Effect of Crumb Rubber Material on Concrete Mix

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ABSTRACT : *The term concrete mix design may be defined as the process of selecting suitable ingredients for construction of concrete and to determine their relative amounts with an objective to produce a concrete mix having the required, strength, workability, and durability in as economical manner as possible. The plastic and the hardened states are the two states governing the proportioning of ingredient of the concrete mix. If the concrete (in plastic state) is not workable it becomes difficult to be properly placed and compacted. Therefore, the property of workability becomes of vital importance. The present work is based on the effect of addition of rubber crumbs on Portland cement concrete. The present study is based on studying the effects of replacement of 5% and 10% of coarse aggregates by rubber crumbs on Portland cement concrete.*

Keywords *– aggregates, compressive strength, concrete, weight loss, rubcrete.*

I. INTRODUCTION

Every year, at an average of about 11,000,000 new vehicles are added to the Indian roads. Also, there is an increase of about 30,000,000 discarded tyres each year which pose a potential threat to the environment. Though, the tyres are being recycled yet there is a significant number of tyres added to the existing tire dumps or landfills. The generation of such waste tyres far exceeds than that which are now being recycle. Waste rubber tyres cause serious environment problems all around the globe. Thus, this accumulated waste material can be used for the civil engineering construction.

Earlier studies have been performed on the use of worn out tyres in the asphalt mixes which were found to be very promising. Although, not much attention has been given to the use of rubber (obtained from scrap tyres) in Portland cement concrete.

II. MATERIALS USED

1. COARSE AGGREGATES: 20 mm nominal size aggregates are used confirming to IS 383.
2. FINE AGGREGATES: Sand confirming to IS : 383 has been used.
3. CEMENT: 43 grade cement conforming to IS : 8112 has been used.
4. WATER: Portable clean water has been used for concrete construction and curing confirming to IS : 10262
5. TYRE CRUMB: The crumb rubber basically consists of particle size ranging in from 4.75 mm to 0.075 mm. The methods used to convert scrap (discarded) tyres into crumb rubber are
   (i) cracker mill process,
   (ii) granular process and
   (iii) micro mill process.

III. PROPERTIES OF RUBCRETE

In the early study it was found that coarse grading of rubber granules lowered the compressive strength of rubber mixtures more than fine grading. There was about 85% reduction in compressive strength and 50% reduction in tensile strength when the coarse aggregate was fully replaced by coarse rubber chips. However, it was observed that the specimen lost about 65% of their compressive strength and 50% of their tensile strength when the fine aggregate was fully replaced by fine crumb rubber. The more rough the rubber used in concrete mix the better the bonding developed between the surrounding matrix and the rubber particles which results in higher compressive strength. If somehow the bond between the surrounding cement paste and the rubber particles is improved then significantly higher compressive strength of rubcrete can be obtained.

IV. METHODOLOGY

1. CONSTRUCTION OF CONCRETE MIXES: The concrete mixes are prepared so as to achieve target strength of 10N/mm ^{2} (i.e. M 10 concrete). The proportion used for concrete mixing is 1 : :3 : 6. The quantity of material used for construction of 9 cubes for each mix are tabulated below.

Table 1. Weight of materials used in concrete mix

Materials	Cement (kg)	Sand (kg)	Aggregate (kg)	Crumbs (kg)
Mix 1 (Normal)	8.1	24.3	48.6	-
Mix 2 (5% crumbs)	8.1	24.3	46.17	2.43
Mix 2 (10% crumbs)	8.1	24.3	43.74	4.86

2. PREPERATION OF CONCRETE CUBES
The concrete cubes were prepared in accordance to IS : 516. The cubes were kept in normal curing conditions for 7 days, 14 days and 28 days in water.

3. SLUMP CONE TEST
The fresh concrete mixes were tested for their consistency with the help of slump cone test.

4. DETERMINATION OF WEIGHT OF CUBES
The weight of each concrete cube was measured with the help of electronic weighing machine having an accuracy of 10 grams.

5. TESTING FOR COMPRESSIVE STRENGTH
The concrete cubes were test for compressive strengths after the completion of their curing period.

6. COMPARITIVE STUDY
Comparative study for slump, weights and compressive strengths of concrete cubes of all the three mixes is carried out.

V. RESULTS

1. SLUMP CONE TEST
The following results are obtained for the slump cone test performed on different concrete mixes.

Table 2. Slump Values for different concrete mixes

	Slump (mm)			Avg. Slump
Mix 1 (Normal)	35	32	33	33.33
Mix 2 (5% crumbs)	38	36	35	36.33
Mix 2 (10% crumbs)	40	38	37	38.33

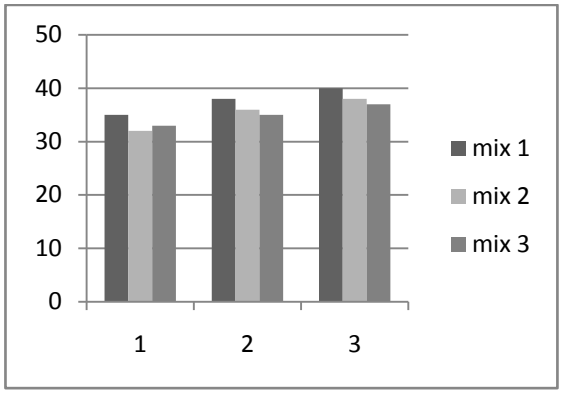

Fig. 1. Bar Chart for comparison of slump values for different concrete mixes.

2. WEIGHTS OF CONCRETE CUBES
The comparison of weights of all the three mix obtained are tabulated below:

Table 3. Weight of all concrete cubes for all three mixes

Weight of Cubes (kgs)			
Cube No.	Mix 1	Mix 2	Mix 3
Cube 1	8.5	8.27	8.06
Cube 2	8.65	8.3	8.12
Cube 3	8.7	8.36	8.09
Cube 4	8.57	8.31	8.09
Cube 5	8.55	8.37	8.06

Cube 6	8.6	8.42	8.01
Cube 7	8.58	8.26	8.14
Cube 8	8.62	8.31	8.2
Cube 9	8.77	8.33	8.12
Average Weight	8.6	8.3	8.1

Table 4. Percentage variation in weights of rubcrete mixes when compared to normal concrete mix

Cube No.	Percentage reduction in weight	
	Mix 2	Mix 3
Cube 1	2.71	5.18
Cube 2	4.05	6.13
Cube 3	3.91	7.01
Cube 4	3.03	5.60
Cube 5	2.11	5.73
Cube 6	2.09	6.86
Cube 7	3.73	5.13
Cube 8	3.60	4.87
Cube 9	5.02	7.41
Average % reduction	3.4	6.0

3. COMPRESSIVE STRENGTH OF CUBES

The load sustained by cubes (before failure) as obtained after 7 days, 14 days and 28 days of curing are tabulated below.

Table 5. Load taken by cubes before failure

Cube No.	Load (KN)			No. of days
	Mix 1 (Normal)	Mix 2 (5% crumbs)	Mix 3 (10% crumbs)	
Cube 1	160	165	145	7
Cube 2	165	175	160	
Cube 3	175	180	165	
Cube 4	210	225	200	14
Cube 5	210	220	190	
Cube 6	220	230	185	
Cube 7	230	260	200	28
Cube 8	240	245	230	
Cube 9	240	250	230	

Table 6. Average compressive strength of cubes obtained after 7 days, 14 days and 28 days of curing

Cube No.	Load (KN)			No. of days
	Mix 1 (Normal)	Mix 2 (5% crumbs)	Mix 3 (10% crumbs)	
Cube 1	7.11	7.33	6.44	7
Cube 2	7.33	7.78	7.11	
Cube 3	7.78	8.00	7.33	
Average	7.41	7.70	6.96	
Cube 4	9.33	10.00	8.89	14
Cube 5	9.33	9.78	8.44	
Cube 6	9.78	10.22	8.22	
Average	9.48	10.00	8.52	
Cube 7	10.22	11.56	8.89	28
Cube 8	10.67	10.89	10.22	
Cube 9	10.67	11.11	10.22	
Average	10.52	11.19	9.78	

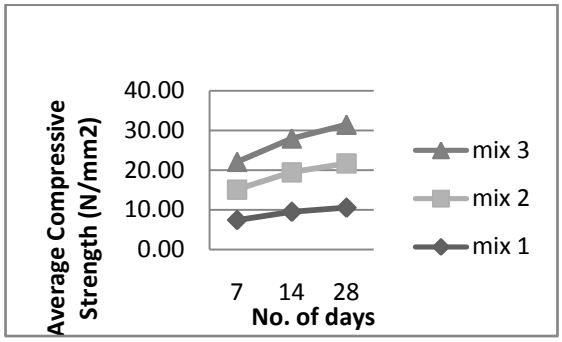

Fig. 2. Comparison of average compressive strength of cubes in 7 days, 14 days and 28 days

Table 7. Percentage average reduction in compressive strength of cubes of rubcrete obtained after 7 days, 14 days and 28 days of curing are tabulated below

No. of days	Percentage average reduction in compressive strength	
	Mix 2	Mix 3
7	-4.00	6.00
14	-5.47	10.16
28	-6.34	7.04

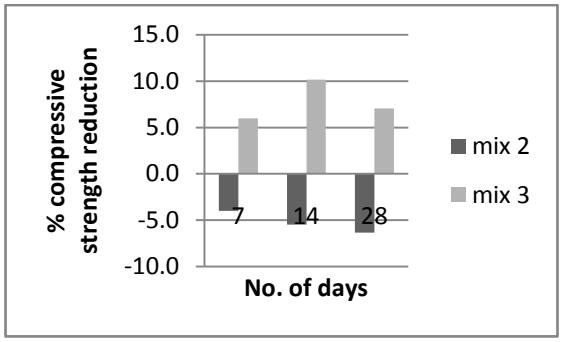

Fig. 3. Bar chart for average compressive strength reduction of mix 2 and mix 3 in comparision to mix 1

VI. CONCLUSION

The following conclusions are obtained from the present study:

1. The addition of rubber crumb resulted in increase in workability. The increase in workability is in direct proportion to the amount of rubber crumb added. The average slumps of mix 1, mix 2 and mix 3 are obtained as 33.33, 36.33 and 38.33 mm, respectively.

2. The addition of rubber crumbs resulted in reduction in weight of concrete. The reduction in weight is in direct proportion to the amount of rubber crumb added. The average weights of mix 1, mix 2 and mix 3 are obtained as 8.6, 8.3 and 8.1 kgs., respectively.

3. The addition of rubber crumbs resulted in increase in compressive strength of concrete at first and then it reduces.

4. The average increase in compressive strength of mix 2 for 7, 14 and 28 days is obtained as 4%, 5.47% and 6.34%, respectively.

5. The average reduction in compressive strength of mix 2 for 7, 14 and 28 days is obtained as 6%, 10.16% and 7.04%, respectively.

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