EXPERIMENTAL STUDY ON THE PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF FINE AGGREGATES WITH WASTE TYRE CRUMB RUBBER

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Abstract: Concrete is the most extensively used building material on the planet, it is in like manner the greatest customer of normal resources of totals with a yearly use of 12.6 billion tons. It is a mix of totals, water. Aggregates fuse sand, smashed stone/rock. Use of these conventional materials generally could deplete the consistent resources except if and until the point when the moment that fitting alternatives are used. In this way the normal sums in cement can be supplanted by squander tire crumbs. Practically one crore ten lakhs of new vehicles are added to Indian lanes reliably and about the extension of 3 crores arranged tyres each year have a potential hazard to nature. As the waste tyre versatile is non degradable, its utilization in concrete as sums can reduce the potential harm to the earth. It is evaluated that 11% of post used tyres are exchanged and 27% are sent to landfill, put away or dumped unlawfully and only 4% is used for structural building ventures. From now on undertakings are been taken to perceive the potential usage of waste tyres in structural building ventures.This paper overviews a segment of the examinations which have been finished for creating elastic changed concrete. In this test examination we are not entirely supplanting fine aggregate with piece tire morsels in rates of 4,8,12,16 and 20%. The standard cube specimens of 150x150x150 mm size and cylinders will be casted. The specimens will be cured as per the Indian standards. The specimen will be tested for its 7 days, 14 days and 28 days respectively.We will overview its impact on compressive, split tensile ability and slump properties of new concrete and to locate the ideal level of substitution to pick up the most extreme quality and contrast it with the test results of control specimens of M20 concrete.

Keywords: Waste tire, Crumb rubber, Compressive strength, Split tensile strength, Slump properties.

INTRODUCTION

Tire versatile squanders address a critical environmental issue of growing significance. A normal 1000 million tires accomplish the complete of their supportive lives per year. At present huge measures of tires are amassed or arrive filled as appeared in figure. Tire filling is accountable for a bona fide common threat. At the point when tires start to burn as a result of coincidental reason's high temperature happen and hurtful vapor are made other than the high temperature influences tires to melt, along these lines conveying oil that will corrupt soil and water. Still a colossal number of tires are essentially being secured wherever all through the world. The tires have gathered for an impressive timeframe both legitimately (dumps) and unjustly. Just in US there are nearly two billion in the whole country, with a normal 279 million that will be increased to this value in the next years. The legitimate total of tires grows the peril of flares that can expend for an extensive time allotment, making more vital air and soil pollution, while the unlawful

move of tires in boondocks, courses and void parts has caused tainting that can't be overseen.

The failure of landfills to bargain satisfactorily with tire transfer has animated research on the most proficient method to effectively reuse tires in products and assets, for example, solid, black-top and different tires. To change over the waste tire into a significant item, it should initially be lessened in size and after that reused. The reusing procedure starts by granulating the tires into little reasonable chips, which are then cooled to cryogenic temperatures, making the parts wind up weak as appeared.

These fragile pieces are splashed on a material that must be screened to expel vast bits of elastic or polymer. At last, the rest of the fibre and the attractive material are isolated from the pounded material utilizing an attractive separator and a vibrating separator. This type of reusing is deferential with the earth and enables you to utilize a significant asset again and again. There is the likelihood of utilizing elastic from disposed of tires to make enacted carbon adsorbents for air quality control applications. Such a methodology gives a reusing course to squander tires and the creation of new adsorbents from a minimal effort squander material. Likewise, reused elastic from tires is utilized as a part of a few items ordinarily known as "tire determined items". Such items incorporate black-top clearing blends and as extenders in an assortment of elastic items, for example, roofing materials, strolling cushions, covers and floor covers and different items. More comparative items are being produced.

Crumb waste tyre rubber

Crumbrubber is reused versatile made from auto and truck scrap tires. Amid the reusing procedure, steel and tire rope (cushion) are expelled, leaving tire flexible with a granular consistency. Continued taking care of with a granulator or saltine process, possibly with the guide of cryogenics or by mechanical means, diminishes the range of the particles further. In general, a common waste tire contains (by weight)70 percent of recoverable rubber

- 15 percent steel
- 3 percent fibre
- 12 percent foreign material (for example, inert fillers).

Below are the basic arrangements of the rubber piece:

- Retreader tire buffings will comprise perfect, crisp and dry grinding of tire retread preparation activities.
- Tire granule will be part of the granular tire piece, only guaranteed metal free black, measured. Isolated attractive materials are not satisfactory. Cushion of the evacuated tire chain.
- Tire granule will be part of the granular tire part, Metal free guaranteed in black and white, measured at less than 40 meshes. The attractively insulated materials are not worthy. Tire cushion of the evacuated tire.
- Tire granule will be part of a piece of granulated tire, only black, magnetically separated, measured. Cushion of the tire chain ejected.
- Tire granule will be part of a piece of granulated tire, black and white magnetically separated, measured. Cushion of the tire chain ejected.
- Tire granule will consist of pieces of granular tires not classified, size, not separated, not attractively isolated, rinsed from the tire line not ejected.

DATA COLLECTION

General

The substances that are employed for the planning of the solid in this examination are bond, fine totals, coarse totals, crumb squander tire elastic and water. All the required data regarding all the materials is collected, this data include the materials physical, chemical properties and characteristics.

Study Area

This part is mainly focused on the properties of conventional concrete with Waste tyre crumb rubber. Five volume percentages of crumb elastic totals are used to examine the impact of volume proportions of crumb elastic totals to properties of concrete.

The scope and limitations of this study are:

1. Ordinary Portland Cement (OPC) of 53 grade is the type of cement is used in concrete mix.
2. The size of crushed aggregate used is 12 mm and 20 mm.
3. All the concrete specimens are put through to wet curing.
4. The proper tests and assessments of concrete specimens are done in laboratory scaled sample.

The testing and assessment of concrete mainly on Compressive Strength, Split Tensile Strength, Slump properties of concrete specimens.

Objectives of study

In this undertaking my fundamental goal is to consider the impact of fractional supplanting of fine totals with waste tire rubber and compare these resulted conventional concrete specimens to reference specimen.

- The compressive ability split tensile ability of standard M20 concrete are found out. Likewise compressive quality, split tensile ability were acquired for 4%, 08%, 12%, 16% and 20% supplanting of fine totals with morsel tire crumbs and are looked at.
- To locate the ideal level of scrap elastic that would give the most ideal outcomes in the solid.
- To produce green concrete thereby protecting the environment.
- To diminish the impact of the waste tire elastic as a contamination to nature

Cement

The run of the mill Portland obligation of 53 survey is used as a piece of concurrence with Seems to be: 12269-1987.

Properties of cement had been attempted and recorded underneath.

1. Fineness of cement = 5%
2. Specific gravity of cement = 3.02
3. Standard Consistency of cement = 33%
4. Basic setting time = 50mins
5. Final setting time = Not extra than 10 hours.

Fine aggregate

The specific gravity of the sand was seen to be 2.62 and changing in accordance with zone II of table 4 of IS 383-1970.

Coarse aggregate

The degree of the coarse aggregate is 20 mm and 10 mm. its specific gravity is 2.68.

S.No.	Properties	Fine aggregate (sand)	Coarse aggregate (gravel)
1	Maximum size of aggregate(mm)	2.36	20
2	Bulk specific gravity	2.56	2.71
3	Absorption capacity (%)	1.22	0.46
4	Density (kg/m^3)	1480	1556
5	Fineness modulus	2.71	6.72

Chemical composition of rubber

S.No.	Chemical composition	Percentage (%)
1	Styrene Butadiene Rubber	46
2	Carbon black	44
3	Zinc oxide	1.4
4	Extender oil	1.7
5	Accelerator	0.6
6	Sulphur	0.7
7	Stearic acid	0.5

Chemical composition of rubber

The chemical components present in the waste tyre elastic are mentioned in the table below. The percentages of the components are also given.

METHODOLOGY

To achieve the objectives which are discussed, the test program aims to examine by partially replacing the FA with Waste tyre crumb rubber. In this experimental investigation six castings were done. Table shows the total no of cubes and cylinders casted. In each casting nine cubes each of 150 mm and 150 mm size and 2 cylinders each of 150 diameter and 300 height were cast in order to analyze the strength variability, the table 4.2 shows the dimensions and volume of the cubes and cylinders.

Showing the number of cylinders and cubes casted

S.No.	% replacement of fine aggregates	Compressive strength of concrete			Split tensile strength of concrete
		7 Days	14 Days	28 Days	28 Days
1	0%	3	3	3	2
2	4%	3	3	3	2
3	8%	3	3	3	2
4	12%	3	3	3	2
5	16%	3	3	3	2
6	20%	3	3	3	2
		54 cubes			12cylinders

Showing the dimensions of the cubes and cylinders

S. No.	Type of test	Shape of block	Length (m)	Breadth (m)	Height (m)	Diameter (m)	Volume of 1 block (m^3)
1	Compressive strength	Cube	0.15	0.15	0.15	–	0.00375
2	Split tensile strength	Cylinder	–	–	0.3	0.15	0.0053

Mix design

Developing mix design is a method of calculating the amount of concrete and with their relative amounts of materials to build-up the concrete to attain minimum strength, workability and durability (esteem designed) as it would be possible.

ANALYSIS AND INTERPRETATION

To perform the analysis for concrete mix of M20 grade, design mix is required for estimating the material proportion and after performing the mix design, workability of concrete and slump value are to be known.

Mix design for M20 grade concrete:

- M20 grade concrete test data
- Evaluating the Compressive Strength which is required for the span of 28 days and the grade of the concrete - **M 20**
- Form of Cement : OPC 53 Grade confirming to IS 12269
- Maximal size of aggregate : 20 mm
- Coarse aggregates : Angular
- Type of hazardous/exposure weather conditions of the structure will be subjected to (as defined in IS: 456) : Moderate

Material test data

- Cement used: OPC 53 grade confirming code IS-12269-1987.
- Specific Gravity of Cement : 3.15
- Specific gravity of Fine Aggregate (sand) : 2.70
- Specific gravity of Coarse Aggregate : 2.80
- Water Absorption

  -Coarse Aggregate : 0.4%

  -Fine Aggregate : 1.0%

- While preparing design mix, usually assumed aggregate are to be in saturated and surface dry condition.

Sieve Analysis

Fine aggregates : Confirming to Zone III of Table 4 IS – 383

Mix Design of M 20 Grade Concrete

Number of Cubes = 9

Volume of 1 Cube = 0.15X 0.15 X 0.15

= 0.003375 m^3

Total Volume of Cube = 9 X 0.003375=0.030375 m^3

Volume of 2 Cylinders = 0.01059 m^3

Total Volume = 0.030375 + 0.01059

= 0.04097 m^3

Target strength of mix proportions

Step1: Solving the target strength for mix proportions

$f_t = f_{ck} + 1.65XS$

Where,

f_t =Target average compressive strength at 28 days

f_{ck}= Characteristic compressive strength at 28 days

S = Assumed standard deviation in N/mm^2 = 4 (as per table -1 of IS 10262- 2009)

= 20 + 1.65 X 4.0 = 26.56 N/mm^2

Step 2: Selection of water-cement ratio

Maximum water-cement ratio = 0.50

Step 3 Selection of water content

Maximum water content for 20 mm aggregate

= 186 kg (for 25 to 50 slump).

i.e.,Estimated water content for 100 slump

= 186+ (6/100) X186 = 197.16 litres

Water content = 197.16 litres

Water content = 197.16 kg / m^3

197.16 / C = 0.50,

(Cement) =?

C = 394.32 kg

Fine Aggregate - 40%, Coarse Aggregate - 60%

$$\text{Volume of cement} = \frac{\text{Mass of cement}}{\text{Specific Gravity}} X \frac{1}{1000}$$

$$= \frac{394.32}{3.15} X \frac{1}{1000}$$

= 0.125 m^3

$$\text{Volume of water} = \frac{\text{Mass of water}}{\text{Specific Gravity}} X \frac{1}{1000}$$

$$= \frac{197.16}{1} X \frac{1}{1000}$$

= 0.19716 m^3

Total volume of aggregate = 1- (volume of cement + volume of water)

= 1 - (0.125 + 0.19716)

= 0.678 m^3

Mass of Coarse aggregate = Total volume X specific gravity X 1000

= 0.67 X 0.60 X 2.74 X 1000

= 1111.4 kg

Mass of fine aggregate = 710.619

394.32kg: 710.61 kg : 1111.63 kg

Cement: Fine aggregate: Coarse aggregate

1 : 1.78 : 2.8

Concrete mix proportions for trial number 1

Cement : 394.32kg/m^3

Water : 197.16 kg/m^3

Fine aggregates : 710.61kg/m^3

Coarse aggregate : 1111.62 kg/m^3

Water-cement ratio : 0.5

Final trial mix for M20 grade concrete is 1:1.78:2.8 at w/c of 0.50

Quantities of materials

S. No.	Material	Cement	Fine Aggregates	Coarse Aggregates	Water
1	Weight	394 kg	710.61 kg	1111.62 kg	197.17 kg
2	Proportions	1	1.78	2.8	0.5

- Calculation of quantity of materials required.
- Volume of 1 cube of 0.15X0.15X0.15=0.003375 m^3

Now, cement = (2400/5.58)X0.00337

= 1.45 (approximately 1.5 kg)

FA = 1.63X1.5

= 2.58 kg

CA = 2.8 X1.5

= 4.2 kg

Now, water= 1.5X0.50 = 0.75 litres

- Volume of 1 cylinder = 3.1415X0.075X0.075X0.30

= 0.0053 m^3

Quantity of cement = (2400/5.58)X0.0053

= 2.279 kg

FA = 1.78 X 2.279 = 4.012 kg

CA = 2.8 X 2.279 = 6.381 kg

water = 0.50 X 2.279 = 1.1395 litres

For 45 cubes

Cement = 54 X 1.45 = 78.3 kg

FA = 54 X 2.58 = 139.32 kg

CA = 54 X 4.2 = 226.8 kg

Water = 54 X 0.75 = 40.5 litres

For 12 cylinders

Cement = 12 X2.279 = 27.34 kg

FA = 12 X4.012 = 48.144kg

CA =12 X6.381 = 76.572 kg

Water = 12 X 1.1395 = 13.674 litres

for M20 grade of concrete for each batch of mix

Total cement = 78.3+27.34 = 105.64

Approximately 106 kgs

Total FA = 139.32 + 48.144 = 187.464

Approximately 188 kgs

Total CA = 226.8+76.572= 303.372

Approximately 304 kgs

Water = 40.5+13.67 = 54.17 litres

Approximately 55 litres

Mix proportion quantities of waste tyre crumb rubber percentages

S. No.	Components	Proportions (kilograms)					
		Crumb rubber 0%	Crumb rubber 4%	Crumb rubber 8%	Crumb rubber 12%	Crumb rubber 16%	Crumb rubber 20%
1	Cement	17.66	17.66	17.66	17.66	17.66	17.66
2	Fine Aggregate	31.33	30	28.73	27.43	26.13	24.83
3	Coarse Aggregate	50.56	50.56	50.56	50.56	50.56	50.56
4	Water	9.166	9.166	9.166	9.166	9.166	9.166
6	Waste tyre crumb rubber	--	1.3	2.6	3.9	5.2	6.5

RESULTS AND DISCUSSIONS

To evaluate the compressive, split tensile, flexural strengths for the cubic and cylindrical samples which has been casted, cured and tested by using compressive strength testing machine of 2000 KN.

Table showing the compressive strength values.

S. No.	Specimen of cubes	Days	Compressive Strength (N/mm^2)	Average
1	0% of Crumb rubber in replacement of fine aggregates	7	12.5	12.5
			12.1	
			12.9	
		14	17.4	17.73
			18.1	
			17.7	
		28	19.8	20.2
			20.2	
			20.6	
2	4% of Crumb rubber in replacement of fine aggregates	7	11.85	11.6
			11.36	
			11.55	
		14	16.6	17.46
			18.6	
			17.2	
		28	19.9	20.33
			20.44	
			20.66	
3	8% of Crumb Rubber in Replacement of fine aggregates	7	9.11	9.54
			10.2	
			9.33	
		14	14.44	14.6
			15.11	
			14.23	
		28	16.4	16.9
			17	
			17.3	
4	12% of Crumb Rubber in Replacement of fine aggregates	7	6.88	6.84
			7.33	
			6.33	
		14	11.1	11.8
			11.7	
			12.01	
		28	14.1	14.46
			14.9	
			14.4	
5	16% of Crumb Rubber in Replacement of fine aggregates	7	7.4	7.38
			7.62	
			7.12	
		14	11.41	11.18
			11.12	
			11.01	
		28	13.45	13.17
			13	
			13.1	
6	20% of Crumb Rubber in Replacement of fine aggregates	7	8.3	8.03
			7.77	
			8.1	
		14	11.49	11.09
			10.98	
			10.8	
		28	12.4	12.39
			12.58	
			12.1	

Table showing the split tensile strength values

S.No.	Specimen of cylinders	Days	Split tensile Strength (N/mm^2)	Average(N/mm^2)
1	0% of crumb rubber as replacement.	28	2.12	2.19
			2.26	
2	4% of crumb rubber as replacement.	28	2.47	2.29
			2.122	
3	8% of crumb rubber as replacement.	28	1.42	1.49
			1.56	
4	12% of crumb rubber as replacement.	28	1.20	1.31
			1.43	
5	16% of crumb rubber as replacement.	28	1.13	1.09
			1.05	
6	20% of crumb rubber as replacement.	28	0.99	1.005
			1.02	

The results of the split tensile strength of the concrete with partial replacement of fine aggregates with waste tyre fine pieces. The maximum split tensile strength was achieved at 4%.

Table showing the slump test values

S. No.	Crumb rubber	Slump(mm)
1	0%	52
2	4%	55
3	8%	49
4	12%	45
5	16%	37
6	20%	28

CONCLUSIONS

The cubes and cylinders are casted after replacing fine totals with morsel tyre elastic according to the mix proportions calculated, wet curing of cubes and cylinders is done. Later the cubes and cylinders are dried and the compressive and split tensile abilities are tested. Based on the above tests performed, results obtained with varying the percentage of morsel tyre elastic in the concrete mix the following conclusions are drawn.

- The compressive ability of blocks are expanded by supplanting of fine totals with piece rubber powder up to 4% and any advance in expansion of scrap rubber percentage the compressive ability reduces drastically.
- The slump value also decreased with increase in the percentage of crumb rubber. Its value was highest when the crumb tire percentage was 4%.
- The split tensile ability of blocks are expanded by supplanting of fine totals with piece rubber powder up to 4% and any advance in expansion of scrap rubber percentage the split tensile ability reduces drastically.
- These discoveries demonstrate that it isn't prudent to utilize elastic totals in concrete blends for high quality and load bearing applications, however its usage in low quality concretes in less percentages is advisable as it can tackle the issue to some extent.
- Elastic total can be utilized as a part of different applications for non-stack bearing segments, for example, street clearing, ground surface, patio, artificial turfs and other works.
- Utilization of scrap tires will tackle the issues of its transfer, thus keeping nature free from contamination.

Future scope

By differing water cement proportion and utilising dispersing agents the compressive ability of blocks can be checked for similar extents of materials. The admixtures like fly ash, ground granulated blast furnace slag, silica fumes can be included which are temperate and solid to expand the abilities of concrete. With similar material, the investigations can be performed for higher evaluations. Same extents of materials should be possible with higher grades of cement. Crumb rubber fineness can be varied and the experiments can be performed, fine totals and coarse totals percentage can be replaced little bit with crumb rubber and experiment can be performed.

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