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REPLACEMENT OF CEMENT BY GRANITE POWDER IN PAVER BLOCKS

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Abstract- Granite powder is obtained from the crusher units in the form of finer fraction. The products are left largely unused and are hazardous materials to human health because the product is airborne and can be easily inhaled. This experimental study investigates the strength performance of paver block using granite powder replacing cement. Initially, granite powder samples were collected and its properties were investigated. Normal consistency and setting time of pastes containing cement and granite powder at 25%, 50% & 75% replacement were investigated using paver block. By casting Zigzag paver block of size 250x123x80 mm with M40 grade of concrete mix were used. Test results showed that Granite powder can be used effectively and more durable in paver blocks.

***Key Words*: Granite powder, paver block, Residual compressive strength, Flexure strength, cost analysis**

1. INTRODUCTION

Now a Days Paver Blocks uses is increasing day by day, Interlocking concrete Pavement has been extensively used in a number of countries like India, China, Japan, Pakistan etc. Intermediate concrete block pavement (ICBP) technology has been introduced in India in construction a decade ago, as a specialized problem solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environment constraints for specific requirements viz. footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable.

Interlocking concrete pavements or pavers are a special dry mix pre-cast piece of concrete commonly used in pavement applications. As per IS 15658 Standard thicknesses of paver blocks are 60mm (for light traffic), 50mm (no-Traffic), 80mm (heavy traffic) is common used in India . Paver block required high compressive strength, flexure strength, Residual compressive strength, water absorption to use it in paver blocks.

2. MATERIALS AND METHODS

In this experimental study, cement, fine aggregate, Coarse aggregate, Granite powder were used. Commercially available Ordinary Portland cement (53 grade) was used in this experimentation confirming to ACI 544:IR96. The maximum size of coarse aggregate was 10 mm and specific gravity was 2.71. Locally available sand was used to prepare all the paver blocks which passes through 4.75 mm sieve as per IS 383:1970. Potable water was used throughout this experimental study. The following table shows the properties of various materials used in this investigation.

Table 1 – Properties of Materials

Property	Cement	Coarse aggregate	Fine aggregate	Granite powder
Grade	53	-	-	-
Initial setting time	28 min	-	-	-
Final setting time	600 min	-	-	-
Specific gravity	3.15	2.6	2.6	2.72
Tensile strength	-	-	-	158-220 MPa

3.Mix Proportion

Mix design had been determined based on IS 10262:2009 for M40 grade concrete.

The mix ratio adopted is 1:1.642:2.802. Characteristic compressive strength required in the field at 28 days was 40Mpa. Maximum size of coarse aggregate is 10mm. Degree of quality control is good. For easy identification, the specimens were designated as 25%, 50%, 75%. The percentage composition details are shown in table 2.

Table 2 – Specimen Details

MIX	CEMENT %	GRANITE POWDER %
CC	100	0
25%	75	25
50%	50	50
75%	25	75

Plastic Paver Mould

Mixing

Compaction by Vibrator

Casting

Demoluding of paver blocks

Curing Tank

Water absorption

Compressive Strength

4. COMPRESSIVE STRENGTH TEST

For compressive strength, cube specimens of dimensions 250 mm x 123 mm x80 mm were casted with M40 grade. The Paver moulds were filled with concrete. After 24 hours, the specimens were demoulded and were transferred to curing tank and kept for 28 days.

These specimens were tested in compression testing machine. The load was applied as per IS 15658:2006. Compression testing machine of 2000 kN was used for loading. In each category, three cubes were tested and their average compressive strength value is reported by using the formula.

Compressive strength = Load / Area (MPa)

5. FLEXURAL STRENGTH TEST

The flexural strength of concrete prism was determined based on IS 15658:2006 . The beam specimens of size 250 x 123x80 mm were casted and demoulded after 24 hours and kept for 28 days of curing. The specimens were tested in Universal Testing Machine.

Flexure strength = PL/bd^2

P = Maximum load

L = Length

B = breadth

D = depth

6. WATER ABSORPTION TEST

Saturation:

The Paver block shall be completely immersed in water at room temperature for 24±2 h. The paver block then shall be removed from the water. Visible water on the paver block shall be removed with a damp cloth. The paver block shall be immediately weighed and the weight for each specimen noted in N to the nearest 0.01 N (WW).

Drying:

After saturation, the paver block shall be dried in a ventilated oven at 107 + 7°C for 24 h and until two successive weighing at intervals of 2 h show an increment of loss not greater than 0.2 percent of the previously determined mass of the paver block. The dry weight of each specimen (Wd) shall be taken in N to the nearest O.O1N.

Percent Water Absorption $Wpercent=(Wa-WdWd)\times100$

7. RESIDUAL COMPRESSIVE STREGTH TEST

The fire resistance of concrete for most applications is adequate. However, when subjected to elevated temperatures, the strength and durability properties are significantly affected due to physical and chemical changes .The specimens were heated to a maximum core temperature of 150°C, at heating rate of 50C/min. The compression strength test of concrete paver under different temperature conditions was carried out by using universal testing machine. The characteristics of failure modes and the development of cracks were observed. A graph was plotted for residual compressive strength and temperature.

8. COST ANALYSIS

Cost analysis is a technique that quantifies all of the costs associated with the construction and maintenance of a pavement over a set analysis period. Higher performance life of pavers as compared to asphalt and lower capital cost of pavers compared to cast in place of concrete pavers.

9. RESULTS AND DISCUSSION

The properties of granite powder with different proportions were casted and tested. The properties like compressive strength, flexure strength were estimated for the specimens casted and the optimum mix ratio was ascertained and used. All the results showed good enhancement in the properties were tested. Results of compressive, flexure strength tests, Residual compressive strength, Water absorption Test and Cost analysis are shown in table 3.

Mix	Average Compressive strength at 28 days (MPa)	Average Flexural strength at 28 days (MPa)	Average Residual compressive strength at 28 days (MPa)		Average % of Water absorption <6%	Cost Analysis Per paver block
			Room temp	150°C		
CC	41.53	4.9	44.12	39.44	5.23	Rs.15.23
25%	44.74	5.51	42.08	38.96	5.82	Rs.13.72
50%	36.62	4.5	36.32	30.43	5.81	-
75%	23.39	3.11	28.98	23.12	5.69	-

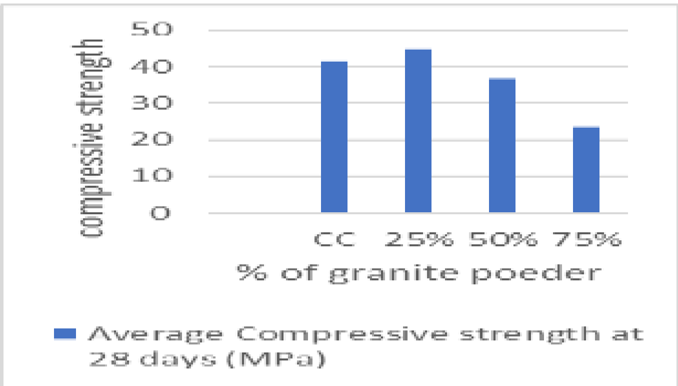

Table 3 - Influence of Granite powder on paver block

Fig 1. Compressive strength Graphical representation

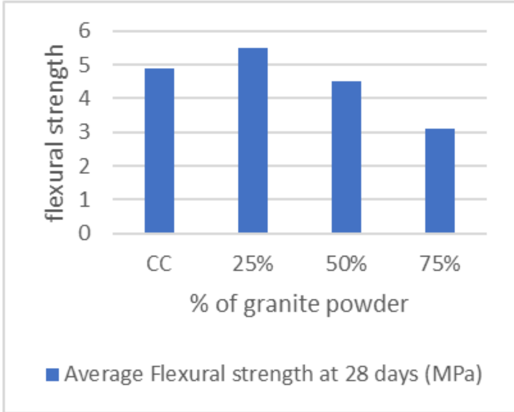

Fig 2. Flexural strength Graphical representation

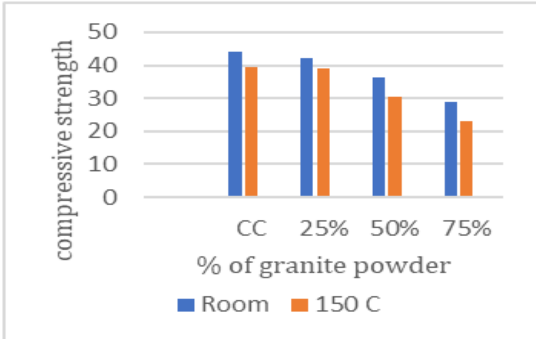

Fig 3. Residual Compressive strength Graphical representation

10.CONCLUSIONS

Experimental investigations were conducted to determine the characteristic strength of concrete paver by replacing of cement with granite powder the addition of three mix ratios. Concrete paver specimens were casted and tested to determine the Compressive strength, Flexural strength, water absorption ,Residual compressive strength, and Cost analysis. Based on the test results it was inferred, which mix ratios gave better results than the conventional concrete paver with respect to 28 days.

- Based on the experimentation conducted on the specimens with replacement of granite powder over cement in different percentages (25%, 50%75%) the following conclusions were drawn.
- In a nutshell it can be concluded that the use of granite powder in paver block is an effective method to improve the compressive strength. To get the maximum benefit it is recommended to replace cement by granite powder about 25%. At 25% the compressive strength achieved is 44 N/mm^2 which is 7% more than the compressive strength of conventional concrete paver.
- It was found that the replacement of cement by granite powder at 25%increases the flexural strength of the paver block. To get the maximum

flexural strength. It is recommended to replace cement by granite powder about 25%. At 25% the flexural strength achieved is 5.51 N/mm^2 which is12% more than the flexural strength of conventional concrete paver.

- The experimental result shows that the compressive strength of concrete paver after 150^{0}C is slightly less than the concrete paver at room temperature (27^{0}C).
- With the replacement of granite powder over cement the water absorption rate increases slightly.
- In general, 25% replacement of cement by granite powder was found to be optimum for concrete paver considering compressive, flexural and residual compressive strength as well as cost analysis.

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