Studies on Mechanical Properties of Tyre Rubber Concrete

Sulagno Banerjee[1], Aritra Mandal[2]Dr. JessyRooby[3]

[1]*Research scholar of Civil Engineerieng Department, Hindustan University, Padur, Chennai, Tamil Nadu, India*[2]*Research scholar of Civil Engineerieng Department, Hindustan University, Padur, Chennai, Tamil Nadu, India &Assistant Professor Department of Civil Engineering, Techno India - Batanagar, Kolkata-700141, West Bengal, INDIA*

[3]*Professor & HOD of Civil Engineerieng Department, Hindustan University, Padur, Chennai, Tamil Nadu, India*

Abstract

Due to the rapid growth in automobile industry, use of tyre is increasing day to day and there is no reuse of the same to decrease the environmental pollution. The disposal of waste tyres has facing major problems in India. The growing problem of waste tyre disposal in India can be alleviated if new recycling routes can be found for the surplus tyres. It is estimated that 1.2 billions of waste tyre rubber produced globally in a year. It is estimated that 11% of postconsumer tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering projects. Hence efforts have been taken to identify the potential application of waste tyres in civil engineering projects. In this present study total of 12 prisms are casted of M25 grade by replacing 5, 10, 15, 20, 25 percent of tyre aggregate with coarse aggregate and compared with regular M25 grade concrete. Properties of fresh concrete and flexural strength of hardened concrete were identified.

Keywords*:* *Tyre, Crumb Rubber, Rubberized Concrete, Replacement of coarse aggregate by used rubber*

I. INTRODUCTION

With the development of modern society's aftermath of industrial revolution, the mobility within automobile sector got momentum. The offshoot of this pragmatic revolution gave rise to new dimensions of problems in the form of rubber garbage. Tyre rubber wastes represent a major environmental problem of increasing significance. An estimated 1000 million tyres reach the end of their useful lives every year. At present enormous quantities of tyres are already stockpiled or landfills. Tyre landfilling is responsible for a serious ecological threat.Oncetyres start to burn down due to accidental cause's high temperature take place and toxic fumes are generated besides the high temperature causes tyres to melt, thus producing an oil that will contaminate soil and water. Still millions of tyres are just being buried all over the world. Tyre rubber wastes are already used for paving purposes; however, it can only recycle a part of these wastes. Another alternative is an artificial reef formation but some investigation have already questioned the validity of this option. Tyre waste can also be used in cement kilns for energetic purposes and to producecarbon black by tyrepyrolisis, a thermal decomposition of these wastes in the absence of oxygen in order to produce byproducts that have low economic viability. Some research has already been conducted on the use of waste tyre as aggregate replacement in concrete showing that a concrete with enhanced toughness and sound insulation properties can be achieved. Rubber aggregates are obtained from waste tyres using two different technologies: mechanical grinding at ambient temperature or cryogenic grinding at a temperature below the glass transition temperature. The first method generates chipped rubber to replace coarse aggregates, whereas the second method usually produces crumb rubber to replace fine aggregates. In this work the most relevant knowledge about the properties of concrete containing tyre rubber wastes will be reviewed. Furthermore, it discusses the effect of waste treatments, the size of waste particles and the waste replacement,volume on the fresh and hardened properties of concrete. Investigations carried out so far reveal that tyre waste concretespecially 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.

II. OBJECTIVE & PAST RESEARCH

Concrete is the most used material in construction liable for the depletion of natural resources and increases the scarcity of the ingredients such as cement, steel and aggregates, consequently there is a demand for these materials in the commercial sector. Further mining of river sand causes severe environmental damage by lowering ground water table and disintegration of rock strata causes landslide and earthquake. Engineers are anxious to overcome this problem with other alternatives; many researches have attempted to identify the subsidiary use of the traditional materials. Emiroglu et al [1] found Slump depends on rubber content and gradual decrease in strength with the increase of rubber. Gammel et al [2] tested concrete with 10% - 25% crumb rubber replacement along with Silica fume and Rubcrete. SaliTayeh et al [3] found satisfactory performance against impact load and bending load with increased in percentage of sand replacement by the crumb rubber. Helme et al [4] recommended 25% Substitution showed compressive strength within allowable range for most applications of concrete of the control mix design. Naito et al [5] found unit weight of C R C decreases linearly. Richardson et al [6] found Concrete strength reduction is an indication of air void / crumb spacing which offers freeze / thaw protection. Richardson et al [7] concludedaddition of 0.5% and 1% rubber crumb by mass of concrete to replicate levels of air entrainment that will provide freeze than durability.Naik et al [8] found that it is possible to make relatively high strength rubber concrete using magnesium oxychloride cement, which gives better bonding characteristics to rubber and significantly improves the performance of rubcrete. Senthilet al [9] found grade of concrete plays the major role in the ductility performance of rubber replaced concrete.

III. EXPERIMENTAL INVESTIGATION

A. *Materials Used*

1) *Cement and Aggregates*

Cement- In the present study Ordinary Portland Cement of grade 43, confirming toIS: 8112–1989[10] was used for preparing the concrete. The specific gravity of cement was 3.15. Fine aggregate- Natural River sand passing through4.75mmIS sieve is used for making concrete. As perIS: 383–1970[11] natural river sand was categorized under grading zone II. The specific gravity and fineness modulus of sand is found to be 2.6 and 4.52. Coarse aggregate was passed through 20mm sieve and retained on12mm sieve conforming IS: 383–1970[11] was used for concreting. The specific gravity and fineness modulus of coarse aggregate is found to be 2.7 and 7.3

2) *Water*

Clean portable water free from suspended particles, chemical substances, biological elements etc., is used both for mixing of concrete and curing.

3) *Rubber Aggregate*

This study has concentrated on the performance of a single gradation of rubber prepared by manual cutting. The maximum size of the rubberaggregate was 20 mm. The truck tyre rubber which was chiseled into regular coarse aggregate size was used as coarse rubber aggregate. Specific gravity of rubber chips 1.17. Fineness modulus of rubber chips was 7.52.

IV. MIX DESIGN (as per IS 10262 – 2009) [18]

Based on the trial mixes the final design mix was prepared for M25 grade of concrete as per IS 10262:2009[12]. The concrete mix proportions were as shown in Table

Grade of concrete	Target mean strength (N/mm^2)	W/C ratio	Mix Proportion
M 25	31. 60	0.45	1:1.2:2.7

Preparation of test specimens

We have made 12 nos of 100x100x500 mm moulds for testing. So material calculation as per ratio

V. TESTS FOR PROPERTIES

The flexural test, slump test compaction factor were carried out as per IS516:1959 [13], IS 1199-1959[14]

A. *Slump Test*

The replacement of coarse aggregate by scrap tyre rubber effects on the workability of the concrete. The workability of rubberized concrete shows an increase in slump with increase of waste tyre rubber content of total aggregate volume. The result of the normal concrete mix showed an increase in workability, but it can be summarized that the workability is adversely affected by the incorporation of chipped tyre rubber.

The results of the slump test are as shown

Mix	**Slump (mm)**
RP 0	**0**
RP 5	**0**
RP 10	**7**
RP 15	**20**
RP20	**55**
RP 25	**87**

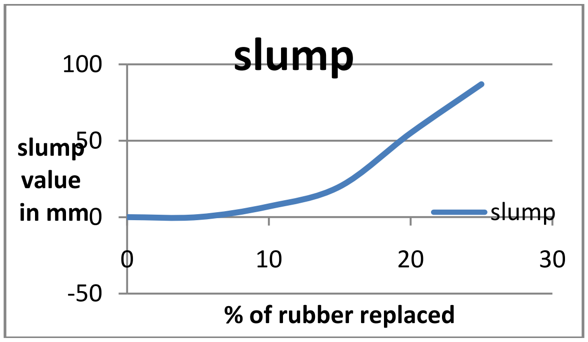

Fig 1 relation Between Slump Value and Percentage of C.A Replaced by Rubber

B. Compaction Factor

MIX	7 days strength (MPa)	28 days strength (MPa)
RP 0	2.5	3.9
RP 5	2.5	3.8
RP 10	2.4	3.6
RP 15	2.3	3.3
RP 20	2.3	3.1
RP 25	2.2	2.7

The compaction was also in three layers as carried out

Mix	Compaction factor
RP 0	0.8
RP 5	0.82
RP 10	0.82
RP 15	0.85
RP20	0.87
RP 25	0.87

marking	% of replacement	Water (kg)	Cement (kg)	C.A (kg)	F.A (kg)	Rubber(kg)
RP 0	0	3	6.7	18	8	0
RP 5	5	3	6.7	17.1	8	0.9
RP 10	10	3	6.7	16.2	8	1.8
RP 15	15	3	6.7	15.3	8	2.7
RP 20	20	3	6.7	14.4	8	3.6
RP 25	25	3	6.7	13.5	8	4.5

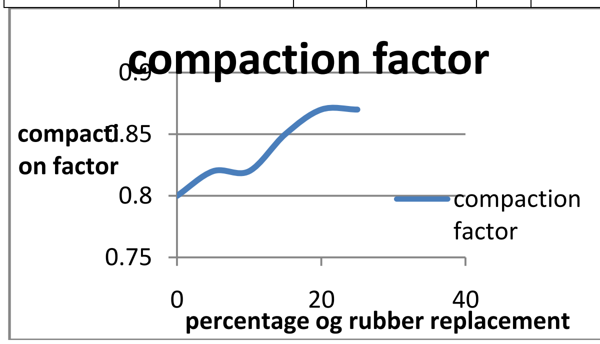

Fig 2 Relation Between Compaction Factor and Percentage of C.A Replaced by Rubber

C. Flexural Strength

The flexural strength of concrete was found out by subjecting the prism to two point loading on a flexural testing machine of 200 tones capacity at the age of 7 and 28 days.

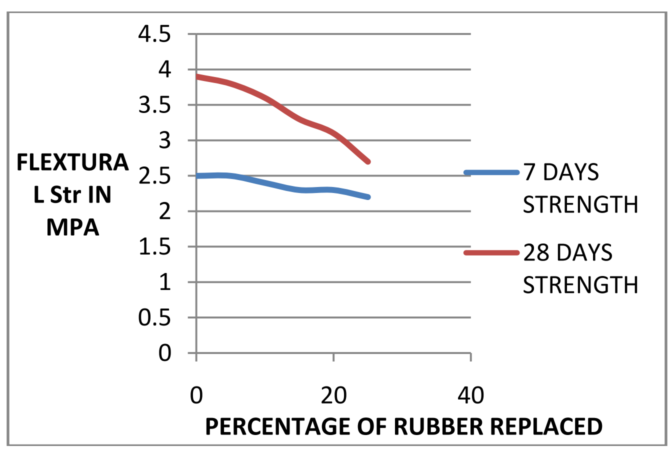

Fig 3 Relation Between Flexural Strengthand Percentage of C.A Replaced by Rubber

VI. CONCLUSION

- It is observed that when rubber replacement increases, the flexural strength decreases in concrete.
- The workability increase with the increasing percentage of rubber. This because of lack of bond between rubber particle and aggregate and hydrophobic nature of rubber.
- In 7 days flexural strength, there is not much variation between conventional concrete and rubberized concrete.
- Rubberized concrete strength may be improved by improving the bond properties of rubber aggregates
- It can be concluded that despite the reduced compressive strength of rubberized concrete in comparison to conventional concrete, there is a potential large market for concrete products in which inclusion of rubber aggregates would be feasible which will utilize the discarded rubber tyres, the disposal of which is a big problem for environment pollution
- Rubber can be used to produce lightweight concrete.

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