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BEHAVIOUR OF PAVER BLOCKS WITH PARTIAL REPLACEMENT OF SAND USING QUARRY DUST

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Abstract:

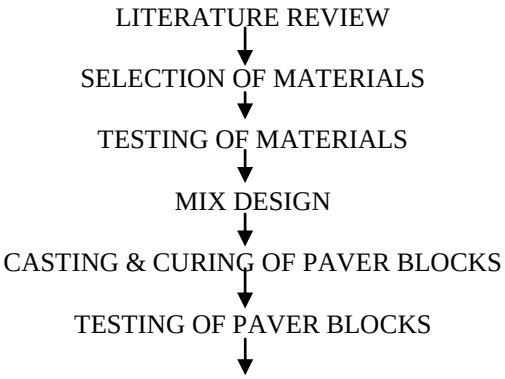
The reduction in the sources of natural sand has resulted in the increased need to identify substitute material to sand as fine aggregate in the production of Paver Blocks. Quarry dust, a by-product from the crushing process during quarrying activities is one of such materials. Granite fines or rock dust is a by-product obtained during crushing of granite rocks and is also called quarry dust. It has recently gained good attention to be used as an effective filler material instead of fine aggregate. This present work is an attempt to use quarry dust as a Partial replacement of sand in concrete. Using this, reduction of cost and safe disposal of material is achieved. The experimental investigations were carried out by replacing sand with quarry dust in various percentage as 0%, 10%, 20%, 30%, 40%, 50%. The effect of using quarry dust as natural sand replacement on mechanical properties such as compressive strength, tensile strength, flexural strength and water absorption were conducted. As a result, the strength of paver blocks increased till 40% replacement of quarry dust and it was concluded that replacement up to 40% of quarry dust was found to be effective for medium traffic.

Key Words: Quarry Dust, Compressive Strength, Tensile Strength, Flexural Strength & Water Absorption

1. Introduction:

Natural sand is a non-renewable resource of nature. Nowadays, there is an increase in demand of natural sand for construction works. Researches were being done to develop some alternative materials to natural sand. Utilization of used quarry dust from industrial waste is showing prospective application in construction industry as an alternative to natural fine aggregate. Concrete is the most widely used building material in the world due to its versatility, low cost and durability. Fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river sand. The demand for natural sand in the construction industry has consequently increased due to the extensive use of concrete resulting in the reduction of sand sources. Natural sand takes millions of years to form and is not replenish able. Because of its limited supply and excessive cost of transportation from natural sources, the cost of natural sand has sky rocketed and its consistent supply cannot be guaranteed. The large scale depletion of these sources also creates environmental problems. Erosion and failure of river banks, lowering of river beds, damage to the bridge foundations and other structures situated closer to the rivers, saline water intrusion into the land and coastal erosion are the major adverse effects due to intensive river sand mining. The Government has already banned sand mining due to environmental problems in some identified areas of major rivers. Therefore, it becomes necessary to explore the possibilities for alternative sources to minimize river sand extraction. Thus, an investigation is needed to identify a suitable substitute that is eco- friendly and inexpensive and in this connection the use of quarry dust as fine aggregate has occupied a promising factor in the preparation of concrete. On account of this, to reduce disposal of quarry dust, investigations were undertaken to produce low cost concrete by replacing various proportions of fine aggregate with quarry dust. Paver blocks made fast development in the construction industry and have almost become a preferable choice for pavements. Paver blocks are made up of concrete. Pavers are also known as "Interlocking concrete block Pavement". Paver block is solid, unreinforced pre-cast cement concrete paving units used in surface course of pavement. By improving its compressive strength, it can be used in surface course of pavement. Nowadays concrete paver blocks are used in various applications like street road, small and medium market roads, low volume roads and other construction places. Concrete block pavement will absorb stress such as earth quakes, freezes and thaws and slight ground erosion by flexing. In this paper, an experimental investigation is carried out to study the behavior of paver blocks with partial replacement of sand using quarry dust.

2. Methodology:



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COMPARISON OF RESULTS

3. Materials:

A. Cement: In production of paver blocks, OPC 53 had been utilized. The specific gravity of cement is 3.15

B. Coarse Aggregate: The aggregates utilized for creation of paver blocks are sound and free from honeycombed particles. The nominal size of coarse aggregate is 10mm and specific Gravity is 2.62.

C. Fine Aggregates: The fine aggregate used for the experimental programme was locally procured and conformed to grading zone III as per IS: 383-1970. Fine aggregates passing through 2.36mm sieve is used.

D. Water: Water is essential for the blend to complete the chemical reaction and give appropriate workability. The water utilized for blending of concrete is potable water of pH lies at 7.5 and water is free from organic matter. The solid substances in water should be within the admissible limits according to IS 456-2000.

E. Quarry Dust: Quarry rock dust is an industrial by-product. It is formed by screening products of secondary and subsequent stages of crushing igneous rocks, sedimentary rocks or gravel. It can be classified by the size of the particles as 0 to 4.75 mm.

4. Experimental Study:

Paver block samples of size 0.185 m x 0.275 m x 0.080 m, were cast in the proportion of 1:1.49:1.65 by weight with water cement ratio as 0.40.

Figure 1: Casting of Paver Block

5. Test Results for Paver Blocks:

Compression strength test, split tensile test, Flexural strength test and water absorption test were done for 0% , 10%, 20% , 30%, 40% and 50% replacement of fine aggregate.

Compressive Strength Test:

Figure 2: Compressive Strength Test

Results of Compressive Strength tests are given below.

Table 1: Compressive strength for 7, 14 and 28 days

S.No	Percentage replacement	Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
1.	0%	25.91	36.03	44.10
2.	10%	26.02	36.14	45.17
3.	20%	26.99	37.21	46.03
4.	30%	27.10	37.75	47.21
5.	40%	28.07	38.07	49.29
6.	50%	41.2	43.8	43.9

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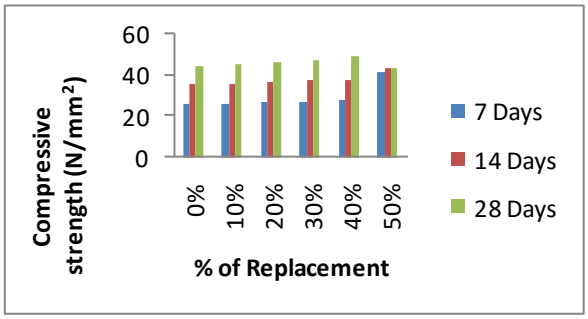

Figure 3: Comparison of Compressive strength for 7, 14 &28 days

Split Tensile Strength Test: Split tensile test has been done according to IS 15658:2006. Results for split tensile strength are shown in the Figure 5.

Figure 4: Split Tensile Strength Test

Table 2: Split Tensile Strength for 28 days

S.No	Percentage Replacement	Split Tensile Strength (N/mm^2)
		28 days
1.	0%	4.56
2.	10%	4.86
3.	20%	5.01
4.	30%	5.3
5.	40%	5.74
6.	50%	5.3

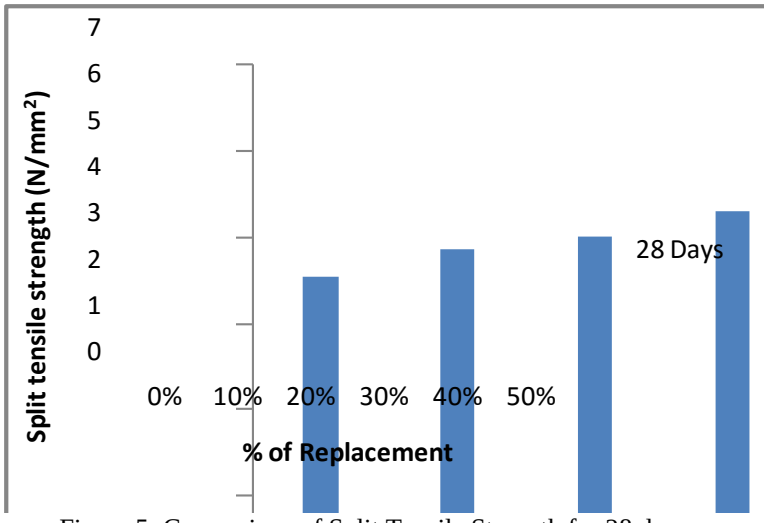

Figure 5: Comparison of Split Tensile Strength for 28 days

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Flexural Strength Test: Flexural strength test has been done according to IS 15658:2006. Results for flexural strength are shown in the figure 7

Figure 6: Flexural Strength Test

Table 3: Flexural Strength for 28 days

S.No	Percentage Replacement	Flexural Strength Test (N/mm^2)
		28 days
1.	0%	6.41
2.	10%	6.70
3.	20%	6.9
4.	30%	8.26
5.	40%	9.42
6.	50%	9.12

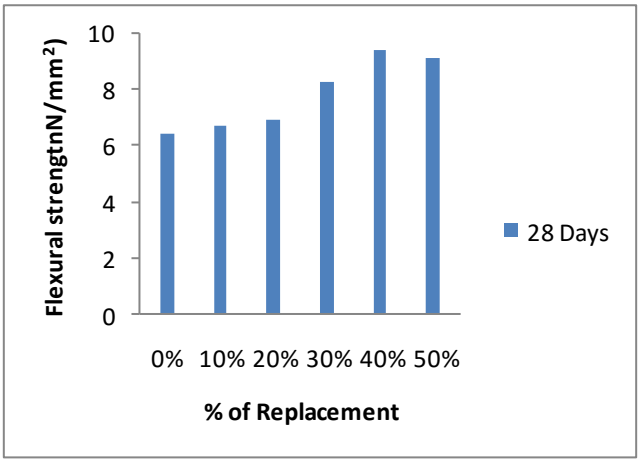

Figure 7: Comparison of Flexural Strength for 28 days

Water Absorption Test: Water Absorption test has been done as per IS: 15658:2006. Results are shown in table below.

Table 4: Water Absorption

Percentage Replacement	Sample	Dry weight (kg)	Wet weight (kg)	Water absorption (%)	Mean (%)
0%	1	4.094	4.344	6.106	6.28
	2	4.053	4.314	6.439	
	3	4.075	4.320	6.012	
10%	1	3.931	4.197	6.76	6.47
	2	4.143	4.98	6.22	
	3	4.043	4.303	6.43	
20%	1	3.653	3.924	7.38	6.7
	2	4.252	4.521	6.32	
	3	4.140	4.405	6.40	

30%	1	3.977	4.240	6.61	6.28
	2	4.313	4.578	6.14	
	3	4.171	4.426	6.11	
40%	1	4.218	4.528	7.34	6.6
	2	4.129	4.389	6.29	
	3	4.094	4.355	6.37	
50%	1	4.240	4.544	7.16	6.65
	2	4.285	4.555	6.30	
	3	4.225	4.500	6.50	

Specification for Paver Blocks: In this work, all paver blocks cast according to IS-15658:2006 for technical specifications and manufacturing of concrete paver bricks.

6. Results and Discussions:

The results obtained from the tests carried out on 28 days of curing were compared to determine the strength parameters of paver blocks. Based on the results, the strength of the paver block increases up to 40% replacement of fine aggregate with quarry dust. There was a slight decrease in the strength of the paver block at 50% replacement of fine aggregate. The binders present in the quarry dust increases the mechanical properties of the concrete.

7. Conclusions:

The concept of replacement of natural fine aggregate with quarry dust highlighted in the present investigation could improve the utilisation of quarry dust and thereby reducing the disposal of waste. From the experimental study, it is concluded that the quarry dust can be used as a replacement of fine aggregate. It is found that 40% replacement of fine aggregate by quarry dust gives maximum results in strength compared to normal concrete and the strength decreases slightly from 50%. The results proved that up to 40% replacement of sand by quarry dust induced higher compressive strength & workability of concrete and the strength decreases as replacement increases. Thus the environmental effects and waste can be significantly reduced.

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