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EXPERIMENTAL INVESTIGATION ON UTILIZATION OF CRUMB RUBBER IN RIGID PAVEMENTS

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ABSTRACT

As the mode of transportation is increasing worldwide, there is an enormous increase in crumb rubber in landfills, which is a serious threat to the environment. In order to reduce the trash and mining of natural sand, which distresses the bridges, river banks and nearby structures, replacement of filler material is the best choice. In view of this aspect crumb rubber from landfills will be a good option for replacement in concrete. In this project an emphasis on replacement of natural material is given. Natural fine aggregate is replaced with crumb rubber at varying percentages i.e., 5, 10, 15, 20 and also adding fly ash to the cement at 5 percentage respectively, and adding 0.2% of silane coupling agent to the fly ash modified cement at all proportions. Related comparisons for the mechanical properties of crumb rubber modified concrete at different proportions in line with the conventional concrete were found out.

KEYWORDS: *Crumb rubber, Fly Ash, Silane Coupling Agent.*

INTRODUCTION

Now days, India is facing challenging task in dealing with waste. Some of the waste can be used now in many ways by recycling processes. Un required waste is disposing on the earth using landfills, pits etc., as population is enormously increasing, that leads to increase of requirements of transportation facilities. One of the modes of the transportation is road ways which is being used more and many times by us.

It is of prime importance of carryout research works on the feasibility of using alternative materials and its suitability for potential utilization in concrete constructions. Today construction cost is very high with using conventional materials due to unavailability of natural resources.

Rubberized concrete can be used for many purposes for required properties. Usage of rubberized concrete varies with proportions of rubber in concrete. Enough bond between rubber with the ingredients of the concrete makes effect exhibited by silica contrasts with the difficulty on the process ability of the silica-filled rubber compounds because of the poor disparity of silica particles in the rubber matrix. Silica particles show strong filler–filler interactions and adsorption of polar compounds in that silica is abundant in Silanol groups on its surface. In order to solve this problem, the introduction of new additives in the filled rubber is required.

Crumb rubber is recycled rubber produced from automotive and truck scrap tires. The particles are sized and classified based on various criteria including colour.CR can be used for rubberized asphalt, ground cover and as a artificial turf as a cushioning. CR is the waste from rubber products which is non-biodegradable and causes pollution to earth if it disposed on to the earth. Storing of waste is also very difficult because of presenting requirements needs for the waste like place, temperature etc.., the discarding of CR is one of the major concerns of all over the world. With day to day increase of automobiles in India during the past few decades, the demand of utilization of trees has reached up very high. The disposed vehicle tire into the landfills constitutes one of the important parts of solid waste from the remaining. Among the disposal methods, burning of tires in the open air is causing serious fire hazards. Rubber is the one which causes rising issues of landfill & burning generated per year to global warming.

LITERAUTRE REVIEW

Bashar S Mohammed et al. (2017) stated that rubber Crete has improved workability and freeze resistance. Reduction in the strengths of rubber Crete can be offset economically using Nano silica as cementations addition. The lower drying shrinkage of rubbercrete will promote it as well repair mortar and also in mass concreting applications such as dams and rigid pavements. Due to the ability of rubbercrete in absorbing impact loading, members subject to accidental impact loads can be made of rubbercrete such as crush barrier. The improved fatigue load cycles and toughness of rubbercrete makes it suitable for roller compacted rigid pavement. The rubbercrete can be used in producing of members/products that can be used in improving life quality of habitats due to its high sound absorption, high electrical resistivity and lower thermal conductivity.

Ankit et al. (2017) Fine aggregate by crumb rubber with 5% to 30%**.** The 7 day and 28-day compressive strength of the specimens increased by addition of silica fume to concrete containing crumb rubber. Addition of 5% crumb rubber gives more strength as compared to conventional concrete for m30 grade of concrete. Use of 0.5% and 1% of crumb rubber as a fine aggregate in concrete for m25 grade does not show any changes. Rubber fails the initial surface absorption test is the surfaces of their concrete mixes are almost impermeable. Decrease in strength is mainly due to the lower bond strength between cement paste and rubber tire aggregate.

Mehmat gegoslu et al. (2015) studied the influence of waste rubber utilization of the fracture and steel-concrete bond strength properties of concrete. In his study, mechanical and fracture properties of concrete in which natural aggregates were replaced with crumb rubber were investigated. The results indicated that utilization of rubber decreased compressive strength and modulus of elasticity.

Selva Kumar et al. (2015) presented the strength properties of concrete using crumb rubber with partial replacement of fine aggregates. This project is aimed to study the effectiveness of rubber as a substitute for concrete. The concrete specimens were tested with concrete mix in various percentages of replacements (5%, 10%, 15% & 20%). Compressive strength of crumb rubber concrete with 5% replacement is 38.66 N/mm^2.It was found that rubber possesses less bonding ability which has affected on the strength of concrete.

Yogender Antil et al. (2014) Crumb rubber consists of particles ranging in size from 4.75mm to less than 0.075mm. Crumb rubber as an asphalt modifier use particle ranging in size from 0.6mm to 0.15mm. Concrete with higher percentages of crumb rubber possess high toughness. The slump of the modified concrete increases about 08% with the use of 1 to 10% of crumb rubber. The compressive strength of the concrete decreases about 37% when 20% sand is replaced by rubber. For large percentages of crumb rubber, the compressive strength gain rate is lower than that of plain concrete.

Mustafa et al. (2012) discussed that fine aggregate by crumb rubber with 5% ,10% and 20%.

The rubberized concrete was stronger and energy absorbing under impact loading than under static loading. It has been experimentally demonstrated that the impact up, inertial load and bending load of cement concrete increased with the increase in the percentage of sand replacement by fine crumb rubber.

A. *Cement*

B. *Fly Ash*

C. *Aggregate*

D. *Crumb Rubber*

E. *Admixture*

F. *Mix Design*

MATRIALS AND METHODS

Table 1: Laboratory results of Cement.

Laboratory tests	**Result**	**Limitations**
consistency	31.5%	26-33
Initial setting time	28 min	30 min
Final setting time	598 min	600 min
soundness	8 mm	10 mm max.

Table 2: Property of Fly Ash.

Laboratory tests	**Result**	**Limitations**
Specific gravity	2.24	2.1 – 3.0

Table 3: Properties of fine aggregate.

Laboratory tests	**Value**	**Limitations**
Sieve analysis	Zone II	IS 383-1970
Specific gravity	2.65	2.5 – 2.9
Bulk density	1590.80 kg/m^3	450 kg/m^3 – 1650 kg/m^3
Water absorption	0.5%	-

Table 4: Properties of coarse aggregate.

Laboratory tests	**Value**	**Limitations**
Aggregate crushing value	2.2%	2.2 – 2.6
Aggregate impact value	21%	Less than 35%
Specific gravity	2.67	2.5 – 3.0
Water absorption	0.5%	

Table 5: Properties of Crumb Rubber.

Laboratory tests	Result
Specific gravity	1.15
size	30 µ (popularly 30 mesh)

Table 6: Properties of silane coupling agent.

Properties	Value
Sulphur Content	22.5%
By-products, GC	<= 3.5%
Average sulphur chain length, HPLC	3.70
Average molecular weight	532 g/cm^3
Density	1.10 g/c m^3
Appearance	Yellowish liquid

Table 7: Proportion of Mix.

Mix no.	Cement (kg)	Fly ash (kg)	W/c ratio	C.A (Kg)	F.A (Kg)	C B (Kg)	% CA	Water (litres)
1	405	-	0.4	1124	684	-	-	197
2	405	20.25	0.4	1124	649.8	34.2	5	197
3	405	20.25	0.4	1124	615.6	68.4	10	197
4	405	20.25	0.4	1124	581.4	102.6	15	197
5	405	20.25	0.4	1124	547.2	136.8	20	197

RESULTS and DISCUSSIONS

A. Mechanical Properties

Table 8: Compressive Strength @ 7, 14, 28 days.

MIX	Compressive Strength (N/mm^2)		
	7 Days	14 Days	28 Days
CC	23	28.6	38.6
CRC-5%	22	26.4	42.26
CRC-10%	12	22.13	37.68
CRC-15%	9.98	12.66	33.21
CRC-20%	8.68	14.5	30.78

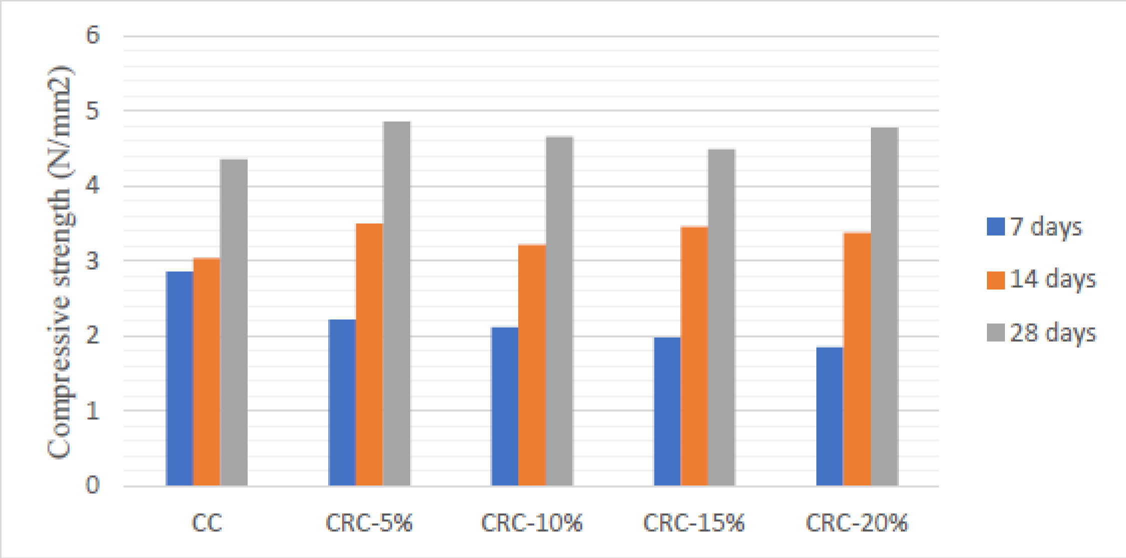

Figure 1: Compressive strength at various replacements.

Table 9: Flexural Strength @ 7, 14, 28 days.

Mix	Flexural strength (N/mm^2)		
	7 days	14 days	28 days
CC	2.4	3	4.2
CRC-5%	2.43	3.29	4.76
CRC-10%	2.41	3.25	4.51
CRC-15%	2.3	3.38	4.16
CRC-20%	1.35	2.48	4.08

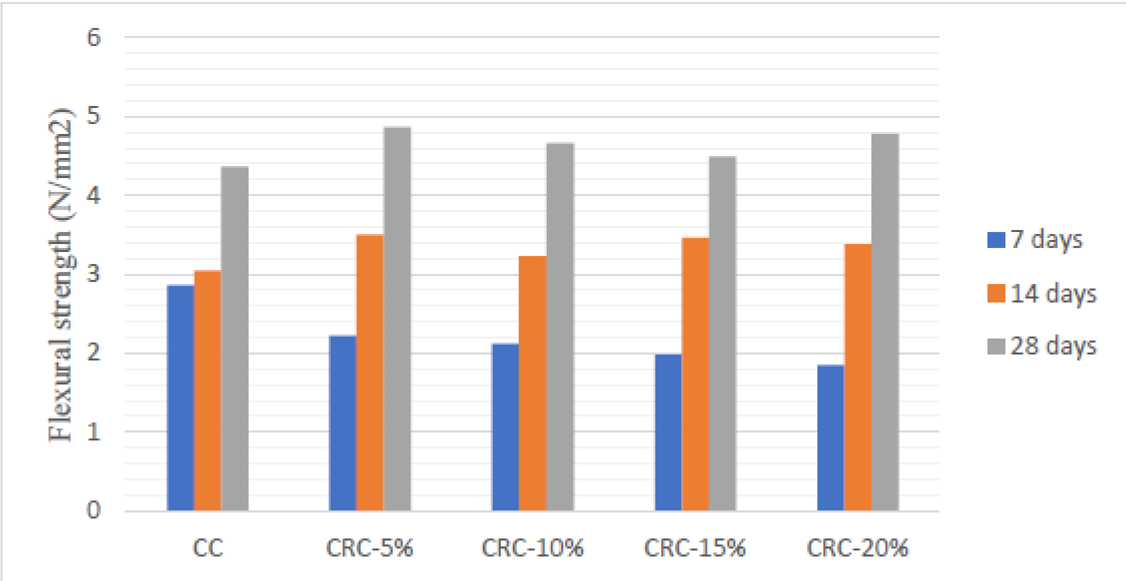

Figure 2: Flexural strength at various replacements.

Table 9: Split Tensile Strength @ 7, 14, 28 days.

Mix	Split Tensile strength (N/mm^2)		
	7 days	14 days	28 days
CC	2.86	3.04	4.36
CRC-5%	2.22	3.5	4.86
CRC-10%	2.12	3.22	4.66
CRC-15%	1.98	3.46	4.49
CRC-20%	1.85	3.38	4.78

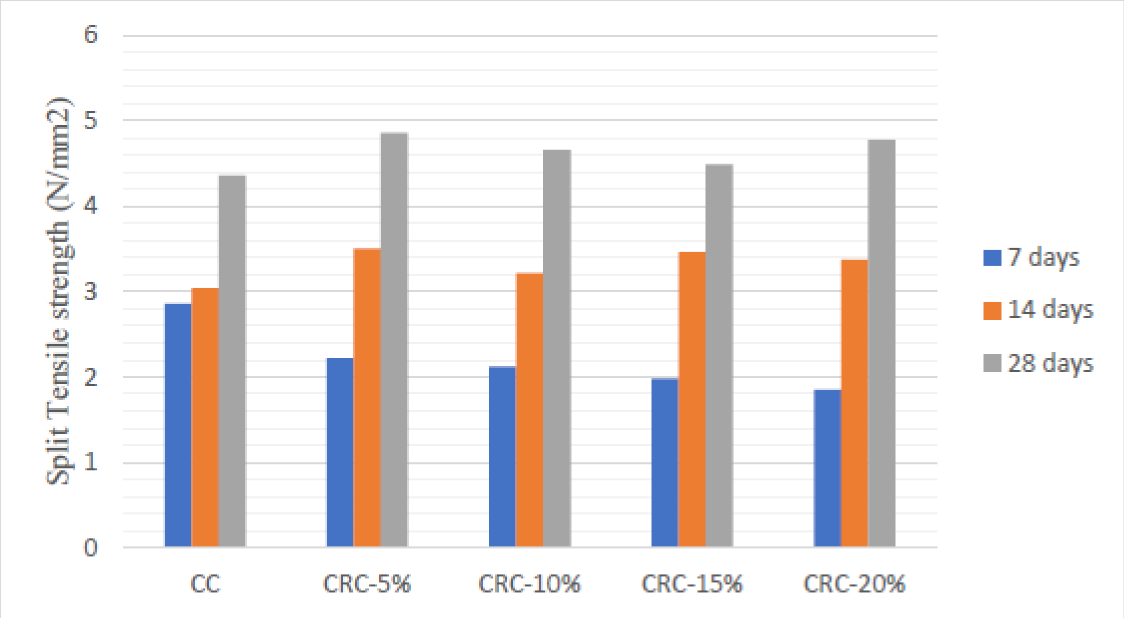

Figure 3: Split Tensile strength at various replacements.

CONCLUSIONS

Based on the results obtained by the experimental study the following observations were made:

- Rubbercrete has experienced very low strength in compression when compared to conventional mix.
- Rubbercrete of 5% was observed to reach the characteristic strength @ 28days.
- Rubbercrete has experienced high elastic nature when compared to compression on utilization of silane coupling agent.
- Overall, it was concluded that the rubbercrete has low compressive strength but has a definite elastic nature and durability which to absorb the sound energy.
- It was concluded from compression as well as Flexure is that a proportion of 5% can be replaced for 30mesh. Rubber particles as replacement to Fine aggregate.
- Rubbercrete has achieved low tensile strengths in lowest proportions and it increases at

15% and again decreases.

- This proportion of rubbercrete can be utilized for pavement accessories like shoulders, Footpaths, Krebs.

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