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Properties of Paver Blocks with Groundnut Husk Ash as Fine Aggregates

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Abstract - *Use of concrete Paver Blocks in road pavements is more common nowadays. Concrete Paver Block is a better option in road construction when compared to the conventional road which is made by bitumen and gravel from the point of view of cost and better suitability. As India is a developing country, construction of roadways and buildings plays an important role. In the present investigation paver blocks were prepared using M40 mix using 10 mm Coarse aggregates, Portland Pozzolana Cement and Fine Aggregates .The dimension of the paver block is 215 x 170 x 55 mm. The fine aggregates were partially replaced using Groundnut husk ash in percentage of 0, 10, 20, 30, 40, 50, and 60. Tests were carried out to find out the Compressive Strength, Water Absorption and Density. The main objective of this paper is to use waste products like groundnut husk ash for the production of Paver Blocks which will useful in construction.*

Key Words: Paver Block, Groundnut Husk Ash, Compressive Strength, Water Absorption

1. INTRODUCTION

Concrete plays a vital role and a huge quantity of concrete is being used in every construction practices. Concrete blocks have become an attractive and cost-effective alternative to both flexible and rigid pavements. The strength, durability and aesthetically satisfying surfaces of paver blocks have made them attractive for many applications such as pedestrian walks, parking areas, container yards and roads. Overall behavior and performance of concrete paver blocks used are mainly governed by properties of materials, water cement ratio, mixing process and curing process. The conventional sources of fine aggregates for paving blocks are river sand or alternatively, artificial sand by crushing rocks. Recently, rapid developments in infrastructure have caused an increased demand for river sand, which is largely used as a fine aggregate for construction. The removal of sand from river bed and river banks may cause unfavorable effects on the environment, like erosion of river banks, degradation of river beds and deterioration of river water quality. Several research works have been carried out in the past to study the feasibility of utilizing waste materials and industrial byproducts in the manufacturing of paver blocks. Replacement fine aggregate by crusher dust up to 50% by weight has a insignificant effect on the reduction of any physical and mechanical properties of concrete paver blocks while there is a saving of 56% of money[1].It is also possible to use recycled plastic aggregates in concrete mix up to 20% in the making of paver blocks [2].The addition of polyester fiber by 0.4% in paver blocks gives maximum compressive, flexural strengths and minimum water absorption at 7 and 28 days[3].Utilization of brick kiln dust up to 15 % as a replacement material for cement is effective in the construction of the paver blocks[4]. Also the use of fly ash in paver block can solve the disposal problem, reduce cost and produce a greener ecofriendly paver blocks for pavements [5].The aim of this work was to study the use of groundnut husk ash as fine aggregates to produce concrete blocks for paving.

2. MATERIALS AND METHODS

2.1 Materials used

Fine aggregates

The fine aggregate used for the study consists of natural river sand and groundnut husk ash. The fine aggregate was sieved by using 4.75 mm sieve to eliminate deleterious materials and over sized particles. Groundnut husk ash was used as a replacement material for natural river sand. The fine aggregates used in the present investigation confirms to the requirements of Indian standard specifications as shown in Table 1.

Table -1: Physical properties of fine aggregates

S.No	Property	River sand	Groundnut husk ash	Test method
1	Grading Zone	II	II	IS: 383-1970
2	Fineness modulus	2.79	2.86	IS: 383-1970
3	Specific gravity	2.58	2.13	IS: 2386(Part III)-1963

Coarse Aggregate
The coarse aggregates shall conform to the requirement of IS 383. For ensuring durability, the aggregate used for the manufacturing of paver blocks shall be sound and free from honeycombed particles. The nominal size of coarse aggregates used in the production of paver block was 10 mm. The specific gravity of coarse aggregate was found to be 2.65.

Cement
The cement used for this work is Portland Pozzolana cement. The specific gravity of cement was tested as per IS: 4031 (Part III) - 1988 and was found to be 3.1.

Mix proportion
Paver blocks were cast using M40 grade of concrete designed as per IS 10262: 2009. Mix ratio obtained was 1:2.83:2.48 with a water-cement ratio of 0.5. The cement content is limited to 350 kg/m³. Fine aggregate was partially replaced with groundnut husk ash at various percentages such as 0,10, 20 , 30, 40 , 50 and 60. The details of different mix proportions are given in Table 2.

Table -2 :Mix proportions

S.No	Mix ID	River sand kg/m³	Groundnut husk ashkg/m³	Coarse Aggregate kg/m³
1	FA_{100} G_0	992	0	868
2	FA_{90} G_{10}	892.8	99.2	868
3	FA_{80} G_{20}	793.6	198.4	868
4	FA_{70} G_{30}	694.4	297.6	868
5	FA_{60} G_{40}	595.2	396.8	868
6	FA_{50} G_{50}	496	496	868
7	FA_{40} G_{60}	396.8	595.2	868

2.2 Preparation of test specimens
Density, compressive strength and water absorption was found out using paver blocks. Totally 42 paver blocks were cast with 6 blocks for each ratio. Out of 42 paver blocks 21 blocks were used to find the average density and compressive strength. Before subjecting the specimens to compression test, each specimen was weighed to find out the density. Remaining 21 blocks were used to obtain the water absorption.

2.3 Casting and Testing
Rubber based moulds of size 215 x 170 x 55 mm were used for the preparation of I- shaped paver block. The materials used for the casting of paver blocks such as cement, water, groundnut husk ash, fine aggregate and coarse aggregate were mixed together properly before placing into the moulds. After de-molding paver blocks were kept in under shade for one day and after that samples were kept in water for 28 days and then it is used for further testing. The paver blocks that were cast are shown in Fig.1.

Fig -1: Paver Blocks ready for test

Test procedure
Density of paver blocks is calculated by dividing the mass by the volume of paver block. After weighing the paver blocks, compressive strength test was performed using Compression Testing Machine of capacity 2000 kN. The compressive strength is the ratio of the maximum load to the surface area of paver block. Three paver blocks were tested for each mix ratio and the average of three specimens is taken as the compressive strength. In the water absorption test, the dry weight of paver block was measured and noted as weight (W1). Then the paver blocks were completely immersed in water at room temperature for 24 hours. After 24 hours the paver blocks are removed from the water, allowed to drain and any traces of water were wiped out with damp cloth. Then this weight was noted as the wet weight (W2). From the increase in weight of the specimens, water absorption values were calculated.

3. RESULTS AND DISCUSSION

3.1 Density
The density values of paver block specimens for various mix proportions are calculated by dividing the mass by the volume of paver block. From Fig.2, it was observed that, for paver blocks without groundnut husk ash, the density values are comparatively higher as compared to that of blocks containing groundnut husk ash as fine aggregates. It was also seen that density values decreases with increase in groundnut husk ash content. Density values are below 2000 kg/m³ when the groundnut husk ash content gives beyond 30%.

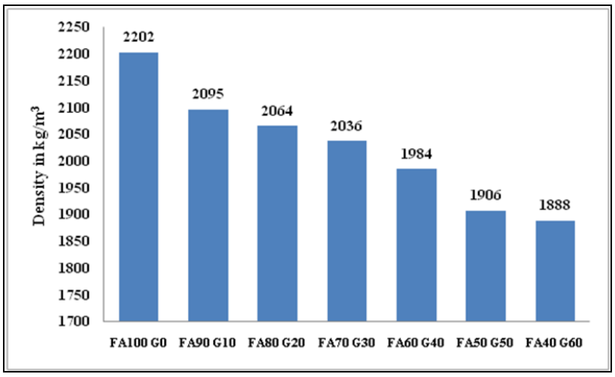


Fig -2 : Effect of Groundnut husk ash content on density

3.2 Compressive Strength

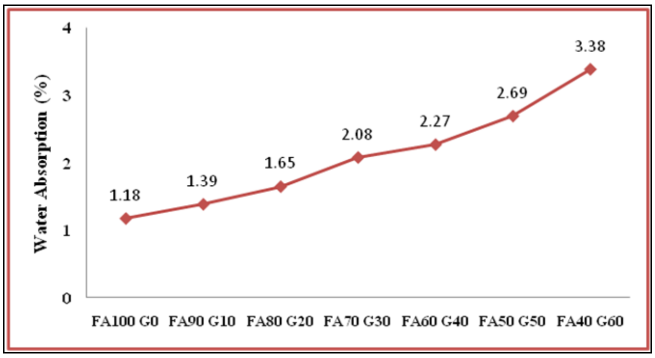
The compressive strength of paver blocks for various mix proportions are given in Table 3. From the test results, it can be seen that, for paver blocks without groundnut husk ash, the compressive strength values are comparatively higher as compared to that of paver blocks containing groundnut husk ash as fine aggregates. It was also observed that, compressive strength decreases with increase in groundnut husk ash content. The reduction in compressive strength with respect to control specimens without groundnut husk ash is about 4%, 10%, 15%, 24%, 37% and 48% respectively.

Table -3 : Compressive Strength

Mix ID	Maximum Load (kN)	Compressive Strength (N/mm²)	Average Compressive Strength (N/mm²)
$FA_{100}G_0$	1607	43.98	41.98
	1533	41.94	
	1463	40.03	
$FA_{90}G_{10}$	1359	37.18	40.38
	1520	41.59	
	1549	42.38	
$FA_{80}G_{20}$	1344	36.77	37.72
	1385	37.89	
	1407	38.50	
$FA_{70}G_{30}$	1295	35.43	35.49
	1289	35.27	
	1308	35.79	
$FA_{60}G_{40}$	1131	30.94	31.94
	1170	32.01	
	1201	32.86	
$FA_{50}G_{50}$	975.2	26.68	26.56
	960.6	26.28	
	977	26.73	
$FA_{40}G_{60}$	744.6	21.74	21.82
	813.3	22.25	
	784.6	21.47	

3.3 Water Absorption

The water absorption values of paver blocks specimens are calculated for various mix proportions and the effect of groundnut husk ash content on water absorption is shown in Fig.3. From the test results, it can be seen that the water absorption values for all the specimens of mix ratios were lower than 7% as per IS: 15658-2006 specifications. It was also found that, for specimens without groundnut husk ash, the water absorption values are comparatively lower as compared to that of specimens containing groundnut husk ash as fine aggregates. It was also observed that, water absorption increases with increase in groundnut ash content. The water absorption increases by about 18%, 40%, 76%, 92%, 128% and 186% respectively with respect to control specimens without groundnut husk ash.



3. CONCLUSIONS

- Density of paver blocks is within the range of 1888-2202 kg/m³. Density values decreases with increase in Groundnut husk ash.
- Groundnut husk ash is suitable in making paver blocks as the water absorption is less than 7%.
- The paver blocks prepared using M_{40} grade of concrete s can be used for light traffic commercial vehicles like Pedestrian plazas, shopping complexes ramps, car parks, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads, etc.

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