Use of Waste Rubber Chips for the Production of Concrete Paver Block

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Abstract - *This paper attempts to carry out study on use of waste rubber chips at the percentage of 0%, 5%,10%, 20% and 40% to be used in the production of concrete paver block. Morever, after preparing this specimens by using mix proportions of M20 to be used, these samples are kept in water tank for curing period of 7 days. Then samples are taken out and their hardened concrete properties such as unit weight and compressive strengths test are carried out and their strengths are calculated. Conclusions are drawn from the results of the tests.*

***Key Words*: Paver Block, Compressive strength, Rubber Chips, Unit weight.**

1.INTRODUCTION

Worldwide uses of rubber products are increasing every year. A significant proportion of waste rubber is generated during the manufacturing process of rubber products, and the disposal of such waste has been a problem due to the non-degradable complex structure of rubber and categorized as hazardous waste. Previous studies have shown that adding waste rubber increases the skid resistance and decreases abrasion resistance while making it more flexible. However, compressive strength get reduced with the addition of rubber waste. Therefore, further studies are necessary to find a balance between the desired properties and come up with an optimum mix design for rubberized concrete. Most of previous studies are related to use of crumb rubber. Therefore, attempts are made to carry out an experimental study to develop a mix which gives the required compressive strength with the highest proportion of waste rubber content in the mix to give a value addition to this waste product. (Gamalath H., 2016).

Advantages of using Rubber in concrete:

1. The rubber concrete is affordable and cost effective.
2. It resists the high pressure, impact and temperature.
3. They have good water resistance with low absorption, improved acid resistance, low shrinkage, high impact resistance, and excellent sound and thermal insulation.

1.1 Material Properties:

A. Cement:

In manufacturing of paver blocks OPC 53 grade will be used. The properties of the cement are as follows:
Fineness of cement - 90%,
Standard consistency of cement – 32%,
Initial setting time of cement – 30min,
Final setting time of cement – 360min,
Specific gravity – 2.3,
Strength of cement – 38.32 N/mm2 (for 28 days)

B. Fine Aggregates:

Locally available river sand conforming to grading zone-III was used. The sand was crushed sand screened at site to remove deleterious material. The fineness modulus of sand used is 2.45 and with a specific gravity of 2.65.

C. Coarse Aggregates:

In the present study a locally available coarse aggregate from quarry was used. The aggregate has been conforming to the Indian standard code of IS: 383:1970 will be selected. The nominal size of coarse aggregate used for pavers is 10-12 mm size. The test made on the coarse aggregate is specific gravity 2.45 and fineness modulus of 3.84. The weight ratio of course to fine aggregate of all paving blocks was kept to about 1 : 2 throughout the whole experimental works.

D. Silica Fume:

It is used to provide proper finish to the paver block.

E. Water:

Water used in the experimental work is conformed to IS: 456-2000 for mixing as well as curing of Concrete specimens.

F. Rubber Chips:

The scrap tyre are collected and cut into small pieces. The rubber chips are sieved through 12 mm and retained in 10 mm for the replacement of coarse aggregate as shown in figure 1.

Fig -1: Rubber chips.

2. PREPARATION AND DETAILS OF TEST SPECIMEN:

In the present experimental investigation, the total numbers of specimens casted were 6. Out of 6 samples, Specimen ID 1 has no rubber chips content and admixtures. Specimen Id 2 has no rubber chips content but the presence of hardner. Specimen Id 3 contains 5 % rubber chips are present in blocks without use of admixture. Similarly Specimen Id 4 and 5 contains each respectively of 10% and 20 % rubber chips with no admixtures. Specimen Id 6 contains 40% rubber chips and with use of admixtures. The presence of rubber chips in paver block in wet condition is as shown in figure 2.

Fig -2: Presence of rubber chips in paver blocks.

2.1 Mix Proportion:

The casting of rubber concrete contains waste tyre rubber chips of 12 mm with partial replacement of coarse aggregate at various percentages like 0%, 10% & 20% and 40%. The mix identification is given in the table 1.

Specimen ID	Mix	No. of Specimens for 7 days curing
P1	Control Specimen	1
P2	Control Specimen with admixture	1
P3	P1+5% Rubber Chips	1
P4	P1+10% Rubber Chips	1
P5	P1+20% Rubber Chips	1
P6	P1+40% Rubber Chips+ Admix.	1

Table -1: Mix Identification

Paver blocks were casted in mould of size 320x210x70mm. Mix proportion for all specimen was cast as per the ratios are given in table 2. After that the coarse aggregate was replaced with 5%, 10%, 20% and 40% crumb rubber by weight of fine aggregates. The water cement ratio is taken as 0.31. Mix M20 has been adopted.

2.2 Casting of control specimen:

The ingredients for various mixes were weighed, required water was added and mixed by using concrete drum mixer machine as shown in figure 3. After preparing mix, the concrete was placed in moulds and the moulds were placed on machine vibrator for compaction as shown in figure 4. Specimens were cast for the determination of unit weight and compressive strength respectively. The specimens were demoulded and placed immediately in water tank for curing.

Fig -3: Drum mixing machine.

Fig -4: Placing of blocks on vibrating platform.

3. TEST RESULTS & DISCUSSIONS:

3.1 Unit weight:

The unit weight values used for the analysis of this section are measured from the paver block samples after 7 days of curing. The results for the unit weight are presented in table 2 and figure 5 demonstrates the comparative decrease in unit weight of the rubberized concrete in contrast with the respective control concrete.

No.	Specimen ID	Mix	Unit Weight (Kg/m³)	% Reduction
1	P1	Control Specimen	1749.31	0.00
2	P2	Control Specimen with admixture	1609.60	7.98
3	P3	P1+5% Rubber Chips	1755.21	0.00
4	P4	P1+10% Rubber Chips	1702.08	2.70
5	P5	P1+20% Rubber Chips	1674.53	4.27
6	P6	P1+40% Rubber Chips+ Admixture	1576.15	9.89

Table -2: Unit weights of the control concretes and rubberized concrete. (7 Days)

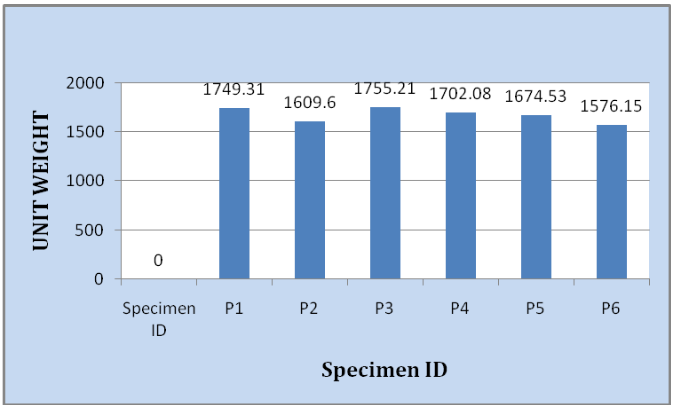

Fig -5: Comparative graph of Unit weights.

From the figures it can be seen that density reduces by the addition of rubber aggregates. The general density reduction was to be expected due to the low specific gravity of the rubber aggregates with respect to that of the mineral aggregates. The reduction in density can be a desirable feature in a number of applications. From table 5.2, we can see that for specimen P1, Unit weight is 1749.31. For Specimen P2 unit wt. is 1609.60 and percentage reduction is 7.98. For P3, unit wt. is 1755.21 and there is no percentage reduction. For specimen P4, unit wt. is 1702.08 and percentage reduction is 2.70. For specimen P5, unit wt. is 1674.53 and percentage reduction is 4.27, finally for specimen P6, unit wt. is 1576.15, percentage reduction is 9.89.

3.2 Compressive Strength:

Compressive strength is defined as the capacity of a material or structure to resist compression when a load is applied on it, in order to push it together. In other words, we can say compressive strength of a material can also be defined as the minimum amount of load required at which that particular material breaks down.

In this experiment we have tested all the blocks that we had casted with different ratios of crumb rubber for their compressive strengths. After finishing, the samples were covered with sheets to minimize the loss of moisture. The specimens were de-moulded after 24 hours and then kept in water for curing. The compressive strength test was carried out after 7 days.

No.	Specimen ID	Mix	Compressive Strength (MPA) at 7 days	% Strength Loss
1	P1	Control Specimen	6.70	0.00
2	P2	Control Specimen with admixture	6.85	0.00
3	P3	P1+5% Rubber Chips	5.95	11.19
4	P4	P1+10% Rubber Chips	5.21	22.23
5	P5	P1+20% Rubber Chips	4.46	33.43
6	P6	P1+40% Rubber Chips+ Admixture	3.72	44.47

Table -3: Compressive strength test results.

The compressive strengths of concrete specimens were determined after 7 days of curing. For rubberized concrete, the results show that the addition of rubber aggregate resulted in a significant reduction in concrete compressive strength compared with the control concrete. The reason for the compressive strength reductions could be attributed both to a reduction of quantity of the solid load carrying material and to the lack of adhesion at the boundaries of the rubber aggregate. Soft rubber particles behave as voids in the concrete matrix. The compressive strength test results of block after 7 days are as shown in table 3.

From table 3, we can see that compressive strength for specimen P1 is 6.70, compressive strength for specimen P2 is 6.85 and there is no percentage loss in strength, compressive strength for specimen P3 is 5.95 and percentage loss in strength is 11.19%. Compressive strength of specimen P4 is 5.21 and percentage strength loss is 22.23%, Compressive strength of specimen P5 is 4.46 and percentage strength loss is 33.43%, Compressive strength of specimen P4 is 3.72 and percentage strength loss is 44.47%. From the results we can see that as the percentage of rubber goes on increasing, the compressive strength of the block goes on increasing, and ultimately affects on the % reduction in strength. Results in the form of graph are as shown in figure 6.

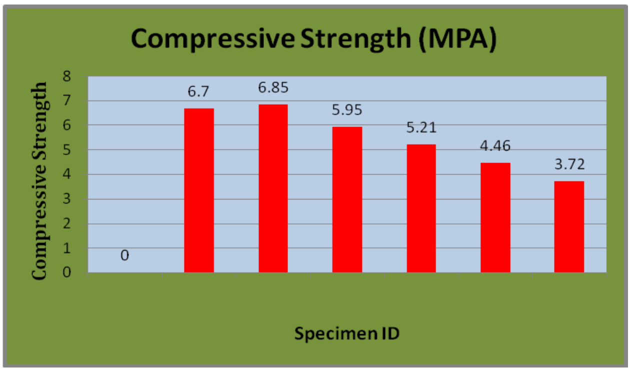

Fig -5: Compressive strength test results.

3. CONCLUSIONS

a) The introduction of recycled rubber tires into concrete significantly increased the slump and workability. It was noted that the slump has increased as the percentage of rubber was increased.
b) For rubberized concrete, the test results show that the addition of rubber chips resulted in a significant reduction in concrete compressive strength compared with the control concrete. This reduction increased with increasing percentage of rubber chips.
c) The overall results of this study show that it is possible to use recycled rubber tires in concrete construction as a partial replacement for coarse aggregates. However, the percentage replacement should be limited to specified amounts as discussed above and the application should be restricted to particular cases where the improved properties due to the rubber aggregates outweigh the corresponding demerits that may occur due to them.
d) Rubber replacing concrete can be used in light weight concrete as it decreases the density of the concrete.

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