International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.12, pp : 1414-1417 01 Dec. 2014

Studies on Scrap Tyre Added Concrete for Rigid Pavements

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Abstract:Waste tyre treatment is now global threat. Waste tyre dumping, disposal of these materials or burning these tyres cause serious environmental and health problems. This paper investigate the wide range of physical and mechanical properties of concrete containing waste tyre aggregates and assess its suitability as a construction material. Waste tyres are powdered into fine particles of various sizes and are used to replace the fine aggregate used in concrete. The fine scrap tyre aggregate is added as 2%, 4%, 6%, 10%, and 12% increment to replace the fine aggregate. This study aims to investigate the optimal use of waste tyre aggregates as fine aggregate in concrete composite.

Key Words—**Rubberized concrete, scrap tyre aggregate, waste tyre aggregate, rubcrete**

I. Introduction

India has done a major leap on developing the infrastructures such as express highways, power projects and industrial structures, dams etc. to meet the requirements of globalization. For the construction of civil engineering works, concrete play main role and a large quantum of concrete is being utilized. Both coarse aggregate and fine aggregate is a major constituent used for making conventional concrete, has become highly expensive and also scarce. In the backdrop, there is large demand for alternative materials from wastes.

Waste tyre management is a serious global concern. Millions of waste tyres are generated and dumped or burned every year, often in an uncontrolled manner, causing a major environmental and health problem [1]. Tyres are durable and not naturally biodegradable. Waste tyres will remain in dump sites with little degradation for a long time, leads to environmental hazard. Therefore, recycling of waste tyre plays a vital role in concrete. The primary objective of this study was to evaluate the reuse potential of crumb rubber in concrete mixtures for pavement applications. Mixtures in this study incorporated waste-stream materials such crumb rubber
“recycled tyres”, and aggregate. Up to 30% crumb rubber may be allowed for use in concrete mixtures produced for highway applications. It is anticipated that the use of crumb rubber in future concrete highway pavements will have to be incentive based in order to introduce its use to designers and contractors.

Utilization of waste tyres in the study process has been focus to reduce tyre wastes, economic, environmental management[2]. Test results of 28 days rubberized concrete shown 10%, 15% replacement of junk tyre rubber gives low compressive strength than conventional concrete specimens. Checking for rubberized concrete in non structural elements like pavements, runways, drainage, harbours etc. Rubberized concrete is also a Light Weight Concrete. Fast growing world motor vehicle usage is increasing in every year, Promisable future product for replacement of coarse aggregates. Alternative to coarse aggregate to recycle tyres helping the conservation of the environment, reduce the natural source utilization, improve to use modified materials. Since the natural resources are scarce in nature, we have to find the alternate methods to make concrete. Rubber tyre aggregate can be used for this purpose. Replacement of waste tyre rubber aggregate with fine aggregate will gives optimal and safest replacement in concrete composites.[3]

Scrap tyre rubber chips can be also used as coarse aggregate with the replacement of conventional coarse aggregate[4]. The feasibility of incorporating scrap tyre rubber chips as coarse aggregate in concrete mixes and determine the change in the properties after the incorporation of the rubber into the concrete mix is to be investigated. Due to replacement of the aggregates by rubber particles, the weight was reduced. Due to non-uniform distribution of rubber particles in the concrete, non-homogenous samples may produce, which in turn results in reduction in concrete strength. The stiffness of rubber is lower as compared to stiffness of coarse aggregate, the presence of rubber particles in concrete reduces the concrete mass stiffness and also decreases load bearing capacity of concrete.

Development of Self Compacting Rubberised Concrete (SCRC) uses the advantages of both Self Compacting Concrete (SCC) and Rubberised Concrete[5]. The study presents an opportunity for the utilisation of waste tyres and provides a correlation between compressive strength and the various durability parameters. The reduction in compressive strength due to the incorporation of scrap rubber in SCC could be compensated to some extent by the addition of steel fibres. All the durability characteristics were found to be within the limits prescribed by the codes for normal concrete. However, when compared to SCC, SCRC satisfies all the durability requirements better than SCC, except for the sorptivity index. The rubberised concrete with fibres was seen to have the best resistance against abrasion. The effect of fibres on the other durability indices was not significant in the rubberised concrete specimens .

Tyre rubber wastes represent a serious environmental issue that needs to be addressed with urgency by the scientific community[6]. Investigations carried out so far reveal that tyre waste concrete is specially recommended for concrete structures located in areas of severe earthquake risk and also for applications submitted to severe dynamic actions like railway sleepers. This material can also be used for non load-bearing purposes such as noise reduction barriers. Investigations about rubber waste concrete show that concrete performance is very dependent on the waste aggregates. Further investigations are needed to clarify for instance which are the characteristics that maximize concrete performance. Nevertheless, future investigations should clarify which treatments can maximize concrete performance being responsible for the lowest environmental impact. Mechanical trituration can be done to rubber scraps of post-used tyres from motor vehicles and trucks. They have long been investigated for resource reutilization as an aggregate in concrete resulting in the Rubcrete mix, which can be conveniently used in various applications with promising effects. Rubcrete provides a final product with good mechanical properties and also represents an effective and inexpensive way of recycling the discarded tyres, replacing partially or totally natural aggregates. [7]

Experimental investigation to study the structural characteristics of concrete using various combinations of copper slag and discarded rubber tyres for the partial replacements for fine and coarse aggregates shows that the strength of concrete is increased due to the presence of copper slag[8]. When the rubber tyre pieces are replaced up to definite percentage of coarse aggregates, there is no decrease in strength. The concrete with copper slag and the rubber tyre pieces could be useful for all structures. The utilization of copper slag as a partial replacement for sand imparts strength up to 50% replacement. It can be applied for all construction activities. Concrete mix having discarded rubber tyres up to 15% (for coarse aggregates) can be applied for construction of pavements, minor works etc.

This thesis will investigate suitability of rubber tyre aggregate as a construction material. In this waste tyre rubber added concrete is termed as Rubberized concrete. My present study aims to investigate the optimal use of waste tyre rubber aggregates as fine aggregate in concrete composite. Based on the literature survey it was seen that compressive strength of concrete reduces with the addition of rubber aggregate, so selected M35 as reference mix.

II. Materials and Methodology

Utility of scrap tyre aggregate as a substitute for fine aggregate for the improvement of the concrete properties in road construction was studied. A series of compression test, split tensile strength test, flexural strength tests were carried out in M35 mix with different percentages of rubber aggregate.

Standard cubes, beams and cylinders were casted for each mix. The moulds used for casting the specimen were selected as per IS: 10086-1982.

2.1 Material used

Scrap tyre aggregate was collected from a Rubber Park, near Irapurom Kerala. With the addition of Scrap tyre aggregate the physical properties of fresh and hardened concrete studied and compared. Tests were conducted using well graded quarry dust passing 4.75mm sieve and scrap tyre aggregate passing 4.75 mm sieve. Table 2.1 shows the properties of cement, Table 2.2 shows the properties of fine aggregate Clay, Table 2.3 shows the properties of coarse aggregate and Table 2.4 gives the material combinations studied and sample names.

Table 2.1
Material combinations and sample names

Sample Name	Percentage of rubber aggregate added
R0	0
R2	2
R4	4
R6	6
R8	8
R10	10
R12	12

Table 2.2
Properties of cement

SL No.	Properties	Value
1	Specific gravity	3.15
2	Standard consistency (%)	35%
3	Initial Setting time (min)	140
4	Final Setting time (min)	320
5	Average compressive strength (N/mm^2)	56.5

Table 2.3
Physical properties of fine aggregate

SL No.	Properties	Value
1	Specific gravity	2.66
2	Water absorption (%)	12
3	Fineness modulus	3.12
4	Grading Zone	Zone II

Table 2.4
Physical properties of coarse aggregate

SL No.	Properties	Value
1	Specific gravity	2.72
2	Water absorption (%)	1.03
3	Crushing value	25
4	Impact value	29

III. RESULT AND DISCUSSIONS

3.1 SLUMP TEST

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199–1959 is followed. Table 3.1 shows the result of slump test.

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Table 3.1
Slump value

Mix Designation	Slump (mm)
R 0	110
R 2	110
R 4	106
R 6	103
R 8	101
R 10	96
R 12	92

3.2 COMPRESSIVE STRENGTH

Three cubes of size 150x150x150 mm were tested for each mix in a compression testing machine on 7th and 28th days of curing for its compressive strength. The results are shown in table below. Fig 3.1 shows the variation of compressive strength (7 day) with addition of rubber aggregate. Fig 3.2 shows the variation of compressive strength (28 day) with addition of rubber aggregate.

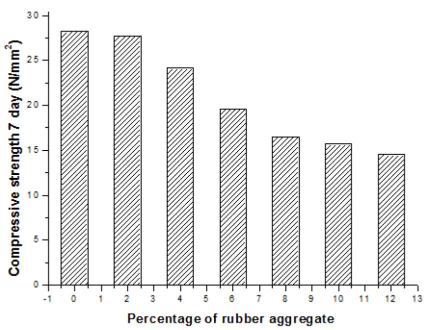

Fig 3.1 Variation of compressive strength (7day) with addition of rubber aggregate

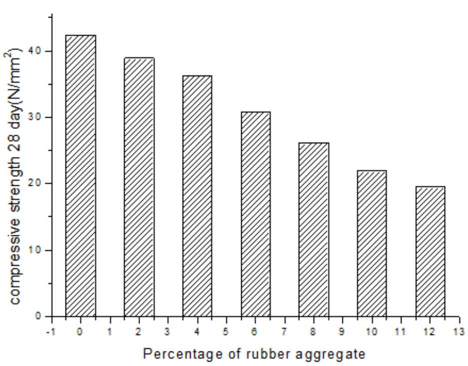

Fig 3.2 Variation of compressive strength (28 day) with addition of rubber aggregate

3.3 SPLIT TENSILE STRENGTH

Three cylinders with diameter 150 mm and height 300mm were tested for each mix for its split tensile test. Fig 3.3 shows the variation of split tensile strength with addition of rubber aggregate

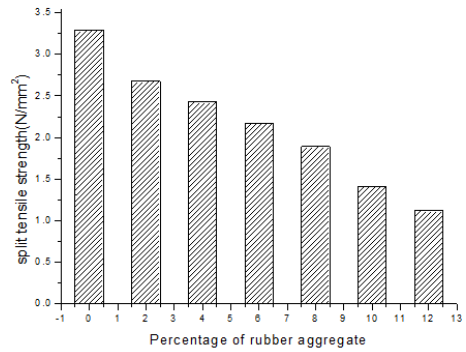

Fig 3.3 Variation of split tensile strength with addition of rubber aggregate

3.4 FLEXURAL STRENGTH TEST

In this test a concrete beam was subjected to flexure using symmetrical two point loading until failure occurs. Three standard beam of size 150 x 150 x 700 mm is tested for each sample for its flexural strength. Fig 3.4 shows the variation of flexural strength with addition of rubber aggregate. Even with the addition of rubber aggregate up to 8% in M35 mix shows the strength of M20 mix.

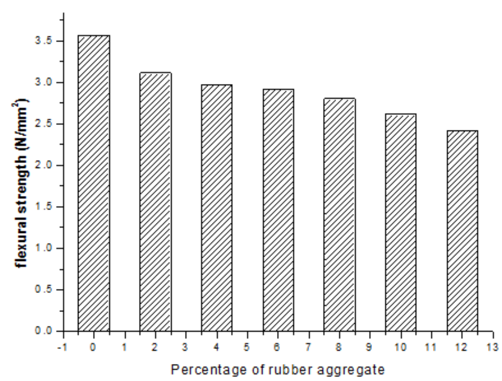

Fig 3.4 Variation of flexural strength with addition of rubber aggregate

IV. Conclusions

Studies were conducted by adding different percentages of rubber tyre aggregates to M35 mix. The studies show that not much increase in slump value with the addition of rubber aggregates. Gradual reduction in compressive strength and tensile strength was observed with the addition of used rubber tyre aggregate. From this study it can be concluded that upto 8% of rubber aggregate can be added into concrete mixes without considerable reduction in strength. Based on this study rubber tyre aggregates can be added to concrete for structural constructions mainly for rigid pavement constructions. Utilization of rubber tyre aggregates, which is a waste product, in rigid pavements is economically viable and environmentally effective.

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