Partial Replacement of Aggregate with Debris and Glass Waste in Interlock Paver Brick

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Abstract- **The main objective of this paper is to partially replace of coarse aggregate and fine aggregate with demolition waste and glass pieces in paver brick. Pavement are blocks mostly prepared by concrete which are used in pavements used in street roads, parking areas, patios, kitchen slabs and pavements. By using debris and glass pieces in formation of paver blocks the cost of construction is reduced as waste material are used and so it is good for environment. By using glass pieces and debris the cost of paver brick is reduced as compared to that of convention concrete paver bricks. This research is conducted to study and investigate the potential of using waste material as partial substitute for aggregate in producing concrete paving block. The proportion adopted to make concrete paver block is 1:1:2, i.e. 1 part of cement, 1 part of sand, 2 part of aggregate. Three different proportions are created by partially replacing coarse aggregate by debris and fine aggregate is replaced by glass partials. debris and glass waste is taken in replacement of 25, 30, 35 the percentage of coarse aggregate and 30, 35, 40 the percentage of fine aggregate respectively in concrete paver block. Compressive strength has been conducted in concrete paver block after 7, 14, 28 days curing. Compressive strength is then calculated to check the strength of paver blocks. Thus, strength and costing is calculated for all three proportions.**

Index Terms- **Pavement, paver blocks, debris, glass pieces, partial replacement.**

I. INTRODUCTION

Paving blocks are easy to manufacture if adequate location of space and water is available. Paving block are concrete material. Concrete paver blocks were replacement of paver bricks which were first introduced in Holland in fifties. Concrete paver blocks had same size as the bricks and were rectangle in shape. When we see the changes in paver blocks in last five decades it has changes a lot in shape from rectangular or non-interlocking to partially interlocking to complete interlocking shapes. If the pavement doesn't have interlocking properties, then it is called as 'non-interlocking Pavement Block' or 'Concrete Pavement Block' and if it has interlocking properties (partially or completely) then it is called as 'Interlocking Concrete Block Pavement'. Paving blocks are widely used in India in both areas having light or heavy traffic. Paving blocks comes in different sizes and shapes as per requirements.

A semi dry mix is prepared for manufacturing of interlocking concrete paving blocks. In the the mix vibration and pressure is applied during manufacturing. Through this process dense and strong concrete paving blocks can be formed. concrete paving block which provides interlocking behavior spreads the loads to larger areas. Interlocking stone paving blocks are superior to asphalt and stone pavements in terms of structural, aesthetics, construction and maintenance, workmanship and economic properties. Like other pavements, the design of concrete pavements is based on the influence of the environment, traffic, sub-base support and pavement materials and their interactions.

Demolition waste is the waste generated when buildings, roads, bridges or other objects are destroyed. Demolition waste comes from the construction, renovation, repair and demolition of buildings, buildings, roads, bridges and other structures. The most common types of waste from demolition activities are bricks, tiles, stones, plastics, etc. garbage that is thrown away after something is destroyed. Glass is a versatile product with many uses, and although it is recyclable, it is far from taking full advantage of glass waste. According to the US Environmental Protection Agency (2020), only 2.75 x 109 kg of the 10.32 x 109 kg glass produced in the USA was recycled in 2017, which equates to 26.6% of the total produced.

Concrete is the most widely used for all type of construction in the world. Using waste and recycled materials in concrete mixes for paver blocks becoming increasingly important to manage and reduce waste generation material. In this study partially replacement of course and fine aggregate with debris and glass waste in the percentage of 25, 30, 35 and 30, 35, 40 respectively in concrete paver block. Compressive strength has been conducted in concrete paver block after 7, 14, 28 days curing which gives satisfactory result.

II. LITERATURE REVIEW

Mwalimu K.Musau et al.(2020): Rice husk is a product of rice grown in central and western Kenya. Rice husk processing is a major challenge for companies that process rice, and only a few rice husks are used by companies that produce cement for their boilers. To find another way to use rice husk, this study was conducted to investigate its partial suitability as a substitute for coarse aggregate in paving slabs. Seven conversion rates are used: 5%, 10%, 15%, 25%, 50%, 75% and 100%. The samples were tested for compressive strength, tensile splitting strength and water absorption. It has been determined that the parquet bricks at 5% change have a compressive strength of 65.61MPa and thus are suitable for use in areas with heavy traffic. In addition, paving bricks made with 10% and 25% change are suitable for medium-traffic areas, and their compressive strength is 46.86MPa and 45.08MPa, respectively.

Jeevan Ghuge et al. (2019): Concrete is the most used material in the world. The use of waste and recycled materials in concrete mixes for paving blocks is an important contribution to the management and disposal of industrial by-products and municipal waste. These bricks are rectangular and approximately the same size as the bricks. Over the last five years, blocks have gone from noninteractive to partially interactive to fully interactive. The use of non-biodegradable plastic waste is growing rapidly and poses a threat to the environment in many ways. This study demonstrates the use of waste plastic to create paving stones and how it can be effectively made from waste plastic material.

Mayur A Patil et al. (2017): Targeted paving blocks using high-grade steel fibers and fly ash. In this project. The performance was evaluated of treated or untreated pavers with the addition of superplasticizer. The effect of adding steel fiber and fly ash on the compressive strength of paving bricks were analysed and the paver block test was performed of composite construction grade M40 showed higher strength after 7 and 14 days compared to the paver composite. Similarly, 28-day strength increased by 54% compared to the average 7-day paver block. The cost difference is not huge, but paver blocks containing fly ash and steel fibers were proven to be more efficient.

B. Shanmugavalli et al. (2017): The aim of this project is to replace cement in paver blocks with plastic waste and reduce the cost of paver blocks compared to concrete. Currently, India produces around 56 tons of plastic waste every year. The degradation rate of plastic waste is very slow. Therefore, this project helps to reduce plastic waste in a meaningful way. They used a variety of plastic waste, ground materials, coarse aggregate and ceramic waste for this project. Slab blocks were prepared and tested and the results were discussed. The conclusions drawn from the experimental analysis were that using plastic waste to produce paving blocks is a good way to deal with plastic waste, compared to concrete blocks and the cost of paving blocks is reduced, paving blocks consisting of plastic waste, soil material, coarse aggregate and ceramic waste are better found. It also shows well in the heat. Although the compressive strength is lower than the stone facing brick, it can be used in garden, walking, cycling, etc.

III. MATERIAL USED

Material used for manufacturing of paver blocks are:

- **Cement**: - OPC 43 quality is used in paving stones.
- **Coarse Aggregate**: - Aggregates are an important component in concrete. Aggregate prevents the concrete from shrinking and it also disrupt the economy. The aggregate used to create the paver blocks is robust and free of cellular particles. In this study, the nominal size of the coarse aggregate is 5-10 mm.
- **Fine Aggregate**: - The basis of fine aggregate for paving bricks is water sand or artificial sand made from crushed stones. Cleaning according to BS 882 does not contain salt and other harmful substances.
- **Debris**: - Debris is generated during the construction, renovation, repair and demolition of buildings, large buildings, bridges and other structures. The most common types of waste from demolition work are brick, tile, stone, plaster, etc. The product is size 4.75-8.5mm IS screen.
- **Glass**: - Used by breaking glass into small partials. In this study, glass that passes through 4.75 mm IS sieve and holds 300 microns is used.
- **Water**: - The amount of water is important to complete the reaction and ensure a proper process. The water used to mix the concrete is drinking water with a pH of 7.5, free of organic matter and a solid content within the limits allowed by IS 456-2000.

IV. METHODOLOGY

Following steps involve for making interlock concrete paver block:

Proportioning: - Proportioning refers to the selection of components necessary to prepare a concrete. Choosing a proportion has a balance between work and placement, strength, durability, density and quality requirements. The desired properties depend on how the concrete will be used and the conditions it must meet when placed. The ratio of our concrete is 1:1:2 and it is 1-part cement, 1-part sand and 2- parts mixture. We use additives as demolition waste and glass waste.

Batching: - Each batch contains test of nine paver block specimen which were cured for 7, 14, 28 days before compression test.

Table 1 Batch classification

Batch no.	Percentage of replacement	Name of material
1	25	Debris
	30	Glass
2	30	Debris
	35	Glass
3	35	Debris
	40	Glass

Mixing and slump cone test: - Optimum amount of water is added and all materials are mixed well. After mixing the slump cone test were conducted on all three batch to check consistency of concrete. Zero slumps are preferred for making concrete paver brick.

Fig 1: - zero slump concrete mix

Moulding and Demoulding: - The concrete mix is poured into an I-shaped rubber mould measuring 200mmx160mmx60mm. Concrete mixed in the mould is compacted for three minutes using a vibrating table to ensure that there are no voids in the mould and to remove air bubbles from the mixture. After compression, the blocks are removed from the mould and placed in a house away from direct sunlight and wind for 24 hours

Fig 2: - Moulding of Bricks

Curing: - When the blocks are hardened curing is performed with water to permit complete moisturized for 7, 14 and 28 days. Water in the curing tanks is changed every 3 to 4 days. After curing, the blocks are dried in natural atmosphere and sent for test.

Test: - In order to investigate the strength increase of concrete, the compressive strength of each group was determined after 7, 14 and 28 days of curing. Compressive strength (N/mm2) = Failure load / cross-sectional area of sample brick.The test uses a 2000KN capacity compression testing machine. The compressive strength of all samples is calculated as follows:

Figure 3: - Compressive strength test

RESULT AND DISSCUSION

Experimental studies were carried out on concrete paving blocks. The tests included workability tests, slump cone tests and compressive strength tests for each group. According to the results, opinions and discussions are as follows: -

- When the replacement value of coarse aggregate and fine aggregate is 35% and 40%, respectively, concrete has the highest compressive strength with 52.02 MPA.
- As the variable increases, the power increases.
- Paving bricks made with 30% coarse aggregate substitution and 35% fine aggregate substitution can be used in heavy vehicles, and those with strong substitution for medium traffic.

Compressive strength test results given below:

Table 2 Compressive Strength at 7 Days

S.No.	% Debris	% Glass	Compressive strength in (N/mm2)	Avg. Compressive strength in (N/mm2)
1	25	30	45.27	45.18
			45.02	
			45.27	
2	30	35	43.27	43.42
			43.33	
			43.66	
3	35	40	41.53	41.37
			41.03	
			41.56	

Table 3 Compressive Strength at 14 Days

S.No.	% Debris	% Glass	Compressive strength in (N/mm2)	Avg. Compressive strength in (N/mm2)
1	25	30	53.36	53.33
			53.36	
			53.29	
2	30	35	53.25	51.65
			50.32	
			51.39	
3	35	40	48.46	48.31
			43.93	
			52.53	

Table 4 Compressive Strength at 28 Days

S.No.	% Debris	% Glass	Compressive strength in (N/mm2)	Avg. Compressive strength in (N/mm2)
1	25	30	56.14	56.54
			56.71	
			56.78	
2	30	35	50.07	49.29
			47.07	
			50.75	
3	35	40	51.5	52.02
			56.5	
			48.53	

Table 5 Material Cost

S. No.	Name of Material	Rate/kg	Batch 1		Batch 2		Batch 3	
			Quantity in kg	Amount	Quantity	Amount	Quantity	Amount
1	Cement	6.50	8.39	54.52	8.39	54.52	8.39	54.52
2	Sand	1.30	13.07	16.99	12.29	15.97	11.40	14.82
3	Coarse aggregate	1.00	5.92	5.92	5.51	5.51	5.94	5.94
4	Glass	2.00	4.39	8.78	5.27	10.53	6.15	12.29
5	Debris	0.50	2.52	1.26	2.94	1.47	3.36	1.68
Cost of Material for 9 Paver Block				87.48		88.00		89.26

V. CONCLUSION

Based on test results and further analysis, can draw the following conclusions:

1. The results of this study show that coarse aggregate can be replaced by debris and fine aggregate can be replaced by glass particles.
2. The price difference is not significant, but pavers made of debris and glass turned out to be more productive.
3. Using waste and glass in paver blocks production is a good way to deal with waste.
4. Create a sustainable environment for autonomous and light vehicles.

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