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Comparative effect on Workability of Concrete by Rebutted Tyre waste as Filler Aggregate

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ABSTRACT

Tyre waste is another emerging environmental issue in the aspect of both soil and air pollution because of the growth rate in automobile industry year-by-year. There is a real chance of including this waste tyre materials in concrete as partial replacement to aggregate for imparting ductile properties up to the desirable limits which is lacking in concrete. In this study, as an initial step, the properties of concrete were analyzed and compared with conventional concrete with rebutted tyre as partial replacement to fine aggregates in proportions of 10%, 20%, 30%, 40% and 50% by weight then compares with nominal mix (without replacement). The study includes detailing of the fresh properties of concrete with and without replacement of rebutted tyre rubber material. A feasible outcome has been obtained making this as useful alternate to fine aggregate which is in depletion stage and also to limit the polluted effect of rebutted tyre and concrete.

Key words: Rebutted Tyre, Concrete, Workability, Environment.

1. INTRODUCTION:

A widediversity of waste materials are considered likely and even much valuable additives for concrete. Some of these materials include cellulose, fly ash, silica fumes and wood particles etc.,. Scrap Rubber obtained from tyres is considered as the most recent waste materials that have been examined because of its huge availability and vital use in the construction field. Things have gone too far away from the hands of human beings in the aspect of environment pollution and its control. As per Wikipedia, about 450 milliom scrap tres generated annully in the country as on 2015. Many nations banned this waste tyre disposal by the means of lansfill and/or burning. Since, it has been proven that lands filling have negative effects on environment and also burning generates hazardous gas emissions into the atmosphere. According to Smithers Rapra Study, it was estimated that about 1.7 billion new tyres produced a year meanwhile 1 billion waste tyres generates per year. It cannot be discharged off simply in the environment as its decomposition takes much time and also produces environmental pollution[4].

On the other hand, the lack of availability of fine aggregates especially in the southern parts of India. The depletion of this natural resource, forcing us to look at an alternative in a preferable manner and quantity available to serve the needs of construction industry. The obtainable studies regarding utilization of scrap tyres rubberin concrete suggests a fair recommendation for the use of this waste as a partial replacement of fine aggregate in concrete production. [1]

Most of the structures in India especially in Andhra are constructed & being constructed with a concrete grades ranging M25-M50. Majority of the local Constructions are based on Ordinary concrete in terms of admixtures, mode of construction etc., Hence this study implied to (Adopt the conditions) finding out the concrete suitable to this localized constructions without admixtures.

Low specific gravity materials tend to move upwards while vibrating/compaction. In other words, high specific gravity materials settle down forcing the others to top. Hence, this type of concrete should be used with at-most care and light compaction. By the Analytical approach done by Priyanka Asuttkar, S.B.Shinde & Rakesh Patel[2], use of rubber aggregtaes as coarse aggregate replacement up to 15% is suggested with limited applications. The rubberized concrete mixtures exibits a lower unit weight compared to conventional plain concrete with a workability of grade Good.

2. MATERIALS AND PROPERTIES:

Ultratech brand of Ordinary Portland cement (53 grade) confirming to IS 12269-1987code was applied in the present study. The Normal consistency was 35%, Specific gravity of cement was found to be 3.15, Initial setting time was 74 min, final setting time was 163 min. As per IS:

383-1970, Natural river sand confirming to zone II was utilized here. Specific gravity of fine aggregate was found to be 2.61, 0.4% of free surface moisture, water absorption as 1.6%, fineness modulus is 2.87. Coarse aggregate is a combination of 10 mm and 20 mm sizes of 40% and 60% were used, fineness modulus of 10 mm size was found to be 5.493, corresponding water absorption was 0.26%, fineness modulus of 20 mm size was found to be 7.211, corresponding water absorption was 0.235%. The Rebutted tyre waste is used in three different sizes which being considered as Fine. The waste tyre is obtained from local industry where the processing called rebutting of tyre takes place available at cheaper rate. The desired particle size of rubber is readily available during that process itself. The specific gravity difference of river sand and rebutted tyre rubber was taken into consideration while replacement in concrete. The ratio of specific gravity of rubber to the specific gravity of sand was calculated and that was multiplied to the mass of fine aggregate to be replaced [1] in the mixture. The average specific gravity of rubber fine is 1.11. The three sizes of rebutted rubber were mixed in definite percentages (35% of 3–4 mm size, 30% of 1.68–3 mm size and 35% of 0.8-1.68 mm size) to match it to zone II.

Figure 1: Tyre Rubber Transformation

2.1 CONCRETE MIX:

The mix design in this experiment was designed as per the guidelines and procedure mentioned in IS 10262-2009. All the samples were prepared using mix deign obtained. M25 grade of concrete was selected for the present investigation since it is the mostly used one. Mix design was done based on I.S 10262-2009 and the design proportions of nominal mix obtained are 1:1.32:2.47 (1part of Cement, 1.32 parts of fine aggregate, and 2.47 parts of coarse aggregates) at a constant water-to-cement ratio 0.48 even for the replaced mixes.

3. EXPERIMENTAL PROCEDURE:

This study presents the initial investigation of behavior of concrete with rubber particles i.e., fresh properties. Hence, the fresh properties like Workability, swelling etc are studied by replacing different proportions of fine aggregate by tyre material in multiples of 10% up to 50% replacement. The mixing of concrete is done by hand mixing metod, no equipment was used for this. The workability is observed in two methods i) Slump Cone Test ii) Compaction Factor Test whereas the shrinkage is observed without any instrument or procedure. The outcome of compaction factor test is calculated from the weights of cylinders with and without compaction whereas in slump cone test, the values are measured by a scale available on tamping rod. The mixing and casting was done manually.

4. TEST RESULTS:

The replacement of the material in various proportions are designated as R0,R1,R2,R3,R4 and R5 for 05, 10%, 20%, 30%, 40% and 50% replacements of rebutted tyre material as fine aggregares respectively. The workability tests are conducted accordingly and the results are tabulated below whereas the bleeding of concrete is bit higher during the moulding process with the increase in rubber content which is discussed later.

4.1 SLUMP CONE TEST:

This is often considered as an in-situ type test where the concrete is being prepared or poured, there we can test its workability. The slump test was conducted for all the proportions of replacement and the corresponding values are been tabulated in Table 1 as shown.

Table 1: Slump test values of concrete with fine aggregate replacement

Mix Designation	Rubber content (%)	Slump (mm)
R0	0	82
R1	10	82
R2	20	84
R3	30	87
R4	40	92
R5	50	99

4.2 COMPACTION FACTOR TEST:

Unlike the slump cone test, this test is more like a laboratory test where the apparatus is been arranged of fixed. The results or the values in this test are calculated from the weights of cylinders with and without compaction. The concrete mix is been tested in according proportions and the results obtained are as shown in the table 2 below:

Table 2: Compaction factor test values of concrete with fine aggregate replacement

Mix Designation	Rubber content (%)	Compaction Factor value
R0	0	0.87
R1	10	0.87
R2	20	0.885
R3	30	0.89
R4	40	0.915
R5	50	0.925

5. DISCUSSIONS:

5.1 SLUMP CONE TEST:

The test results of the slump cone test are shown in graphical way below and the various aspects were drawn from it, as follows:

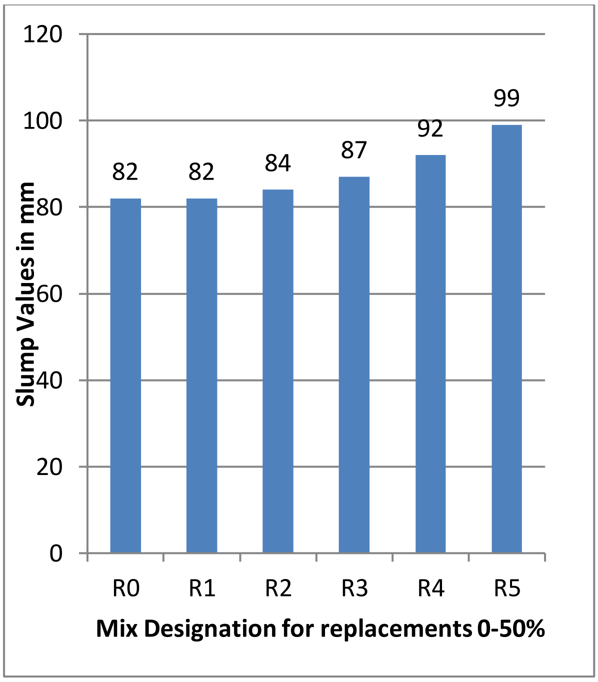

Figure 2: Slump cone results with filler replacement

It is been observed that the slump values are increasing with increase in the rubber particles. The increment of slump is not that much in terms of percentage but it is clear that the addition of the rubber particles will improve the workability[true slump] due to the smooth surface texture it possess. At the initial stage (10-20% replacement) the slump is almost similar to nominal concrete.As the replacement increases further beyond 20%, the slump values increased in a consistent amount of 5%. The slump obtained is not of average because it is nearly 100mm with an amount of half of the fine aggregates. But we cannot say that the rubber shuld be used in concrete because it is improving the workability property of concrete until the mecanical properties of concrete has beenstudied in-detail in all aspects of durability too for sky-scrapers.

Figure 3: Slump Pattern of Concrete

The slump obtained is True Slump with all the replacements but it can be seen that with the increase in the filler replacement with rubber, the shape of the concrete at the base bulging slightly giving the advantage of improving the workability of concrete as shown in fig:2.

5.2 COMPACTION FACTOR TEST:

The test results of the Compaction Factor test are shown in graphical way below for further detailed discussion which as follows:

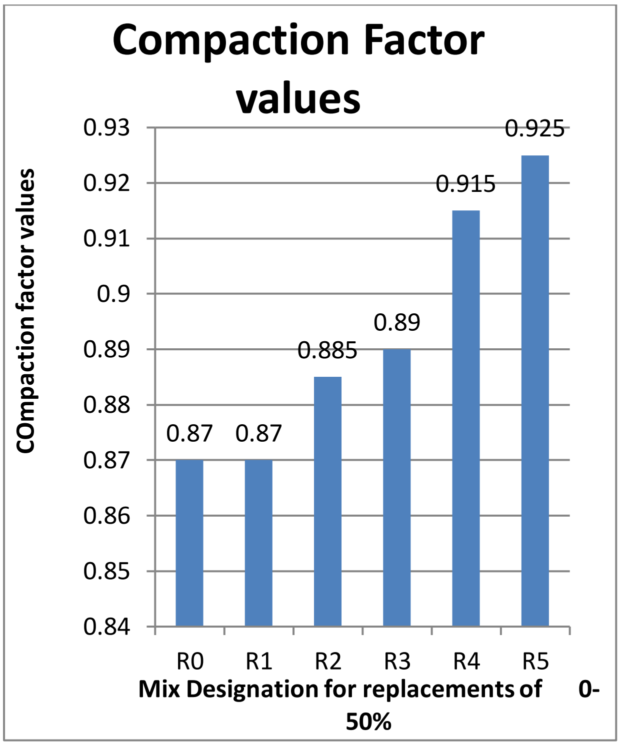

Figure 4: Compaction factor values for various replacements

The pattern of improvement of the workability in this test is similar to that of slump cone test. This test is more like a drop test means the concrete has to move from hopper to hopper neglecting the friction and finally fills the cylinder. The amount of concrete filled without air-voids or simply with minimum voids possible. The Presence of rubber particles with the advantage of smooth texture even though they are fine particles made the coarse aggregate move freely and which allowed the concrete to dense packing giving improved workability. Particularly at the replacements of 40% & 50%, the concrete filling in the cylinder in such a way that at a point of time we can even assume it as flow concrete i.e., the concrete itself is arranging/adjusting into the cylinder without much voids which enhanced the compaction factor values.

As mentioned earlier, the bleeding of the concrete is little more than the normal since the rubber particles tend to move to the top of the mould. This might be due to the compaction effect too which can be handeled or controlled with proper compaction up to the desired standard. There is no segregation observed during mixing or placing of concrete into slump cone or cylinder or mould i.e., it can be said that the rubber particles may not effect the concrete in the aspect of segregation with the particle size used in this investiaton.

Overall the usage of rubber particle as filler material can be considered as an alternative to some of admixtures since it is a possible remedy to the reduction of pollution from tyre waste and also to reduce the natural resource utility particularly the fine aggregate.

6. CONCLUSIONS:

The concrete exhibited better performance in terms of workability with the addition of tyre rubber. The water absorption of the rubber particles is quite negligible which enhanced the workability by providing more water to the mix for that of replaced material. The workability of concrete is most important aspect during the placing and moulding into desired form. Since the processing of rubber is not done in the aspect of chemical composition, utilizing in the concrete may be considered up to a standard for workability but mechanical properties has to be studied for fully operational use in concrete.

This study replaces the filler material i.e., Fine aggregate up to 50% only because this testing aims to prove or at least investigate the utilization of the waste rubber which is being dumped in the earth crust causing the instability to nature. Further, the mechanical properties of concrete with rubber filler will be analyzed. Depending on which the increment of rubber particles percentage will take place. The thermal resistance of concrete in-terms of heat absorption and emission can be reduced due to the presence of rubber but the capacity of this effect depends on the percentage of rubber imparted. Hence, as far as this research is concerned, the rebutted tyre rubber can be utilized in the concrete as filler material up to 30% as optimum reducing the cost of the material for ordinary constructions. In other words, the rebutted tyre waste can be used in concrete where the strenth of concrete is not primary factor like kerbs, dividers, footpaths, finising works, parking lots, recreational constructions etc.,

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