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EFFECT OF METAKAOLIN CONTENT ON THE PROPERTIES OF CONCRETE PAVER BLOCKS

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Abstract - *Suitably planned and built paver blocks give brilliant execution at areas where traditional asphalt frameworks have lower administration life because of various ecological, geographical requirements. Yet, with the utilization of elite solid they can be intended to support light, medium, substantial and extremely hefty traffic conditions under any conditions. The goal of the current work was to assess the exhibition of cement changed with Metakaolin for paver blocks for use in asphalts and other application territories. As compressive, flexural qualities and water assimilation are the main properties for concrete paver blocks the equivalent have been read for different cement blends in with shifting rates of Metakaolin. Metakaolin was utilized as partial substitution of concrete in the investigation and various rates were received for assurance of compressive strength, flexural strength and water assimilation of different states of paver blocks. The blend in with 10% substitution was found to give most extreme compressive, flexural strength and least water ingestion for a wide range of paver blocks.*

Key Words: Metakaolin, Compressive Strength, Flexural Strength, *paver blocks, concrete*

1. INTRODUCTION

Concrete is an item achieved artificially by solidifying the combination of concrete, sand, rock and water in reasonable amounts. As we probably are aware cement is a composite material which is for the most part utilized in development industry everywhere on the world. It is misleadingly accomplished by blending the cementitious materials, totals and water in foreordained amounts. "Concrete" is begun from the Latin word "concretus" which has the importance to become together to solidify. The strength properties for the solid rely on the properties for constituent of material utilized and their joined activity. In the assembling cycle of concrete CO_2 gas outflow is high, which brings about harming the common habitat and climatic conditions. To diminish the use of concrete, fractional reserve of concrete for certain extra cementitious materials like Metakaolin, base debris, rice husk debris, GGBS and silica rage and so on, are utilized in solid creation. Metakaolin is a dehydroxylated type of the Kaolin mud mineral. Stones having the high level of kaolinite are called as the china dirt (kaolin) was customarily utilized as the assembling of the porcelain fired material. Metakaolin responds with $Ca(OH)_2$ which is one of the result of hydration response of concrete and its structures the C-S-H gel. This gel development brings about expanding strength and solidness of the solid. By replacing concrete with metakaolin expands the strength and solidness and lessens the porosity in the solid and diminishes the penetrability too. The primary target of this project is to explore the possible utilization of Metakaolin as a halfway substitution of concrete in paver squares of various shapes.

1.1 Paver blocks

Concrete paver blocks were first utilized in Holland as replacement of paver blocks. These squares were rectangular fit as a fiddle and had practically similar size as the blocks. Since most recent fifty years the square states of clearing blocks had been altered relying upon the applications. At first they were planned as non-interlocking or halfway entomb locking, at that point changed to completely interlocking shape types. These paver blocks are precast solid units which are laid on a meager compacted bedding over a profiled base course to build an asphalt. If non-interlocking or partially-interlocking paver blocks are used, then it is called Concrete Block Pavement (CBP) and if interlocking paver blocks are used the pavement is called 'Interlocking Concrete Block Pavement (ICBP). These blocks being pre-casted units can be applied to any areas and don't relies upon geographical, climate conditions. They can be cast of any shapes and sizes to provide food the need. They additionally offer expedient development and can be intended to deal with light, medium and hefty traffic conditions securely.

Fig-1: Paver Block

2. EXPERIMENTAL METHODOLOGY

The cycle to choose the blending materials and their suitable amounts is done through mix design. There are approaches to locate the solid mix design. The strategies which are utilizing in India are as per the BIS. The fundamental target of the solid blend configuration is to locate the fitting extent where the solid fixings like concrete, water, fine total and coarse total ought to be blended to give the predetermined strength, solidness and functionality and conceivably meet different prerequisites as indicated by IS: 456-2000. IS: 10262-2009 code which gives the rules for the ostensible solid mix design. The properties of the material utilized and strategy for developing cement blends in with Metakaolin in shifting rates. The primary goal of this examination study was the evaluation of the different properties as far as compressive strength, flexural strength and water ingestion of cement. The materials used for this research work and experiments performed on concrete specimens have been discussed.

2.1 Manufacturing of paver block

Concrete, sand, coarse aggregate, water and superplasticisers were blended altogether in the solid mix. At that point it was filled in the elastic paver form of various shapes and distinctive thickness. All the filled paver molds were vibrated utilizing table vibrator. Subsequent to projecting all the examples were finished with a steel scoop and it was saved for 24 hours. Following 24 hours they were remolded from the paver shape and kept in the water tank for water relieving. A similar method was accomplished for 5%,10% and15% supplanting of concrete with metakaolin. To know the impact of backup of concrete with metakaolin, compressive strength, flexural strength, was done on the paver block.

Table 1 Paver block details

SI	Shape	Thickness (mm)	Plan Area (m^2)	Length (cm)	Width (cm)
1	Zigzag	80	0.0285	23.5	12.5
2	"I" shape	60	0.033	22.5	12.5
3	Dumbel	60	0.036	26.5	11

2.2 Testing of Paver block

Compressive strength

As per IS 15658: 2006, compressive strength of paver block was determined at 7 and 28 day using universal testing machine (UTM). Minimum 3 samples were tested for 7 and 28 day strength. The average strength of 3 samples at 28 days were taken as compressive strength of paver block. The apparent compressive strength of paver block was multiplied with correction factor as it is mentioned in IS 15658: 2006 of table 5 Annex D to get corrected compressive strength of paver block.

Table 2 Correction Factor for Thickness of Paver Block for Calculation of Compressive Strength

S.No	Paver block thickness(mm)	Correction factor
1	60	1
2	80	1.12

Fig-2: Compressive testing machine of paver block

Flexural strength

Flexural strength of paver blocks for control mix and for different percentage of sand and cement replacement with MK were done as per IS 15658: 2006.

The flexural strength of paver block calculated as follows:

□□= 3Pl / 2b□□

Where:

F□= Flexural strength in N/□□2,

P = Breaking load in N,

l = Distance between center to center of supporting rollers,

b = Average breadth of block measured in both faces

Fig-3: Flexural strength test conducted by using Universal Testing Machine

3. RESULTS AND DISCUSSION

The results obtained from experiments conducted on concrete paving blocks have been discussed in this chapter. A comparison of results has been made to evaluate the effect of the partial replacement of the cement by Metakaolin in concrete mixes to determine the mechanical properties at the age of 7 days and 28 days.

One reference mix M0 of M40 grade was prepared without addition of Metakaolin and three more mixes M1, M2 and M3 were prepared with Metakaolin of varying amounts 5%,10% and 15% used as partial replacement of cement respectively. Three different shapes of paver blocks, Zigzag, I shaped, and Dumbel shaped were adopted for the study. Eight specimens of each type of paver blocks were cast and cured for 7days and 28 days.

Table 3 Details of Paver Blocks of different shapes

Shape	Zigzag	I-shape	Dumbel
Thickness(mm)	80	60	60
Plane Area(m2)	0.0285	0.033	0.036
Length	23.5	22.5	26.5
Width	12.5	12.5	11

Compressive strength

As per IS 15658: 2006, compressive strength of paver block was determined at 7 and 28 day using Universal testing machine (UTM). Minimum 3 samples were tested for each 7days and 28 day strength. The apparent compressive strength of paver block was multiplied with correction factor as it is mentioned in IS 15658: 2006 to get corrected compressive strength of paver block.
Correction factor for 80mm thickness is 1.12

Table 4 7-days Compressive strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	Dumbel (60 mm)	I-shape (60 mm)
M0	0	53.25	53.41	51.97
M1	5	56.1	56	54.2
M2	10	62.15	62.36	60.71
M3	15	58.96	58.23	56.73

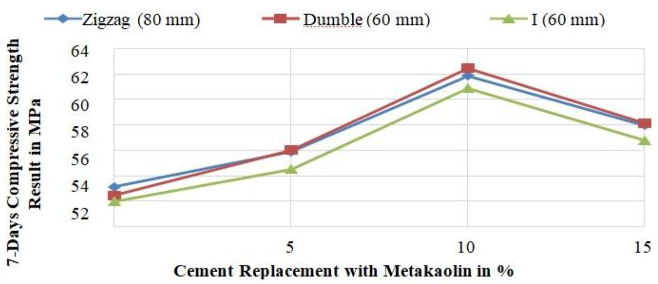

Fig-4: 7- days Compressive strength result MPa

Table 5 28-days Compressive strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	Dumbel (60 mm)	I-shape (60 mm)
M0	0	62.41	61.73	59.25
M1	5	66.41	65.22	63.89
M2	10	73.21	74.24	71.12
M3	15	70.11	69.32	68.45

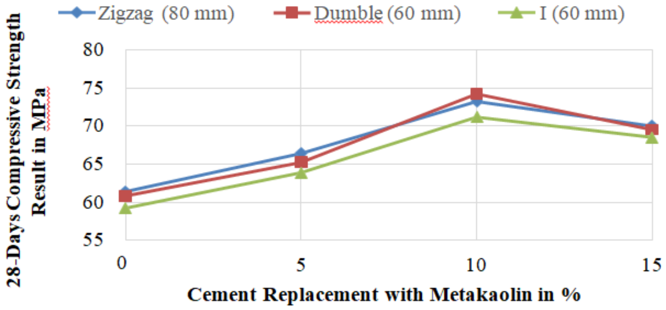

Fig-5: 28 days Compressive strength result MPa

It was observed that 7-days and 28-days' compressive strength of all shapes of paver blocks had increased due to incorporation of Metakaolin compared to control mix M0. Mix with 10% Metakaolin exhibited maximum strength gain. Compared with I-shape Zigzag and Dumbel shape gave more strength and their behavior were almost same.
Compared with control mix maximum percentage increase in 7 days compressive strength for M10 mix was 17 % found with I shape, 19% with Dumbel shape and 16% with zigzag shape. Similarly maximum percentage increase in 28 days compressive strength was observed as 20% with I shape, 22 with Dumbel shape and 19 was with zigzag shape.
Maximum percentage increase were obtained for Dumbel shape then I shape and lowest for zigzag shape.
For Dumbel shape 7% increase in strength were found with 5% MK, 22% increase with 10% MK and 14 % increase with 15 % MK as partial replacement. The same trend was shown for other shapes.
Flexural strength
Flexural strength or breaking load of paver blocks for control mix and for different percentage of sand and cement replacement with MK were done as per IS 15658: 2006.
The flexural strength of paver block calculated as follows:
$F_b = 3Pl / 2bt^2$
Where: F_b = Flexural strength in N/mm^2,
P = Breaking load in N,
l = Distance between center to center of supporting rollers,
b = Average breadth of block measured in both faces

Table 6 7-days Compressive strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	Dumbel (60 mm)	I-shape (60 mm)
M0	0	5.22	5.12	4.79
M1	5	5.64	5.78	5.61
M2	10	6.11	6.42	6.11
M3	15	5.63	5.57	5.57

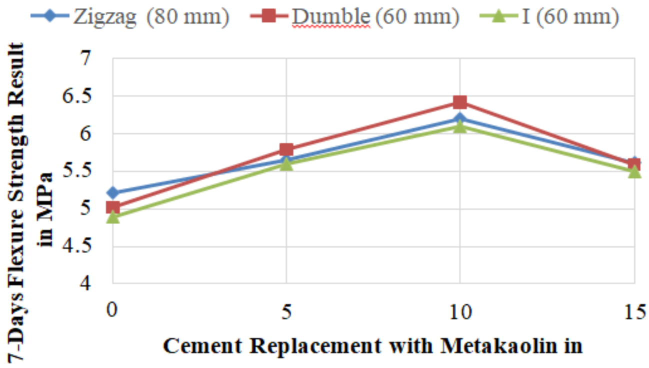

Fig-6: 7-days Flexure strength result MPa

Table 7 28-days Flexure strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	Dumbel (60 mm)	I-shape (60 mm)
M0	0	7.21	7.14	6.98
M1	5	7.56	7.35	7.28
M2	10	7.84	7.91	7.67
M3	15	7.69	7.56	7.29

It was seen that 7-days and 28 days Flexure strength of all states of paver blocks had expanded because of joining of metakaolin contrasted with control blend M0. Blend in with 10% Metakaolin displayed greatest strength acquire. When contrasted and I-shape Zigzag and Dumbel shape invigorated more and their conduct were practically same. Contrasted and control blend most extreme rate increment in 7 days Flexure strength for M10 blend was 18 % found with I shape, 15% with Dumbel shape and 12% with crisscross shape. Additionally most extreme rate increment in 28 days Flexure strength was seen as 11% with I shape, 12% with Dumbel shape and 8% was with crisscross shape. Most extreme rate increment was acquired for Dumbel shape then I shape and least for crisscross shape. For Dumbel shape 4% increment in strength were found with 5% MK, 12% expansion with 10% MK and 9 % increment with 15 % metakaolin as halfway substitution. A similar pattern was appeared for different shapes.

Water absorption

The test Results of water retention test are classified in the Table 4.6. It is seen from Table4.6, water ingestion of paver squares of the relative multitude of shapes are expanding up to 5 rate substitutions and again diminishing at 10 level of concrete substitution. However, greatest lessening in water assimilation happen at 10% substitution of concrete. For 5% concrete swap water ingestion for all the states of paver blocks are more than control blend. The maximum water absorption occur at 5% replacement which is less than 6% specified in IS 15658-2006 as maximum limit.

% Water Absorption = $[(W_W - D_W) / D_W] \times 100$

Where, W_W = Wet Weight of paver block, D_W = Dry Weight of paver block

Table 8 Cement replacement Vs. Water absorption

Mix	Metakaolin (%)	Zigzag (80 mm)	Dumbel (60 mm)	I-shape (60 mm)
M0	0	2.3	2.1	2.2
M1	5	2.45	2.4	2.5
M2	10	1.6	1.9	1.8
M3	15	2.2	2.2	2.1

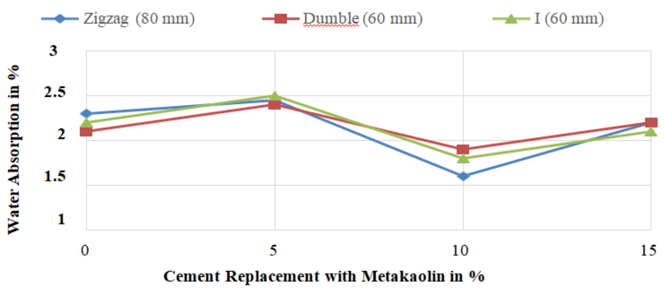

Fig-7: cement replacement Vs. water absorption

4. CONCLUSIONS

The aim of the current exploration work is to decide the mechanical properties of cement with MK as the admixture for M40 grade of cement Paver blocks.

Based on exploratory examination of the current examination study, the accompanying ends have been drawn.It is seen that compressive strength of paver block for all the shape and thickness at 7 and 28 days are expanded as level of concrete supplanting with metakaolin increments up to 10%. . 7 days compressive strength of paver block for all the shapes are more than required objective strength up to 15% concrete substitution. The most extreme compressive strength for all the shapes is more at 10% of substitution. The most extreme compressive strength of Dumbel (60mm) thickness at 10% substitution is 74 MPa which is about 23% more than that of control concrete. Flexural strength is expanding as concrete substitution increments up to 10% after that for 15% concrete substitution it is more than control concrete and furthermore over 5% substitution. 7-day and 28-day flexural strength is increments up to 10 % substitution after that it diminishes as level of substitution increments. Despite the fact that there is decline in flexural strength at 28 days after 10% substitution of concrete the flexural strength at 15% swap additionally more than 4 MPa for all the shapes which is required strength for unbending solid asphalt. Utilization of metakaolin as partial substitution of concrete increments mechanical properties like compressive strength, flexural strength of cement. Concrete with metakaolin likewise displayed better toughness regarding water ingestion. It was seen that 10% metakaolin utilized as partial substitution of concrete improve general properties of cement paver blocks.

REFERENCES

[1] Sing Lam and Sun Poon : "The effect of aggregate-to-cement ratio and types of aggregates on the properties of pre-cast concrete blocks", Cement and Concrete Composites,Volume 30, Issue 4,April 2008, Pages 283–289.

[2] Patil B.B and Kumar P.D "Strength and Durability Properties of High Performance Concrete incorporating High Reactive Metakaolin" Vol. 2, Issue 3, may- June 2012, pp-1099-1104.

[3] Srinivas rao, Ravi ch "Properties of concrete paving blocks made with waste marble", Journal of Cleaner Production ,Volume 21, Issue 1, January 2012, Pages 62–70

[4] Srivastava,V Kumar.R , Agarwal V.C. and Mehta, P.K. "Effect of silica fume and metakaolin combination on concrete" International Journal of Civil Structural Engg. 2(3),2012: 893 – 900.

[5] Srinivasa Rao P, Sravana, Z. and Seshadri Sekhar, "Durability Studies on Steel Fiber Reinforced Metakaolin Blended Concrete", AKGEJC International Journal of Technology,Vol. 3, 2013 No.1, pp.38-43.

[6] Indian standard recommended guidelines for concrete mix design: 10262-198.

[7] Kumar A and Kumar S "Development of paving blocks from synergistic use of red mud and fly ash using geopolymerization",2013 Construction and Building Materials 38 ,865–871.

[8] Kumar N "A study of Metakaolin and Silica Fume used in various Cement Concrete Designs" International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463 Vol. 3 Issue 6, June-2014, pp: (176-181).

[9] Saikumar A.V.S, Rao krishna.B "A Study on Strength of Concrete With Partial Replacement of Cement With Quarry Dust And Metakaolin" International Journal of Innovative Research in Science, Engineering and Technology vol. 3, Issue 3, March 2014.

[10] Aiswarya S, Arularj G, Dilip C : "A Review on use of metakaolin in concrete", Engineering Science and Technology: An International Journal (ESTIJ),ISSN: 2250-3498, Vol.3, No.3, June 2014.

[11] Revathi S, Kumutha R and vijiay K "Properties of Paver Blocks with Groundnut Husk Ash as Fine Aggregates", International Research Journal of Engineering and Technology (IRJET) , Volume: 02 Issue: 02 May-2015.

[12] Devi M (2015): "Implication of Metakaolin in Quarry Dust Concrete", International Journal of Structural and Civil Engineering Research Vol. 4, No. 2, May 2015.

[13] Nishikant Koli, Sangar Abishek Manufacturing of paving blocks by using waste glass", International Journal of Scientific and Research Publications, Volume 6, Issue 6, June 2016 61 ISSN 2250-3153.

[14] Shan C Sabu, Rijuldas V, Aiswarya S "Effect of metakaolin on various properties of concrete", International Journal of Advanced Technology in Engineering and Science, Vol. No.4, Issue No.01, January 2016.