



## EFFECT ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE BY RUBBER DUST AND COARSE AGGREGATE BY TYRE CHIPS

### Engineering

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### ABSTRACT

Solid waste management has gained a lot of attention to meet the requirements of globalization in construction of buildings and other structures. Pertaining non-biodegradable nature of waste tyres has become a problem of interest. The usage of tyre rubbers as fuel is not environment friendly and requires high cost. The present investigation aims at the study of properties of recycled concrete in which *stone dust & rubber dust* is used as a partial replacement for natural fine aggregate and *tyre-chips* of size 4.7 to 10 mm as partial replacement of coarse aggregate by weight for concrete. It was observed that the inculcation of rubber dust imparts strength to concrete up to some extent but further increment in the percentage of recycled materials leads to subsidence in strength of concrete.

### KEYWORDS:

OPC cement, Coarse aggregate, Rubber Dust, Tyre chips

### INTRODUCTION

Solid waste management has gained a lot of attention to the research community in recent days. As concerned solid waste, accumulated waste tyres, has become a problem of interest because of its non-biodegradable nature [Malladi, 2004]. It has been observed that the rubberized concrete may be used in places where desired deformability or toughness is more important than strength like the road foundations and bridge barriers. Apart from these the rubberized concrete having the reversible elasticity properties may also be used as a material with tolerable damping properties to reduce or to minimize the structural vibration under impact effects [Siddique et al.2004]. [Shukla et al 2000] investigated the use of crusher dust for partial replacement of fine aggregate [Prakash et al 2016] investigations were with full replacement of fine aggregate and stone dust in concrete only. Investigations on partial replacement of fine aggregate concrete with crusher dust as is available from the crusher are reported in this paper. Also, the fines below 150-micron size are removed from this unrefined cm crusher dust and the micro fines removed cm crusher dust is used for full replacement of fine aggregate in masonry and tested for basic compressive strength. So, the experimental work with micro fines removed stone dust as replacement for fine aggregate in concrete work is not reported so far. [Eldin N.N and Senouci A.B. 1993] "Rubber tyre particles as coarse aggregates" examined compressive and tensile strengths of rubberized concrete. He notes that rubberized concrete did not perform as well as normal concrete under repeated freeze-thaw cycles. [Kashif et al 2015] investigated that rubber can be used at some extent as a replacement of coarse aggregate. It exhibited lower compressive and tensile strength than of normal concrete but unlike normal concrete, rubberized concrete had the ability to absorb a large amount of plastic energy under compressive and loads. It did not demonstrate the typical brittle failure, but rather ductile, plastic failure mode.

The main objective of the study is to evaluate relative performance of the concrete made by normal fine aggregate and stone dust, aggregate and tyre chips. This study ensures the stone powder or as an appropriate alternative of fine aggregate in concrete manufacturing as a building materials. Stone dust considered to be a solid waste materialist posing a serious disposal problem is utilized as a partial material for fine aggregate in concrete works.

### MATERIAL AND METHODS-

#### Cement

Ordinary Portland cement of 43 grade were used, conforming to recommendations stated in IS 4031(1999). The normal consistency and initial setting time of cement was 30% and 32 minutes respectively.

#### Coarse Aggregate

Two single sized crushed stone aggregates ranging from 12.5 mm to 2.36 mm and 20 mm to 4.75 mm (10mm and 20mm sizes) were used in respective proportions in concrete mixes. The sieve analysis was carried out conforming to IS-383:(1970) recommendations.

#### Fine aggregate

The fine aggregate with fineness modulus 2.93 used was locally available coarse sand. The test procedures as mentioned in IS-383(1970) were followed to determine the properties of fine aggregate. **Table 3.4 Sieve Analysis of Different Type of Stone Dust**

Sieve size (mm)	Weight retained (kg)	q	O	Cumulative weight passing
Sample 1	Sample 2	Sample 3	Sample 1	Sample 2
34.75	100.100	059898992	360.150	15.2068687
11.180	200.150	134646	48	bo
0.170	150.143	53540	300	m
0.200	250.272	72728	150	m
0.200	250.252	22223	Total weight	1.01.01.0296296309
Fineness Modulus	2.962	963.09	<b>Average Fineness Modulus = 3.01</b>	<b>Stone Dust</b>

The stone dust passing through the 4.75 mm and retained on 150-micron sieve with the fineness modulus of 2.985 was used. Available locally were taken for analysis as per IS: 383-1970 for sand and concrete respectively.

#### Tyre/Rubber Dust

Artificial and recycled tyre rubber shredded form in varying particle size of 4.75 to 10mm (styrene-butadiene co-polymer- SBR) containing 25% styrene is used.

#### Water

As per recommendation of IS: 456 (2000), the water to be used for mixing and curing of concrete should be free from deleterious materials. Therefore, potable water was used in the present study in all operations demanding control over water quality.

#### Mix Proportion-

Mix design pertains to design the quantities of materials that can be used for concrete mixture. Trial mixes for preparing the specimens proportioned by weight. The mix design as per IS 10262:2009 was carried out for concrete grade M20 for getting target mean strength which gives the ratio 1:1.66:3.03 at 7 days and 28 days. The concrete specimens were prepared with partial replacement of fine aggregate with 30% stone dust which is taken as conventional concrete which is compared with rubber dust with replacement level 0.5%, 1%, & 1.5% i.e. substituting natural river sand and crumb rubber of size 4.75 to 10 mm with partial replacement of coarse aggregate at levels 3%, 4% and 5% & 6%.

**Preparation Of Specimens**

Cube specimens of size 150 mm x 150 mm x 150 mm were cast. All specimens were tested on 7 and 28 days respectively. All concrete mixes in the study were prepared following the procedure prescribed as per IS 456-2000. All the concrete specimens were cast under laboratory conditions, demolded at 24 h after casting, and then fully submerged in water at (25 ± 2) °C until further testing.

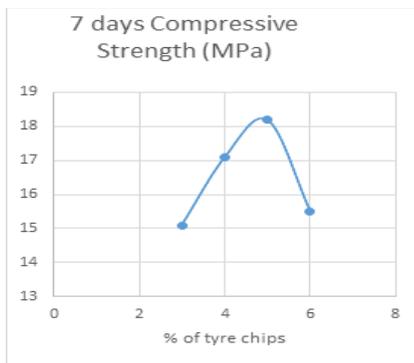
**Testing Of Specimens**

Laboratory tests include compression test as per IS 516-1959, carried out on the concrete mixes at the specified ages.

**RESULT AND DISCUSSION**

**Compressive Strength of Tyre Chips and Rubber Dust Based Concrete-** Compression test according to IS 516(1959) was carried out on cubes. The specimens were loaded at constant strain rate until failure. The concrete has been checked under compression by using tyre chips aggregate at the increasing rate of 1% by weight of aggregate in volume fraction of 3%, 4%, 5% and 6% while rubber dust is used by weight of fine sand at increment of 0.5% in volume fraction of 0%, 0.5%, 1% and 1.5%. The mixes checked for 7 days and 28 days respectively for tyre chips and rubber dust based concrete. In all the mixes the stone dust is used at the fixed rate 30%.

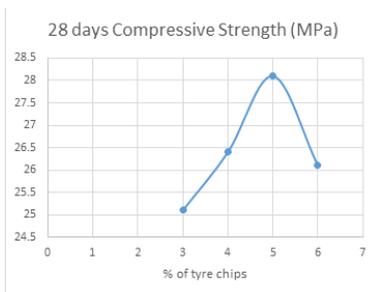
**a) 7 Days Strength of concrete containing tyre chips-**



**Figure 1 7 days' compressive strength of M20 mix with tyre chips**

The 7 days' strength containing 30% stone dust with 0% of tyre chips considered as conventional concrete and the results are compared. It was observed that at 3% tyre chips there is decrement of 16.57%, at 4% tyre chips decrement of 2.76%, at 5% tyre chips there is increment of 0.55% and at 6% tyre chips there is decrement of 14.36%. The optimum dosage was obtained at 5% with the compressive strength of 18.2MPa and the minimum compressive strength was obtained at 3% of tyre chips with strength of 15.1MPa.

**b) 28 Days Strength of concrete containing tyre chips-**

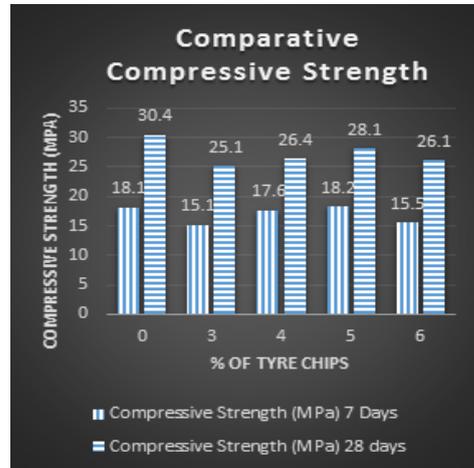


**Figure 2 28 days compressive strength of M20 mix with tyre chips**

The 28 days strength containing 30% stone dust with 0% of tyre chips considered as conventional concrete and the results are compared. It was observed that at 3% tyre chips there is decrement of 17.43%, at 4% tyre chips decrement of 13.16%, at 5% tyre chips there is decrement of 7.56% and at 6% tyre chips there is decrement of 14.14%. The

optimum dosage was obtained at 5% with the compressive strength of 28.1 MPa and the minimum compressive strength was obtained at 3% of tyre chips with strength of 26.1 Mpa.

**c) Comparative 7 days and 28 days strength of concrete containing tyre chips-**



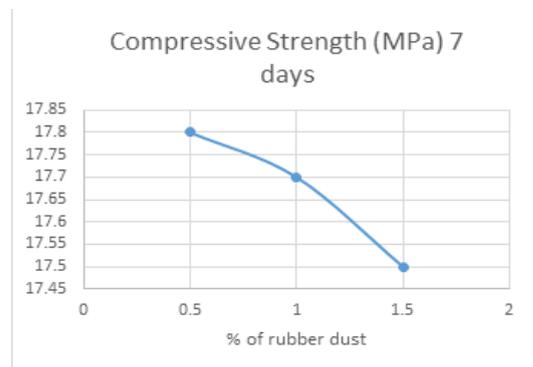
**Figure 3 comparative compressive strength of M20 mix with tyre chips**

Comparing conventional concrete with 7 days and 28 day concrete it was observed that the 5% tyre chips effects the 7 days strength with increase of 0.55% but tyre chips does not strengthen the 28 days strength yet gives the maximum value on 5% with tyre chips, as at every percent of increment of tyre chips the strength decreases.

**Table-1**

%age of tyre chips	Compressive Strength (MPa)	
	7 Days	28 days
0	18.1	30.4
3	15.1	25.1
4	17.6	26.4
5	18.2	28.1
6	15.5	26.1

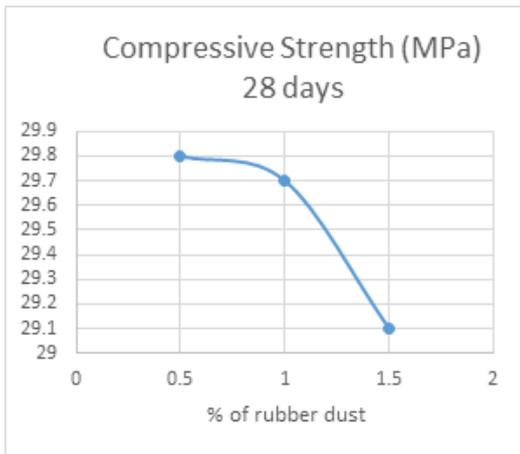
**d) 7 days strength of concrete containing rubber dust-**



**Figure 4 7 days compressive strength of M20 mix with Rubber Dust**

The 7 days strength containing 30% stone dust with 0% of Rubber Dust considered as conventional concrete and the results are compared. It was observed that at 0.5% rubber dust there is decrement of 1.65%, at 1% rubber dust decrement of 2.21%, at 1.5% of rubber dust there is decrement of 3.31%. The optimum dosage was obtained at 0.5% with the compressive strength of 18.1 MPa and the minimum compressive strength was obtained at 1.5% of rubber dust with strength of 17.5 MPa.

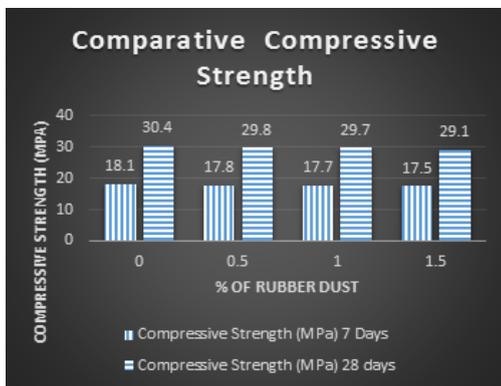
e) 28 days strength of concrete containing rubber dust-



**Figure 5 28 days compressive strength of M20 mix with Rubber Dust**

The 28 days strength containing 30% stone dust with 0% of Rubber Dust considered as conventional concrete and the results are compared. It was observed that at 0.5% rubber dust there is decrement of 1.97%, at 1% rubber dust decrement of 2.3%, at 1.5% of rubber dust there is decrement of 4.27%. The optimum dosage was obtained at 0.5% with the compressive strength of 29.8 MPa and the minimum compressive strength was obtained at 1.5% of rubber dust with strength of 29.1 MPa.

f) Comparative 7 days and 28 days strength of concrete containing Rubber Dust-



**Figure 6 Comparative Compressive Strength Of M20 Mix With Rubber Dust**

Comparing conventional concrete with 7 days and 28-days concrete it was observed the maximum strength, at every increment of rubber dust, does not strength the concrete, instead the incorporation degrades the strength.

**Table-2**

%age of Rubber Dust	Compressive Strength (MPa)	
	7 Days	28 days
0.0	18.1	30.4
0.5	17.8	29.8
1.0	17.7	29.7
1.5	17.5	29.1

**Conclusion**

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.

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