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"EXPERIMENTAL STUDY ON WASTE RUBBER AS A PARTIAL REPLACEMENT OF COARSE AGGREGATES IN CONCRETE"

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ABSTRACT

Dumping of waste rubber tires has become major issue in India in the past few years as it has very few uses, and if new tires are to be produced from waste rubber then it has to be melted and remolded. This process intern increases pollution and releases toxic gases in the air, which are harmful to the environment as well as living creatures. The main constituent of glass is silica; hence it can be helpful in AAR which take place in all types of concrete. Natural coarse aggregate are extracted from quarries and a result this quarries will soon be depleted in few decade if the rate of their uses continuous at this pace .As a result there was a need of permanent solution to this long-lasting problem. Keeping this view the feasibility of use of waste tires as replacement of coarse aggregate construction has been experimentally assessed in this project. Basic mechanical and physical test have been carried out on aggregates. The strength and durability characteristics of concrete mixtures have been computed in the present work by replacing 0%, 5%, 10%, 15% and 20% of coarse aggregates with the waste tyre rubber.

1. INTRODUCTION

Traditional concrete is primarily made up of four fundamental ingredients, i.e. coarse aggregate, fine aggregate (i.e. sand), cement and water. It has been used for over a century. Concrete occupies a unique place among modern construction materials. It gives freedom to mould the structure to any shape which is not possible with other material. Rubberized Concrete is the concrete in which coarse as well as fine aggregate is replaced by scrap tyre rubber. Nowadays, large quantities of scrap tires are generated each year globally. If these waste tires are not disposed of properly, the resulting stockpiles would cause major health risks for the public and environment. This is dangerous not only due to potential environmental threat, but also from fire hazards and provide breeding grounds for rats, mice, vermin's and mosquitoes. To protect environment from this damage, waste tyre rubber should be reused. In the last 20 years, a lot of work by using these waste materials has been done in various civil engineering projects. By using waste tyre rubber as a coarse aggregate as well as fine aggregate in concrete the natural resources can be saved and environmental pollution can be minimize. Partially replacing the coarse or fine aggregate of concrete with some quantity of small waste tire cubes can improve qualities such as low unit weight, high resistance to abrasion, absorbing the shocks and vibrations, high ductility and brittleness and so on to the concrete. It has been observed that the use of waste tyre as aggregate replacement improves the toughness and sound insulation properties of concrete. Rubberized concrete is specially recommended for concrete structures located in areas of severe earthquakes risk and also for applications submitted to severe dynamic actions like railway sleepers. The rubberized concrete is affordable, cost effective and withstand for more pressure, impact and temperature when compare it with conventional concrete. It is observed that the Rubber Modified Concrete (RMC) is very weak in compressive and tensile strength. But they have good water resistance with low absorption, improved acid resistance, low shrinkage, high impact resistance, and excellent sound and thermal insulation. Rubberized Concrete improves the mechanical and dynamic properties such as energy absorption, ductility and resistance.

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Consumption world ranking	4th
Total number of Tyre Companies	36
Total number of Tyre Factories	51
Tyre Production 2016-17 (Estimated)	130 Million
Industry Turnover (Estimated)	Rs. 39000 crores
Capacity Utilization (Estimated)	84%
Growth in Truck & Bus tyre production	15%

Indian tyres industry general detail

2. CONSTITUENT MATERIALSUSED

The constituent materials used are cement, fine aggregate, coarse aggregate, stone dust and water. The recommended materials have been described below.

Cement

Ordinary Portland cement grade 43 conforming to BIS: 8112-1989 was used in this study. It was fresh and without any lumps.

Fine Aggregate

The natural sand used in this research work was from Dera Bassi Punjab confirming zone II as per BIS 383-1960. Sand particles were sieved through 4.75mm sieve to remove the particles coarser than 4.75mm before used in concrete.

Coarse Aggregate

Crushed stone coarse aggregate was taken from quarry located near Derabassi, Punjab, India. Maximum size of coarse aggregate was 20 mm. Fineness modulus, specific gravity and water absorption of coarse aggregate were determined as per procedure laid in BIS: 2386 Part III- 1963.

Tyre Rubber Chips

Tyre Rubber chips were procured from Motor Market, Ambala City. It is used to partially replace the coarse aggregate and having the dimension of about 20 mm. The particle shape of the rubber aggregate was irregular and rough.

Water

Mixing water should be fresh, clean and potable. Water should be free from impurities like clay, loam, soluble salts which lead to deterioration in the properties of concrete. Potable water is fit for mixing or curing of concrete.

3. MIXDESIGN

The specimens are to be cast with concrete of characteristics strength 30 N/mm2 .The physical properties of constituent materials are investigated and presented as follows.
Mix calculation

The mix calculations per unit volume of concrete shall be as follows

*volume of concrete = 1 m3
Volume ofcement = 437.5/(3.01x1000)=0.14535m3
Volume ofwater =0.197
Volume of coarse aggregate = 2.66×0.67965×0.63×1000 =1138.959 kg/m³
Mass of fine aggregate = 2.59×.67965×0.37×1000 = 638.735 kg/m³
Mass of cement = 437.5 kg/m3
Massofwater = 175kg /m3
The mix proportion for the above calculation is 1:1.5:2.6

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Table 1 Mix Designation

S. No	Mix designation	%age of silica fume	Waste tyre rubber (%)	Water kg/m³	Cement kg/m³	Fine aggregate kg/m³	Coarse aggregate kg/m³	Waste tyre rubber kg/m³
1.	M-X	0	0	175	437.5	638.735	1138.95	0
2.	M-1	5	5	175	437.5	574.861	1082.01	56.947
3.	M-2	10	10	175	437.5	510.988	1025.05	113.895
4.	M-3	15	15	175	437.5	447.1145	968.107	170.842
5.	M-4	20	20	175	437.5	383.241	911.16	227.79

4. CASTING AND CURING

The ingredients of concrete were mixed in 0.06 m3 capacity mixer. Weighed quantities of cement, sand were dry mixed until uniform colour was obtained without any cluster of cement and sand. Then weighed quantity of coarse aggregate was added and mixed in dry state until homogenous mixture was obtained. Measured quantity of water was added and ingredients were mixed in the mixer. All the moulds were oiled before casting the specimens. Cube specimens of size 150 mm x 150 mm x 150 mm of each concrete mixture were cast to determine the compressive strength, splitting tensile strength, Cylindrical specimens of size 150 mm x 300 mm were cast to measure the modulus of elasticity of concrete. The specimens were de-moulded after 24 ±1 hr of adding water to concrete mixture. After demoulding the specimens were cured in water at room temperature

5. TESTING OF SPECIMENS

The cubes were tested in compression testing machine after 7 and 28 days with uniformly increasing loads capacity compression testing machine. The loading was transmitted from loading machine to the specimen by rigid steel plates placed on both above and below the specimen. The load was applied until needle started deflecting backward after crushing of the specimen and the last reading was noted.

The beams were tested in a frame having varying capacity with two point load test. The specimens were divided in three parts equally and two point loads were kept at the end of middle third part of specimen and the load was applied through cylindrical iron piece kept below the dialgauge.
The cylinders were tested in compression testing machine with uniformly increasing capacity compression testing machine. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressiveplatens

6. RESULT ANAYLSIS

- **Compressive Strength of Specimens:** Compressive strength of the design mix was check by casting and testing of cubes after the curing period of 7 days &28days. Also it gives the percentage increase or decrease of compressive strength with respect to control mix(0%).

Compressive strength test for all mixes

S .No	Mix designation	7-days compressive strength	28-days compressive strength
1	M-X	20.72	38.75
2	M-1	23.91	39.02
3	M-2	24.1	39.22
4	M-3	23.03	37.9
5	M-4	20.71	33.24

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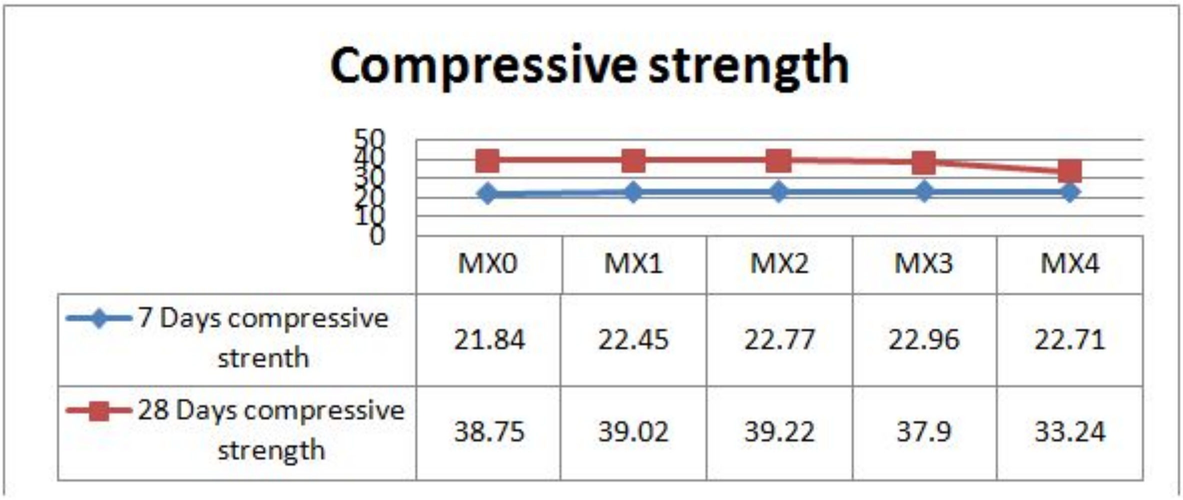
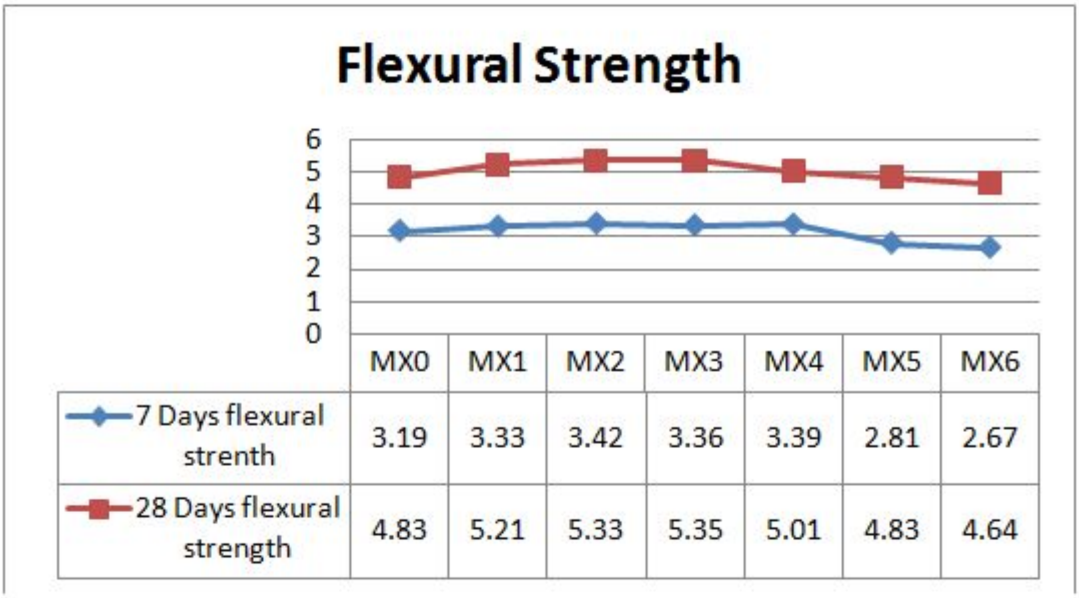


Graph Comparison of Compressive strength test for all mixes

- **Flexure Strength Test:** Although the concrete is not designed to resist tension, the knowledge of tensile strength of concrete is of value in assessing the load at which crack will start appearing in concrete. Flexural Strength of specimen at 7 Daysand 28 days are shown in Table

Flexural strength test for all mixes

S .No	Mix designation	7-days flexural strength	28-days flexural strength
1	M-X	3.27	5.01
2	M-1	3.23	5.08
3	M-2	3.38	5.22
4	M-3	3.15	5.01
5	M-4	2.97	4.86



Graph Comparison of Flexural strength test for all mixes

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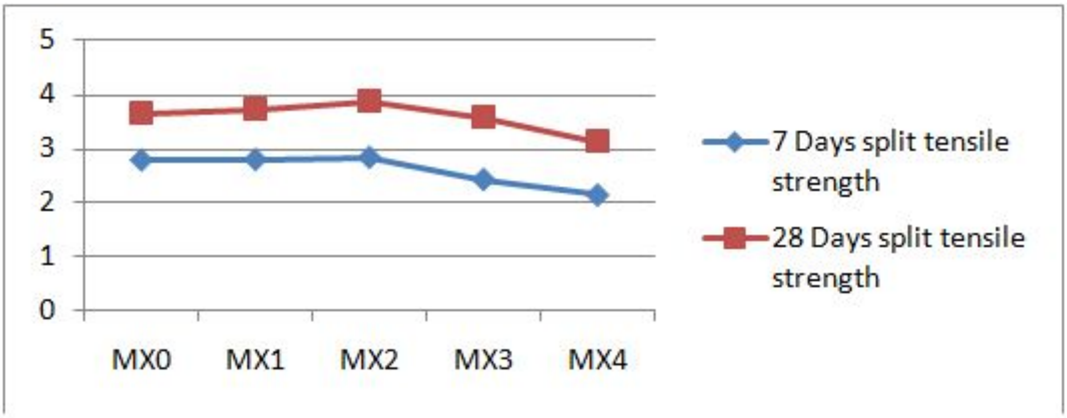
- **Split Tensile Strength Test:** The split tensile strength of concrete was conducted on various mixes as per guidelines of IS 516-1970.Split Tensile strength of 7 and 28 days are shown inTable

Average Split Tensile strength test for all mixes

S .No	Mix designation	Average split tensile strength N/mm²	% increase average split tensile strength
1	M-X	2.78	
2	M-1	2.79	3.65
3	M-2	2.83	3.71
4	M-3	2.42	3.87
5	M-4	2.13	3.58



Graph Comparison of Split Tensile strength test for all mixes

Compressive Strength

- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.15%, 1.01% after 7 days, whereas after adding 15% and 20% there is a decrease of 0.95% and 0.89% in compressive strength of 7 days.
- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.01%, 1.01% after 28 days, whereas after adding 15% and 20% there is a decrease of 1.03% and 1.14% in compressive strength of 28 days.
- The early age strength gain is higher as compared to later ages if more than 10% waste tyre rubber is used as a coarse aggregate replacement.

Flexural Strength

- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.01%, 1.04% after 7 days, whereas after adding 15% and 20% there is a decrease of 1.07% and 1.06% in compressive strength of 7 days.
- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.01%, 1.02% after 28 days, whereas after adding 15% and 20% there is a decrease of 1.04% and 1.03% in compressive strength of 28 days.
- The early age strength gain is higher as compared to later ages if more than 10% waste tyre rubber is used as a coarse aggregate replacement.

Split Tensile Strength Test

- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.0%, 1.01% after 7 days, whereas after adding 15% and 20% there is a decrease of 1.16% and 1.13% in compressive strength of 7 days.
- After adding 5% and 10% waste tyre rubber in the mix, there is an increase of 1.01%, 1.04% after 28 days,

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whereas after adding 15% and 20% there is a decrease of 1.08% and 1.14% in compressive strength of 28 days.

- The early age strength gain is higher as compared to later ages if more than 10% waste tyre rubber is used as a coarse aggregate replacement

7. CONCLUSIONS

The strength and durability characteristics of concrete mixtures have been computed in the present work by replacing 0%, 5%, 10%, 15% and 20% of coarse aggregates with the waste tyre rubber. On the basis of present study, following conclusions are drawn.

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