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Investigation On Metakaolin Modified Concrete Paver Blocks

Indra Naryan Mandal
Department Of Civil Engineering,
Mewar University, Gangrar, Chittorgarh, Raj. 312901

Abstract- Concrete paver blocks are extraordinary pre-projected bits of substantial squares of non-interlocking or interlocking sorts, normally utilized in outside finishing asphalt applications. Appropriately planned and built paver blocks give phenomenal execution at areas where ordinary asphalt frameworks have lower administration life because of various ecological, topographical limitations. Be that as it may, with the utilization of elite substantial they can be intended to support light, medium, weighty and exceptionally weighty traffic conditions under any requirements. Present day cement can be adjusted with expansion of mineral admixtures which refine the microstructures of the substantial and improve its actual properties and sturdiness. Metakaolin, delivered by controlled warm treatment of kaolin, can be utilized as a substantial constituent, since it has pozzolanic properties. It is an exceptionally effective Pozzolans and respond quickly with the overabundance calcium hydroxide coming about because of OPC hydration by a pozzolanic response, to deliver calcium silicate hydrate and calcium alum inosilicate hydrates. Thus the target of the current work was to assess the presentation of cement changed with Metakaolin for paver blocks for use in asphalts and other application regions. 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 fractional substitution of concrete in the review and three rates 5%.10% and 15% were taken on for assurance of compressive strength, flexural strength and water assimilation of crisscross, dumbel and I shape paver blocks. The blend in with 10% substitution was found to give most extreme compressive, flexural strength and least water assimilation for a wide range of paver blocks.

Keywords- paver, ecological, Metakaolin, Pozzolans, asphalt, calcium alum inosilicate hydrates, compressive, flexural strength.

I. INTRODUCTION

Concrete is an item achieved misleadingly by solidifying the combination of concrete, sand, rock and water in appropriate amounts. As we probably are aware cement is a composite material which is for the most part utilized in development industry from one side of the planet to the other. It is Falsely accomplished by blending the cementitious materials, totals and water in foreordained amounts. "Concrete" is started from the Latin word "concretus" which has the importance to become together to solidify. The strength properties for the substantial rely on the properties for constituent of material utilized and their joined activity In the assembling system of concrete CO2 gas emanation is high, which brings about harming the common habitat and climatic conditions. To lessen the usage of concrete, fractional reserve of concrete for certain extra cementitious materials like Metakaolin (MK), base debris, rice husk debris, GGBS and silica seethe and so forth, are utilized in substantial creation. Metakaolin is a dehydroxylated type of the Kaolin dirt

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 toughness of the substantial. By supplanting concrete with MK expands the strength and toughness and decreases the porosity in the substantial and lessens the penetrability too.

fundamental properties in the concrete substantial blend.

7.5	Mass (%)
CaO	60-67
SiO2	17-25
Al2O3	3-8
Fe2O3	0.5-6
MgO	0.1-4

Table 1. Chemical Composition of Cement.

1. Paver blocks

Concrete paver blocks were first utilized in Holland as replacement of paver blocks. These squares were rectangular fit and had practically similar size as the blocks. Since most recent fifty years the square states of clearing blocks had been adjusted relying upon the applications. At first they were planned as non-interlocking or somewhat bury locking, then, at that point altered to completely interlocking shape types. These paver blocks are precast substantial units which are laid on a flimsy compacted bedding over a profiled base course to develop an asphalt. In the event that non-interlocking or to some degree interlocking paver blocks are utilized, it is called Concrete Block Pavement (CBP) and if interlocking paver blocks are utilized the asphalt is called 'Interlocking Concrete Block Pavement (ICBP).

These clearing blocks being pre-projected units can be applied to any areas and don't relies upon land, climate conditions. They can be cast of any shapes and sizes to provide food the need. They additionally offer quick development and can be intended to deal with light, medium and weighty traffic conditions securely.

II.MATERIALS

Cement- Ordinary Portland Cement (OPC) is the most well-known concrete utilized in everyday substantial development. It is utilized as a fundamental element of cement. Ordinary Portland Cement are delegated OPC-53, OPC-43, OPC-33 grades. The 43 grade OPC is the most famous broadly useful concrete in India. The four fundamental synthetic mixtures of OPC are tricalcium silicate (3CaO.SiO2), di calcium silicate (2CaO.SiO2), tricalcium aluminate (3CaO.Al2O3) and tetra calcium alumino ferrite (4CaO. Al2O3.Fe2O3). Their overall rate in concrete determine the

Metakaolin

Metakaolin is an exceptionally responsive Pozzolana for use in concrete. It's anything but a side-effect yet an item that is fabricated for use result and is framed when china mud, the mineral kaolin, is warmed to a temperature somewhere in the range of 600 and 800ºC. Its quality is controlled during fabricate, bringing about a substantially less factor material than mechanical Pozzolana that are results. First utili zed during the 1960s for the development of various enormous dams in Brazil, Metakaolin was effectively joined into the substantial with the first expectation of stifling any harm because of antacid silica response. When used to supplant concrete at levels of 5 to 10% by weight, the substantial delivered is by and large more firm and more averse to drain.

Subsequently, siphoning and completing cycles require less exertion. The compressive strength of solidified cement is likewise expanded at this degree of substitution. Marginally higher substitution levels (up to 20%) produce a concrete network that has low porosity and penetrability. This outcomes in upgrades to opposition of the solidified cement to assault by sulfates, chloride particles and other forceful substances, like mineral and natural acids. Freeze/defrost obstruction is improved and the danger of harm coming about because of the impacts of effect or scraped spot is diminished for Metakaolin substantial that has been done and restored appropriately.

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Table 2 Chemical Composition of Metakaolin

Chemical Composition	Mass (%)
SiO2	61.88
Al2O3	27.96
Fe2O3	1.41
CaO	0.78
MgO	0.56

Metakaolin behaves like pozzolana. It responds with CH hydrates and structure auxiliary CSH gel alongside calcium aluminate hydrates and calcium alumino silicate hydrate gels. They are of cementitious nature. The get saved on essential CSH gel and structure smaller and smooth plates like construction. Metakaolin likewise carry on like filler and make up for the shortcomings between the hydrate plates subsequently expanding thickness of hydrated mass

Cement + Water = CSH gel + Ca (OH)2
Ca(OH)2+Metakaolin = C4AH13 + C2ASH8 + CSH gel.

III.METHODOLOGY

The process to choose the mixing materials and their fitting amounts is done through mix plan. There are approaches to track down the concrete mix plan. The techniques which are utilizing in India are as per the BIS.

The principle objective of the concrete mix configuration is to track down the fitting extent in which the concrete fixings like concrete, water, fine total and coarse total ought to be mixed to give the predefined strength, toughness and usefulness and potentially meet different necessities as indicated by IS: 456-2000. IS: 10262-2009 code which gives the rules for the nominal concrete mix designs.

This part manages the properties of the material utilized and strategy for advancing concrete mixes with Metakaolin in changing rates. The fundamental goal of this exploration study was the evaluation of the mechanical properties as far as compressive strength, flexural strength and water absorption of concrete. The materials utilized for this examination work and tests performed on concrete.

IV.RESULTS AND DISCUSSION

The results obtained from experiments conducted on concrete paving blocks have been discussed. 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 3Details of Paver Blocks of different shapes

Shape	Zigzag	I-shape	Dumbel
Thickness(mm)	80	60	60
Plane Area(m^2)	0.0285	0.033	0.036
Length	23.5	22.5	26.5
Width	12.5	12.5	11
			

1. Compressive strength

As indicated by IS 15658: 2006, compressive strength of paver not really set in stone at 7 and 28 days using Universal testing machine (UTM). Least 3 examples were tried for each 7days and multi day strength. The apparent compressive strength of paver block was expanded with correction factor as it is referred to in IS 15658: 2006 to get changed compressive strength of paver block.

Table 4 7-days Compressive strength result MPa

Mix	Metakaolin (%)	Zigzag(80 mm)	I-shape(60 mm)	Dumbel(60 mm)
M0	0	52.14	49.98	52.46
M1	5	54.9	53.5	56
M2	10	60.85	61.89	63.46
M3	15	57.95	56.79	58.13

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Table 5 28-days Compressive strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	I-shape (60 mm)	Dumbel (60 mm)
M0	0	61.43	59.23	60.83
M1	5	66.42	63.9	65.24
M2	10	73.24	71.2	74.26
M3	15	70.01	68.54	69.54

- It was seen that 7-days and 28-days' compressive strength of all states of paver blocks had expanded because of fuse of Metakaolin contrasted with control blend M0. Blend in with 10% Metakaolin showed most extreme strength acquire. Contrasted and I - shape Zigzag and Dumbel shape gave more strength and their conduct were practically same.
- Compared with control blend most extreme rate expansion in 7 days compressive strength for M10 blend was 61.89 found with I shape, 63.46 with Dumbel shape and 60.85 with zigzag shape. Likewise most extreme rate expansion in 28 days compressive strength was seen as 71.2 with I shape, 74.26 with Dumbel shape and 73.24 was with zigzag shape.

2. Flexural strength

Flexural strength or breaking heap of paver blocks for control blend and for different level of sand and substantial rate with MK was finished by IS 15658: 2006.The flexural strength of paver block calculated as follows:

$$F_b = 3Pl / 2bd^2$$

Where: F_b= Flexural strength in N/mm^2,

P = Breaking load in N,

l = Distance between centre to centre of supporting rollers,

b = Average breadth of block measured in both faces.

Table 6 7-days Flexure strength result MPa

Mix	Metakaolin (%)	Zigzag (80 mm)	I-shape(60 mm)	Dumbel(60 mm)
M0	0	5.21	4.89	5.02
M1	5	5.65	5.6	5.79
M2	10	6.2	6.1	6.42
M3	15	5.61	5.5	5.59

Table 7 28-days Flexure strength result MPa.

Mix	Metakaolin (%)	Zigzag (80 mm)	I-shape (60 mm)	Dumbel (60 mm)
M0	0	7.22	6.99	7.04
M1	5	7.56	7.29	7.34
M2	10	7.84	7.77	7.9
M3	15	7.68	7.39	7.57

It was seen that 7-days and 28 days Flexure strength of all states of paver blocks had expanded because of fuse of Metakaolin contrasted with control blend M0. Blend in with 10% Metakaolin showed greatest strength acquire. When contrasted and I - shape Zigzag and Dumbel shape gave more strength and their conduct were practically same.

- Compared with control blend most extreme rate expansion in 7 days Flexure strength for M10 blend was 18.1 % found with I shape, 15.06% with Dumbel shape and 12.39% with crisscross shape. Essentially most extreme rate expansion in 28 days Flexure strength was seen as 11.11% with I shape, 12.4% with Dumbel shape and 8.7% was with crisscross shape. Maximum rate increment was acquired for Dumbel shape then I shape and most reduced for crisscross shape.

3. Water absorption

The test Results of water retention test are coordinated in the under. water retention of paver squares of the overall large number of shapes are growing up to 5 rate replacement and again decreasing at 10 degree of substantial replacement. Nonetheless, most outrageous decrease in water ingestion occur at 10% replacement of cement. For 5% substantial exchange water retention for all of the conditions of paver blocks are more than control mix. The best water ingestion occur at 5% replacement which is under 6% shown in IS 15658 - 2006 as most outrageous limit.

% Water Absorption = [(WW – DW) / DW] x 100

Where, WW = Wet Weight of paver block, DW = Dry Weight of paver block.

Table 8 Cement replacement Vs. Water absorption

Mix	Metakaolin (%)	Zigzag (80 mm)	I-shape(60 mm)	Dumbel(60 mm)
M0	0	2.34	2.1	2.2
M1	5	2.5	2.2	2.6
M2	11	1.5	1.9	1.8
M3	14	2.1	2.3	2.3

V. CONCLUSION

The point of the current examination work is to decide the mechanical properties of cement with MK as the admixture for M40grade of cement Paver blocks. Based on exploratory examination of the current exploration 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 MK increments up to 10%. . 7 days compressive strength of paver block for every one of the shapes are more than required objective strength up to 15% concrete substitution. The most extreme compressive strength for every one of the shapes are more at 10% of substitution. The greatest compressive strength of Dumbel (60mm) thickness at 10% substitution is 74.26 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 4.5MPa for every one of the shapes which is required strength for inflexible substantial asphalt.
- Use of Metakaolin as fractional substitution of concrete increments mechanical properties like compressive strength, flexural strength of cement.
- Concrete with Metakaolin additionally displayed better solidness as far as water ingestion.
- It was seen that 10% Metakaolin utilized as fractional substitution of concrete work on in general properties of cement paver blocks.
- About 20% increment in 28-days compressive strength were noticed for a wide range of paver blocks.
- About 11% expansion in 28-days flexural strength were noticed for a wide range of paver blocks.
- The most extreme strength acquire was noticed for Dumbel shape paver blocks.
- Metakaolin gives unmistakable lustrous white tone to paver blocks which increment the reflectivity and makes it reasonable for explicit applications like in pools, rooftops and so on to upgrade building magnificence moreover.
- Less porousness makes it appropriate to be utilized in mechanical floors, parking structures, connect decks and so forth.

REFERENCES

1. Sing Lam and Sun Poon (2008): "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 (2012): "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. 2012. "Effect of silica fume and metakaolin combination on concrete" International Journal of Civil Structural Engg. 2(3): 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: 10262-1982.
7. Kumar A and Kumar S (2013): "Development of paving blocks from synergistic use of red mud and fly ash using geo polymerization", 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 (2014): "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 (2015): "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 (2016): 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(2016): "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