Study the properties of paver block by using waste material like Fly Ash

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Abstract— Now a days as the better looking options for the footpaths and pedestrian road laying there is used concrete blocks pavements. In this study we will conclude cement replaced by fly ash and adding gypsum and super plasticizer with various percentages in the construction of concrete block pavements. As we know dumping of fly ash is the biggest issue now days in India in due to fly ash environmental pollution and human hazards increasing day by days. The aim of this research is make economical and environmental friendly paver block, and solves the disposal problem fly ash

Key words: concrete block pavements, fly ash, gypsum, super plasticizer

I. INTRODUCTION

In Now days in such a huge construction work whether it is related with building or road texture finishing also plays an important role. So, on the basis of my topic I had design paver block by using cement concrete mixture. So this is used in construction of highway or side way footpaths. But as per the load on the highways are too much so we cannot use such paver blocks. So, such paver blocks ideally used in the construction of footpaths along side of roadways to make them easy lying, better look and finish. There are number of different types of paver block now days are designed of different size, and shapes i.e. rectangular, square, and round blocks. And this are made of locally available materials likes coarse aggregate, fine aggregate and cement and can be easily design and time saving process as there mould is also available in the market. One of the best thing which can be noticed in all the paver blocks that they are design in such a way that interlocking is possible with their adjacent paving blocks. They are mostly used in urban areas and semi urban areas and also available in market. So from the topic I will discuss the materials and its properties used in the design of paver block and the design of M35 concrete mixture and its compressive strength.

II. OBJECTIVE OF STUDY

(1) Cement is your most costly material and by doing trials with different percentage of Fly ash we are able to minimize on cement content and so decrease your costs.
(2) The main objective of this investigation is to develop a strong and durable cement concrete mix using Fly ash with partial replacement of cement.
(3) It is also aimed to compare the properties of these cement concrete mixes.
(4) The properties of cement concrete mixes investigated are compressive strength, flexural strength, abrasion resistance, permeability, and clogging potential.

III. LITERATURE REVIEW

The effects of cement replacement with fly ash and the effects of different types of fine aggregate on compressive strength of paver block replacing the fine CSS with fine aggregate, the decrease in compressive strength of Paver block was 17%, 13.4%, 6.7%, 14.84% and 3.3%, respectively, depending on fly ash replacement ratio from 0% to 40%. Evangelista and Brito studied the use of fine recycled concrete aggregates as partial or full replacements of natural fine aggregates in structural concrete. The experimental results indicated that the compressive strength went down by 10% as a result of the fine aggregate replacement ratio of 100%. Strength of pavement blocks are usually evaluated with tensile splitting strength values. It is well known that for a given replacement level with mineral admixtures, the properties of concrete are influenced by the reactivity of the mineral admixtures. When comparing the Paver block with CSS that contain no fly ash, an increase in the compressive strength due to the 10% fly ash content was 8.7%; however, the increase in compressive strength of Paver block was 12% and 3.21% for fly ash content of 10% and 20%, respectively. On the other hand, the decrease in the compressive strength due to the 20%, 30% and 40% fly ash content was 7.57%, 12.2% and 39.5% when fine CSS aggregate was used in the production of Paver block. The reduction in compressive strength of PCIB with CW ranged between 11% and 50.5% for fly ash content of from 10% to 40% while the reduction in compressive strength of PCIB with MW ranged between 10.5% and 30% for the fly ash replacement ratio from 30% to 40%. Salem and Burdette[28] found that the 28-day compressive strength, using 14% and 28% fly ash, of recycled concrete decreased from 38.85 to 35.5 MPa (9% reduction) and of natural concrete decreased from 38.1 to 34.1 MPa (11% reduction). Therefore, based on the results of this study, the optimum percent of added FA to enhance the compressive strength is 10%.

IV. MATERIAL UTILIZED

A. Cement

As per availability of cement in the market we can use one of the following type as per concerning to IS code

Sr. No.	Cement types	IS code recommended
1	33 Grade ordinary Portland cement	IS 269
2	43 Grade ordinary Portland cement	IS 8112
3	53 Grade ordinary Portland cement	IS 12269
4	Portland slag cement	IS 455

5	Portland-Pozzolana cement (fly ash based)	IS 1489 (Part 1)
6	Portland-Pozzolana cement (calcined clay based)	IS 1489 (Part 2)
7	Rapid hardening Portland cement	IS 8041

B. Mineral admixture

Mineral admixtures are used to replace the OPC (ordinary Portland cement) with various percentages to find the strength of concrete blocks pavements. The following types of admixture can be concerned in the construction of concrete blocks pavements

Sr. No.	Mineral admixtures	IS code recommended
1	Fly ash grade 1	IS 3812
2	Silica fume	IS 15388
3	Ground granulated blast furnace slag	IS 12089
4	Rice husk ash	IS 456
5	Metakaoline	IS 456

C. Aggregates

(1) Basically aggregates are divided into two categories coarse aggregate and fine aggregate in the construction of concrete blocks pavements. The nominal maximum size of coarse aggregates is 12 mm in construction of concrete blocks pavements. The recommendation of coarse and fine aggregate is shown below

Sr. No.	Aggregate	IS code recommended
1	Coarse aggregate	IS 383
2	Fine aggregate	IS 383

D. Coarse aggregate

In construction of concrete blocks pavements crushed or semi crushed aggregate can be used. For the durability of the concrete blocks pavements aggregate should be free of soft and honeycombed particles and should be sound. Other types of aggregate like steel slag, over burnt brick, tile, and bloated clay aggregate and sintered fly ash aggregate can also be used.

E. Fine aggregate

In construction of concrete blocks pavements both river/quarry sand and stone dust can be used.

F. Admixture

Admixture which is used in construction of concrete block pavements should be conforming to IS 9103, it is not affecting the property of concrete block pavements.

G. Pigment

The pigments are used in durable colour of paver blocks. It has two categories synthetic or natural pigments concerning to following IS codes

Sr. No.	Pigment	IS code recommended
1	Black or Red	IS 44
2	Brown pigment	IS 44
3	Green pigment	IS 54
4	Blue pigment	IS 55 and IS 56
5	White pigment	IS 411
6	Yellow pigment	IS 50

H. Water

The water used in production of paving blocks should be portable and having minimum pH value of 7 to 8 as per IS 456.

V. GRADE DESIGNATION OF PAVER BLOCK

Grades of Paver Blocks for Different Traffic Categories as per IS 15658:2006

Sr. No.	Grade of paver block	Traffic category	Examples of application
1	M-30	Non-traffic	Building premises, monument premises, landscapes, public garden/parks, domestic drives, paths and patios, embankment slopes, sand stabilization area, etc
2	M-35	Light-traffic	Pedestrian plazas, shopping complexes ramps, car parks, office, driveways, housing colonies, office complexes, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways, residential roads, etc.
3	M-40	Medium-traffic	City streets, small and medium market roads, low volume roads, utility cuts on arterial roads, etc.
4	M-45	Heavy-traffic	City streets, small and medium market roads, low volume roads, utility cuts on arterial roads, etc.
5	M-50	Very heavy-traffic	Bus terminals, industrial complexes, mandi houses, roads on expansive soils, factory floor, service stations, industrial pavements, etc.
6	M-55	Very	Container terminals, ports,

		heavy-traffic	docks yards, mine access roads, bulk cargo handling areas, airport pavements, etc.

VI. Acceptance Criteria

As per IS code15658:2006 Sampling requirements

S. No.	Property	NO. of paver blocks
1	Visual Inspection	4
2	Dimensions	4
3	Thickness of wearing layer	4
4	Water absorption	3
5	Compressive strength	4
6	Tensile splitting strength	4
7	Flexural strength / breaking load	4
8	Abrasion resistance	4
9	Freeze-thaw durability	3

The block will be kept under cover and protected from extreme conditions of temperature, relative humidity and wind till they are required for test. The test is done as soon as practicable after the sample is taken.

VII. Experimental Procedure

The following formula is used to determined the test result of the sample specimen

Plan Area (A_{sp})

$$A_{sp} = 20000 \times \frac{m_{sp}}{m_{std.}}\ mm^2$$

Wearing Face Area (A_{sw})

$$A_{sw} = 20000 \times \frac{m_{sp}}{m_{std.}}\ mm^2$$

VIII. Aspect Ratio

The aspect ratio of the specimen shall be calculated by dividing the mean length by the mean depth of specimen.

A. *The volume of the specimen*

Volume = $(W_W - W_a) \times 10^{-3}\ m^3$

IX. Determination Of Water Absorption:

A. *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 (W_W).

B. *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 (W_d) shall be taken in N to the nearest O.O1N.

Percent Water Absorption ($W_{Percent}$)

$$W_{percent} = \frac{W_a - W_d}{W_d} \times 100$$

X. Testing Machine:

Compression test is done on the compression testing machine which shall be equipped with two steel bearing blocks for holding the Paver block.

The apparent compressive strength of individual paver block shall be calculated by dividing the maximum load (in N) by the plan area (in mm^2).

XI. Determination Of Abrasion Resistance

The abrasive wear of the paver block after 16 cycles of testing shall be calculated as the mean loss in paver block volume ΔV, from the equation:

$$\Delta V = \frac{\Delta m}{PR}$$

Where:

ΔV = loss in volume after 16 cycle, in mm3;

Δm = loss in mass after 16 cycles, in g; and

PR **=** density of the paver block, or in the case of two-layer specimens, the density of then wearing layer, in g/mm.

The abrasive wear shall be reported to the nearest whole number of 1000 mm^3 per 5000 mm^2.

XII. Determination Of Tensile Splitting Strength

The paver block shall be placed on the testing machine with the packing pieces on the upper face and the bed face, in contact with the bearers. It shall be ensured that the packing pieces and the axes of the bearers are in line with the splitting section of the paver block.

A. *Calculation*

The area of failure plane(s) of the paver block

From the equation $S = l \times t$

Where

S = area of the failure, in mm^2

l = mean of two measurements of the failure length, one at the top and one at the bottom of the paver block in mm

t = mean of three measurements of thickness at the failure plane, one in the middle and one at either end, *in mm.*

The tensile splitting strength of the paver block determined by equation

$T = 0.637 \times k \times \frac{P}{S}$

Where

T = tensile splitting strength, in MPa; and

P = failure load in N

The failure load per unit length of the paver block is

$$F = \frac{P}{L}$$

Where,

F is the failure load, in N/mm.

XIII. Determination Of The Flexural Strength

As per IS 15658:2006 flexural strength of the paver block can be calculated as

$$F_b = \frac{3Pl}{2bd^2}$$

F_b = flexural strength, in N/mm^2

P = maximum load, in N

l =distance between central lines of supporting rollers, in mm

b=average width of block, measured from both Faces of the specimen, in mm;

d= average thickness, measured from both ends of the fracture line, in mm.

XIV. Conclusion:

The aim of this research paper is production of paver block with use of fly ash as partial replacement of cement in concrete, how much optimum percentage of fly ash replacement possible in cement without more change in compression strength, split tensile strength and flexural strength etc. This study also give the solution of an environmental problem, if we use the fly ash in paver block can solve the disposal problem, reduce cost and produce eco-friendly paver block for road pavement. This study helps in converting the non- valuable fly ash into paver block and makes it valuable. It also reduces the cost of material per paver block.

References

[1] IS 15658:2006, Precast concrete blocks for paving page, "Bureau of Indian Standard", New Delhi

[2] IS 2185 (part -1): 2005, Concrete masonry units specification: Part 1 hollow and solid concrete blocks, "Bureau of Indian Standard", New Delhi

[3] Nanda P. Radhikesh and Amiy a K. Das Moharana.N.C, 2010, , "Stone crusher dust as a fine aggregate in Concrete for paving blocks", IJCASE, Vol.1, No 3, ISSN 0976-4399

[4] Ahmed A. E. K., 1989, "Properties o f concrete incorporating natural and crushed sand Very fine sand", ACE Material Journal, Vol .86(4), pp 417-424

[5] Hameed, M. S. and Sekar A. S. S., 2009, "Properties of green concrete containing quarry rock dust and Marble sludge powder as fine aggregates", ARPN journal of Engineering and applied Science, Vol.4(4), pp 83-89.

[6] Raman, S. N. M., Zain, F.M., Mahmud H. B. & Tan, K. S., 2005. "Influence of quarry dust & fly ash on the concrete compressive strength development". Proc AEESEAP Int. Conf. 2005. Kualam Lumpur, Malaysia, 7-8 Jun 2005

