STUDY ON COARSE AGGREGATE PARTIAL REPLACEMENT WITH WASTE RUBBER TYRE IN RIGID PAVEMENT

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Abstract – Good *environment condition is very essential to all livings but, due to some toxic gases which is created by waste plastic is very harmful to our environment. In this study we try to minimize the plastic waste in the form of tyre with the help of partial replacement as coarse aggregate with natural coarse aggregate in a rigid pavement.*

Key Words: rigid pavement, coarse aggregate, toxic gases, environment

1. INTRODUCTION

Backbone of a country is wholly dependent on road connectivity. Roads are the foundation on which economy of any country runs. All the heavy construction works require huge quantity of cement and aggregates which results in depletion and degradation of natural resources such as river sand and rock strata. Cost of these construction materials is rapidly increasing day by day because of inadequate raw materials and rise of transport cost due to hike in transport charges and of other inputs. Further mining of river sand causes severe environmental damage by lowering ground water table and disintegration of rock strata causes land sliding and earthquake. This emerging problem obliges contemporary material usage to balance the ecology. Day by day heavy road construction and road maintenance is taking place to connect each and every corner of country and to make the existing roads more effective in serving their effect, hence it is becoming necessary to use the alternative materials which do not pose any threat to the environment and serve the purpose for which aggregates are known to serve. It has been well reported that about 1 billion of used automobile tires are generated each year globally. The increase of tons of discarded tyre rubber poses a serious threat to our environment. This is considered as one of the major environmental challenge faced by municipalities around the world because the waste rubber is not easily biodegradable after a long period of landfill treatment. Utilization off scrap tires should minimize environmental impact and maximize conservation of natural resources .One possible solution for this problem is to incorporate rubber particles into cement based materials .Scrap tires can be shredded into raw materials for use in hundreds of crumb rubber products.

2. LITERATURE REVIEW

Literature pertaining to similar studies conducted all around the world is collected from various sources and is as under:

1. **NI Fattuhi, et al., (1996) [1]** examined properties of 32 prepared mixes which included density, compressive strength, impact and fire resistance. Results showed that density and compressive strength were decreased by addition of rubber. Density varied between 1300 and 1000 kg/m3.Compressive strength reduced by 70% when proportion of rubber to total solid content by mass reached about 13%.

2. **Ali, et al., (1998) [2]** studied the effects of incorporating crumb rubber, very fine tire rubber particles, into Portland cement concrete. The objective of the study is to evaluate the effects of rubber aggregate into portlant cement concrete (PCC) properties. Initially, the rubber content replacing fine aggregates into the concrete mix was investigated by examining the concrete failure characteristics and the amount of energy absorbed during testing.

3. **Zaher K. Khatib, et., (1999) [3]** made rubberized PCC mixtures using ground tire rubber by partially replacing coarse aggregates. The workability of RPCC mixtures is dependent on the rubber content in the mix. Based on the mix workability, an upper level of rubber content of about 50% of total aggregate volume may be used. Strength data developed in this investigation (compressive, flexural and split tensile) indicate a systematic reduction in the strength with the increase of the rubber content. The strength of RPCC mixes can be reduced to as low as 10% of the original control mix strength for high rubber contents, >60% by aggregate volume. From a

practical viewpoint it was seen that rubber content should not exceed by 20% of the aggregate volume due to severe reduction in strength.

4. Khan A., and Nehdi M., (2001) [4] emphasizes another technically and economically attractive option, which is the use of recycled tire rubber in portland cement concrete. Preliminary studies show that workable rubberized portland cement concrete (rubcrete) mixtures can be made provided that appropriate percentages of tire rubber are used in such mixtures. Achievements in this area are examined in this paper, with special focus on engineering properties of rubcrete mixtures. These include: workability, compressive strength, split-tensile strength, flexural strength, elastic modulus, Poisson's ratio, toughness, impact resistance, sound and heat insulation, and freezing and thawing resistance.

5. Taha, et al., (2003) [5] added various percentages of waste plastic aggregate having the size of 5mm to 20mm. when 100% aggregate were replaced by waste material, a huge reduction of 75% in the compressive strength of resultant concrete was found which is considered to be extremely poor.

6. Chi-Sun Poon, and Dixon Chan., (2006) [6] investigation done on the cause of the self-cementing properties by measuring X-ray diffraction patterns, pH values, compressive strength and permeability of various size fractions of the FRCA obtained from a commercially operated construction and demolition waste recycling plant. Their influence on the overall sub-base materials was determined. The results indicate that the size fractions of <0.15 and 0.3–0.6 mm (active fractions) were most likely to be the principal cause of the self-cementing properties of the FRCA.

7. Mehmet Gesoglu, and Erhan Guneyis., (2007) [7] carried out in order to investigate the strength development and chloride permeability characteristics of plain and rubberized concretes with and without silica fume. For this purpose, two types of tire rubber, namely crumb rubber and tire chips, were used as fine and coarse aggregate, respectively, in the production of rubberized concrete mixtures which were obtained by partially replacing the aggregate with rubber.

8. Rafat Siddique, et al., (2008) [8] presented a detailed review about waste and recycled plastics, waste management options, and research published on the effect of recycled plastic on the fresh and hardened properties of concrete. The effect of recycled and waste plastic on bulk density, air content, workability, compressive strength, splitting tensile strength, modulus of elasticity, impact resistance, permeability, and abrasion resistance is discussed in this paper.

9. Eshmaiel Ganjian, et al., (2009) [9] studied performance of concrete mixtures incorporating 5,7.5 and 10 percent of discarded tyre rubber as aggregate. Selected standard durability and mechanical tests were performed and results were analysed. The mechanical tests included compressive strength test, flexural strength, tensile strength and modulus of elasticity. The durability test included permeability and water absorption. In general, compressive strength was reduced with increased percentage of rubber replacement though with 5% replacement of aggregate decrease in compressive strength was low (less than 5%) without noticeable changes in other concrete properties. The highest reduction was related to 7.5 and 10% percent replacement for both grades of rubber used. The reduction in compressive strength at 28 days was about 10-23 percent for aggregates. Reduction in modulus of elasticity was 17-25 % in case of 5 to 10 % aggregate replacement. In case of 5-10% aggregate replacement the reduction in tensile strength was 30-60%.

10. Sara Sgobba, et al., (2010) [10] studied the effects of rubber derived from two sources i.e., truck tire rubber and car tyre rubber. Despite some drawbacks such as the large decrease in compressive strength, the tests demonstrate that the rub Crete mix possesses important properties that can be useful in structural and nonstructural applications. The performance of the concrete is significantly affected by the type and content of rubber particles as well as by the cement type and the admixtures used. Mix 07-PR with particles from truck tires and Mix 010-PR with rubber from car tires satisfied the required qualifications of having specific gravity (<2100 kg /m3) and acceptable compressive strength for possible structural applications. Mix 08-PR with rubber from truck tires and 012- PR with rubber from car tires showed very low density (<1000 kg /m3) offering concrete useful for nonstructural applications.

3. RESULTS

The results of compressive strength, flexural strength, split tensile strength, workability (compaction factor and slump test), at 14 days and 28 days of concrete mixes are given in Tables and in Figures. These results are discussed in the following sections as under:

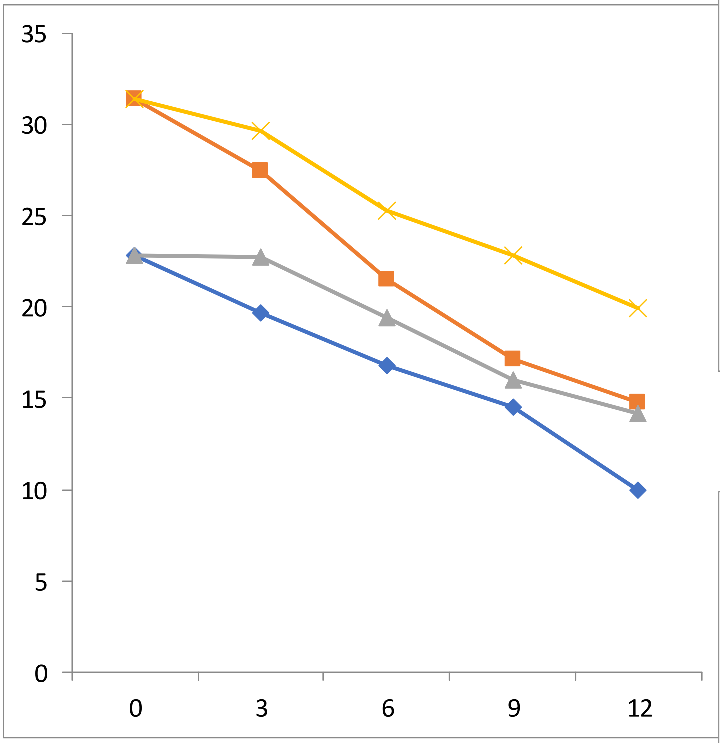

Fig. 4.5 Compressive strength vs. waste rubber tyre (untreated & treated) replaced with coarse aggregate

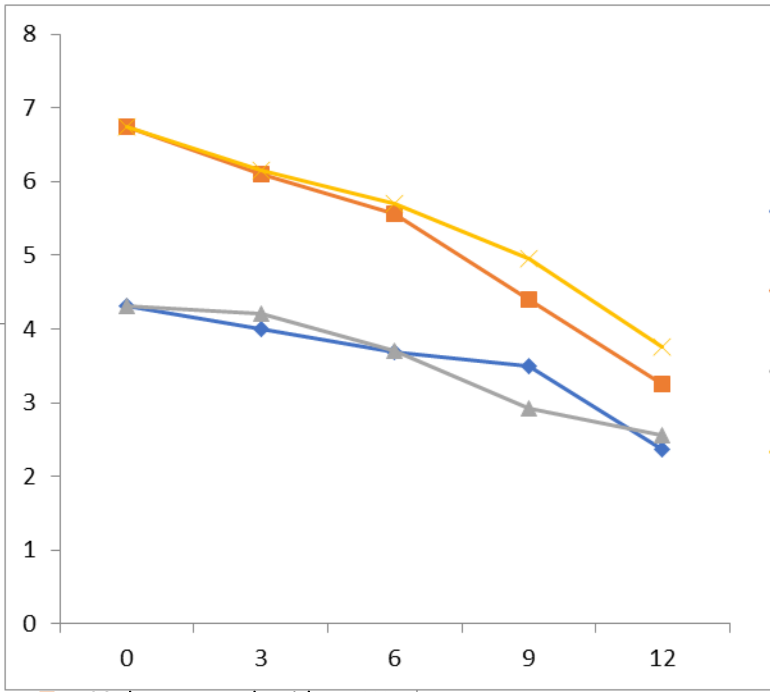

Fig. 4.10 Flexural strength vs. waste rubber tyre (untreated and treated) replaced with coarse aggregate

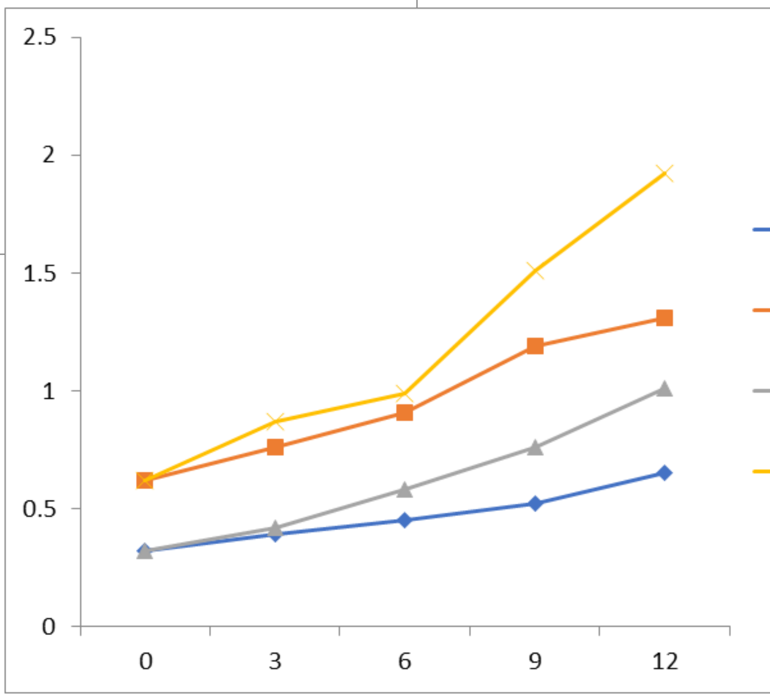

Fig. 4.15 Split tensile strength vs. waste rubber tyre (untreated and treated) replaced with coarse aggregate

4. CONCLUSIONS

During the study on the partial replacement of coarse aggregate with waste rubber tyre in construction mix design proportion, the following conclusions have been drawn based on the observations:

- The compressive strength increases but maximum at 3.00% replacement of coarse aggregate by plastic waste material likewise flexural strength increases but maximum at 3.00% replacement of coarse aggregate by plastic waste material and split tensile strength increases but maximum at 12.00% replacement of coarse aggregate by plastic waste material. Most important is compressive strength is found at 3.00% replacement of coarse aggregate by plastic waste material which is optimum.
- Slump value and compaction factor value decreases with increases the percentage of treated as well as untreated plastic waste material.
- Economical and environmental compulsions justify consideration of this alternative material source i.e. plastic waste material, in places where there is lesser-availability of natural aggregate helps in waste disposal management.

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