Analysis Of Concrete By Partial Replacement Of Coarse Aggregate With Crumb Rubber

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***Abstract*— The principle point of the investigation is to distinguish the utilization of reused material in the concrete as it upgrades the mechanical properties of cement. As "Crumb Rubber" is likewise one of the strong waste which can be utilized as a part of cement by somewhat supplanting fine aggregate. In this investigation "Crumb Rubber" was supplanted by volume of coarse total as 0% to 20% volume of "Crumb Rubber" supplanted coarse aggregates at an interval of 5% increase. Numerous tests were done for fresh concrete (i.e. Slump test, Flow test, Compaction factor etc.) and for hard concrete (i.e. Compressive strength). The elastic properties are also determined from concrete cubes. 3 cubes for each percentage of replacement are casted and tested after 28th days of curing. This attempt of replacing the coarse aggregates with rubber aggregates will save the natural aggregates, reduces weight of structure and also helps achieve sustainability.**

***Index Terms*—Rubber, Crumb Rubber, elastic, Specific gravity.**

I. INTRODUCTION

Crumb rubber is the recycled rubber produced from industries like automotive etc. During the process of recycling, elements like steel and tire wastes are removed, leaving the tire rubber with a minimum visible size and shape. Upon on further processing with a granulator/ mill by mechanical means, the size and shape of the recycled product will be refined and further classified by their color and size (usually ¼ inch size or 10-20 holes per inch sizes in India). This crumb rubber after these processing can be used as artificial cushioning and it has many other areas of applications.

Areas of application of Crumb Rubber in Construction Industry.

As the crumb rubber is comprised of 71% recoverable rubber, 14% steel, 3% fiber, 12% extraneous material, it has numerous application is various areas of construction.

- Crumb rubber can be used for replacement of aggregates (both coarse and fine) depending upon the its application and location of use.
- To prepare the surface of Athletic fields and surfaces.
- Footings of the Horse Arena centers
- Construction of Indoors pavements/ Sport courts etc.
- Landscaping of trails and walkways.
- Lying of Asphalt pavements/ Highways.
- Sealant for stoppage of seepage of soil.

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II. METHODOLOGY:

The replaced material, i.e. the crump rubber is obtained by the process of shredding the unused and waste tires into 20mm size (nominal size of coarse aggregates). For this experiment heavy duty tires were exclusively used for preparing this aggregate as the posses better physical properties than compared to that of the normal light vehicle tires. The replacement of the aggregates is by volume batching, and the cube sizes are standard (150mm X 150mm X 150mm). The treated crumb rubber, which is finally set for replacement with aggregates, fine aggregate (sand) and Coarse aggregate used have the following properties:

	Specific Gravity	**Bulk Density (Kg/m^3)**
Fine Aggregates	2.6	1650
Coarse Aggregates	2.8	1720
Crumb Rubber Aggregates	1.1	650

The properties thus attained are now used in calculation of the mix confining to the IS Code IS: 10262:2009 and the mix proportions obtained are tabulated below:

	Cement (KG)	**Water (liters)**	**Fine aggregates (KG)**	**Coarse Aggregates (KG)**	**Crumb Rubber Aggregates (KG)**
NR – 0%	364.81	225.17	610.43	1239.64	-
PR – 05%	437.77	224.2	590.03	1177.65	23.30
PR – 10%	437.77	224.2	590.03	1115.67	46.73
PR – 15%	437.77	224.2	590.03	1053.69	70.10
PR – 20%	437.77	224.2	590.03	991.71	93.46

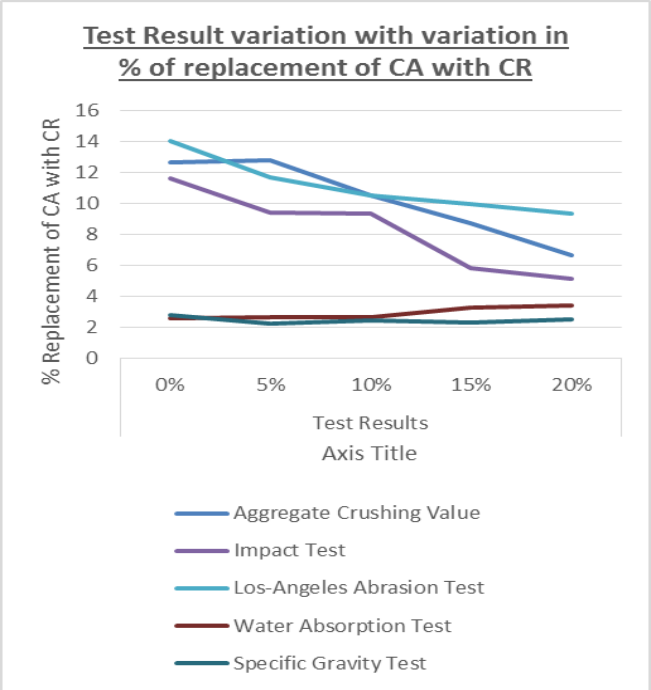
* NR – Nil Replacement; PR – Partial Replacement

Test performed:

The following tests were conducted on coarse aggregates as well as partially replaced coarse aggregates as per IS standards and the standard values for Sub Base layer were compared.

Sr No:	Test Performed	IS Code	Standard Value (Max.)	Test Results				
				0 %	5 %	10 %	15 %	20 %
1.	Aggregate Crushing Value	IS 2386 (part IV) -1963	45%	12.70	12.83	10.56	8.73	6.66
2.	Impact Test	IS 5640-1970	50%	11.63	09.43	9.39	5.82	5.17
3.	Los-Angeles Abrasion Test	IS 2386 (part IV)-1963	40%	14.05	11.67	10.56	10.0	9.37
4.	Water Absorption Test	IS: 2386 (Part III)-1963	4%	2.62	2.66	2.68	3.26	3.39
5.	Specific Gravity Test	IS: 2386 (Part III)-1963	2.7%	2.83	2.24	2.45	2.33	2.56

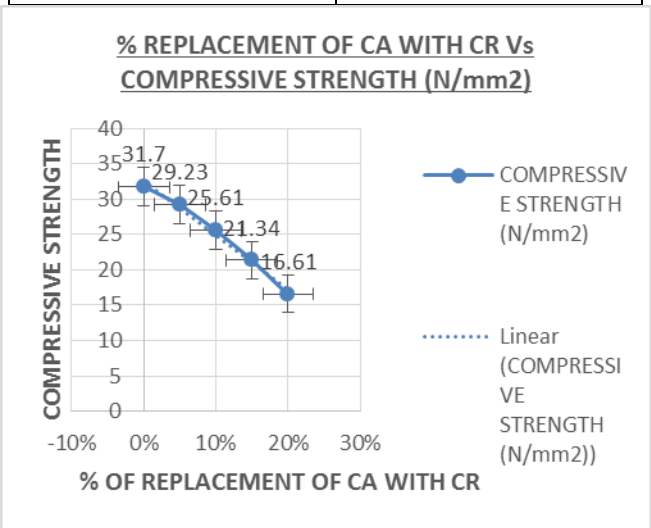
1. **Crushing Test:** The aggregate size ranging from 12.5mm to 10mm were tested. It was observed that with the increase in the Waste Rubber content, the crushing value decreases from 12.7% to 10%
2. **Impact Test:** The aggregate size ranging from 12.5mm to 10 mm were tested. It was observed that with the increase in the Waste Rubber content, the impact value decreases. Depending on the layer in which the aggregates are to be used, the impact value may differ.
3. **Abrasion Test:** The test was carried out using Grading B specification. Replacement by Waste Rubber led to decrease in abrasion value
4. **Water Absorption Test:** It was observed that with the increase in the Waste Rubber content, the water absorption value remains constant with negligible variation up to 10% of replacement but the value increases after that.
5. **Specific Gravity Test:** The specific gravity of coarse aggregates normally used in road construction ranges from 2.5 to 3.2. The replacement of aggregates by rubber led to decrease in the value of specific gravity up to 2.24.



Compressive Strength of Concrete:

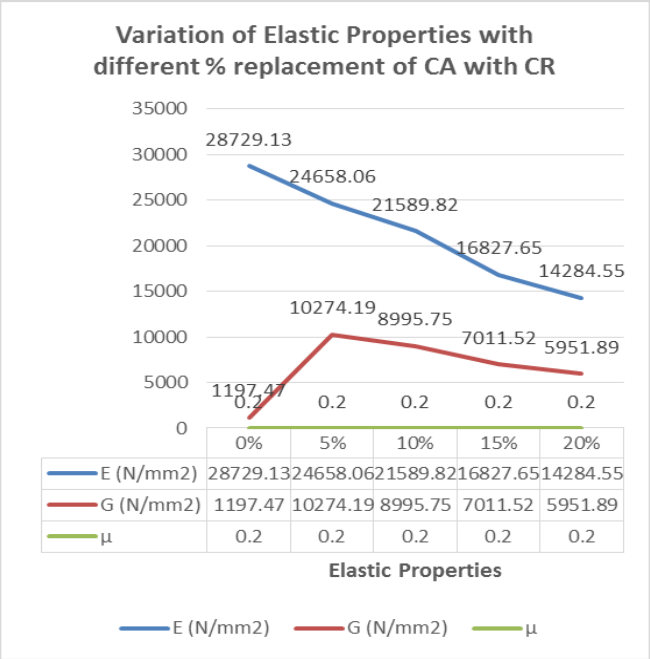
This test is preformed after 28 days of proper and timely curing of the concrete cubes of standard size and cubes casted with different replacement percentages of coarse aggregates from 0% to 20% for every 5% rise in Crumb rubber percentage and the results are as discussed below:

% OF REPLACEMENT OF COARSE AGGREGATES WITH CRUMB RUBBER	COMPRESSIVE STRENGTH (N/mm^2)
NR – 0%	31.7
PR – 05%	29.23
PR – 10%	25.61
PR – 15%	21.34
PR – 20%	16.61



And thus, the elastic properties of the material are also calculated for different percentage replacement of Coarse aggregate with Crumb Rubber:

% OF REPLACEMENT OF COARSE AGGREGATES WITH CRUMB RUBBER	LOAD (KN)	E (N/mm^2)	G (N/mm^2)	μ
0 %	100	28729.13	1197.47	0.2
5 %	98.8	24658.06	10274.19	0.2
10%	97.5	21589.82	8995.75	0.2
15%	93.2	16827.65	7011.52	0.2
20%	85.2	14284.55	5951.89	0.2



III. CONCLUSIONS:

Replacement of coarse aggregates by tire leads to decrease of the aggregate impact value. After replacing the rubber content by 15 % the impact hammer starts bumping and it becomes difficult to conduct the test by increasing the percentage of waste rubber. The present tests are not completely adequate for higher percentages of replacement of rubber. Percentage wear of aggregates after replacing decreases as the rubber is tough enough but not as tough as Natural Coarse Aggregates. Water Absorption Value of the aggregates also increases with an increase in rubber content.
Experimentally it is seen that the compressive strength of the concrete decreases when coarse aggregates are replaced by rubber aggregates. The rubber aggregates can be effectively replaced up to 15%.
Due to the usage of waste rubber in construction, the burden on the dumping yards reduces.

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