. These are the aggregates which are retained on a sieve of size 4.75 mm. The properties of coarse aggregate such as shape, size, water absorption and strength influence the properties of concrete. The greater the size of the coarse aggregate less is the demand of water. Round aggregate are more economical to use but angular coarse aggregate are desired in case of high strength concrete. Thus coarse aggregate are important for increasing the strength and durability of concrete. The aggregate are categorized on size rather than chemical and mechanical properties. These tests were carried out on coarse aggregate to check the quality of coarse aggregate used.

3.4 Sugarcane bagasse ash

Table -1 Chemical composition of SBA

Constituent	Bagasse ash	Cement
Sio2	71.0	81.42
Al2O3	1.9	10.41
Fe2O3	7.8	1.54
CaO	3.4	3.35
MgO	0.3	0.76
NA2	3.4	1.36
K_2O	8.2	1.31

3.5 TOBACCO WASTE ASH

Table -2 Chemical composition of TWA

Particular	Percentage
Silicon Dioxide (SiO_2)	25.67
Aluminum Oxide (Al_2O_3)	0.16
Ferric Oxide (Fe_2O_3)	0.31
Sodium Oxide (Na_2O)	0.49
Calcium Oxide (CaO)	25.54
Magnesium Oxide (MgO)	4.6
Sulphur Trioxide (SO_3)	7.04
Potassium Oxide (K_2O)	17.84

4. METHODOLOGY

4.1 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.

4.2 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.

4.3 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 3,7,28 days.

4.4 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.

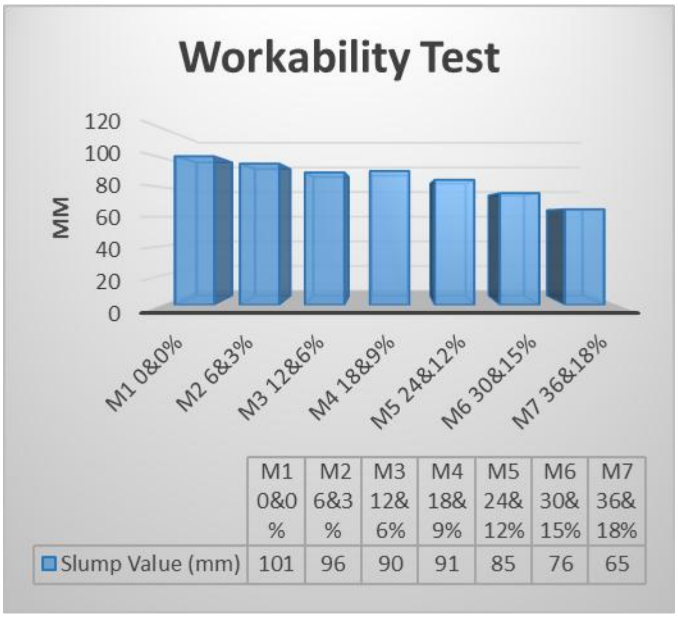


Fig -3: SLUMP CONE TEST

4.5 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.

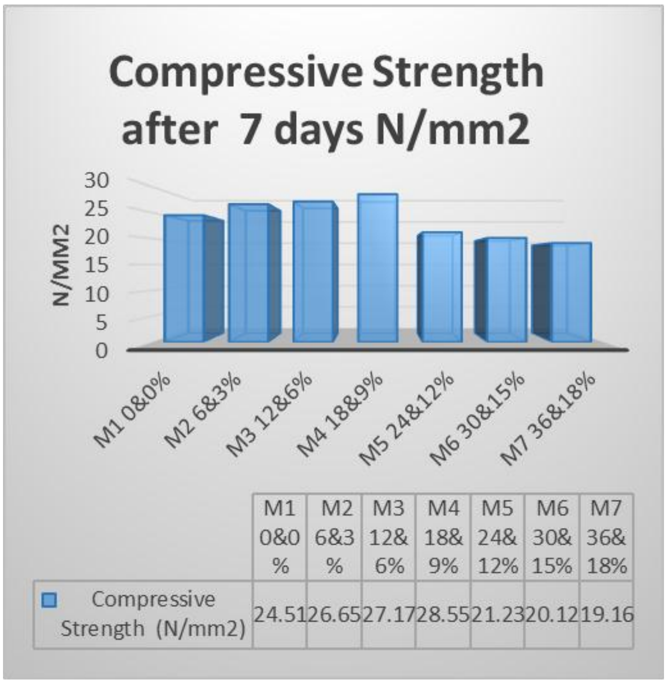


Fig -4: COMPRESSIVE STRENGTH TEST 7

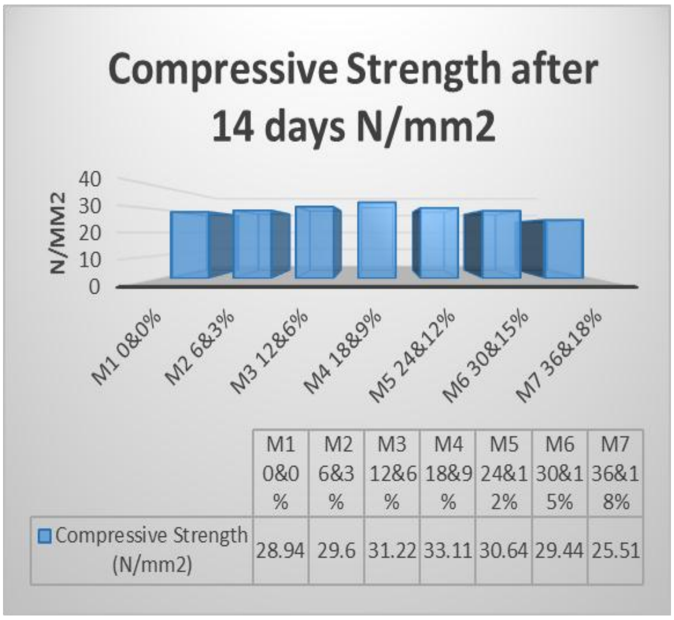
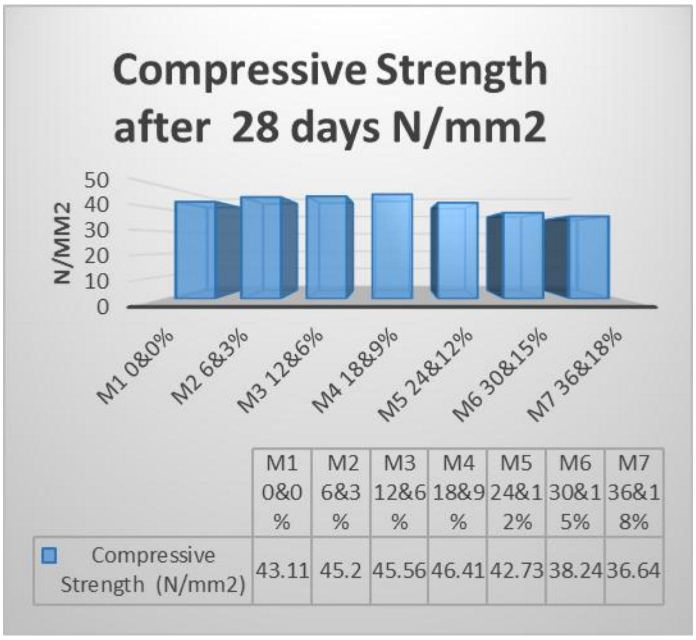


Fig -5: COMPRESSIVE STRENGTH TEST 14

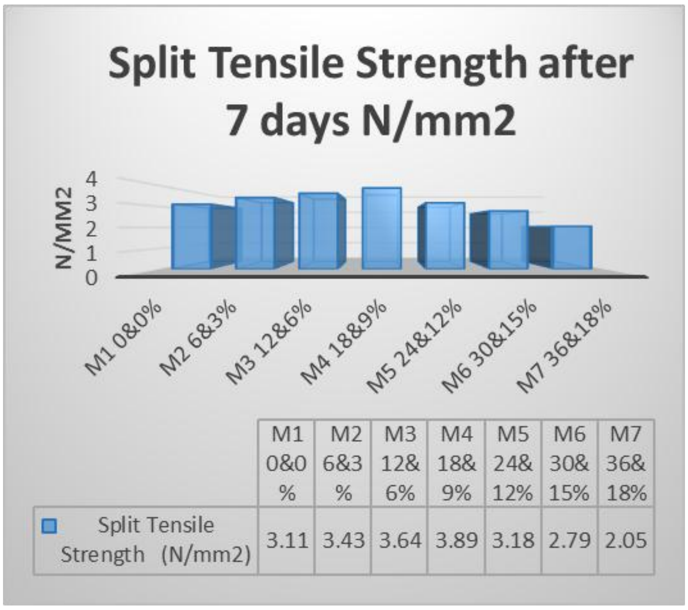


	M1 0&0%	M2 6&3%	M3 12&6%	M4 18&9%	M5 24&12%	M6 30&15%	M7 36&18%
Compressive Strength (N/mm2)	43.11	45.2	45.56	46.41	42.73	38.24	36.64

Fig -6: COMPRESSIVE STRENGTH TEST 28

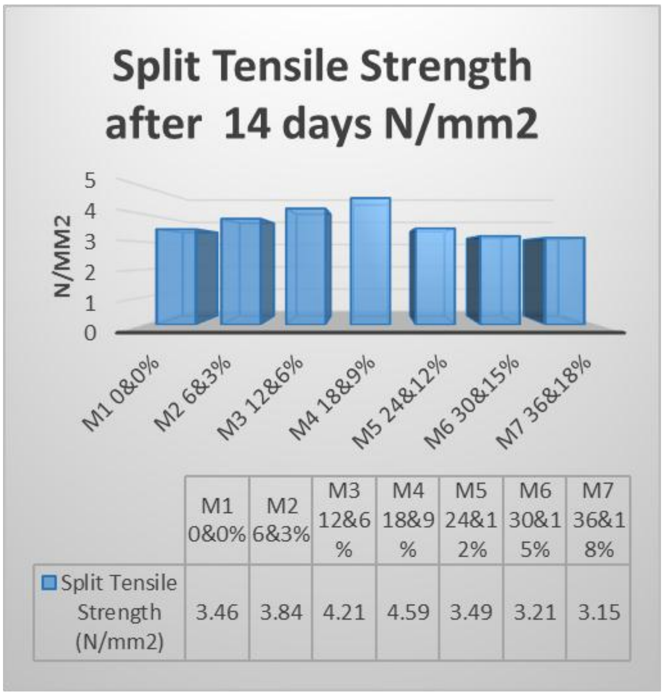
4.6 SPLIT TENSILE STRENGTH TEST

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.



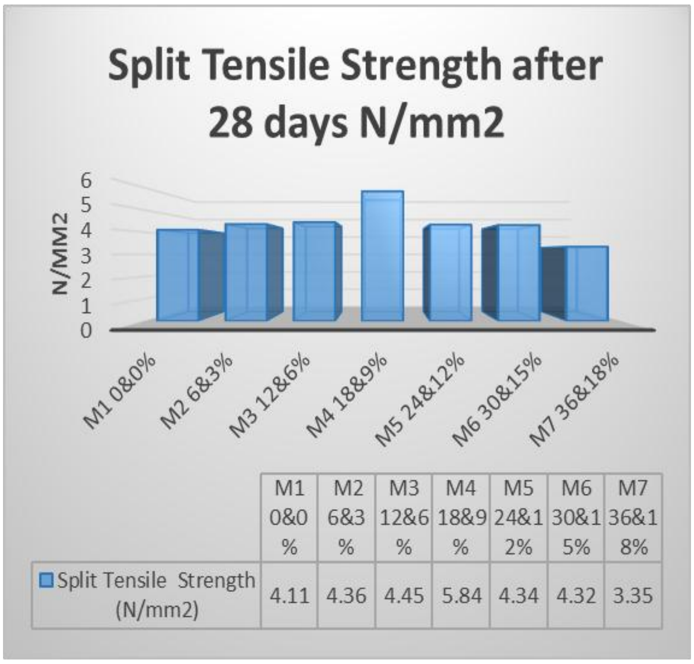
	M1 0&0%	M2 6&3%	M3 12&6%	M4 18&9%	M5 24&12%	M6 30&15%	M7 36&18%
Split Tensile Strength (N/mm2)	3.11	3.43	3.64	3.89	3.18	2.79	2.05

Fig -7: SPLIT TENSILE STRENGTH TEST 7



	M1 0&0%	M2 6&3%	M3 12&6%	M4 18&9%	M5 24&12%	M6 30&15%	M7 36&18%
Split Tensile Strength (N/mm2)	3.46	3.84	4.21	4.59	3.49	3.21	3.15

Fig -8: SPLIT TENSILE STRENGTH TEST 14



	M1 0&0%	M2 6&3%	M3 12&6%	M4 18&9%	M5 24&12%	M6 30&15%	M7 36&18%
Split Tensile Strength (N/mm2)	4.11	4.36	4.45	5.84	4.34	4.32	3.35

Fig -9: SPLIT TENSILE STRENGTH TEST 28

4.7 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.

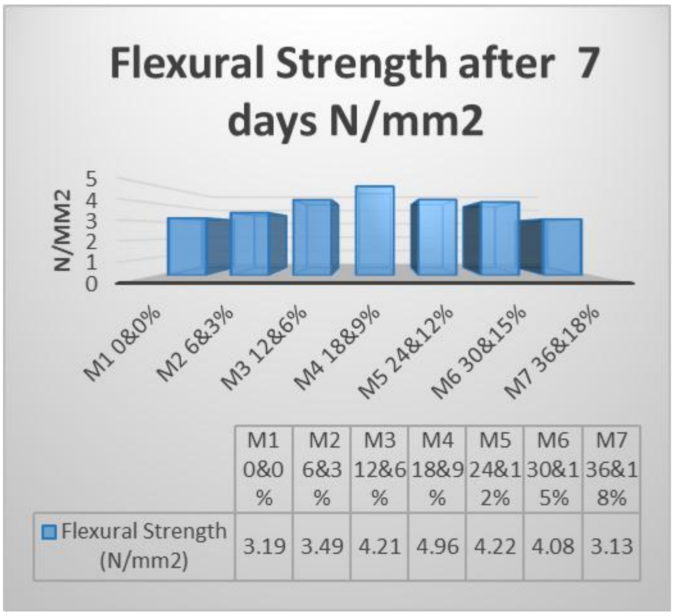


Fig -10: FLEXURAL STRENGTH TEST 7

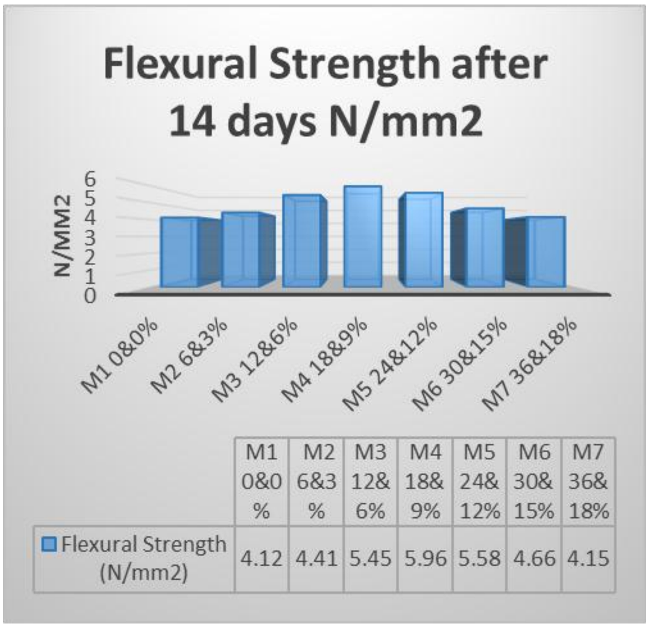


Fig -11: FLEXURAL STRENGTH TEST 14

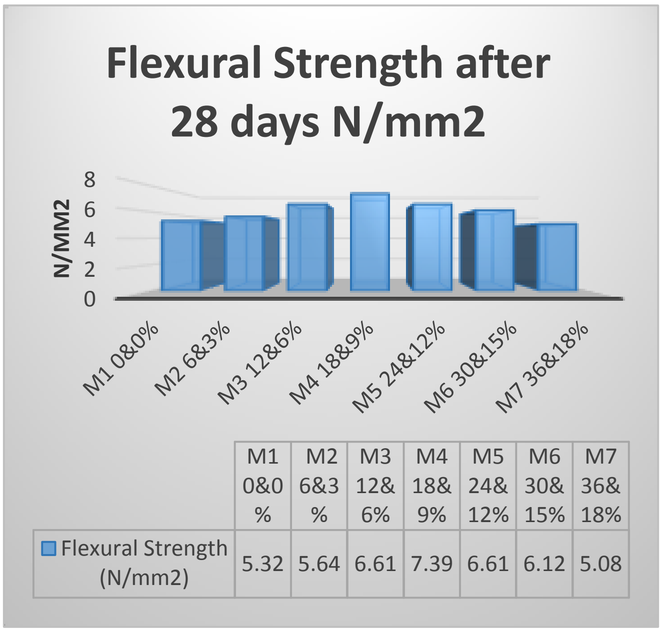


Fig -12: FLEXURAL STRENGTH TEST 28

5. CONCLUSION

•The use of Tobacco waste ash and bagasse ash as partial replacement of cement should be taken up for acceptable and environmental friendly construction.

•By using these easily available and agricultural waste materials in construction, we can easily decrease the cost of construction up to a certain level and overcome the environmental hazards.

•This investigation has also demonstrated that the use of Tobacco waste ash and bagasse ash by certain percentage can produce positive results when partially replaced by cement. Thus can be used in construction purpose.

•The max compressive strength is achieved by replacing cement with 18% replacement of bagasse ash and 9% replacement of Tobacco wash ash with cement on 28th day as 46.43 Mpa compared to 43.11 Mpa as of standard concrete

•The split tensile strength is optimum at 18% replacement of bagasse ash and 9% replacement of Tobacco wash ash with cement. After a further increase in replacement, it keeps on decreasing. 28th day split tensile strength at this replacement is 5.84 Mpa compared to 4.11 Mpa as of standard concrete.

• The flexure strength is optimum at 18% replacement of bagasse ash and 9% replacement of Tobacco wash ash with cement. After a further increase in replacement, it keeps on decreasing. 28 days flexural strength at this replacement is 7.39 Mpa compared to 5.32 Mpa as of standard concrete.

•Hence from this research work, it can be concluded that the optimum value of strength for different tests performed on concrete observed at 18% replacement of bagasse ash and 9% replacement of Tobacco wash ash with cement.

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