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Experimental Investigation on the use of Waste Tyre & M-Sand Aggregates in Concrete

B. Mohanraj [1], J. Nandakumar [1], V. Vijay [1], F. Siluvai Anish [1], P. Arunkumar [2]
Department Of Civil Engineering,
Nadar Saraswathi College Of Engineering And Technology, Theni.

Abstract:- **The main objective of this investigation is to study the performance of concrete which is made by using the scrap rubber and M-sand as replacement of coarse and fine aggregates respectively. The concrete specimens were casted under the usage of scrap rubber (with and without M-sand) and tested under compression and tension. The load carrying capacity of these specimens under compression and tension with respect to the replacements of scrap rubber and M-sand are investigated. The percentage of scrap rubber is added as partial replacement of coarse aggregate are 3%, 9% and 15% respectively. The M-sand is added as fine aggregate for the full replacement of river sand in the scrap rubber concrete to increase its bonding strength. The effect of addition of M-sand as full replacement of fine aggregate in scrap rubber concrete is investigated.**

Key Words: Tyre, Rubber, Rubberized Concrete, scrap tyre aggregate, waste tyre aggregate, rubcrete.

INTRODUCTION:-

In the present scenario the Civil Engineering construction industry is the biggest industry in the world, which is flourishing and giving more opportunities for employment. We all know that Civil Engineering industry provides one of the basis amenities namely "Sheller" which is essential for every mankind to survive on this planet. Major part of the construction depends upon the main part of construction namely "Concrete" which is a composition of materials (Cement, fine aggregate and Coarse aggregate).It is estimated that more than 270 million scrap-tires weighing more than 3million tons are produced in the United States each year, this quantity is in addition to the more than 300 million scrap-tires that are stockpiled already. Those stockpiles represent a severe fire risk due to lightning, spontaneous combustion, or just plain carelessness. They also pose other health hazards including diseases due to rodent and mosquito infestation and pollution to land, water, and air. Most landfills are refusing to take anymore tires due to the fact that they are harmful to the environment and are not bio-degradable. New means of disposal or recycling must be used. A side from tire derived fuel (TDF), the most promising use of recycled tires is in engineering applications. Some of those innovative and promising applications are as artificial reefs, erosion control, and as aggregate in asphalt and concrete. The use of recycled tires as partial aggregate in concrete has been considered for several years. Rubber is the principal element of tire, making up about 85% of the tire where both synthetic and natural rubbers may be used. Natural rubber is an elastic hydrocarbon polymer which occurs as a milky colloidal secretion in the sap of several varieties of plants. Rubber can also be produced synthetically, as a thermo set polymeric material in which individual monomer chains are chemically linked by covalent bonds during polymerization. This investigation consists of three initial tests programs, two of which have been 4 completed with the third test program currently being executed. The experimentation and results shown in this paper correspond to data obtained from the first two test programs.

II) LITERATURE REVIEW

(Eldhose. C 2014) Using Waste tires are powdered into fine particles of various sizes and are used to replace the fine aggregate used in concrete. The fine scrap tyre aggregate is added as 2%, 4%, 6%, 10%, and 12% increment to replace the fine aggregate. This study aims to investigate the optimal use of waste tyre aggregates as fine aggregate in concrete composite.

(M Balaha 2007) The aim of this work is to investigate the possibility of the usage of ground waste tire rubber (GWTR) in the civil construction as a partial replacement for fine aggregates and the influence of these wastes on the properties of ordinary concrete. The results show that the mass density of hardened rubberized concrete decreases with increasing rubber content, this is an advantage for that concrete application.

(Public Work Department 2004) M-Sand dust a waste product obtained while crushing stone, is polluting the environment around Granite Quarries causing health hazards to the villagers residing in the nearby areas of stone quarries. Further, "sand" a natural resource and an important constituent of building construction is slowly becoming a rare and costly commodity. Hence it is now proposed to replace sand in the concrete works to a 30% by M-Sand with a view to reduce the over exploitation of natural resource i.e. Sand and at the same time prevent the pollution of environment around the Granite Quarries. Experiments in this regard being conducted in PWD.

III) MATERIALS

The selection of materials depends on various the physical and chemical properties, such as, particle size, specific gravity, etc. Also, the compatibility and performance in the presence of other materials need to be established which may help in short listing of the materials when two or more type are available. Concrete is a composite material of cement, fine aggregate, coarse aggregate and water. In this research project we partially replace scrap tires instead of coarse aggregate added to it additionally. Concrete is one of the binding materials used especially in concrete to bind all materials used in concrete and form a single substance. Commonly Ordinary Portland cement (OPC) of 33, 43 & 53 are used for all types of construction works. Here 53 Grade OPC has used. Sand is used as a fine aggregate from the day of introduction of concrete which makes the quality of concrete better when it consists of round shaped grains rather than angular shaped. Only river sand is used as fine aggregate in concrete but not sea since it consist of more amount of salt which destroys the quality of concrete also corrosion of reinforcement take place. In this research study we use river after sieve analysis as per IS 383 – 1970. Car tires are different from truck treys with regard to constituent materials. Usually three main categories of discarded Tyre rubber have been considered such as chipped, crumb and ground rubber. Chipped or shredded rubber is used to replace the gravel. To produce this rubber, in first stage the rubber has length of 300– 430 mm long and width of 100 - 230 mm wide. In the second stage its dimension changes to 100 -150 mm by cutting. If the shredding is further continued particles of about 13–76 mm in dimensions produced.

IV) EXPERIMENTAL RESULTS

4.1 SPECIFIC GRAVITY

Specific gravity bottles like density bottle, pycnometer bottles are used for finding the specific gravity of cement, M-sand, coarse aggregates. The Pycnometer method can be used for determination of the specific gravity of solid particles of both fine grained and coarse grained soils. The result of specific gravity is indicated in Table (1).

Table 1 Specific gravity of the materials

	Cement	Fine aggregate	Coarse aggregate
Specific gravity	3.15	2.65	2.65

4.2 FINENESS TEST

The fineness and standard consistency tests were conducted on cement, The fineness test results for OPC grade is less than 10%. The cement have satisfied the recommendations of OPC. The standard consistency test is to find out the percentage of water to be added to the cement. The result of Fine Test is indicated in Table (2).

Table 2 Fineness & standard consistency

Description	Cement
Fineness test	3%
Standard Consistency	35%
Initial Setting Time	35%

4.3 PREPARATION OF MIX DESIGN

Mix proportion for M35 grade concrete - 1m^3 Table 3 M35 grade concrete mix

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
191.5	400kg	595kg	1181kg
		OR,	
0.48	1	1.5	2.9

4.4 COMPRESSION TEST

The compression test on cement concrete cubes (150 X 150 X 150 mm) carried out after 7, 28 days of water curing meanwhile the Scrap rubber concrete cubes (150 X 150 X 150 mm) tested after 7 & 28 days of curing.

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm²)		
		3%	9%	15%
1	42.22	37.33	26.22	18.22
2	42.67	37.78	25.78	18.67
3	43.11	38.67	24.89	19.11
Final mix	42.67	37.93	25.63	18.67

Sl no	M35 concrete (N/mm^2)	Scrap rubber with out M-Sand concrete (N/mm^2)		
		3%	9%	15%
1	29.33	22.67	17.78	15.11
2	30.22	23.11	18.67	16
3	30.67	24	19.61	16.44
Final mix	30.07	23.26	18.52	15.85

Sl no	M35 concrete (N/mm^2)	Scrap rubber with M-Sand concrete (N/mm^2)		
		3%	9%	15%
1	28.33	27.11	28	19.56
2	30.22	27.55	28.44	20
3	30.67	28.44	28.89	20.89
Final mix	30.07	27.7	28.44	20.15

Fig.1 Compression test

4.5 TEST RESULTS

The Compressive and Split tensile test Resuts and Comparison figures are given below.

4.5.1 COMPRESSIVE TEST RESULTS

Table 4.1 Compressive Test after 7 days curing Scrap rubber without M-Sand

Table 4.2 Compressive Test after 7 days curing Scrap

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm^2)		
		3%	9%	15%
1	42.22	40.44	36.44	25.78
2	42.67	40	37.33	26.67
3	43.11	40.89	37.78	27.11
Final mix	42.67	40.44	37.78	26.52

rubber with M-Sand

Table 4.3 Compressive Test after 28 days curing Scrap rubber without M-Sand

Table 4.4 Compressive Test after 28 days curing Scrap rubber with M-Sand

4.5.2 Comparison Chart for Compressive Test after 7&28 days curing

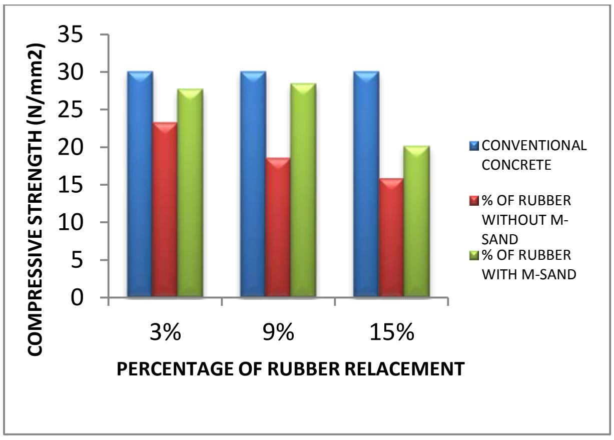

Fig. (2) Comparison Chart on after 7 days curing for Compressive Test

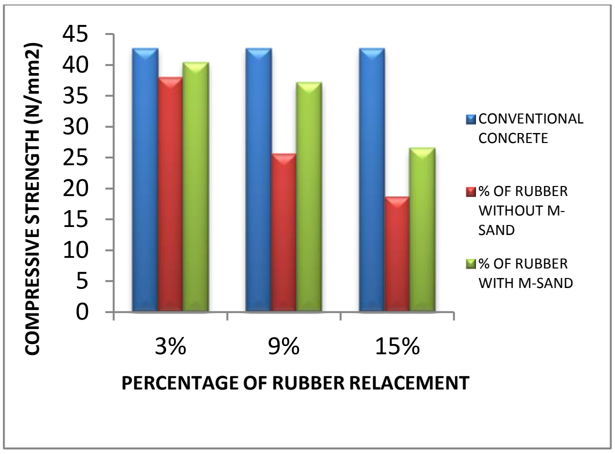

Fig. (3) Comparison Chart on after 28 days curing for Compressive Test

4.5.3 SPLIT TENSILE TEST RESULT

Table 4.5 Split Tensile Test after 7 days curing Scrap rubber without M-Sand

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm^2)		
		3%	9%	15%
1	3.81	3.50	2.87	2.86
2	3.81	3.50	3.18	2.86
3	3.50	3.18	2.87	2.56
Final mix	3.70	3.40	2.97	2.76

Table 4.6 Split Tensile Test after 7 days curing Scrap rubber with M-Sand

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm^2)		
		3%	9%	15%
1	3.81	3.82	3.18	2.87
2	3.81	3.50	3.18	2.87
3	3.50	3.50	2.86	2.87
Final mix	3.70	3.6	3.07	2.87

Table 4.7 Split Tensile Test after 28 days curing Scrap rubber without M-Sand

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm^2)		
		3%	9%	15%
1	4.46	4.14	3.18	2.55
2	4.77	4.14	3.18	2.86
3	4.77	3.82	3.18	2.55
Final mix	4.67	4.03	3.18	2.65

Table 4.8 Split Tensile Test after 28 days curing Scrap rubber with M-Sand

4.5.4 Comparison Chart for Split Tensile Test after 7&28 days curing

Sl no	M35 concrete (N/mm^2)	Scrap rubber concrete (N/mm^2)		
		3%	9%	15%
1	4.46	4.45	3.82	3.50
2	4.77	4.45	3.50	3.50
3	4.77	4.77	3.14	3.82
Final mix	4.67	4.56	3.82	3.60

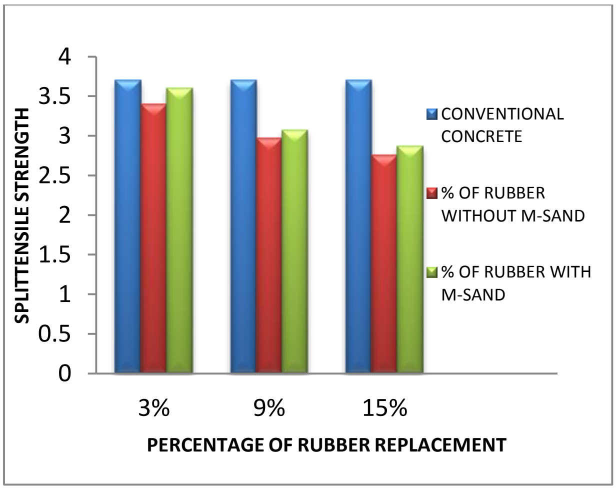

Fig. (4) Comparison Chart on after 7 days curing for Split Tensile Test

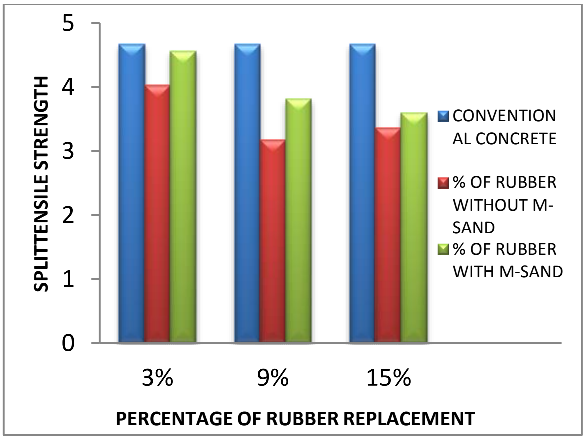

Fig. (4) Comparison Chart on after 7 days curing for Split Tensile Test

V.CONCLUSION

The addition of scrap rubber and M-sand as aggregates in concrete affects the load bearing capacity of the concrete under compression and tension. Addition of scrap rubber in different percentage as partial replacement of coarse aggregate in concrete reduces the strength under both compression and tension. The strength of concrete decreases with increase in scrap rubber dosage under both compression and tension. In scrap rubber without M-sand condition, the strength of concrete contains 3% replacement of coarse aggregate by scrap rubber is more when compared with the concrete contains 9 and 15% of scrap rubber replacements under the same casting condition under both compression and tension. The M-sand increases the strength of the concrete under both compression and tension by improving the bonding strength of the concrete when it is added as full replacement of fine aggregate in scrap rubber with M-sand condition. In scrap rubber with M-sand condition, the strength of concrete contains 3% replacement of coarse aggregate by scrap rubber is more when compared with concrete contains 9 and 15% of scrap rubber replacements under the same casting condition under both compression and tension. The strength of the concrete increases with the increase in curing periods up to 28 days of curing. However the strength of the concrete contains scrap rubber with M-sand is more when compared with the concrete contains scrap rubber without M-sand under both compression and tension. It is experimentally proved that the strength of scrap rubber concrete (which contains scrap rubber as partial replacement of coarse aggregate up to 15%) can be increased under both compression and tension if the bonding strength increasing medium used in concrete.

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