Re-Using of Waste Tyre Materials as Coarse and Fine Aggregate in Concrete

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Abstract—Discarded waste tires are one of the important parts of solid waste which had historically been disposed of into landfills also causing serious environmental problems. Waste rubber can be used as a part of fine aggregate and coarse aggregate. It can be used as an additive to Portland Pozzolana cement (PPC).The waste tires substituted into the concrete mix by weight 0%,5%,10% respectively. Two types of waste tires i.e., as coarse and fine aggregate are tested to find their mechanical properties. In order to determine the optimal enhancing replacement ratios of waste tires as compressive strength, Flexural strength performing slump at curing of 7,28 days for standard concrete mix.A total of 30 cubes and 15 beams are casted of M30grade by replacing 0%,5%,10% of tire aggregate with coarse aggregate and fine aggregate compared with regular M30grade concrete.

Keywords—Chipped Rubber, Rubber Powder, Portland Pozzolana Cement (PPC), Compressive Strength, Flexural Strength, Workability, Conventional Concrete

INTRODUCTION

Sustainability was a big issue that being concerned in making a development. This is because sustainable development has become a key aspect in society, Economics and development. Sustainable development shall meet the needs of the present without compromising ability of future generation to meet their own needs. It also shows that development that is going to be made to sustain the planetary resources by using them effectively without making unnecessary wastage. Like the usage of waste tire rubber as a partial replacement for coarse and fine aggregate in concrete. Now-a-days coarse and fine aggregate has become scarce and very cost. Hence we are forced to think of alternative materials. The waste tire rubber may be used in the place of coarse and fine aggregate fully or partly. Tire rubber wastes represent a serious environmental issue that needs to be addressed with urgency by the scientific community.Concrete is specially recommended for structures located in earth quake prone areas 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. Nevertheless, future investigations should clarify which treatments can maximize concrete performance being responsible for the lowest environmental impact.

LITERATURE REVIEW

K.C. Panda, P.S. Parthi and Jena have researched on accumulated waste tires, that they have become a problem of interest because of its non-biodegradable nature. In this study an attempt has been made to identify the various properties necessary for the design of concrete mix with the coarse tire rubber chips as aggregate in a systematic manner. In the present experimental investigation, the M30 grade concrete has been chosen as the reference concrete specimen. Scrap tire rubber chips, has been used as coarse aggregate with addition of conventional coarse aggregate.

Parvin A. Shirule, MujahidHussainhad worked on a safe and environmentally consistent method of disposal of tire waste material. The fine rubber particles obtained during remoulding process of tire at state transport workshop are used for replacement of fine aggregate (sand) in certain percentage in concrete. The blends are prepared by replacing 0%, 3%, 6%, 9%, 12%, 15% and 18% of fine aggregate (sand) by fine rubber particle by weight. The mechanical property of wet concrete like density, compressive strength, split tensile strength and flexural strength are test for strength of concrete.

Kotresh K.M, MesfinGetahunBelachew investigated that the disposal of waste tires is becoming a major waste management problem in the world. It is estimated that 1.2 billion of waste tire rubber produced globally per year. This is estimated that 11% of post-consumer tires are exported and 27% are sent to landfill, stockpiled or dumped illegally and 4% is uses for civil engineering project. Hence efforts have been taken to identify the potential application of waste tires in civil engineering projects. In this context, our present study aims to investigate the optimal use of waste tire rubber as coarse aggregate in concrete composite.

MATERIALS USED

Waste Tire Rubber:

Rubber Powder and Chipped Rubber are obtained from locally available mills. The Chipped Rubber was sieved through 20mm and retained on 16mm. Rubber Powder sieved through 2.36mm to remove large size particles. The specific gravity of Chipped Rubber is 1.04 and Rubber Powder is 0.4

Fig1: Rubber Powder

Fig2: Chipped Rubber

Coarse Aggregate:

These are materials passing through 20mm and retained on 16mm, these are generally used in preparation of concrete, as it is a parametric material. Coarse aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete.The specific gravity of Coarse aggregates is 2.8

Fine Aggregate:

These are materials with the size less than 2.36mm, these are generally used in preparation of concrete, as it is a parametric material. Fine aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete. The specific gravity of Fineaggregates is 2.62

Cement:

It is a material which is used for providing the binding property between the materials of the concrete. It also increases the strength. The specific gravity of cement is 2.79

Water:

In this experimental investigation portable water which is free from organic substances is used for mixing and curing.

EXPERIMENTAL INVESTIGATIONS

In present study, M30 grade concrete was designed as per IS: 10262-2009.

A. Workability

Freshly mixed concrete were tested for workability by slump value. In this investigation, M30mix concrete is considered to perform the test by weight basis by partially replacing 0%, 5%, 10% of coarse and fine aggregate by Chipped Rubber and Rubber Powder.

B. Compressive Strength

In this investigation, M30 mix concrete is considered to perform the test by partially replacing 0%, 5%, 10% of fine and coarse aggregate byRubber Powder, chipped rubber. A 150 X 150mm concrete cube was used as test specimen to determine the compressive strength of concrete. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes were properly compacted. All the concrete cubes were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory at age of 28 days. Compression test was conducted with 2000KN capacity on universal testing machine. The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surface of the compression testing machine and the load was applied within shock until the failure of the specimen occurred.

C. Dry density

The dry densities at each curing age tend to decrease with the increase of waste tire rubber ratio in each concrete mixture, but the dry densities tend to increase with time for each concrete mixtures at all curing ages. It is clear that at 28 days curing age, the lowest dry density (2370 kg/m3) exceeds the range of the dry density for structural light weight concrete. The use of modified tires rubber concrete for each curing age reduced the dry densities of all mixtures with increasing the waste tire rubber, because, the density of waste tire rubber lower than that of sand by (53.1) %, (10,11) %.

D. Flexural Strength

In this investigation, M30 mix concrete is considered to perform the test by partially replacing 0%, 5%, 10% of fine and coarse aggregate by Rubber Powder, chipped rubber. A 15 X 15 X 70cm beam mouldused as test specimen to determine the flexural strength of concrete.The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The beams were properly compacted. All the concrete beams were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory at age of 28 days. Flexural test was conducted with 400 kg/ min capacity on universal testing machine. The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surface of the Flexural testing machine and the load was applied within shock until the failure of the specimen occurred.

RESULTS AND DISCUSSIONS

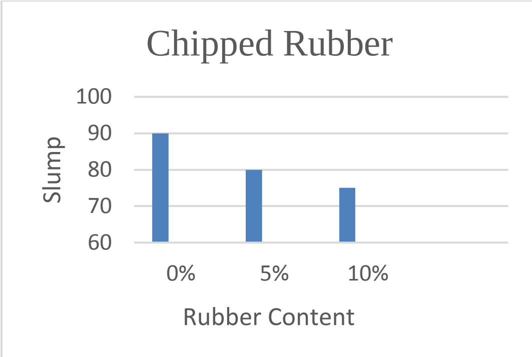
A. Workability

Table-1: Slump values for partial replacement of Rubber Powder as fine aggregate of M30 grade concrete.

S. No	Rubber Content	Slump value (mm)
1	0%WTR	90
2	5%WTR	86
3	10% WTR	79

Table-2: Slump values for partial replacement of Chipped Rubber as coarse aggregate of M30 grade concrete.

S. No	Rubber Content	Slump value (mm)
1	0% WTR	90
2	5 % WTR	80
3	10% WTR	75



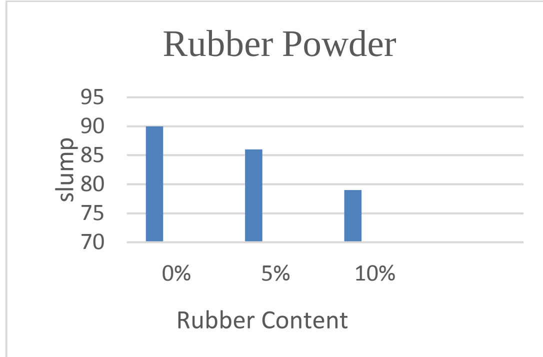


Fig3: Slump values for partial replacement of Chipped Rubber as coarse aggregate

Fig4: Slump values for partial replacement of Rubber Powder asfine aggregate

B. Compressive Strength Test

The compressive strength test of concrete was achieved in 28 days of various proportions and presented below. The specimens were casted and tested as per IS: 516-1959.

Table-3: Compressive Strength values for partial replacement of rubber powder as fine aggregate of M30 grade concrete.

S. No	**Rubber content**	**Average compressive strength @ 7 days (N/mm^2)**	**Average compressive strength @ 28 days (N/mm^2)**
1	0% WTR	23	32.5
2	5% WTR	22.3	31.4
3	10% WTR	20	30.37

Table-4: Compressive Strength values for partial replacement of Chipped Rubber as coarse aggregate of M30 grade concrete.

S. No	**Rubber content**	**Average compressive strength @ 7 days (N/mm^2)**	**Average compressive strength @ 28 days (N/mm^2)**
1	0% WTR	23	32.5
2	5% WTR	20	30.66
3	10% WTR	16.5	24.44

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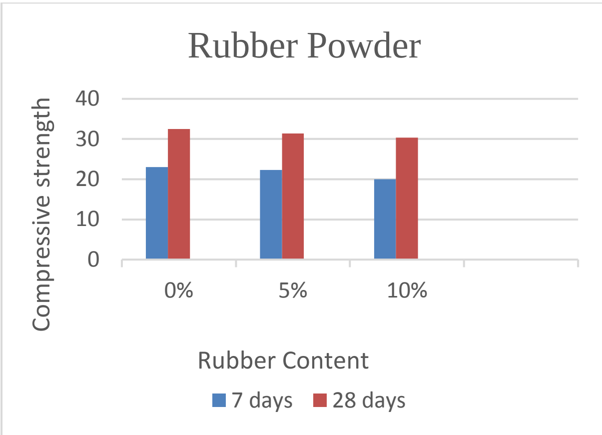


Fig5: Compressive Strength for partial replacement of Rubber Powder as fine aggregate

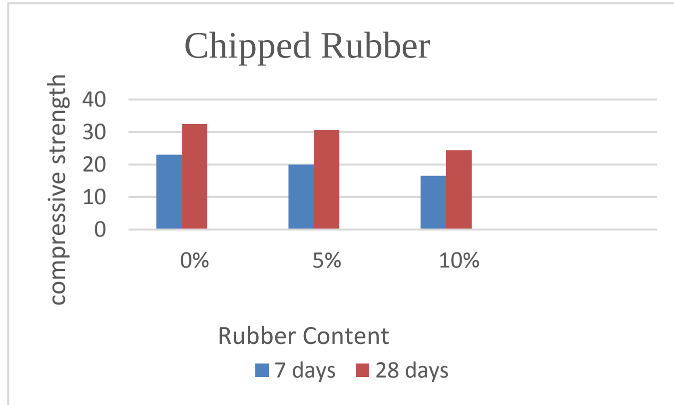


Fig6: Compressive Strength for partial replacement of Chipped Rubber as coarse aggregate

From the above compressive strength results, it is observed that Rubber based concretes have achieved a decreased in strength for partial replacement of coarse and fine aggregate for 28 days when compared to conventionalconcrete.

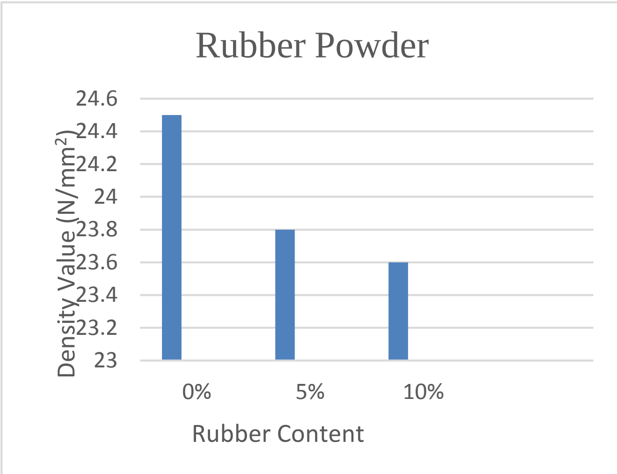
C. Dry density

Table-5: Dry Density values for partial replacement of Rubber Powder as fine aggregate.

S. No	Rubber Content	Density Value
1	0%	24.5 N/mm^2
2	5%	23.8 N/mm^2
3	10%	23.6 N/mm^2

Table-6: Dry Density values for partial replacement of Chipped Rubber as coarse aggregate.

S. No	Rubber Content	Density value
1	0%	24.5 N/mm^2
2	5%	23.07 N/mm^2
3	10%	23.09 N/mm^2



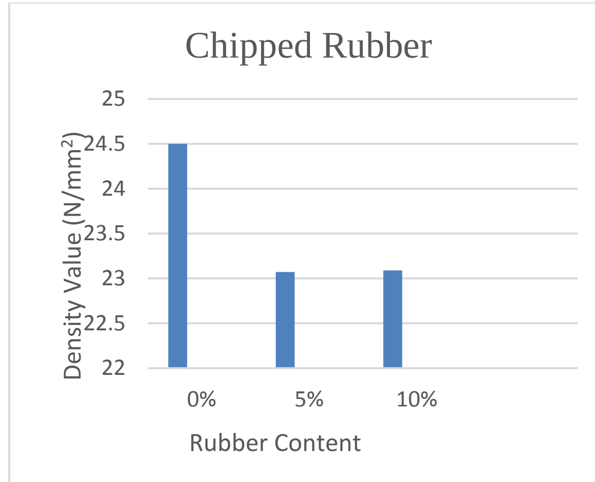


Fig7& Fig8:: Dry density for partial replacement of Rubber Powder as fine aggregate Chipped Rubber as coarse aggregate

D. Flexural Strength Test

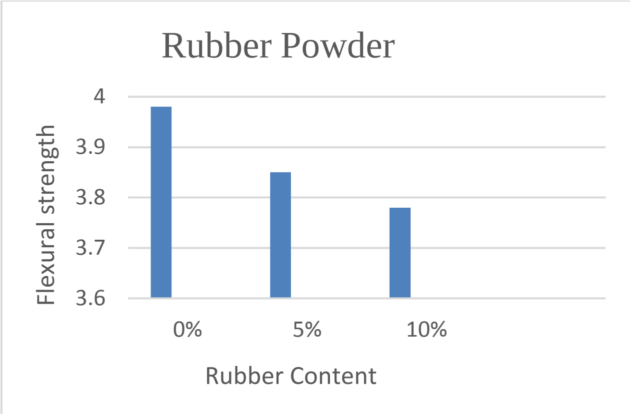
TheFlexural strength test of concrete with 28 days curing period for various proportions and presented below. The specimens were casted and tested as per IS: 516-1959

Table-7: Flexural Strength values for partial replacement of Rubber Powder as fine aggregate of M30 grade concrete.

S. No	**Rubber content**	**Average flexural strength @ 28 days (N/mm^2)**
1	0% WTR	3.98
2	5% WTR	3.86
3	10% WTR	3.78

Table-8: Flexural Strength test for partial replacement of Chipped Rubber as coarse aggregate of M30 grade concrete.

S. No	**Rubber content**	**Average flexural strength @ 28 days (N/mm^2)**
1	0% WTR	3.98
2	5% WTR	3.8
3	10% WTR	3.6



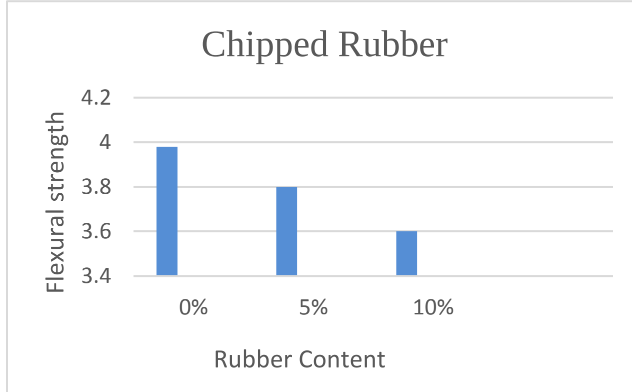


Fig9& Fig10: Flexural Strength for partial replacement of Rubber Powder asfine aggregateChipped Rubber as coarse aggregate

From the above Flexural strength results, it is observed that Rubber based concretes have achieved decreased in strength for partial replacement of coarse and fine aggregate for 28 days when compared to conventional concrete.

CONCLUSION

Based on the experimental results and their plots and subsequent discussion on the results the following conclusions are given:

- Slump values are decreased as the percentage of waste tire rubber increased. So, there is decrease in workability.
- The compressive strength is decreasedwith increased percentage of waste tire rubber, but rubber concrete developed slightly higher compressive strength than those of without rubber concrete.
- The Flexural strength is decreased with increased percentage of waste tire rubber.
- Decrease in compressive strength, flexural strength of the specimen is due to lack of proper bonding between rubber and concrete.

FUTURE SCOPE OF WORK

- Replacing coarse aggregate and fine aggregate with different proportions will give different strength and can be investigated as well as optimum amount can also be determined to get maximum strength.
- Similar investigation can be done for M40, M50 and also for high strength concrete.

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