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Experimental Investigation on Partially Replacement of Fine Aggregate with Kota Marble Dust and Coarse Aggregate with Tyre Rubber Tube Fiber

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Abstract

As construction in India and other developing countries increases, the consumption of energy and resources is also increasing in an alarming way. Most of the developing nations have reduced the usage of virgin material like aggregates in construction, due to economic and environmental reasons, so they focused on the environment, safeguarding of natural resources, and recycling of wastes materials. Many industries produce lot of waste products, which is disposed into landfills. This material can be reused in construction industry as alternative to conventional materials. Such practice conserves natural resources and reduces the space required for the landfill disposal of these waste materials. In this investigation, Mix M40 is to be designed first to evaluate the strength of cement concrete mix using two waste products namely rubber fibers and kota stone marble. Rubber fiber is partially replaced with coarse aggregates and kota stone marble is partially replaced with fine aggregate. The dimensions of the rubber fibers taken as 50-60 mm in length and 1.5 - 2 mm in width. The concrete mix was treated with rubber fibers and kota stone marble in various mix proportions. Then various tests were conducted to determine the different concrete properties such as compressive strength and split tensile strength on the samples of concrete. The compressive strength test and split tensile strength test were performed on the cubes and cylinders respectively with the partial replacement of coarse aggregates at 5%, 10%, 15% and 20% by weight with the rubber fibers and 0%, 7%, 11% and 15% kota marble stone with the fine aggregate. The major advantages of using an industrial waste i.e. kota stone marble is in the construction of roads and to reduce the problem of disposal of these wastes which as a result helps to reduce the chronic diseases caused by it. The use of rubber fibers improves the properties of concrete like elastic behavior, insulation against heat and sound.

***Keywords*:** Kota stone marble, rubber fibber, aggregate, concrete

I.Introduction

Concrete is an artificially solidified mass comprising cement, aggregates (fine and coarse aggregates) as well as water in definite proportion, divided on the basis of user's requirements [1]. The plastic mass obtained by mixing the above ingredients is capable of being poured into suitable mould to set into a hard-solid mass. Cement acts as a binding material in the above-mentioned mixture [1]. The addition of water to the afore said mixture of the ingredients commences the process of hydration. The chemical reaction is relatively a slow one and it requires time and favorable temperature for its completion. To achieve enhancement of characteristics of the mixture to suit the different site parameters, various experiments and researches have laid down the use of composite materials in the mixture [2]. The composite material is a blend of two mutually compatible materials to yield a stronger material which imparts properties superior to those of the individual components.

Cement being basic ingredient in concrete, its demand is increasing day by day. As its demand increases, its production also increases and it directly effects our environment by emission of tremendous amounts of carbon-

dioxide into atmosphere, it tends to impart global warming [3]. So, it is necessary to minimize the use cement and this can be achieved only if cement is replaced by alternative binding material either fully or partially [3]. The useful research has been conducted to channelize the utilization of industrial waste like fly ash, blast furnace slag, silica fume etc. in concrete without adversely affecting its inherent characteristic [4]. This is due to the fact that such materials because of their filler effect and pozzolanic reactions have the ability to improve and enhance the characteristics and performance of cement.

Globally, the demands of rational development are increasingly rapidly. Basic challenge is to exploit the desirable advantages of concrete, with diminishing the reliance on Portland cement. There are basically four basic concepts to realize the requirement; the first in this direction is the increased use of recycling process of materials [4]. Since the dominant constituent of concrete is aggregates, the most recycling strategy will have to incorporate the substitute of recycled materials for good ones, second is to improve durability. To enhance the life of the structure the number of materials needed for their replacement can be cut to half amounts [5]. Third is to improve the mechanical characteristics, the improved mechanical strength and similar properties leads to a reduction of materials needed. For example, for members designed on the basis of strength, if the concrete strength is described the amount of materials is reduced to about 50%. Fourth is to augment the use of replaceable cementitious materials there is a lot of carbon dioxide produced during the production of Portland cement [5], since the process is energy intensive. The increased use of other materials, especially those which are by-products of industrial processes, will tend to have a definite positive effect. Fly ash and Slag are some of the common examples of such by products. Implementation of all these tools and strategies will readily help in sustainable development. A lot of research work is already been conducted towards the utilization of such materials which are easily available and cheaper in cost [6].

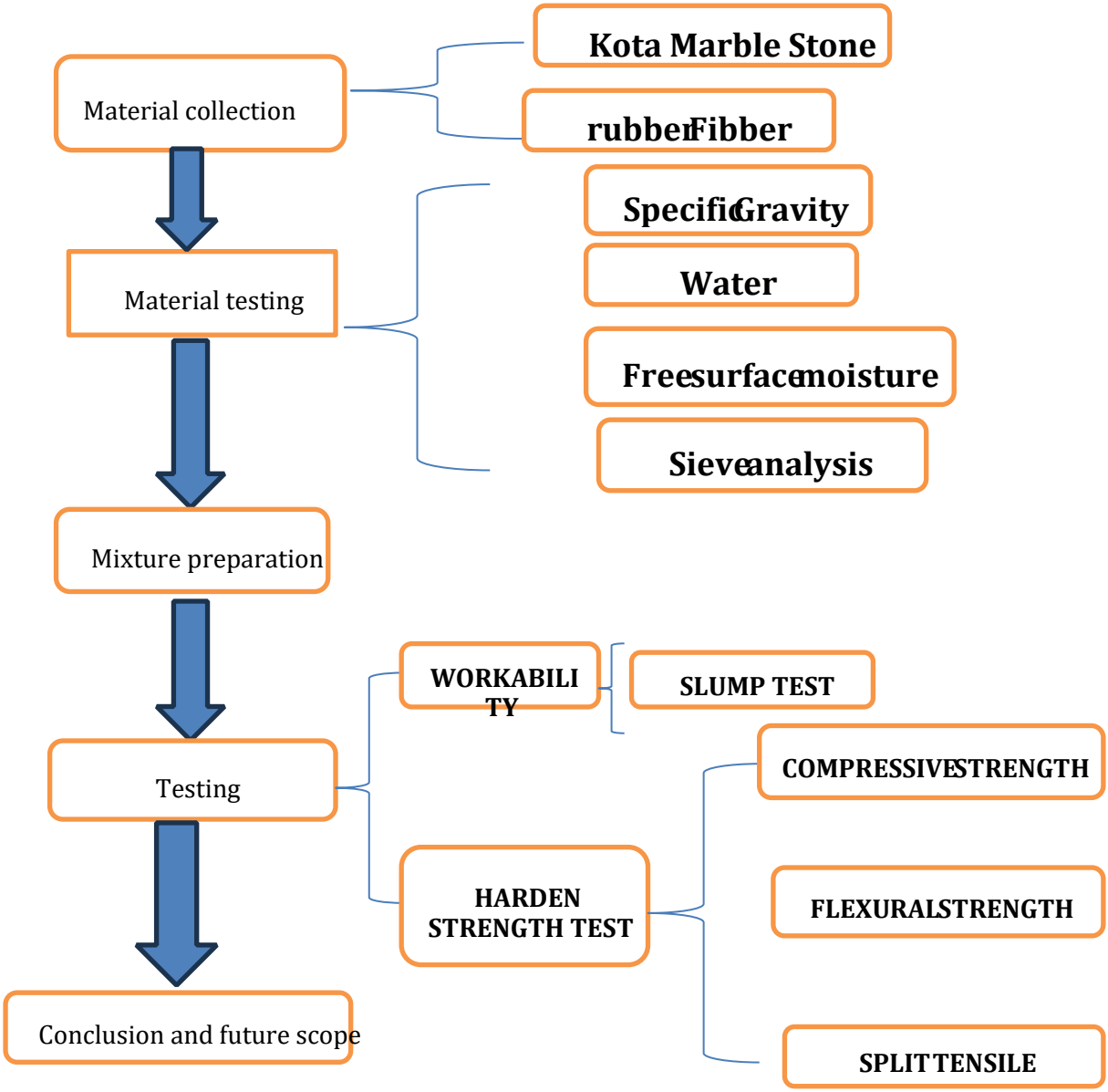
II.Objective Of The Study

The objective of the study is to develop concrete with good strength. Concrete using rubber fibers and Kota marble waste dust as waste material. So, the experimental programmed to be undertaken; on strength characteristics of concrete are investigated. The precise objectives of the study are as follows: -

1. To design M40 grade concrete and to study its compressive strength after the prescribed 7 days and 28 days.
2. To examine the workability by using slump test by partially replacing of fine aggregate with Kota marble dust and using tyer rubber as coarse aggregate on M40 grade of concrete.
3. To investigate the compressive strength by replacing partially replacing of fine aggregate with Kota marble dust and using tyer rubber as coarse aggregate on M40 grade of concrete.
4. To investigate the split tensile strength by partially replacing of fine aggregate with Kota marble dust and using tyer rubber as coarse aggregate on M40 grade of concrete.
5. To investigate the flexural strength partially replacing of fine aggregate with Kota marble dust and using tyer rubber as coarse aggregate on M40grade of concrete.

III.Research Methodology

The characteristic strength of concrete used for the study will be determined. Tests to be conducted on the ingredients of concrete are as follows:



The experimental study was divided into the following stages:

1.Properties of material used in the study.
2.Mix Design according to IS 10262-2009.
3.Workability test of concrete mixes.
4.Casting and curing of specimens.
5.Strength tests on specimens.

Properties of Material

The test specimens were prepared using cement, fine aggregate, coarse aggregate, Kota stone powder, rubber fibers and water. The materials, in general, conformed to the specifications laid down in the relevant Indian standard codes. The materials used for making concrete mix specimens were having the following characteristics:

1. Cement:

Table: Physical properties of cement

S. No.	Properties	Observations
1	Specific gravity	3.15
2	Initial setting time	30 min
3	Final setting time	600 min
4	Standard Consistency	5-7%
5	Fineness (90 microns IS Sieve)	4%
6	28-days compressive strength	40.17Mpa

2. Fine Aggregates:

Table: Physical properties of fine aggregate

Sr. No.	Properties	Observations
1.	Fineness modulus of fine aggregate	4.03
2.	Specific gravity of fine aggregate	2.54
3.	Water absorption of fine aggregate	2.16%

3. Coarse Aggregates:

Table: Physical properties of coarse aggregate

Sr. No.	Properties	Observations
1.	Fineness modulus of coarse aggregate	6.96
2.	Specific gravity of coarse aggregate	2.86
3.	Water absorption of coarse aggregate	1.57%

4. Kota Marbal Aggregates:

Table: Specific gravity of kota stone

S. No	Particulars	Weight in gms
1	Weight of vessel (W_1)	650
2	Weight of vessel + over burnt brick aggregates (W_2)	1442
3	Weight of vessel + water + over burnt brick aggregates (W_3)	1614
4	Weight of vessel + water (W_4)	1120

Tests On Hardened Concrete

Following tests are conducted to check hardness properties of concrete:

1. Compressive strength test
2. Split tensile strength test
3. Flexural Strength Test

Compressive strength test

Out of general test to designate concrete, this is the most relevant to access the quality of concrete. This single test ensures whether concreting has been accomplished properly or not.

For cube tests, cubes sizes of 15 cm X 15 cm X 15 cm are selected. Concrete is placed in the layers in the cubes and tempered thoroughly to remove voids. Tests specimens are removed from the moulds after 24 hours and are immersed in water for curing. The top surface of the cube must be smoother and even this achieved by spreading cement paste 2on all the faces of the specimens. The rate of loading should be 350 kg/cm^2/minute and uniform. Three cube moulds to be casted for each mix proportion and at last the average value be adopted for the designed strength for 7 days and 28 days of curing. Specimens should be tested immediately after removal from water so that they are in surface dry condition. Compression test was performed on standard compression testing machine of 2000KN capacity in the usual manner according to Indian Standard guidelines

Figure 1: Compressive strength specimen

Split tensile strength test

The test was conducted on cylinders of size 150 mm diameters and 300mm length. Specimens were taken out from curing tank at the age of 28 days of water curing. Surface was then allowed to drip down. Specimens were tested on 200 tones capacity compression testing machine. The bearing surface of the machine was cleaned and the test specimen was placed in the machine such that the load was applied to the faces other than the cast faces of the specimen.

The maximum split tensile strength on the specimen were record as the load at which the specimen failed to take any further increase in the load. The average of the three samples was taken as the representative value of split tensile strength.

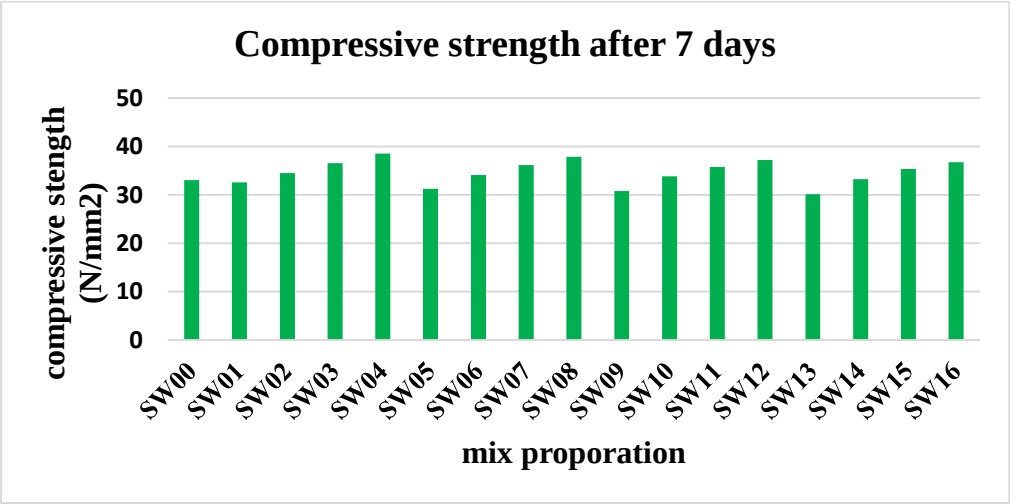
Figure 2: Split tensile strength specimen

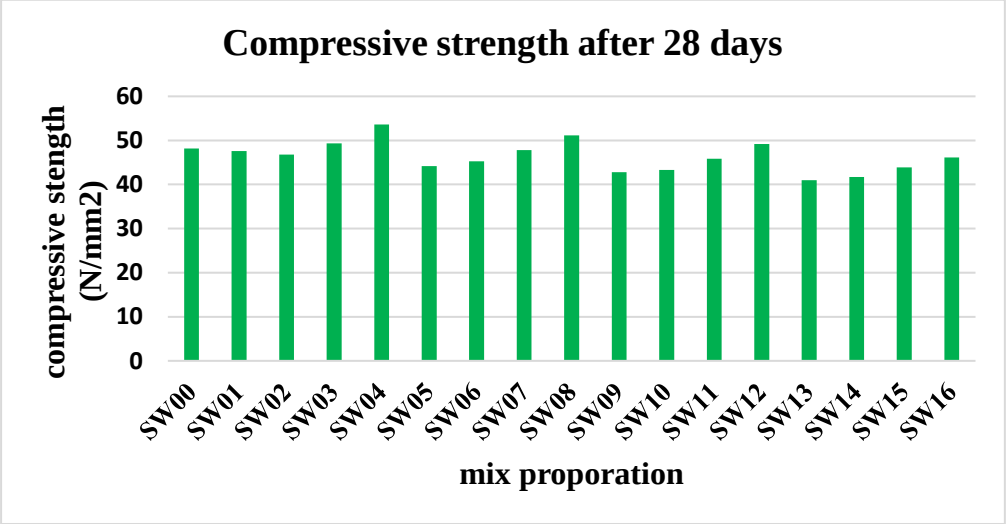
Flexural Strength Test

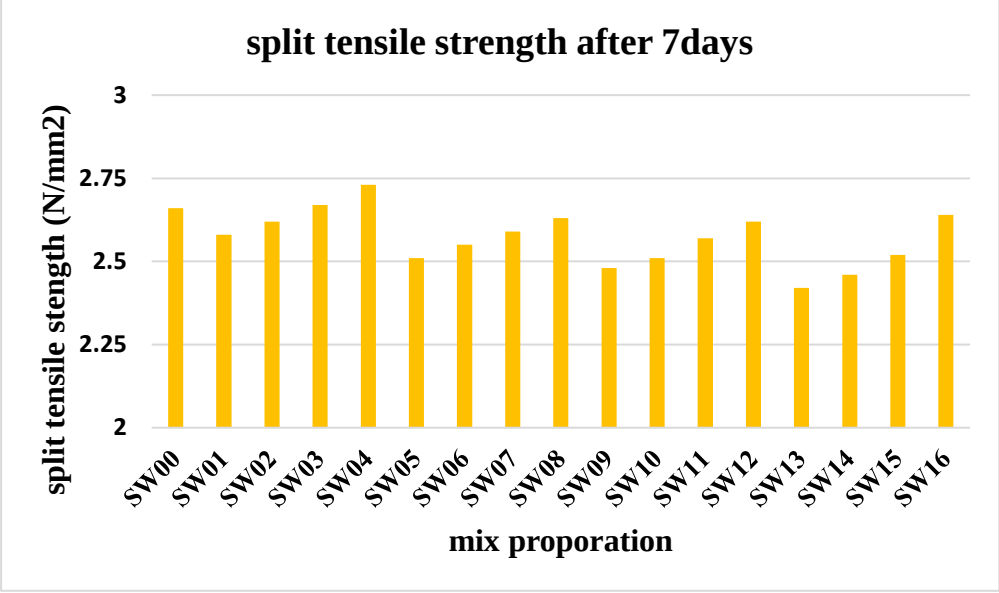
Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three-point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of yield. It is measured in terms of stress. For beam tests, beams of sizes of 10 cm X 10cm X 50 cm are selected. Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer.

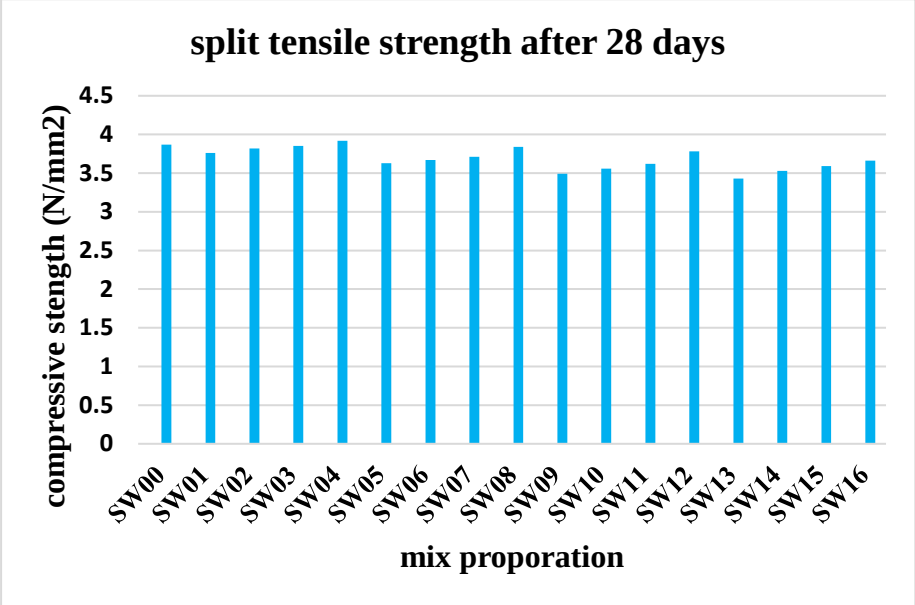
Figure 3: Flexural Strength Test Apparatus

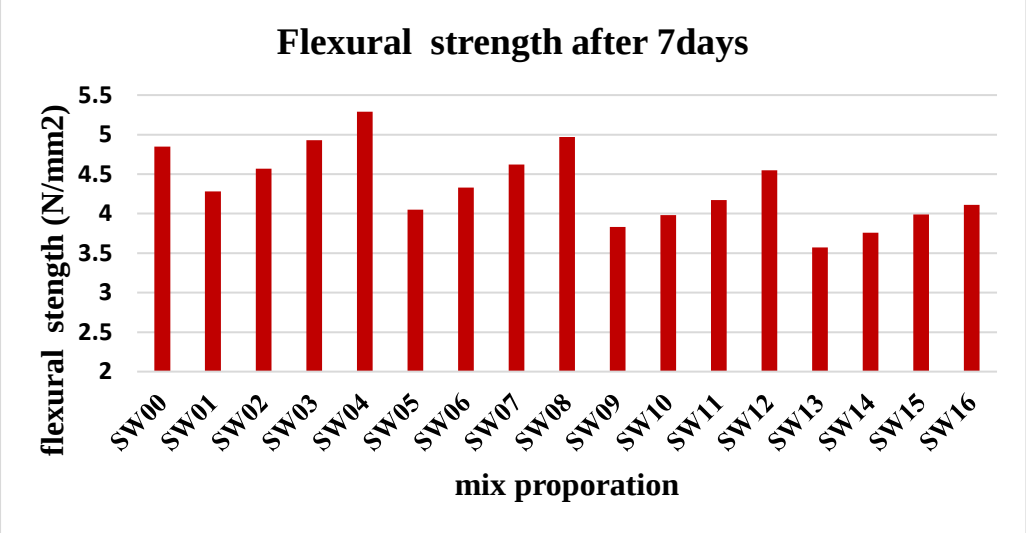
IV.Results

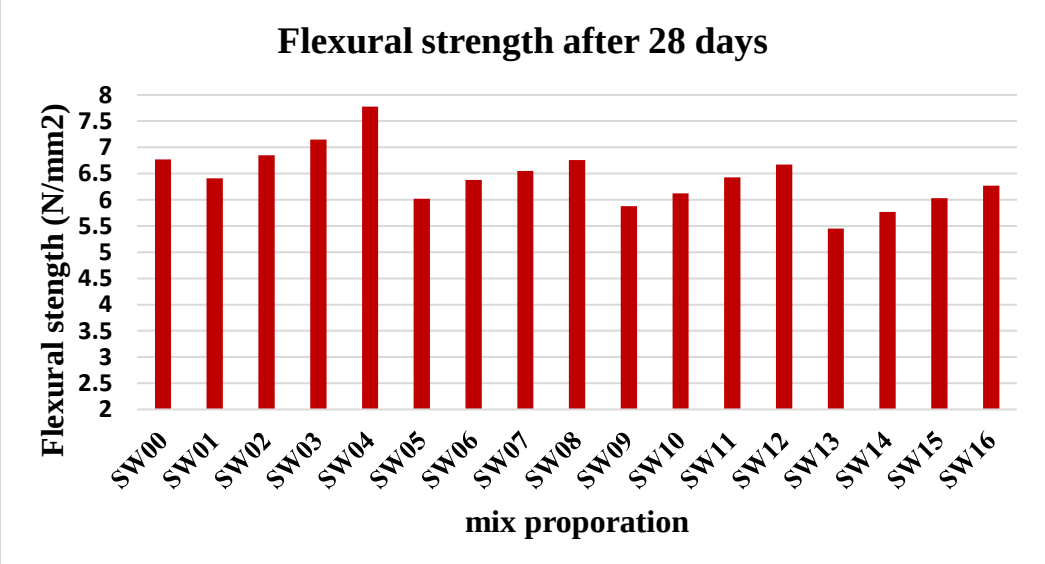

Compressive strength after 7 days
compressive stength (N/mm2)
50
40
30
20
10
0
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation


Compressive strength after 28 days
compressive stength (N/mm2)
60
50
40
30
20
10
0
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation


split tensile strength after 7days
split tensile stength (N/mm2)
3
2.75
2.5
2.25
2
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation


split tensile strength after 28 days
compressive stength (N/mm2)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation


Flexural strength after 7days
flexural stength (N/mm2)
5.5
5
4.5
4
3.5
3
2.5
2
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation


Flexural strength after 28 days
Flexural stength (N/mm2)
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
SW00 SW01 SW02 SW03 SW04 SW05 SW06 SW07 SW08 SW09 SW10 SW11 SW12 SW13 SW14 SW15 SW16
mix proporation

V.Conclusion

In the current investigation, Kota stone dust and rubber fibers were used to examine the strength properties. The conclusions that may be drawn from the results of investigation are as:

I. The workability of concrete decreases with the increase in the variation in the partially replacement of fine aggregate with Kota stone dust and Coarse aggregate with the rubber fiber.

II. The maximum compressive strength of M40 grade for 7 days of all the mixed combinations is found to be 38.52 N/mm^2 when coarse aggregate was replaced with 5% by rubber fibber and fine aggregate with 15% by Kota stone dust.

III. The maximum compressive strength M40 grade of concrete for 28 days of all the mixed combinations is found to be 53.63 N/mm2 when coarse aggregate was replaced with 5% by rubber fibber and fine aggregate with 15% by Kota stone dust.

IV. The maximum split tensile strength M40 grade for 7 days of all the mixed combinations is found to be 2.73 N/mm2 when coarse aggregate was replaced with 5% by rubber fibber and fine aggregate with 15% by Kota stone dust.

V. The maximum split tensile strength M40 grade for 28 days of all the mixed combinations is found to be 3.92 N/mm2 when coarse aggregate was replaced with 5% by rubber fibber and fine aggregate with 15% by Kota stone dust respectively.

VI. The maximum flexural strength M40 grade for 7 days and 28 days of all the mixed combinations is found to be 5.29 N/mm2 & 7.78 N/mm2 respectively. when coarse aggregate was replaced with 5 % by rubber fibber i.e. weight aggregate and fine aggregate with 15 % by Kota stone marble dust respectively.

VII. By using of waste materials such as rubber fiber and Kota stone waste in concrete the structure becomes light weight and economical and environment can be also protected for pollution etc.

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