INNOVATIVE STUDY OF CONCRETE WHEN FINE AGGREGATE IS PARTIALLY REPLACED WITH RUBBER AGGREGATE

1. Momin Mushtaq [1] Tapeshwar Kalra[2]
PG scholar, Surya Educational Charitable Trust , Punjab -140417
Assistant Professor, Surya Educational Charitable Trust , Punjab , -140417

Abstract- Dumping of waste rubber products is becoming an environmental challenge in several developing countries due to their non-biodegradability characteristic . Appropriate waste management is an additional important aspect of sustainable growth. Rubber misuse represent a substantial part of municipal waste, furthermore a large amounts of waste arise as a by-product or faulty product in industry and agriculture. 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 construction applications. Mixtures in this study incorporated waste-stream materials such crumb rubber “recycled tyres”, and aggregate.In this study, the use of tire rubber particles as a replacement for fine aggregate in concrete is investigated. Rubber has replaced fine aggregate at content levels of 0, 3, 6, 9, 12 and 15 in concrete. Six different series of concrete mixtures were designed to investigate the various properties on rubberized concrete. The workability, compressive strength, water absorption, specific gravity etc. has been compared to the corresponding properties of controlled concrete. Gradual reduction in compressive strength was observed with the increase in the percentage of rubber aggregates. It also concludes that up to 3% of rubber aggregates can be added into concrete mixes without considerable reduction in strength of concrete. Percentage of water absorption decreases as the % of rubber aggregate increases. The workability of rubberized concrete decrease as percentage of rubber increased. The objective of the study was to study the effect of partial replacement of fine aggregates with rubber aggregates on different percentages of rubber tyre aggregates to M35 mix..

***Keywords*- Rubberized concrete; Workability; Compressive strength; Fresh concrete**

1. INTRODUCTION

India has done a major leap on developing the infrastructures such as buildings construction, 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 constitute used for making conventional concrete, has become highly expensive and also scarce. In the backdrop, there is large demand for alternative materials from wastes. The primary objective of this study was to evaluate the reuse potential of crumb rubber in concrete mixtures for construction 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 construction applications. It is anticipated that the use of crumb rubber in future concrete construction will have to be incentive based in order to introduce its use to designers and contractors. Utilization of waste tires in the study process had been focus to reduce tire wastes, economic, environmental management (Reddy B D et al 2013). Test results of 28 days rubberized concrete shown 10%, 15% replacement of junk tire rubber gives low compressive strength than conventional concrete specimens. Checking for rubberized concrete in non-structural elements like concrete work, pavements, runways, drainage, harbors etc. The present study aims to investigate the optimal use of waste tire 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. the objective of the present paper is -

a) To investigate the optimal use of waste tire rubber aggregate as fine aggregate in concrete composite.

b) To find an opportunity for the utilization of waste tires and provide a correlation between compressive strength and various durability parameters.

c) To check the compressive strength by replacing aggregate with rubber aggregate at different percentage i.e 3%, 6%, 9%, 12%, 15% for 7 days, 14 days and 28days.

d) To promote the preservation of the environment and natural resources through a process optimization of waste.

e) To minimize the overall environmental effects of concrete production using these materials as partial replacement.

2. LITERATURE REVIEW

Dumne S M (2013) studied an experimental work using recycled rubber tire aggregates as partial replacement to the coarse aggregates in concrete mix. For comparative analysis, concrete mix of M20 grade was prepared for various concrete mixes by varying percentage replacement of mineral coarse aggregates by 0, 5, 10, and 15 rubber aggregates. The test results showed that rubberized concrete gives lesser unit weight in addition to the reduction in work ability.

Rostek and Biernat (2013) conducted the study for waste samples of different density polyethylene, polyethylene terephthalate and rubber from waste tires. These studies were carried out in order to pre determine the kinetics of thermal decomposition. The study, conducted in an atmosphere of argon/nitrogen (non-oxidizing atmosphere), both in terms of the changes of enthalpy and mass.

Teppala (2014) In this present study, initially paper deals with scientific analyses physical properties for crushed stone aggregate for Dense Bituminous Macadam (As Per MORTH Table: 500-8). The study reflected that the properties of CRMB 55 changed with the addition of Zycosoil chemical in required doses, as value of penetration decreases material becomes stiff. Boiling test showed at 0.041% Zycosoil additive incorporation into DBM mixtures helps to resolve the high level of moisture damage that was noted in the control mix.

Li-Juan Li, Gui-Rong Tu, Cheng Lan and Feng Liu (2015). The use of scrap rubber decreased the density, compressive strength, and flexural strength of the RAC. In addition, the decrease in the density, compressive strength, and flexural strength of the RAC became more apparent as the rubber content increased and as the rubber particle size decreased. However, the incorporation of granulated rubber also increased the ductility of the RAC.

Torgal P (2011) stated that tire rubber wastes represent a serious environmental issue that needs to be addressed with urgency by the scientific community. They concluded that tire 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.

Alfoz and Prasad (2012) investigated the potential use of waste plastic as a modifier for asphalt concrete and cement concrete pavement. Plastic waste, consisting of carry bags, cups etc can be used as a coating over aggregate and this coated stone can be used for road construction. Work has been done by using plastic coated aggregates in cement concrete pavements. The results showed better values for asphalt concrete. This is an eco-friendly process.

Ganesan (2012) investigated the strength and durability characteristics of self compacting rubberized concrete with and without the addition of fibers. 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 fibers

2. EXPERIMENTAL PROGRAMME

Testing Procedure

Specific gravity

The Specific Gravity is a dimensionless unit defined as the ratio of the density (mass of a unit volume) of a substance to the density (mass of the same unit volume) of a reference substance. The reference substance is nearly always water for liquids or air for gases.A number of experimental methods for determining the specific gravities of solids, liquids and gases have been devised. A solid is weighed first in air, then while immersed in water; the difference in the two weights, according to Archimedes' principle, is the weight of the water displaced by the volume of the solid. If the solid is less dense than water, some means must be adopted to fully submerge it, e.g., a system of pulleys or a sinker of known mass and volume. The specific gravity of the solid is the ratio of its weight in air to the difference between its weight in air and its weight immersed in water.

Water Absorption

This test helps to determine the water absorption of coarse aggregates as per IS: 2386 (Part III) – 1963. For this test a sample not less than 2000g should be used. The apparatus used for this test are :- Wire basket – perforated, electroplated or plastic coated with wire hangers for suspending it from the balance, Water-tight container for suspending the basket, Dry soft absorbent cloth – 75cm x 45cm (2 nos.), Shallow tray of minimum 650 sq.cm area, Air-tight container of a capacity similar to the basket and Oven.

Compressive strength

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides standard test method for Compressive Strength of Cylindrical Concrete Specimens, for cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

Workability

Workability is affected by every component of concrete and essentially every condition under which concrete is made. A list of factors include the properties and the amount of cement, grading, shape, angularity and surface texture of fine and coarse aggregates, proportion of aggregates, amount of air entrained, type and amount of pozzolana, type and amount of chemical admixture, temperature of the concrete, mixing time and method, and time since water and cement are in contact. These factors interact so that changing the proportion of one component to produce a specific characteristic requires that other factors be adjusted to maintain workability In this experiment slump of all mixes with constant water to cementious material (w/cm) ratio for the same group were measured to get information about workability changes due to the cow dung ash and rice husk ash content.

Porosity test

Porosity test was carried out to calculate the amount of water absorbed by cube. The table and bar chart in result and analysis chapter shows the details about the water absorption test carried out. Out of eight standard cubes of each sample, two cubes were retained to measure water absorption after, 7, 14 and 28 days curing. This test is conducted to measure the capillary absorption which indirectly measures the durability.

4 RESULT & DISCUSSION.

1) General

The present chapter deals with the results of tests conducted on materials used in research work. All the strength performance of various mixes containing different percentage of rubber aggregates will be discussed.

2) Compressive strength of concrete

Three cubes of size 150x150x150 mm were tested for each mix in a compression testing machine on 7th, 14th and 28th days of curing for its compressive strength. The results are shown in table 1.1 Fig 1.1 shows the variation of compressive strength (7 day) with addition of rubber aggregate. Fig 1.2 shows the variation of compressive strength (14 day) with addition of rubber aggregate and Fig 1.3 shows the variation of compressive strength (28 day) with addition of rubber aggregate. Gradual reduction in compressive strength was observed with the addition of used rubber tyre aggregate. From this study it can be concluded that up to 3% of rubber aggregate can be added into concrete mixes without considerable reduction in strength

Table 1.1: Compressive strength of mixes at the age of 7 days, 14 days and 28 days

Mix destination	Compressive Strength(N/mm²)		
	7 days	**14 days**	**28 days**
MK0	24	28.28	36.86
MK3	23.66	26.91	33.43
MK6	20.57	24.05	31.03
MK9	16.54	19.82	26.40
MK12	14.06	16.80	22.29
MK15	13.46	15.28	18.94

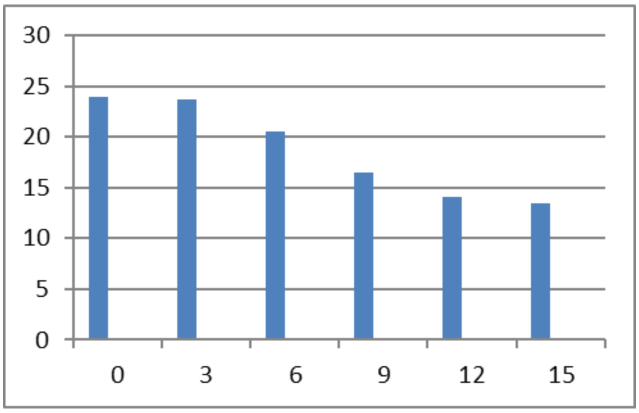
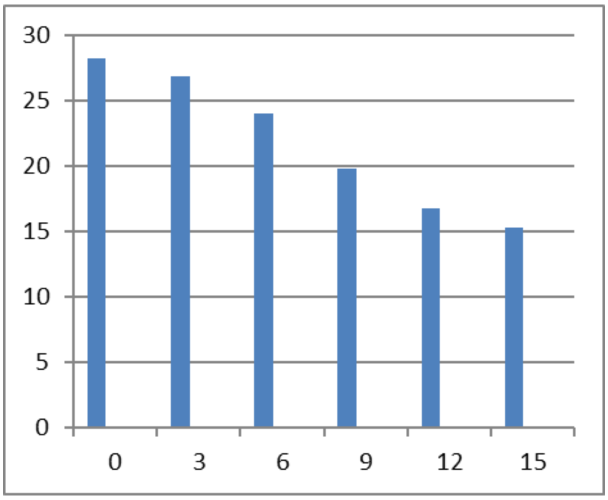
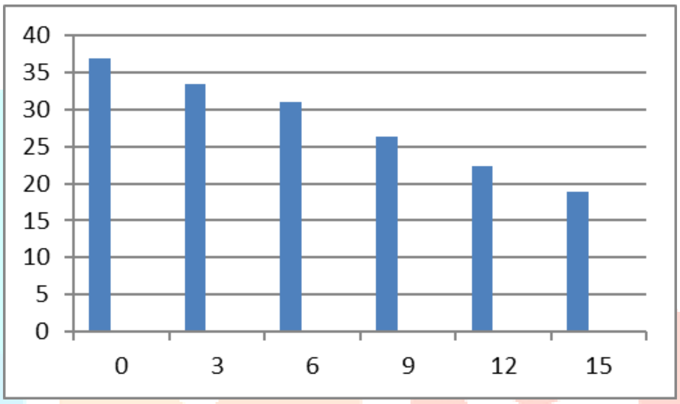


Figure 1.1 Compressive strength of concrete with different replacement levels of fine aggregate with rubber aggregates (7 days)



Figures 1.2 Compressive strength of concrete with different replacement levels of fine aggregates with rubber aggregates (14 days)



Figures 1.3 Compressive strength of concrete with different replacement levels of fine aggregates with rubber aggregates (28 days)

Water Absorption test table of the ConcreteCubes

Table: 1.2 Water Absorption of Concrete Cube

Sr. no.	Waste Tyre aggregate Content in %	Average Dry Weight (gm)	Average Wet Weight (gm) after 30 minutes	Water Absorbed (gm)	Percentage Water Absorption (%)
1	0%	8324	8416	92	1.105
2	3%	8147	8223	76	0.933
3	6%	8112	8172	60	0.780
4	9%	8084	8139	55	0.695
5	12%	8042	8075	33	0.510
6	15 %	8030	8058	28	0.348

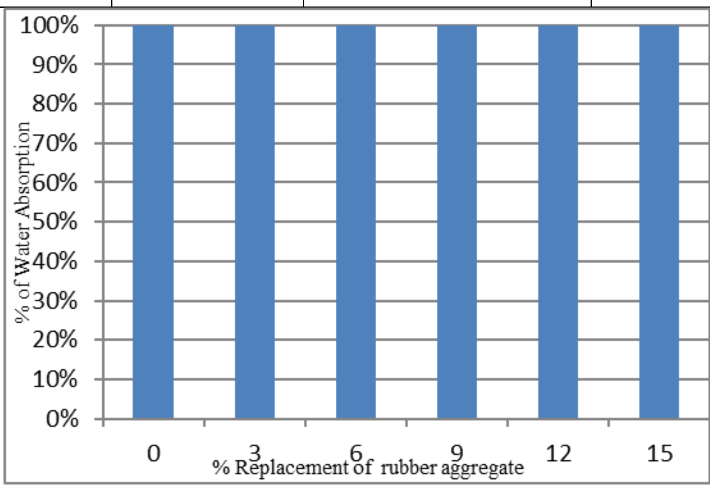


Figure: 1.4 Water Absorption of concrete Samples

II.

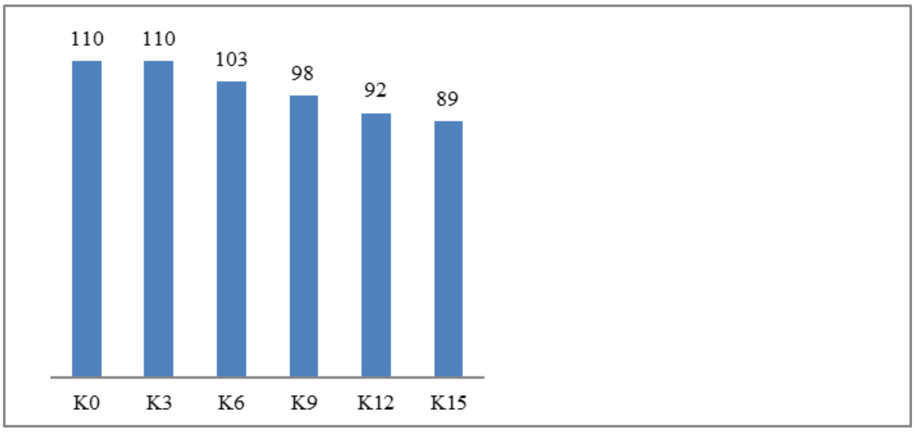


Fig 1.5 Slump Test Result

Slump Test

Slump test is used to determine the workability of fresh concrete. Slump test as per IS : 1199-1959 is followed. Table 1.3 shows the result of slump test. From results it can be concluded that not much increase in slump value with the addition of rubber aggregates. Figure 1.4 show the variation of slump value.

Table 1.3: Slump values for all mixes

Mix Designation	Slump(mm)
K0	110
K3	110
K6	103
K9	98
K12	92
K15	89

CONCLUSION

Present research was carried out to determine the compressive strength and tensile strength of concrete containing rubber aggregates. The objective of the study was to study the effect of partial replacement of fine aggregates with rubber aggregates on different percentages of rubber tire 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 tire aggregate. From this study it can be concluded that up to 3% of rubber aggregate can be added into concrete mixes without considerable reduction in strength. Based on this study rubber tire aggregates can be added to concrete for structural constructions mainly for rigid constructions. Utilization of rubber tire aggregates, which is a waste product, in concrete construction is economically viable and environmentally effective.

From the experimental investigations, it can be concluded that:

a) It was observed that addition of rubber aggregates did not affect the slump value of concrete.
b) Gradual reduction in compressive strength was observed with the increase in the percentage of rubber aggregates.
c) Up to 3% of rubber aggregates can be added into concrete mixes without considerable reduction in strength of concrete.
d) Percentage of water absorption decreases as the % of rubber aggregate increases.

I. REFERENCES

[1] Afroz, S. and Prasad, K.S.B. (2012),"Utilization of waste plastic as a strength modifier in surface course of flexible and rigid pavments", International Journal of Engineering Research and Applications (IJERA), Volume 2 (4), Pages 1185-1191.

[2] Ali R. Khaloo,M. Dehestani and P. Rahmatabadi (2008), "Mechanical properties of concrete containing a high volume of tire-rubber particles", Waste Management, Volume 28, Issue 12, Pages 2472-2482.

[3] Bala Raju Teppala, C.B. Mishra, Alok Sinhaad & Dinesh Kumar (2014), "Experimental Assessment of Properties of Crumb Rubber Modified Bitumen Mix (CRMB 55) With and Without Application of Nanotechnology Additive", International Journal of Innovative Research in Science, Engineering and Technology, Volume 03, Pages 16489-16494.

[4] Beukering, P.J.H.,and Janssen, M.A. (2001) "Trade and recycling of used tyres in Western and Eastern Europe." Resources, Conservation and Recycling, Volume 33, Issue 4, Pages 235-265.

[5] Boudaoud Z. and Beddar M. (2012) "Effects of Recycled Tires Rubber Aggregates on the Characteristics of Cement Concrete." Open Journal of Civil Engineering, Volume 2, pages 193-197.

[6] Dumne S M (2013) "An Experimental Study on Performance of Recycled Tyre Rubber-Filled Concrete" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 12, Pages 766-772.

[7] Eldin, N. N.,and Senouci, A. B. (1992) "Use of scrap tires in road construction." J. Construction Engineering and Management, 118 (3), 561-576.

[8] Eshmaiel Ganjiana,Morteza Khoramib and Ali Akbar Maghsoudic (2009), “Scrap-tyre-rubber replacement for aggregate and filler in concrete”, Construction and Building Materials, Volume 23, Pages 1828-1836.

[9] Ewa Rostek and Krzysztof Biernat (2013) “Thermogravimetery as a Research Method in the Transformation Processes of Waste Rubber and Plastic Products for Energy Carriers” Journal of Sustainable Development of Energy, Water and Environment Systems, Volume 1, Pages 163-171.

[10] Fatuhi, N.I.,and Clark, N.A. (1996), “Cement-based materials containing tire rubber,” Construction Building Materials, Vol. 10, No. 4, Pages 229-236.

[11] G. Nagesh Kumar, V. Sandeep and Ch. Sudharani (2014), “Using tyres wastes assaggregates in concrete to form Rubcrete – mix for engineering applications”, International Journal of Research in Engineering and Technology, Volume 03, Pages 500-509.

[12] Gammal, A, Abdel A, Sherbini K and Shalaby A. (2010) “Compressive Strength of Concrete Utilizing Waste Tire Rubber” Journal of Emerging Trends in Engineering and Applied Sciences, Volume 1, Pages 96-99

[13] Ganesan, Bharati Raj, and Shashikala A.P (2012) “Strength and durability studies of self-compacting rubberized concrete”, The Indian Concrete Journal