Experimental Study on Performance of Crumb Rubber & AcaciaNilotica Ash in Concrete

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Abstract-Concrete is most widely used construction material due to its good compressive strength & Durability. Cement, Coarse aggregates, fine aggregates & water are the constituents of the concrete. Many researchers have found alternative for cement due to its cost & pollution during its manufacturing process. Here in this project, Acacia Nilotica Ash had been replaced for cement. It consists of Calcium, Magnesium & Potassium salts it acts as a binding material. Crumb rubber is a material produced by shredding and commutating used tires. Due to the depletion of natural sand, it is required to use other material than sand being used as the fine aggregate in concrete. Hence Acacia Nilotica Ash & Crumb Rubber is replaced with cement & sand respectively. M25 grade of concrete by maintaining water cement ratio of 0.40 were casted into different specimens by replacing 5% of crumb rubber & 0%, 5%, 10%, &15% of acacia nilotica ash. In this project Compressive strength, Split tensile strength, & Flexural behavior of concrete with varying quantity of acacia nilotica and crumb rubber are evaluated and compared withthe conventional concrete specimen.

Key words: Acacia Nilotica Ash, Crumb Rubber, Compressive Strength, Tensile Strength, Flexural Strength

INTRODUCTION

Concrete is a construction material basically amixture of coarse aggregate, fine aggregate, cement and water. The performance of concrete depends upon the properties of aggregates in order to reduce the consumption of concrete components. Since the human advancement began in this world, man has dependably been included in some type of the development exercises, which likewise straightforwardly includes the utilization of cement concrete. Cement concrete is one of the world's most adaptable and generally utilized development materials.

The worldwide consumption of sand as fine aggregate in concrete production is very high and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years. Now-a-days, good quality natural river sand is not readily available. It is to be transported from a large distance. These resources are also exhausting very rapidly. So, to overcome this problem, the material which has the properties almostsimilar to that of the Fine Aggregate may be used asa replacement in Concrete.

Application of waste tyre rubber has shown great potential in the construction industry where it can be used with cement concrete and asphalt pavements. Certain properties of rubber like better flexibility and light weight are considered to be the main reason for its more and more use in the construction industry. With a great environmental concern and in saving the natural rock aggregates, we have replaced a part of the conventional coarse aggregates by shreddedrubber aggregates resulted from cutting worn tyre.

OBJECTIVE

The main objectives of the study are given below:

- To find the efficiency of the Acacia nilotica ash and Crumb Rubber for civil Engineering constructions.
- To know the fresh concrete properties of Crumb Rubber and Acacia nilotica ash concrete.
- To check the possibility of using Crumb Rubber and Acacia nilotica ash in concrete mixes

LITERATURE REVIEW

1. SANTOSH BHARATHY.V, et al (2018): Studied with replacement of cement with 2%, 10% and 15 % acacia ash and evaluated that 10% replacement of acacia Ash was found to be satisfactory in terms of

strength, cost, handling and workability. The compression strength was found to be higher than the conventional brick strength at a percentage of 7.2% in the first 3 days of curing, 30.6% in the 7 days of curing and 36.7% in 15 days of curing. The cost of manufacturing of the brick wascalculated to be Rs.5.15 per brick, which is Rs.3.35 lower than the conventional brick.

2. J.THANGA MURUGESAN AND C.J.GANGA LAKSHMI (2018): Had done an experimental study on Acacia nilotica ash in concrete to analyze the performance of Acacia nilotica as a replacement of cement in concrete works. Concrete of M30 grade were cast by replacing cement with Acacia Nilotica ash by 0%, 5%, 7.5%, 10%, 12.5%, and 15%. In his experimental work, a total of 72 numbers of concrete specimens were casted to evaluate compressivestrength, split tensile strength, flexural strength ofspecimens it was found that the strength wasincreased from 7.5% to 12.5% replacement of acacia nilotica ash with the cement

3. ABDUL KADIR, et al (2013): Evaluated that the OPC could be partially replaced by the SCBA tosome extent. In this 34.6kg of SCB was obtainedfrom sugar factory and burnt at 700 degrees Centigrade and then total 2.7 kg of SCBA was obtained after passing through 45microns sieve. Chemical test was conducted on SCBA to evaluate itscomposition. In this study, cement was replaced with SCBA at the ratio of 0%, 10%, and 20%. In this study, 48 pieces of 100mm size cubes were cast atthe mix design of 1: 1.66: 2.77. Cubes were properly cured and tested on 7, 14 and 21 and 28 days for the compressive strength results. The required compressive strength was obtained after 28 days of curing at the replacement of cement with SCBA at 10%.

4. MOHD. MOHSIN KHAN, et al (2017): In this study aggregates are replaced by 5%, 10% 15% crumb rubber. It is concluded that fine aggregates can be replaced by crumb rubber up to some extent. The higher amount of crumb rubber reduces the strength of concrete which may not be desirable, but, the rubber based concrete has good toughness anddeformability. Rubber based concrete have reversible elasticity property which is used to decrease the vibrations coming on the base of the structures. The best results are obtained when fine aggregates arereplaced by 5% of crumb.

5. PARTH KHANDLA, et al (2017): Done experiments on sand replacement in the range of 0%, 2.5%, 5%, 7.5% and 10 % by weight for M-25 grade cement (OPC) and evaluated that the compressive strength for M 25 grade for all proportions comes within 25 N/mm2. So sand can be replaced with the crumb rubber up to 10 %, the Flexural strength came optimum when 5% of Crumb rubber is replaced by fine aggregate and the water Absorption is increased with the increase in proportion of the crumb rubber. The product formed is also eco-friendly and cost effective.

6. SULAGNO BANERJEE, et al (2020):
They observed that use of 5% rubber on the mortar the compressive strength of the mortar massively changed. So this mortar can be used in non-load bearing wall or any other project. The use of 10% tyre dust, water absorption increased vigorously and compressive strength decreased severely to a very high extent. So, it is recommended not to use it in any load bearing structure. Addition if rubber aggregate in concrete as replacement for coarse and fine aggregate decreases the workability, modulus of elasticity, compressive, flexural and tensile strengths but increases ductility and durability as compared to concrete.

MATERIALS AND PROPERTIES

1. Cement:

Cement is a binder substance that sets, hardens and adheres to other materials to bind them together. In this project we had used 53 grade of Portland Pozzolana Cement. The concrete produced by the Portland pozzolana cement has high ultimate strength, is more durable, resists wet cracking, thermal cracking and has a high degree of cohesion and workability in concrete and mortar.

The properties of cement are listed in the below table

Table 1: Properties of Cement

Properties	Results
Fineness of Cement	98%
Normal or Standard Consistency	32%
Initial Setting Time	30 min
Final Setting Time	10 hours
Specific Gravity	3.1

2. Fine aggregate:

Fine aggregate is a material that will pass through a

4.75mm sieve. The purpose of fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

The properties of fine aggregate are listed in the below table

Table 2: Properties of Fine Aggregate

Properties	Results
Fineness Modulus	3.23
Specific Gravity	2.57
Water Absorption	1.35%
Bulking of sand	25%

3. Coarse Aggregate:

Coarse aggregates refer to irregular material such as

Table 3: Properties of Coarse Aggregate

Properties	Results
Fineness Modulus	4.4
Specific Gravity	2.63
Water Absorption	0.81%

4. Acacia Nilotica Ash:

The ash of Acacia is obtained by the collecting the sticks of Acacia and drying them in sunlight for 3 or 4 days until the moisture is removed from the sticks and they are burnt to obtain the ash.

Fig.1 Acacia Nilotica Ash

The properties of Acacia ash are listed in the belowtable

Table 4: Properties of Acacia Nilotica Ash

Properties	Results
Fineness of Cement	96%
Normal or Standard Consistency	34%
Initial Setting Time	33 min
Specific Gravity	3.04

5. Crumb Rubber:

The waste rubber tyre are collected and cut into small pieces. The rubber chips are sieved through 4.75 mm for the replacement of fine aggregate. The properties of Crumb rubber are listed in the below table gravel, crushed stones and are used for makingconcrete. We have used aggregates of 20 mm size.

Table 5: Properties of Crumb Rubber

Properties		Results
Specific Gravity		1.2
Bulk Density	Loose	0.416 kg/lt.
	Compacted	0.5 kg/lt.

The properties of coarse aggregate are listed in the below table

Fig. 2 Crumb Rubber

MIX DESIGN

In our experimental work, we used concrete of grade M25 with a mix ratio of 1:1:2 and a water-cement ratio of 0.40. The proportioning of the concrete mix is done in accordance with IS 10262 (2009): Guidelines for Concrete Mix Design.

METHODOLOGY

- The primary goal of the current experiment is to investigate the consequences of using Acacia nilotica ash, a mineral byproduct, to partially substitute cement and Crumb rubber, to partially substitute fine aggregate.
- Using the standard mix ratio of M25 mixing of the concrete is done mechanically.
- There are a total of 12 cylinders, 12 cubes, and 12 prisms that are casted. The specimens undergo 7, 14, and 28 days of curing. The specimens are tested when they have finished curing.
- Cubes, Prisms and cylinders, respectively, were subjected to compression, flexure, and split-tensile testing.

TESTS ON FRESH CONCRETE

Workability is one of the physical parameters of

concrete which affects the strength and durability as well as the cost of the labor and appearance of the finished product. Concrete is said to be workablewhen it is easily placed and compacted homogeneously i.e., without bleeding or segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs and or pockets may also be visible in the finished concrete.

Depending upon the water cement ratio in the concrete mix, the workability may be determined by the following:

1. Slump cone test
2. Compaction factor test
3. Vee-Bee consistometer test

TESTS ON HARDENED CONCRETE

Hardened concrete is concrete that is completely set and able to take the loads. The strength of the concrete plays a vital role in the construction of any building. The strength of the concrete helps to identify whether the concrete can be used in construction or not. The strength of the concrete is defined as the maximum amount of load which the concrete can bear. Strength is considered as one of the most important and valuable properties of concrete. The concrete is tested for three types of strength which are:

1. Compressive strength
2. Flexural strength
3. Tensile strength.

Fig. 3 Cube under Compression

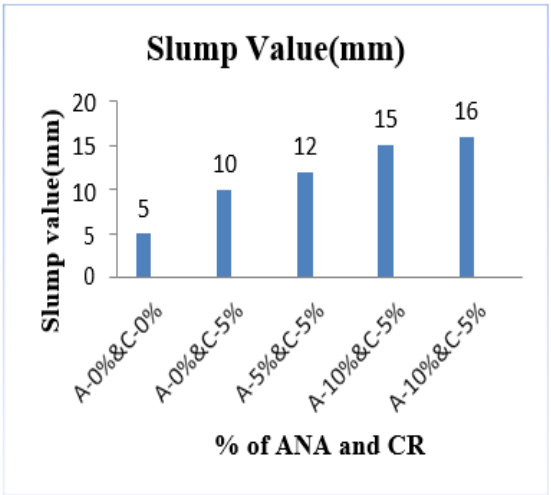
Fig. 4 Cylinder under Tension

Fig. 5 Prism under Flexural

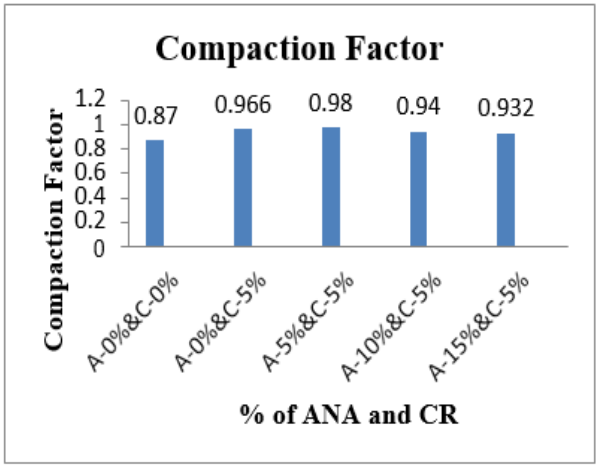
RESULTS &DISCUSSION

1. Slump Cone Test

The results of slump cone test indicating the workability of the acacia nilotica ash in concrete are shown below. The slump value indicates that there is an increase in slump with the increase in acacia nilotica ash.

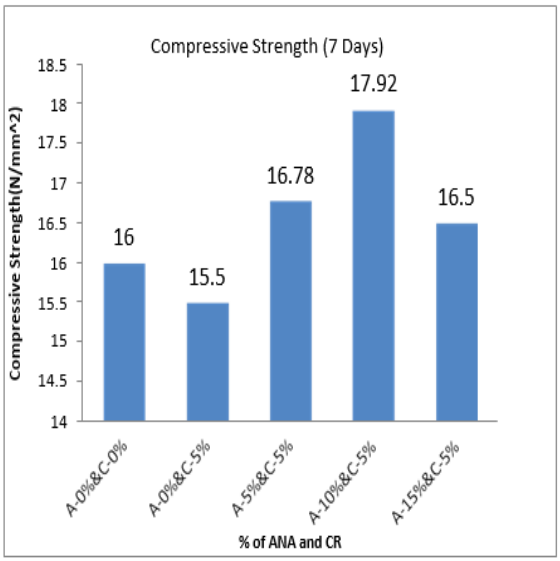


2. Compaction Factor



The results of compaction factor indicate that there is increase in workability with increase in the acacia ashas the partial replacement of cement. This impliedthat more effort would be required to place compact and finish the freshly mixed concrete.

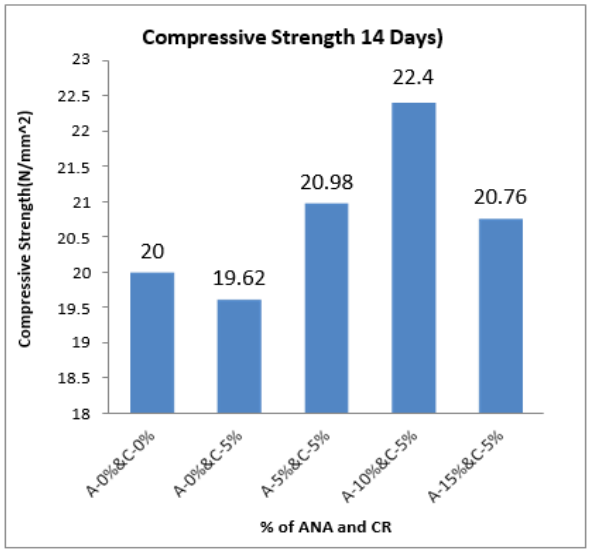
3. Compressive Strength Test: For 7 Days:



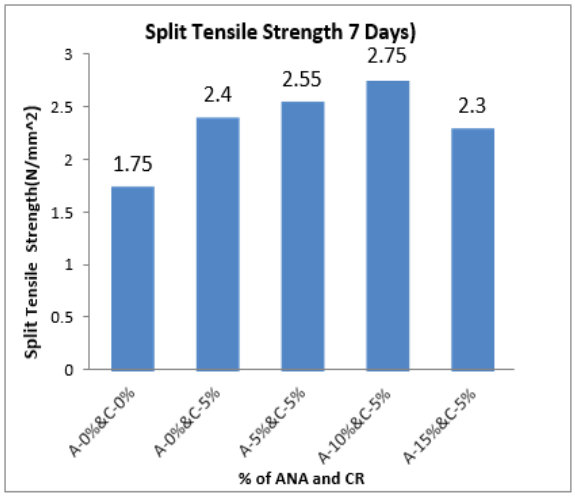
The compressive strength for 7 days is 16 Mpa, 15.5 Mpa, 16.78 Mpa, 17.92 Mpa and 16.5 Mpa were obtained for compressive strengths with 0%, 5%, 10% and 15% Acacia nilotica ash as partial replacement of Cement and 5% crumb rubber with sand. The compressive strength at 5% replacement of both Acacia ash and rubber is 4.875% higher when compared to conventional concrete, at 10% replacement the strength is 12% higher than that of conventional concrete strength and at 15% the strength increases with 3.125% compared to a conventional concrete.

For 14 Days:

The compressive strength for 14 days is 20 Mpa, 19.62 Mpa, 20.98 Mpa, 22.4 Mpa and 20.76 were obtained. The compressive strength at 5% replacement is 4.9% higher when compared to conventional concrete, at 10% replacement the strength is 12% higher than that of conventional concrete strength and at 15% the strength increases with 3.8% compared to a conventional concrete.



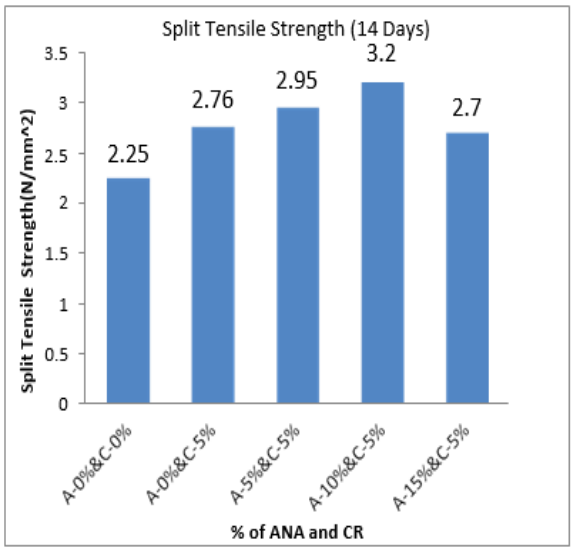
4.Split Tensile Strength Test:For 7 Days:



For 28 days:

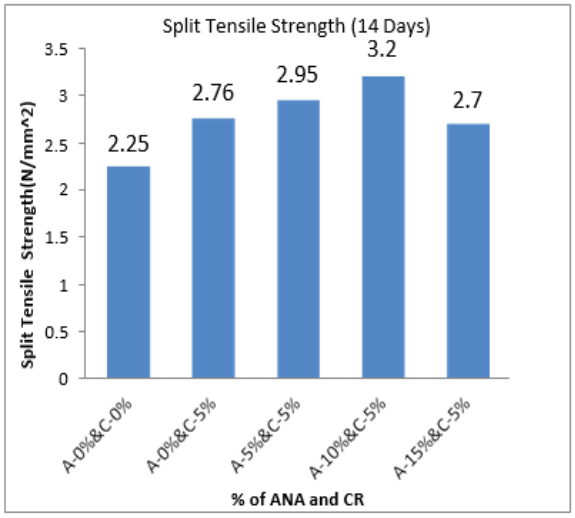
The compressive strength for 28 days is 25.1 Mpa, 24.83 Mpa, 26.79 Mpa, 28.2 Mpa and 26.12 Mpawere obtained for compressive strengths with 0%, 5%,10% and 15% Acacia nilotica ash as partial replacement of Cement and 5% crumb rubber with sand. The compressive strength at 5% replacement is 6.73%

higher when compared to conventional concrete, at 10% replacement the strength is 12.35% higher than that of conventional concrete strength and at 15% the strength increases with 4.06% compared to a conventional concrete.



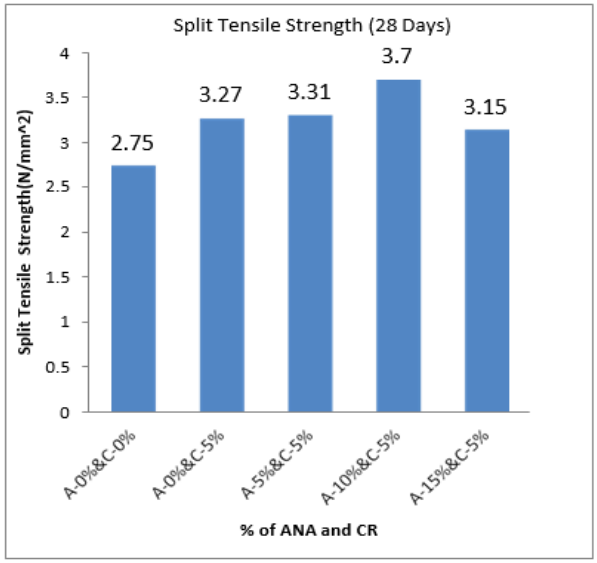
The Split tensile strength for 7days is 1.75 Mpa, 2.4 Mpa, 2.55 Mpa, 2.75 Mpa and 2.3 Mpa were obtained for Split tensile strength with 0%, 5%, 10% and 15% Acacia nilotica ash as partial replacement of Cement and 5% crumb rubber with sand. The Split tensile strength at 5% replacement of both is 45.7 % higher when compared to conventional concrete, at 10% replacement the strength is 57.14 % higher than that of conventional concrete strength and at 15% the strength increases with 31.4 % compared to a conventional concrete.

For 14 Days:



The Split tensile strength for 14days is 2.25 Mpa, 2.76 Mpa, 2.95 Mpa, 3.2 Mpa and 2.7 Mpa were obtained. The Split tensile strength at 5% replacement is 31.11 % higher when compared to conventional concrete, at 10% replacement the strength is 42.2 % higher than that of conventional concrete strength and at 15% the strength increases with 20 % compared to a conventional concrete.

For 28 Days:

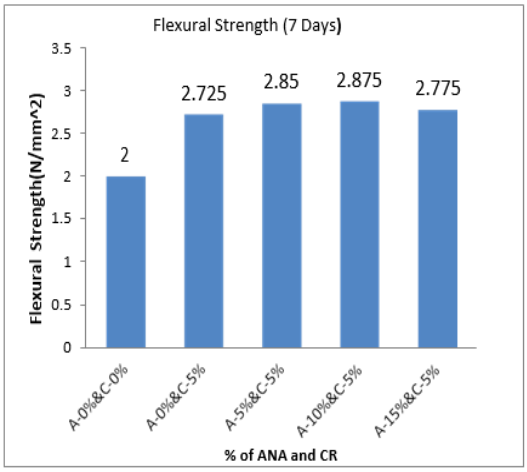


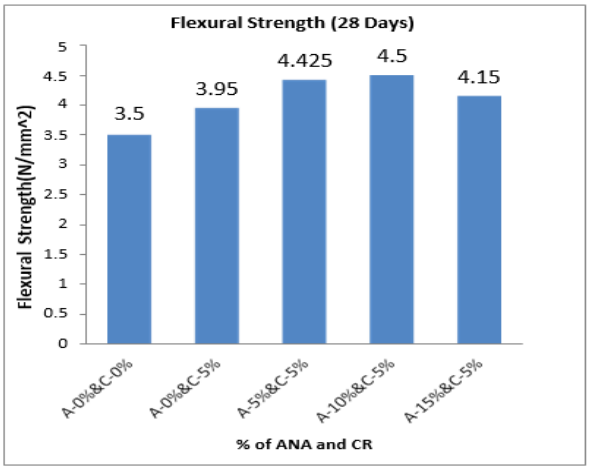
The Split tensile strength for 28days is 2.75 Mpa, 3.27 Mpa, 3.31 Mpa, 3.7 Mpa and 3.15 Mpa were obtained. The Split tensile strength at 5% replacement is 20.36 % higher when compared to conventional concrete, at 10% replacement the strength is 34.5 % higher than that of conventional concrete strength and at 15% the strength increases with 14.54 % compared to a conventional concrete.

4. Flexural Strength Test:

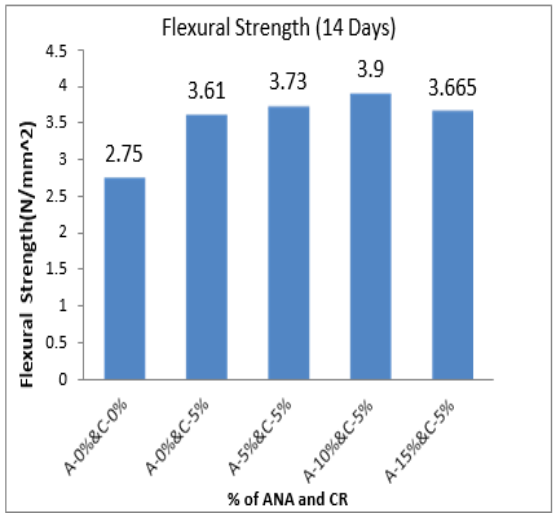
For 7 Days:

The Flexural strength for 7days is 2.0 Mpa, 2.725 Mpa, 2.85 Mpa, 2.875 Mpa and 2.775 Mpa were obtained for Flexural strength with 0%, 5%, 10% and 15% Acacia nilotica ash as partial replacement of Cement and 5% crumb rubber with sand. The Flexural strength at 5% replacement of both is 42.5% higher when compared to conventional concrete, at 10% replacement the strength is 43.75 % higher than that of conventional concrete strength and at 15% the strength increases with 38.75 % compared to a conventional concrete.





For 14 Days:



The Flexural strength for 14 days is 2.75 Mpa, 3.61 Mpa, 3.73 Mpa, 3.9 Mpa and 3.665 Mpa were obtained The Flexural strength at 5% replacement is 35.63 % higher when compared to conventional concrete, at 10% replacement the strength is 41.81 % higher than that of conventional concrete strengthand at 15% the strength increases with 33.27 % compared to a conventional concrete.

For 28 Days:

The Flexural strength for 28 days is 3.5 Mpa, 3.95 Mpa, 4.425 Mpa, 4.5 Mpa and 4.15 Mpa were obtained The Flexural strength at 5% replacement is 26.4 % higher when compared to conventional concrete, at 10% replacement the strength is 28.57 % higher than that of conventional concrete strengthand at 15% the strength increases with 18.57 % compared to a conventional concrete.

CONCLUSION

The use of Acacia nilotica ash and crumb rubber in concrete and their effects had been thoroughlystudied from reputed journals for initiating the work. The preliminary investigations were done for basic ingredients of controlled concrete and with different fractions of replacement of cement (0%, 5%, 10%, and 15%) with acacia nilotica ash and 5 % of Crumb Rubber.

- The Compressive strength of the cube, Split Tensile strength of cylinder and Flexural strength of prism with replacing 10% of acacia nilotica ash and 5 % of crumb rubber was obtained as 28.2 Mpa, 3.7 Mpa and 4.5 Mpa respectively, which is higher than the values obtained for conventional concrete(M25 mix) of percentage increase of 12.35%,34.5% and 28.57% respectively.
- After attaining the maximum value of strengths with replacing of 10% of Acacia Nilotica Ash and 5% of Crumb Rubber. Then the Compressive strength of cube, Split tensile strength of cylinder and Flexural strength of prism was decreased with increasing in the percentage of the acacia nilotica ash beyond 10% and 5 % of crumb rubber.
- Compared to compressive strength the materials shows good in Flexural and Split Tensile, can be used in beams.
- The maximum value of strength obtained with replacing 10% of Acacia nilotica ash with cement and 5% of Crumb Rubber with Fine aggregate and these materials can be used as construction materials.

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