Utilization of Quarry Fines in Cement Concrete Paver Blocks for Medium Traffic

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Abstract— Solid unreinforced cement concrete paver blocks is a versatilely used for the construction of roads. This project is part of a study investigating the structural characteristics of cement concrete paver blocks using various combinations of Natural River sand and quarry fines. Here quarry fines will complete replace river sand as fine aggregate in concrete. Samples of concrete cube were made using varying contents of River Sand and quarry dust as fine aggregate. The quantity of River Sand was varied from 0% to 100% against quarry fines at intervals of 20%. The samples were cured for specified periods and tested in the laboratory for compressive strength. Workability tests were earlier carried out to determine the optimum water/cement ratios for three different mixes. M40 mix was designed as per IS specification with water cement ratio 0.40.

Key words: Paver Blocks, Quarry Fines, Compressive Strength, Workability

I. INTRODUCTION

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from industrial waste. Quarry dust has been used in and continues to be used for concrete production as a replacement for natural sands. Investigations have been undertaken using a crusher to produce manufactured quarry fines with an improved particle shape and grading, for use as a total or partial replacement for natural sands in concrete mixes. Detailed investigations have been carried out to quantify the particle shape improvement of the manufactured quarry fines together with assessment of grading. The aim of the assessment was to optimize concrete mix design and be able to partially or totally accommodate the replacement of natural sands. The investigation was based on three types of quarry fines whereby it was used within a wide range of concrete applications and examined within a range of concrete tests. The feasibility of the usage of Quarry Rock Dust as hundred percent substitutes for Conventional Concrete. Tests were conducted on cubes and beams to study the compressive, flexural strengths of concrete made of Quarry Rock Dust for three different proportions and five different methods. Durability Studies were done for concrete with Quarry Rock Dust and compared with the Conventional Concrete. Shortage of natural sand supplies for the concrete industry, regional sand shortages have encouraged an increased interest in the utilization of quarry tines produced as a by-product of coarse-aggregate production in hard rock quarries. Depletion of existing sand reserves, the environmental impact of an eventual off-shore dredging or opening of new sand quarries, additional transportation and processing costs made the viability of manufactured quarry fines as distinct from quarry fines or crusher fines - a more attractive proposition than ever before. The perception that all quarry fines produced are a waste product is fundamentally incorrect as such products have been successfully incorporated as a supplement in asphaltic concrete, road base, concrete masonry, some pre-mixed concrete, drainage fill and other products. The main objective of this project is to determine compressive strength of paver blocks and workability of concrete when fine aggregate is replaced by quarry fines upto 100% at interval of 20%.

II. METHODOLOGY

For medium traffic as per IS 15658 : 2006, paver blocks of 80mm thickness, I section and M-40 grade concrete is casted for this research article, and dimension of the paver block is

- Length = 200 mm
- Width = 160 mm
- Thickness = 80 mm

Aspect ratio (L/T) = 200/80 = 2.5 < 4.0 as per IS 15658: 2006, Area of the paver block is calculated as per recommendation given under IS 15658: 2006, i.e. approximately 28500 mm^2. Quarry fines used in this project is collected from crusher plant with specific gravity of 2.50, fineness modulus 4.56% and water absorption 0.42%, along with quarry fines Ordinary Portland cement of 43 grade is used of specific gravity 3.12 and fineness modulus 2.8%, natural river sand of Zone II with specific gravity 2.60, water absorption 0.55% and as per IS 15658 : 2006fineness modulus of 4.15% and 20 mm maximum size Natural crushed stone is used as a coarse aggregate with specific gravity 2.70, water absorption 0.6% and fineness modulus 4.2%. Mix design of M40 Concrete is done as per specification given under IS 10262: 2009 with water cement ratio 0.4. these paver blocks are casted in rubber mould and 24 hours these pavers blocks are demolded and left for curing at room temperature i.e. 24^oC in clear water. Water used for curing and in concrete are free suspended and dissolved impurities as per recommendation given under IS 456: 2000.

III. EXPERIMENTS AND RESULTS

A. Workability

The variation of workability of fresh concrete with 0.4 water – cement ratio is measured in terms of slump by slump cone

test and reported in Tables 1 and in Graph 1. It has been observed that quarry fines increases the workability of the concrete. Where control concrete mix gives 35mm slump it goes on increases when percentage of the quarry fines is increased in the concrete.

S.No.	Percentage Replacement	Mix	Slump (mm)
1	0%	M1	35
2	20%	M2	50
3	40%	M3	75
4	60%	M4	100
5	80%	M5	125
6	100%	M6	150

Table 1: Workability of concrete mix

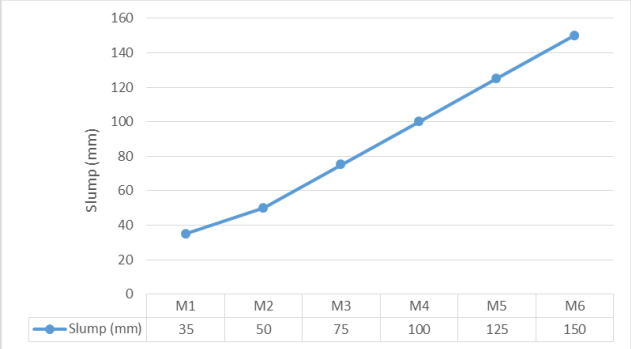

Fig. 1: Workability of concrete mix

B. Compressive Strength Test

Compressive strength of the paver blocks evaluated as per recommendation given under IS 15658 : 2006, and as IS 15658 States that for chamfered paver blocks multiplication of 1.18 is done (for medium traffic, M-40, 80 mm thick) in evaluated compressive strength. Result and variation in compressive strength are given in table 2 and corrected compressive strength are given in Table 3 and Graph 2.

S. No.	Percentage Replacement	Mix	Compressive Strength N/mm^2		
			7 Days	14 Days	28 Days
1	0%	M1	31.22	38.74	47.59
2	20%	M2	32.05	36.12	46.89
3	40%	M3	33.15	36.12	46.13
4	60%	M4	32.624	38.35	42.34
5	80%	M5	33.81	39.01	42.66
6	100%	M6	32.52	38.9	41.36

Table 2: Compressive Strength of Paver Blocks.

S. No.	Percentage Replacement	Mix	Compressive Strength N/mm^2		
			7 Days	14 Days	28 Days
1	0%	M1	36.84	45.71	56.16
2	20%	M2	37.82	42.62	55.33
3	40%	M3	39.12	42.62	54.43
4	60%	M4	38.50	45.25	49.96
5	80%	M5	39.90	46.03	50.34
6	100%	M6	38.37	45.90	48.80

Table 3: Corrected compressive strength of paver blocks

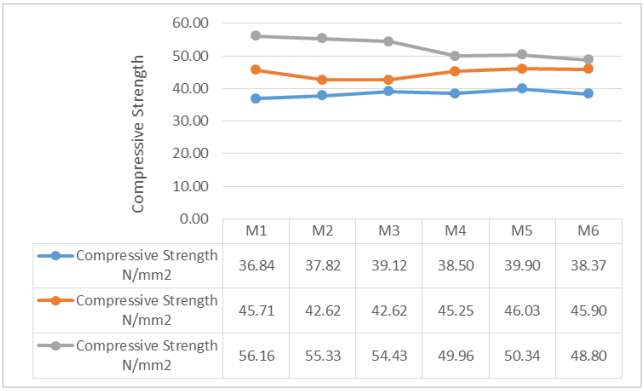

Fig. 2: Corrected Compressive Strength of Paver Blocks

IV. Conclusion

It can be seen from the results of this study that the combination of quarry fines to replace the conventional river sand in the production of concrete for the construction industry in India and other tropical countries of the world results in structures with reasonable structural characteristics, and should be encouraged where there is comparative cost advantage. The following conclusions can be made from this study:

1) The workability of the mix increased when replacement percentage of the quarry fine with natural river sand. So we can also decrease the water cement ratio, with quarry fines good workability of the concrete is achieved with low water cement ratio.
2) The compressive strengths of concrete using lateritic sand and quarry dust were measured in the laboratory. Compressive strength was found to increase with age as for normal concrete paver blocks. The strength properties were found to compare closely with normal concrete. The proportion of 20% to 80% quarry fines produced higher values of compressive strength.
3) Further work is required to get data for other structural properties of the experimental concrete paver blocks. These include: flexural strength, tensile strength, shear strength, water absorption, resistance to impact, creep, etc. The knowledge of the above properties will greatly assist engineers, builders and designers when using the materials for construction works.

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