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Used Of Recycled Tyre/Rubber as Course Aggregate and Stone Dust As Fine Aggregate in Cement Concrete Works

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Abstract: *The present investigation aims at the study of properties of concrete in which stone dust is used as a partial replacement for coarse sand and tyre-chips of size 4.7 to 10 mm as partial replacement of coarse aggregate by weight.*
Keywords: *Cement, Coarse sand, Coarse Aggregate, Stone Dust, Tyre Chips size 4.75 to10mm*

I. Introduction

1.1 General- Sand collected from Aeolian deposit is expensive due to unwanted cost of transportation from natural sources. Large scale exploitation of natural sand creates environmental impact on society.
Grit collected from mountains is also expansive due to unwanted cost of transportation from natural sources.

1.2 Methodology- The present investigation aims in the study of properties of concrete in which stone dust is used as a partial replacement for coarse sand and tyre is used as partial replacement of coarse aggregate. Stone dust is replaced at replacement levels of 20percentage, 25percentage, 30percentage, 35percentage and 40percentage.
After obtaining maximum strength by sand replacement with stone dust , coarse aggregate is partially replaced by tyre at replacement levels of 2 percentage, 5percentage, and 10percentage

II. Literature Review

2.1. Introduction Almost every repair to historic concrete requires the use of concrete. The significance of selecting a suitable concrete, weather for repainting or rebuilding, cannot be underestimated due to the structural and aesthetic roles that concrete plays in concrete construction. Physically inappropriate concrete can cause a repair to fail and can damage the original concrete. Visually inappropriate concrete alters the original intent of the building's designer by changing our perception of the design. For these reasons analysis of historic concrete is a topic of abiding interest to most preservation professionals.

In order to fulfill the requirement of fine aggregates and coarse aggregate, some alternative material must be found.

1) **Nagraj T.S et.al (1996).**[8]**,** reported that rock dust which have higher surface area consumes more cement in with respect to sand which increases workability. He studied to effect of rock dust and pebble as aggregate in cement and concrete and found that crushed stone dust could be used to replace the natural sand in concrete.

2) **Shukla et al. (1998) [9],** investigated the behavior of concrete made by partial or full replacement of sand by crushed stone dust as fine aggregate and reported that 40 percent sand can be replaced by crushed stone dust without effecting the strength of concrete.

3) **Venugopal (1999) et al.[11],** examined the effect of rock dust as fine aggregate in cement and concrete mixes. They have suggested a method to proportion the concrete using rock dust as fine aggregate.

4) **A.K Sahu et al. (2003)**[1] investigated the basic properties of conventional concrete and concrete made using quarry dust have compared. They have studied M20 and M30 concretes. Equivalent mixes are obtained by replacing stone dust partially/fully. Test results shows the effective usage of stone dust with same compressive strength, comparable tensile strength and modulus of rupture. Workability of 40percentage replacement of stone dust with 2percentage Superplasticizer is equal to the workability of conventional concrete. Workability is increased by the addition of perplasticizer.as replaced materials to natural sand has become beneficial and is common in the world. Stone dust is manufactured by crushing larger stones of quarry to particular size of sand. Its chemical & physical properties such as color, size & shape, surface texture up particles depend upon types of stone & its source .Use of crushed sand has become a good substitute for natural sand and it has become essential keeping in view of technical, commercial & environmental requirements. Proper quality control while using crushed sand/ manufactured sand can result in better results. Different researchers have carried out research to study the effect of use of crushed sand on properties of mortar.

5) Hadassa Baum and Amnon Katzl.[4], studied the percentage of fines in crushed sand and its effects on the concrete mixes. They pointed out that the addition of fine filler (mesh 0.075mm) has a positive potential on the properties of the mortar. But, at the same time, the fraction of less than 5 microns of the fine filler used for plastering may have a bad effect on the concrete. They also studied the effect of the composition of water reducing agent on mixes containing crushed sand that exhibited the lowest properties. They noted that Compressive strength improved, chlorides permeability and the shrinkage reduced.

6) Divakar et al. (2012).[12], have experimented on the behavior of M20 grade concrete with the use of granite fines as a partial replacement for sand in 5percentage, 15percentage, 25percentage, 35percentage and 50percentage; and based on the results obtained for compressive, split-tensile and flexural tests, it was recommended that 35percentage of sand can be replaced by granite fines.

7) Toutanji,H.A (1996).[10], "The use of rubber tyre particles in concrete to replace mineral aggregates" Cement concrete investigated the effect of replacement of mineral coarse aggregate by rubber tyre aggregate. Shredded rubber tyres used had a maximum size of 12.7mm and a specific gravity of about 0.61. The incorporation of these rubber tyre chips in concrete exhibited a reduction in compressive and flexural strength. The specimens which contained rubber tyre aggregate exhibited ductile failure and underwent significant displacement before fracture. The toughness of flexural specimens was evaluated for plain and rubber tyre concrete specimens. The test revealed that high toughness was displayed by specimens containing rubber tyre chips as compared to control specimens.

8) Khatib Z.K and Bayon F.M (1999).[13]**,** has developed "Rubberized Portland cement concrete" to conduct experimental program in which two types of rubber fine Crumb Rubber and coarse tyre chips were used in Portland cement concrete (PCC) mixtures. Rubberized PCC mixes were developed by partially replacing the aggregate with rubber and tested for compressive and flexural strength in accordance to ASTM standards. Tyre chips were elongated particles that ranged in size from about 10 to 50mm. Results show that rubberized PCC mixes can be made and are workable to a certain degree with the tyre rubber content being as much as 57percentage of the total aggregate volume. However, strength results show that large reductions in strength would prohibit the use of such high rubber constant. It is suggested that rubber contents should not exceed 20percentage of the total aggregate volume.

9) Mohammed Mustafa Al Bakari. A. Syed Nuzul Fazl S.A, Abu Bakar M. [2]"Comparison of rubber as aggregate and rubber as filler in concrete" this research will attempt to use rubber waste replacement of coarse aggregates to produce early age concrete. It carry out two different type of concrete which are rubberized concrete and rubber filler in concrete. In rubberized concrete, rubbers were used to replace coarse aggregates and sand as fine aggregate. Coarse aggregate usually gravel or crushed stone and shredded rubber as filler in concrete. The compressive strength was reduced in rubberized concrete for several reasons including the inclusion of the waste tyres rubber aggregate acted like voids in the matrix. This is because of the weak bond between the waste tyres rubber aggregate and concrete matrix. With the increase in void content of the concrete, there will be a corresponding decrease in strength. Portland cement concrete strength is dependent greatly on the coarse aggregate, density, size and hardness. Since the aggregates are partially replaced by the rubber, the reduction in strength is only natural.

10) Mavroulido.M and Figueiredo.J (2010).[7]**, "**Discarded tyre rubber as concrete aggregate: a possible outlet for used tyres" it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include nonprime structural applications of the medium to low strength requirements, benefiting from other features of this type of concrete. Even if the rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used

11) Humphrey (1999),**[5]**, some of the advantageous properties of tyre chips include low material density, high bulk permeability, high thermal insulation, high durability, and high bulk compressibility. In many cases, scrap tyre chips may also represent the least expensive alternative to other fill materials. Crumb rubber has been successfully used as an alternative aggregate source in both asphalt concrete and PCC. This waste material has been used in several engineering structures like highway base courses, embankments, etc.

12) Zheng et al. 2008.[14]**,** worked on rubberized concrete and replaced the coarse aggregate in normal concrete with ground and crushed scrap tyre in various volume ratios. Ground rubber powder and the crushed tyre chips particles range in size from about 15 to 4 mm were used. The effect of rubber type and rubber contention strength, modulus of elasticity were tested and studied. The stress – strain hysteresis loops were obtained by loading, unloading and reloading of specimens. Brittleness index values were calculated by hysteresis loops. Studies showed that compressive strength and modulus of elasticity of crushed rubberized concrete were lower than the ground rubberized concrete

13) Khallo et al. 2008.[6]**,** determined the hardened properties of concrete using different types of tyre rubber particle as a replacement of aggregate in concrete. The different types of rubber particles used were tyre chips, crumb rubber and combination of tyre chips and crumb rubber. These particles were used to replace 12.5percentage, 25percentage, 37.5percentage, and 50percentage of the total mineral aggregate by volume not by weight. The results showed that the fresh rubberized concrete had lower unit weight and workability compared to plain concrete. Result showed large reduction in strength and modulus of elasticity in concrete when both tyre rubber chips and crumb rubber were used together as compared to that when these were used individually. It was found that the brittle behavior of concrete was decreased with increased rubber content. The maximum toughness index indicated the post failure strength of concrete with 25percentagerubber content.

14) Ganjian et al. 2008.[3]**,** investigated the performance of concrete mixture incorporating 5percentage, 7.5percentage and 10percentage tyre rubber by weight as a replacement of aggregate and cement. Two set of concrete mix were made. In the first set chipped rubber replaced the coarse aggregate and in the second set scrap tyre powder replaced cement. The durability and mechanical test were performed. The result showed that up to 5percentage replacement in both sets no major changes occurred in concrete characteristic.

Materials and Properties-

The basic materials required for Concrete are:

1. Cement
2. Coarse Sand/Stone dust (as replacement)
3. Water
4. Coarse Aggregate(Grit)/Tyre (as replacement)

1 . **Cement**

Cement used was tested in accordance with the IS 12269:1987 (Specification for 53 Grade Ordinary Portland cement). The results obtained are tabulated below:

Table 3.1 Properties of Fresh Cement

Properties	**Average**
Standard consistency	31.0
Initial Setting time (min.)	29
Final Setting time (min.)	615

Table 3.2 Compressive Strength of Cement

Material	**Type of Cement**	**Compressive Strength**		
		3 days	**7 days**	**28 days**
15X15X15cm cube of mix 1:3 Cement (85kg) : Fine Sand (555kg)	53 Grade Ordinary Portland cement	21N/mm2	32N/mm2	54N/mm2

Coarse Aggregate Specific gravity as per IS2386 (part-III): 1963 aggregate used was found to be **2.65**. Grading Limits as per IS383-1970:

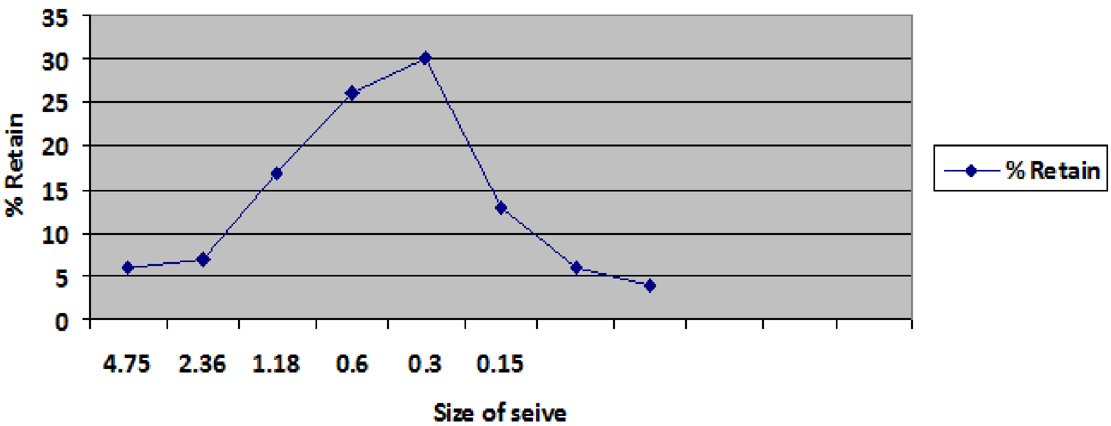
Table 3.3 Grading Limits as per IS383-1970

Weight of Sample	**IS Sieve In mm**	**Weight Retained in gm**	**Cumulative weight retained in gm**	**Weight Passed in gm**	**percentage passing**	**Acceptability against each sieve**	
5000 gm						**Graded**	**Non Graded**
	40	0	0	5000	100	100	100
	20	78	78	4922	96	95-100	85-100
	16	1510	1588	3312	66.24	-	-
	12.5	1120	2708	2275	45.5	-	-
	10	1000	3708	1292	25.84	25-55	0-20
	4.75	1050	4758	242	4.84	0-10	0-5
	Pan	242	5000				

Fine Aggregate(Coarse Sand) The particle size distribution as per IS383-1970, are given in Table 3.4.

Table 3.4 Particle Size Distribution of Sand

Weight of Sample	IS Sieve In mm	Weight Retained in gm	Cumulative weight retained in gm	Weight Passed in gm	percent age passing	Acceptable Limits as per IS code			
1000 gm						Zone I	Zone II	Zone III	Zone IV
	4.75	70	70	930	93	90-100	90-100	90-100	95-100
	2.36	60	130	870	87	60-95	75-100	85-100	95-100
	1.18	170	300	700	70	30-70	55-90	75-100	90-100
	600	260	560	440	44	15-34	35-59	60-79	80-100
	300	300	860	140	14	5-20	8-30	12-40	15-50
	150	130	990	40	4	0-10	0-10	0-10	0-15
	75	6	996	4	0.4				
	Pan	4	1000	0	0				



Graph 1 Particle Size Distribution of Sand

Table 3.5 Physical properties of Tyres

S. No.	Physical Properties	Typical Values
1	Particle Size	4.75 to 10mm
2	Abrasion	0
3	Water Absorption	0
4	Specific Gravity	1.09

Test Program-

A. Concrete Cubes

These were carried out to clearly understand the effect of different levels of Substitution of stone dust and tyre addition on the compressive strength of concrete of varying composition. Whereas, cubes measuring 225 cm2 (area of one face) were used to measure the compressive strength.

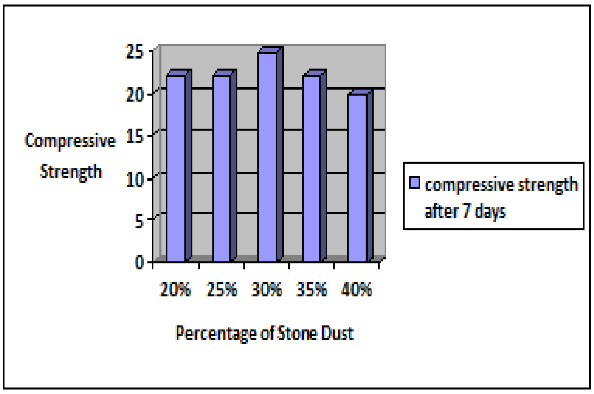
Table 4.1 Concrete Mix Proportions used in the Experiment

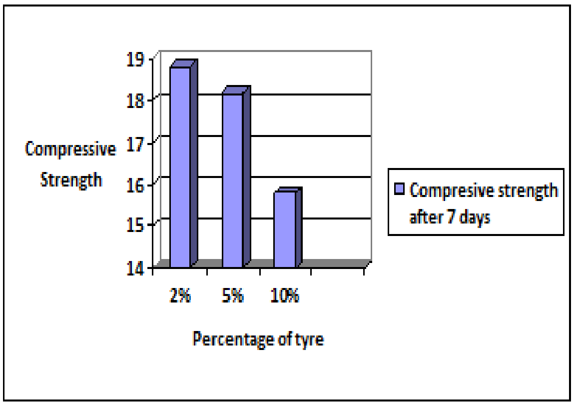
S. No.	Mix Ratio	Water (kg)	Cement (kg)	W/C Ratio	Fine Aggregate (kg)		percentage stone dust	percentage tyre	Tyre (kg)	Coarse
					Sand	Stone dust			10 to 4.75 mm	10 to 20 mm
1		6.4	12.8	0.5	19.2					38.4
2		6.4	12.8	0.5	15.35	3.85	20percentage			38.4
3		6.4	12.8	0.5	14.4	4.8	25percentage			38.4
4	1:1.5:3	6.4	12.8	0.5	13.44	5.76	30percentage			38.4
5		6.4	12.8	0.5	12.48	6.72	35perce ntage			38.4
6		6.4	12.8	0.5	11.52	7.78	40perce ntage			38.4
7		6.4	12.8	0.5	13.44	5.76	30perce ntage	2perc entag	0.77	37.63
8		6.4	12.8	0.5	13.44	5.76	30perce ntage	5perc entag	1.92	36.48
9		6.4	12.8	0.5	13.44	5.76	30perce ntage	10per centa	3.84	34.56

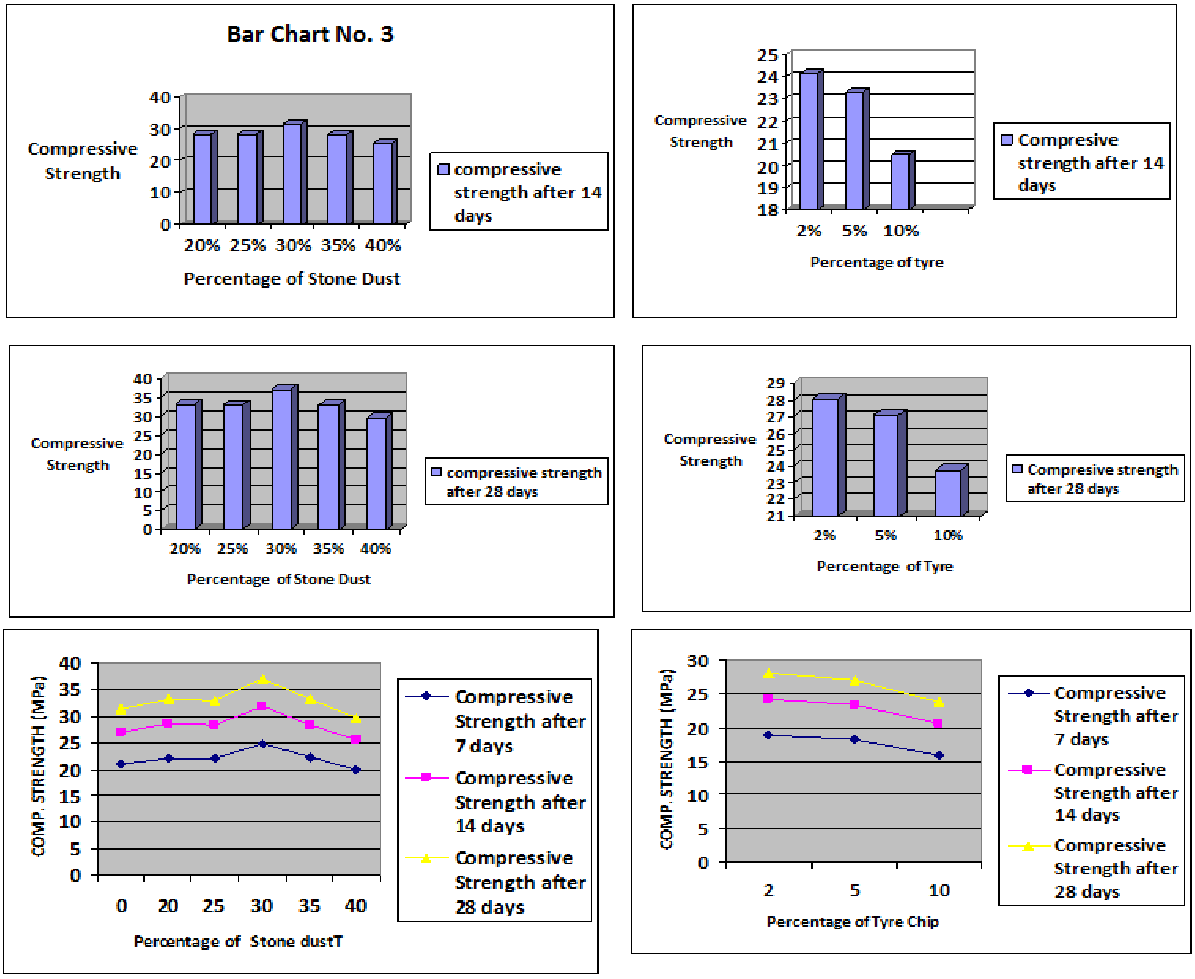
Note: 10Samples are prepared for each proportion.

Test Results-Table 5.1 Compressive Strength of Concrete Cubes in 7, 14 and 28 days for different mix ratios

percentage of Tyre Mix	percentage of Stone Dust Mix	7 days Compressive Strength (MPa)	14 days Compressive Strength (MPa)	28 days Compressive Strength (MPa)
Without any mix		21.02	26.97	31.37
-	20	22.16	28.44	33.07
-	25	22.00	28.42	33.05
-	30	24.76	31.78	36.95
-	35	22.18	28.40	33.07
-	40	19.86	25.49	29.64
2	30	18.79	24.13	28.05
5	30	18.15	23.30	27.09
10	30	15.80	20.49	23.82







Graph for Compressive Strength of concrete for different percentage of stone dust and Tyre-Chips

III. Conclusion

Based on the results obtained in this investigation the following conclusions are drawn regarding the effect of Stone dust as a substitute to natural sand and tyre as a substitute to coarse aggregate compressive strength of concrete.

A) The substitution of natural sand to stone dust is taken to 30percentage replacement of weight of sand in ratio 1:1.5:3 of concrete the ultimate strength more somewhat same to the ultimate strength of concrete without substitution. The substitution of natural sand to stone dust up to 40percentage replacement of weight of sand in ratio 1:1.5:3 of concrete led to a corresponding drop in the strength. This is due to the fact that above the 3 0percentage weight the presence of stone dust tends to reduce the bonding between cement and aggregate Lending to a consequent decrease in strength

B) From the present experimental study and literature review it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include non-primary structural applications of medium to low strength requirements, benefiting from other features of this type of concrete. Even if rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used tyres.

Finally conclusion is that the use of stone dust and tyre used for concrete is reduce the pollution and perform as low weight concrete and used in road base etc.

Future Scope: In future research following points can be taken-

a) Tyre Powder can be used as fine aggregate.

b) Tyre chips can be replaced by same size of coarse aggregate.

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