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SHREDDED RUBBER PARTICLES AS PARTIAL REPLACEMENT TO FINE AGGREGATE IN CONCRETE

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ABSTRACT

Worldwide production of tyre increases due to increase of automobile industry, it is very difficult to dispose the waste tyre as the availability and capacity of landfill spaces decreases. The basic material required in construction of buildings by using concrete are aggregate and cement.Due to rapid growth in automobile industry, use of tyre increases day to day and there is no reuse of the same to decrease the environmental pollution. The decomposition and disposing of waste tyre rubber is harmful to environment.In this research paper we have gone through the properties of rubber and how the form of rubber used changes the strength of concrete.Using such rubber is essentially a method to manage the waste tire problem widespread in India and the world.The overall results of study show that it is possible to use recycled rubber tyre aggregates in concrete construction as partial replacement to natural coarse aggregates.

Keywords: Shredded Rubber, Rubberized Concrete,TyreRubcrete, Compressive Strength, Waste Management, Enviornmental Engineering.

I. INTRODUCTION

“Energy cannot be created, it cannot be destroyed”; it is the base of all intellectual and spiritual thoughts of human beings. Energy is always subjected to cycles. Thus nothing as such is a waste. The so called waste of one process is in fact a raw material for some other process. Rapid growth in automobile industry and increasing use of vehicles, production of tyre is also increased which generate waste tyre rubber. Management of waste tyre rubber is challenging to municipalities and burning or biodegradation of waste tyre rubber is harmful to environment. On the other hand, demand of concrete as construction material from society, it is needed to preserve natural fine aggregate by using alternative material. In this research, reuse of waste tyre shredded rubber in concrete as partial replacement as fine aggregates. In India an annual cumulative growth rate of 8% is expected in buses, trucks, cars/jeep/taxis. Considering the average life of the tyres used in these vehicles as 10 years after rethreading twice, the total

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number of waste disposable tyres will be in the order of 112 million per year. Approximately, one tire is discarded per person per year. These tires are among the largest and most problematic type of waste, due to the large volume produced and their durability over the two decades, researchers have underscored to use waste tyre rubbers in concrete and carried out the test on various concrete mixes using rubber aggregate as partial replacement of fine aggregates. According to the studies carried out previously, we found that changes inproperties of concrete depends on the shape, size of the rubber used in concrete.

In India there are about 100 Crore tires which are thrown away every year. Using these waster tires in some form in the concrete mix can be beneficial in many ways, it can reduce the environmental issues caused by the thrown away tires and it can also impart some unique properties to the concrete mix.

II. METHODOLOGY

Remolding of tyre is done for its further use. During the process of remolding, fine rubber particle (shredded form) are obtained buffing of the layer of tyre by buffing machine. These waste fine particles of rubber are used as replacement of locally available natural sand.

Fig.2.1Sample of shredded rubber

2.1 MATERIALS USED FOR CASTING OF SPECIMEN

Natural Aggregate:

Sand is obtained from nearby available river. They are strong, tough, clear and free from veins, alkali, vegetable matter and other deleterious substances. Aggregates are free from such material, which will reduce strength or durability of concrete. Sand: Natural sand free from silt, veins, alkali, vegetable matter and other deleterious substances.

Fig. 2.2 sample of coarse and fine aggregates

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Cement:

Ambuja cement 53 Grade Ordinary Portland cement is used for all mixes. Fine Scrap tyre rubber: Fine Scrap tyre rubber Obtained from Remolding section, New Roshan tyre works, satpur MIDC, Nashik. Water: Water used for drinking purpose inCollege of Engineering & research center, Nashik is used for mixing and curing.

2.2 INITIAL TESTING ON MATERIAL

2.2.1 Cement

1.Fineness - As perIS 269 – 1989 (sieve Analysis).Finer cement offers greater surface area for reaction to develop strength.

2. Consistency –As per IS 4031 part 2 (Vicat apparatus).To find Initial and Final setting time of cement.

2.2.2 Aggregate

1. Sieve analysis - As per IS 283-1970 (sieve Analysis).To find specific size of aggregate.

2. Impact Value test - IS 283-1970(Impact value apparatus)**.**to find toughness of aggregate.

2.2.3 Water

1. pH value test - IS 456-2000 (pH meter).To find the pH value of water.

2.2.4 Test on fresh concrete

1. Slump test (Workability) - IS 516 – 1959 (Slump cone test).To find the workability of concrete.

2.2.5 Test on harden concrete –

1. Compressive strength test

2. Split tensile test

3. Flexure test

2.3PROPERTIES OF MATERIALS

2.3.1 Cement:

The table below shows the properties of cement used. OPC- 53 grade cement was used. Cement is used as a binding material in concrete. The cement used in the project is OPC-53 Grade cement purchased from local vendors. The properties of cement are shown in table below established using relevant IS codes.

2.3.2Shape and Surface Texture of Aggregate:

Surface texture is the property, the measure of which depends upon the relative degree to which particle surfaces are polished or dull, smooth or rough. Surface texture depends upon hardness, grain size; pore structure. Surface texture affects water cement ratio, workability and strength of the concrete.

2.3.3 Flakiness and Elongation Index:

The flaky and elongated particles tend to orient in one plane and cause laminations which adversely affect the durability of the concrete. The test followed IS: 2386(Part I)-1963.

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TABLE-IPROPERTIES OF COARSE AGGREGATES

Properties Of Coarse Aggregates	NA-20mm
Flakiness Index	13.4%
Elongation Index	33.62%

2.4QUANTITY OF MATERIALS USED FOR EACH BLEND

The blends are prepared by replacing 0%, 6%, 10%, and 14% of fine aggregate (sand) by shredded rubber particle by weight. Each blend is prepared for casting of one set of 6cubes, 6 beams and 6 cylinders each. Quantity of materials used for each blend is estimated.

2.4.1 NaOH Treatment

The shreddedrubber particle are immersed into NaoH solution for 20 min and then dried before using in the concrete mix. NaoH treatment to the surface of rubber particle enhances the adhesion between the rubber particle and concrete.

Before actual mixing of shredded rubber in dry concrete it is essential to give NaOH treatment to rubber it makes rubber surface rough that’s helps to make proper bonding between rubber and cement paste.

2.4.2MIX DESIGN OF CONCRETE (M25)

In conventional mix, rubber is not added at all. Concrete is designed as per regular concrete. These results are taken from average of three cubes. As the designed concrete is of M25, for 7 days & 28days strength of cubes with w/c ratio is OK.

Cement =375.00 Kg/m³

Coarse Aggregate – 20mm = 1236.55 Kg/m³

Fine Aggregate = 749.71 Kg/m³

Shredded Rubber = 6%, 10%, and 14% mixes.

Water Cement Ratio = 0.45

Super Plasticizer = 7.5 liters

Mix Design Proportion – 1:1.99:3.30

2.5 Mixing of Concrete

Hand mixing of concrete is done as per IS code.

2.6 Tests on Fresh Concrete

To measure workability of concrete slump cone test carried on fresh concrete.

2.7CASTING OF TEST SPECIMEN

Six specimen of each blend of Cube, Cylinder and Beam are casted as per IS code.Mould specification -

1) Cube- 150X150X150mm, 2) Prism- 150X150X700mm, 3) Cylinder- 150mm dia. & 300mm Length.

2.8 CURING OF SPECIMEN

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Curing of the specimen is done for 7 days and 28 days after casting of specimen as per IS code.

2.9TESTING OF CONCRETE SPECIMEN

Testing for hardened concrete is also done as per the IS codal provisions.

Fig.2.3 Mixing of shredded rubber in concrete

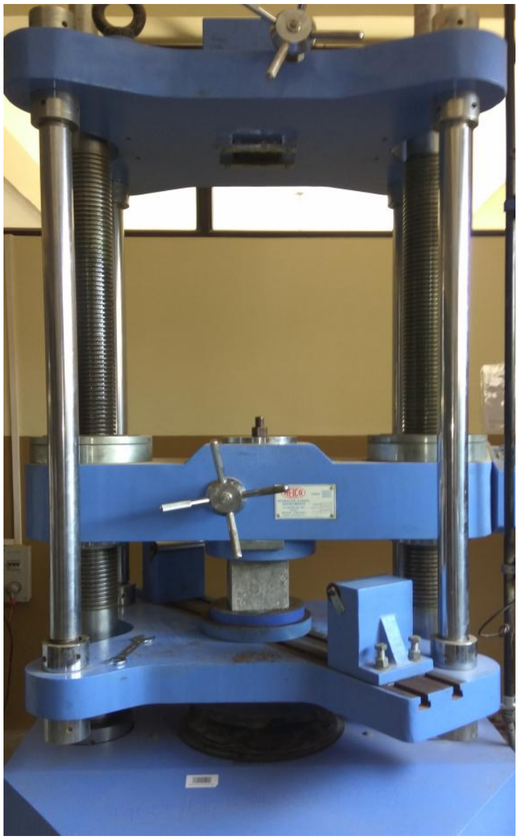

Fig.2.4Testing of specimen on UTM

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2.10 TEST RESULTS

2.10.1 Workability analysis

2.10.2Compressive strength

2.10.3Split tensile test

2.10.4 Flexural test

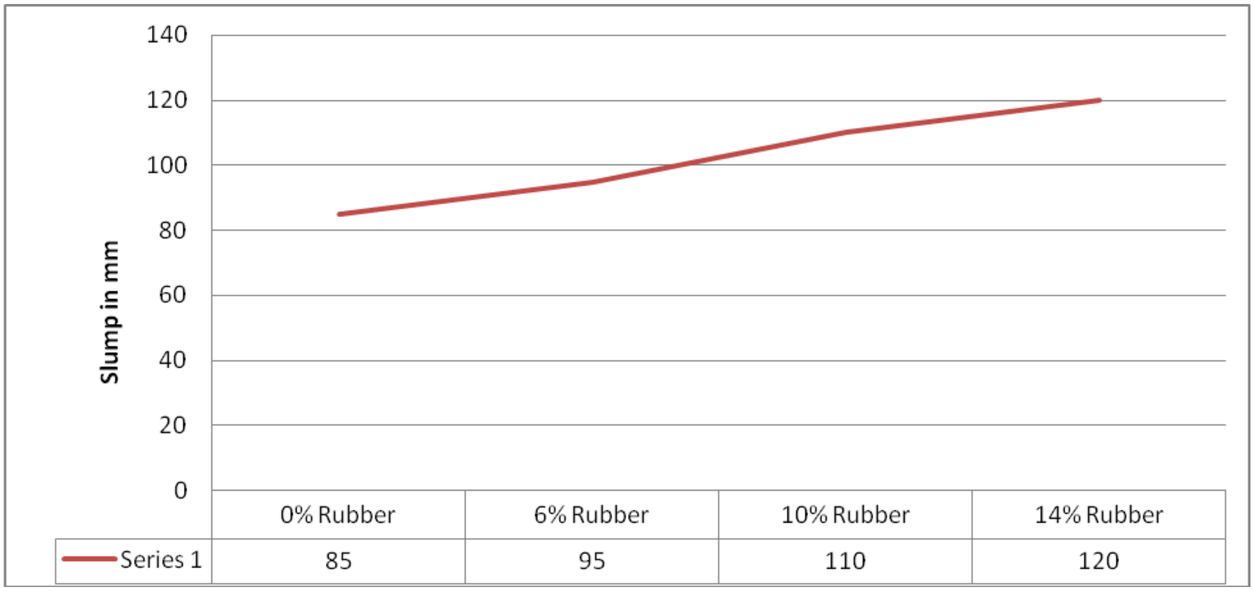

Fig.2.5 Workability analysis

The resultsshowed that, there was decrease in strength of tyre rubberconcrete mixture, but with increase in rubber content from o to 15 % slump values increases. It means that this type ofconcrete is more workable than normal concrete.The slump values were recorded for W/C ratio at different rubber content replaced to fine aggregatein concrete mix are as follows,

W/c ratio = 0.45 slump (mm)

0 % replacement 85

6 % replacement 95

10 % replacement 110

14 % replacement 120

After 7 &28 days curing of concrete cube, compressive test carried on each concrete cube of each blend. Average of three cubes of each blend is calculated and graph is plotted.

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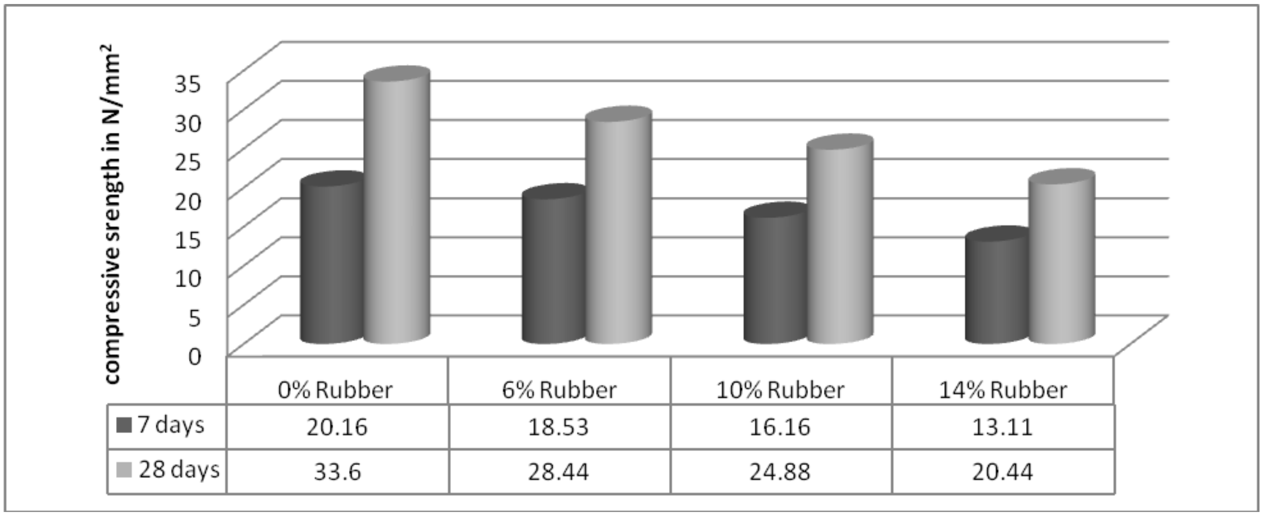

Fig.2.6Compressive strength analysis after 7days & 28 days

DISCUSSION

1. The maximum compressive strength is 18.53 N/mm^2& 28.44at 6% replacement of fine aggregate by shredded rubber aggregate after 7 days& 28 days.

2. Up to 6% replacement of fine scrap tyre rubber aggregate compressive strength isreduced to 15.35% of compressive strength of traditional concrete.

3. For 10% replacement of fine scrap tyre rubber aggregate the compressive strength is decreased by 25.12% to the compressive strength of traditional concrete.

4. At 14 %replacement of fine scrap tyre rubber aggregate compressive strength is decreased by *39.16%* as compared with compressive strength of traditional concrete.

After 7 &28 days curing of concrete cylinder, split tensile strength test carried on each concrete cylinder of each blend. Average of three split cylinder of each blend is calculated out and graph is plot.

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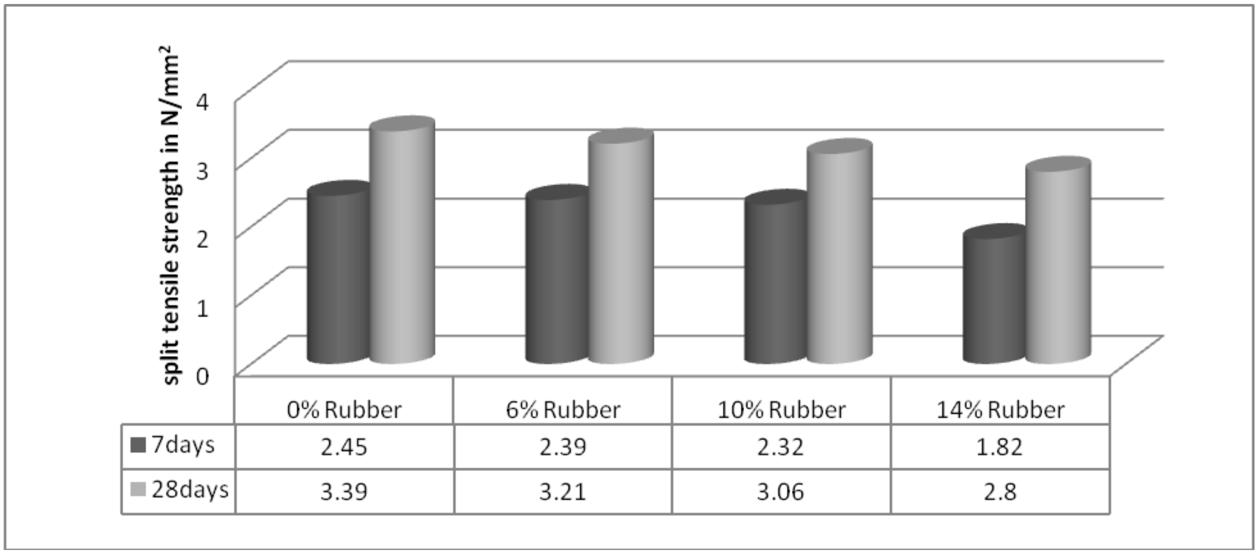

Fig.2.7Split tensile test analysis after 7days and 28 days

DISCUSSION

1. The maximum Split tensile strength of concrete is 3.21 N/mm2 at 6% replacement offine shredded rubber.

2. The maximum Split tensile strength at 6% replacement of fine scrap tyre rubberaggregate is 5.30% less than the split tensile strength of traditional concrete.

3. For 10% replacement of fine scrap tyre rubber aggregate split tensile strength is decrease to 9.73% of traditional concrete.

4. For 14% replacement of fine rubber split tensile strength is decrease to 17.40%of traditional concrete.

After 7 &28 days curing of concrete beam, flexural strength test carried on each concrete beam of each blend. Average of three beam of each blend is finding out and graph is plot.

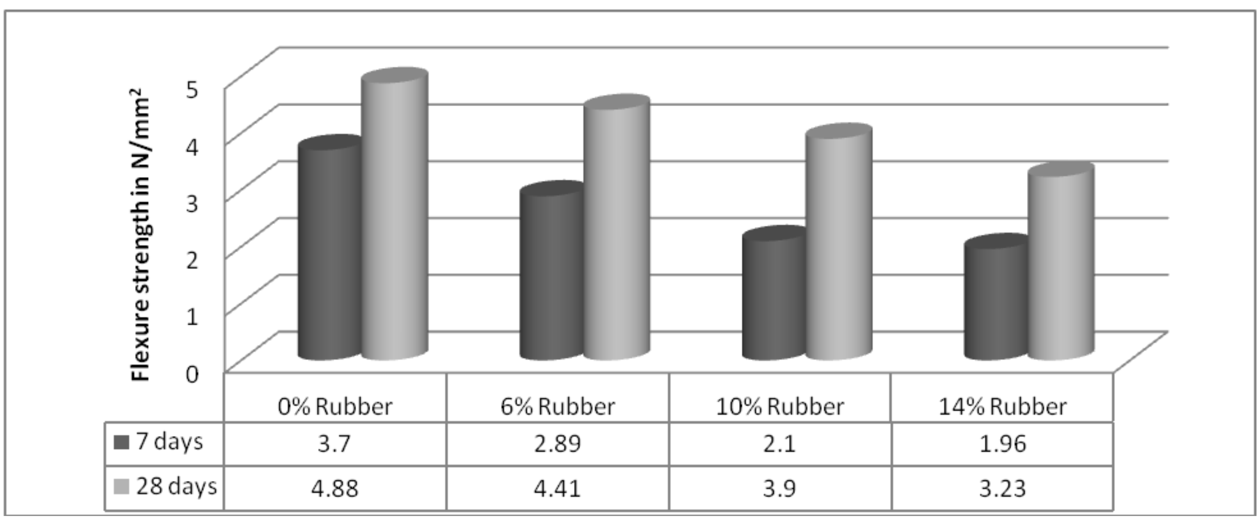

Fig.2.8 Flexural strength test analysis after 7days and 28 days

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DISCUSSION

1. The maximum flexural strength of concrete is 4.41 N/mm^2 at 6 %, 3.90N/mm^2 at 10% & 3.23N/mm^2 at 14% replacement of fine rubber aggregate respectively.
2. The maximum flexural strength at 6% replacement of fine rubber aggregate is 9.63% less than the flexural strength of traditional concrete.
3. At 10 % replacement of fine rubber aggregate flexural strength of concrete is decrease by 11.56% as compared with maximum flexural strength at 6% replacement of fine rubber aggregate.
4. For 14% replacement of fine rubber aggregate the flexural strength of concrete is reduced to 33.81% as compare to flexural strength of traditional concrete.
5. There is not much difference between flexural strength of concrete from 10% to 14% replacement of fine rubber aggregate in concrete saves natural material.

2.11 CONCLUSION

Use of the waste rubber tyre in concrete is a techno- economically feasible andenvironmentally consistent method of waste disposal. The addition of rubber tyre under certain proportion of rubber tyre for an specific property. Further higher proportion of rubbertyre degrades the concrete properties. The optimum values for specific concrete properties are presented in the previous section (Results and Discussions). The proportion of rubber tyre, higher than the optimum can also find application in uses like partition walls etc.where low density is the major requirement. Thus, there is great potential to use rubber tyre waste in concrete. Higher content of waste tyre shredded rubber particle in concrete increases workability of concrete.

The disposal of waste material is one of the most serious environmental concerns globally. There is no difference of opinion that the increasing piles of tires are creating environmental issues. For that matter there must be a way to dispose-off these tires. These tires have potential risks to environment and health. Compressive strength of rubberized concrete depended on two factors; grain size and shape of rubber aggregate and percentage of replacement.

As we are using shredded form of rubber in concrete replacement to fine aggregate we found that, there is less effect on reduction in concrete properties as that of other rubber form used in previous research.

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