

Comparative Study on Partial Replacement of Rubber in Concrete

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Abstract

This paper represent the study on strength, properties and behavior of crumb rubber. The concrete is one of the most widely used construction material consists of cement, fine aggregate, coarse aggregate. Concrete is like a backbone of the infrastructure to development of a nation. Generally nowadays large quantity of rubber wastes are generated by the industries, vehicles etc...and they are not properly disposed till now. These rubber wastes causes global warming. Hazardous waste materials are being generated and accumulated in huge quantities causing an increasing hazard to the environment. Hazardous materials can be considered non-decaying material accumulating with time. This study deals with alternative solution for utilizing the crumb rubber and its safe disposal by using it as partial replacement with fine aggregate for making concrete.

Keywords— Crumb rubber, mechanical property, durability, shredded tire, Ground rubber, slit tire, waste tire.

I. INTRODUCTION

The use of rubber product is increasing every year in worldwide. Almost 1000 million waste tires are generated in the world annually. By the year 2030 this number of counting is expected to reach 1200million currently 75-80% of scrap tires are buried and landfills only 25%or fewer are utilized as a fuel or as raw material for the manufacture of a number of miscellaneous rubber goods. It is not only wasteful but also costly. In 2014 approximately 22.4 million pounds of crumb rubber was used in synthetic turf fields at California. Since 2008 20-25% crumb rubber are produced in whole California. Tires are composed of materials which do not decompose under environmental conditions and cause serious contaminations. it is estimated that 285 million tires are discarded annually in the United states and only 30%(97million)are currently being used or recycled. The remaining 66%(188 million)contribute to the already alarming environmental waste problem. Disposal of whole tire has been banned in the majority of landfills operations because of the bulkiness of the tires and their tendency to float to the surface with time. So many recycling methods for the rubber tire are carried according to the need from one of this process is making the tire rubber into crumb rubber .it is used in many work such as road construction mould

making etc... crumb rubber obtained by cryogenic process, milled tire rubbers treated with sodium hydroxide solution to achieve a patten adhesion with the cement paste, scrap truck tire rubber ,tires tread etc. The growth of rubber and plastic can be considered non decaying materials that disturb the surrounding environment. There is no doubt that the increasing piles of tires create environmental concerns. The long term objective is to find a means to dispose of the crumb rubber in port land cement concrete and still supply a final product with good engineering properties. Therefore effectively reusing waste tires is an urgent and important issue for saving energy and protecting the environment. The initial tire of crumb rubber was used as a asphalt. However the high viscosity and the higher temperature required in production made in unpractical to be widely used. From this study the effective utilization of rubber tire waste as been developed and it made to used in the concrete mixture as fine aggregate.

At present the crumb rubber production in the south India is very less than north. So the material availability was less because of less knowledge about that. These can also include non-primary structural applications of medium to low strength requirements benefiting from other features of this type of concrete

A. Classification of Tire

Tires are classified into 4types they are slit tire, shredded tire or chipped tire, ground rubber, and crumb rubber. Slit tires are produced in tire cutting machines. These machines can slit the tire into two halves or can separate the sidewalls from the tread of the tires. Shredded tire or chipped tires The old tires from cars, trucks, farm, off-road vehicles are used in this research. Shredded tires are separated into two different category Pieces with dimensions not larger than 25mm.Pieces with dimensions not larger than 10mm.The shredded or chipped rubber are involved in two process. They are Primary and secondary shredding process. The size of the chips are vary from each process. The size of primary shredding is can vary from large 300 to 460mm long by 100 to 230mm wide, to as small as 100 to 150mm in length. And the secondary process normal size 76mm to 13mm.

B. Types of Rubber:

Ground rubber particles are intermediate in size between tire chips and crumb rubber. Ground rubber ranging in size vary from big 19mm as to small

as 0.15mm. This depends upon the size reduction equipment and intended application. Ground rubber tire as asphalt binder, consuming an estimated 220 million pounds, or approximately 12 million tires. Crumb rubber is nothing but the fine granular or powdered particles called crumb rubber. It is the processing of the tire into fine particles using cryogenic or mechanical process. This process is also used to remove the still and fabric component of the tire crumb rubber ranging size vary from 4.75mm to less than 0.075mm. Generally 3 methods are used to convert the waste tire into crumb rubber. Thus the methods are cracker mill process, granular process, micro mill process. The cracker mill process is used to reduce the size of tire. The material is passing between the rotating corrugated steel drums by this process used to an irregularly shaped torn particles having large surface. The size of these particles are vary from 5mm to 0.5mm and are commonly known as ground crumb rubber. If the granular process shears are using to rubber with revolving steel plates, producing the granulated rubber particle size ranging vary from 9.5mm to 0.5mm

II. PROPERTIES OF CRUMB RUBBER

Hanbing Liu et al(2016) says the Modifiers for the pretreatment of crumb rubber, including emulsion, ethoxyline resin, synthetic resin, amino-acrylate (contact glue), chloroprene adhesive and unsaturated resins (marble glue), they are commonly used in decoration and construction engineering. They had satisfactory performance in improving adhesion and enhancing strength. Were directly introducing the crumb rubber in concrete. It will affect the mechanical properties and durability of concrete. But the variation of properties in concrete with the changing of rubber content was investigated. Additionally, the effect of modifiers was evaluated. The mechanical property is vary from crumb rubber replacing fine aggregate to replacing of mixture. Compared to the replacement of mixture and replacing of crumb rubber the compressive strength value is vary from one to

another. Compressive strength for replacing of mixture is higher than replacing of fine aggregate. Because replacement of mixture with Crumb rubber reduced the mass of the cement. There are many reasons are available in lower strength of crumb rubber concrete. The first reason. The adhesion of rubber particles and cement paste is weaker than the mineral aggregate. Second reason the distribution of rubber particles in the concrete mixture is non-homogenous, why because compared to other materials rubber have a lower specific gravity. Thirdly the hydrophobic nature of rubber particles takes bubbles into the concrete mixture and increases the air content. Due to the above reason mechanical strength is reduced when the crumb rubber is introduced into the concrete

III. DURABILITY AND APPLICATION OF CRUMB RUBBER

Freezing-thawing resistance and sulfate resistance are the important aspects of the durability of concrete. The crumb rubber concrete had a good resistance against freezing-thawing compared to the normal concrete. There was more loss in compressive strength for concrete less crumb rubber in sulfate corrosion. Furthermore, the anti-corrosion coefficient gradually increased with the increase in percentage of crumb rubber in concrete. The crumb rubber have more application. Some of the major application are used in Sport surface like Kindergarten playgrounds and recreation areas, school sports areas, Tennis and Basketball courts, used in construction such as hospital, industrial and bathroom flooring, floor tile, foundation, waterproofing, dam, silo etc..., used in Rubber and plastic products industries like pipe insulation and lining, garbage cans, shoe soles and heels, wire cable insulation and in automotive industry Bumpers, splash guards and fenders, floor mats for cars and trucks, Floor liners for trucks and vans. Comparison of Partial Replacement of various rubber material by various research listed in table.1

.Table.1 Comparison of Partial Replacement of Various Rubber Material by Various Research

S.No	Author Name	Title of the Paper	Journal Name	Strength of Specimen				
				Days	Percentage (%)	Cube (N/mm ²)	Cylinder (N/mm ²)	Beam (N/mm ²)
1	Er. Yon gender Antil	An Experimental Study on Rubberized Concrete	International Journal of Emerging Technology and Advanced Engineering	7days	0%	27.1	3.6	2.3
					5%	25.3	2.8	2.1
					10%	19.5	1.5	2.0
					15%	17.4	1.4	1.9
					20%	14.9	1.1	1.7
				28days	0%	36.2	4.6	3.4
					5%	32.2	4.1	3.3
					10%	27.7	3.3	3.1
					15%	24.8	2.8	2.9
					20%	22.7	1.4	2.7

2	S.Selva kumar et al.(2014)	Strength Properties of Concrete Using Crumb Rubber with Partial Replacement of Fine Aggregate	International Journal of Innovative research in Science, Engineering and Technology	7days	0% 5% 10% 15% 20%	23.99 26.07 21.92 18.65 16.32	2.22 2.86 2.22 2.01 1.87	6.02 5.75 5.00 4.96 4.56
				28days	0% 5% 10% 15% 20%	36.73 38.66 33.47 29.63 22.17	4.08 3.50 2.96 2.59 2.17	7.83 7.01 5.83 5.42 5.00
3	A Mansoor Ali et.al.(2014)	Experimental Study on Concrete by Partial Replacement Fine Aggregate with crumb rubber	International Conference on Engineering Trends and Science & Humanities	7days	0% 5% 10% 15% 20	16.8 15.03 14.10 12.74 10.22	2.45 1.95 1.76 1.48 1.24	3.53 3.8 4.64 3.6 3.12
				14days	0% 5% 10% 15% 20%	22 20 18 15 13	3.36 2.76 2.38 1.95 1.41	- - - - -
				28days	0% 5% 10% 15% 20%	41.60 36.14 35.11 32.66 29.33	3.65 2.94 2.47 1.86 1.43	5.92 6.53 6.73 5 4
4	Nithiya P et.al.(2014)	Behavior of Partial Replacement of Fine Aggregate with Crumb Rubber Concrete	International Journal of Structural and Civil Engineering Research	7days	0% 5% 10% 15% 20%	25.33 19.15 13.44 9.88 8.39	1.697 1.543 1.432 1.216 1.138	2.862 2.586 1.577 0.875 0.732
				28days	0% 5% 10% 15% 20%	32.43 26.56 21.94 9.69 8.01	2.630 2.462 2.134 1.855 1.734	4.400 3.982 2.433 1.890 1.724
5	Ameer Abdulrahman Hilal	Effect of Crumb Tires Rubber on Some Properties of Foamed Concrete	Anbar Journal for Engineering sciences	7days	0%(FC) 20%(FCR1) 30%(FCR2)	10.08 7.75 5.38	1.12 0.89 0.62	2.24 1.80 1.27
				21days	0%(FC) 20%(FCR1) 30%(FCR2)	15.56 10.83 8.67	1.38 1.11 0.78	3.21 2.03 1.59
				28days	0%(FC) 20%(FCR1) 30%(FCR2)	17.21 13.62 10.71	1.55 1.21 0.83	3.42 2.23 1.78

6	Abhijit sinh Parmar et.al.(2 015)	Use of Crumb Rubber as a Partial Replacement of Coarse Aggregate in Conventional Concrete	Afro - Asian International Conference on Science, Engineering & Technology	7days	5%	14.58	-	3.5				
					10%	14.26	-	3.5				
					15%	13.98	-	3.5				
					20%	13.73	-	3.5				
					25%	13.56	-	3.5				
					30%	13.42	-	3.5				
				28days	5%	20.04	-	3.42				
					10%	19.76	-	3.38				
					15%	19.06	-	3.32				
					20%	18.56	-	3.28				
					25%	18.08	-	3.22				
					30%	17.77	-	3.18				
56days	5%	20.12	-	-								
	10%	19.84	-	-								
	15%	19.11	-	-								
	20%	18.59	-	-								
	25%	18.23	-	-								
	30%	17.97	-	-								
7	Sunil N. Shah et.al.(2 014)	Effect of Chipped Rubber Aggregates on Performance of Concrete	American Journal of Engineering Research (AJER)	7days	0%	-	2.11	4.00				
					3%	-	1.47	3.00				
					6%	-	1.42	2.55				
					9%	-	1.19	1.26				
					12%	-	1.14	1.00				
					28days	0%	-	2.39	4.88			
				3%		-	2.31	4.55				
				6%		-	2.19	4.25				
				9%		-	1.83	3.10				
				12%		-	1.67	2.50				
				8		Dr.J K Dattatr eya et.al.(2 015)	Experimenta l investigation of crumb rubber concrete confined By FRP sheets	Journal of Civil Engineering and Environmental Technology	With FRP	0%	-	2.23
					5%					-	1.98	-
10%	-	1.81	-									
15%	-	1.63	-									
Without FRP	0%	-	3.11		-							
	5%	-	2.94		-							
	10%	-	2.69		-							
	15%	-	2.26		-							

IV. CONCLUSIONS

This study deals with the comparative study among the mechanical properties, durability and application of crumb rubber and it is used to effective utilization of tire rubber wastes are replacement with various material in the conventional concrete of

various grades. This paper is the collection of various papers or results regarding to the strength and properties of crumb rubber. Hence by using this paper one can easily compare the results who wished to undertake the investigation on crumb rubber utilization on in concrete.

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