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Experimental Study on Performance of Metakaolin in Pervious Concrete

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ABSTRACT

Lately, part of examination center around growing new Supplementary cementitious material to fortifying the solid. These materials are utilized as a piece of concretes. Metakaolin is one of the beneficial cementitious materials which are part of the way traded for concrete. Properties of cement with metakaolin are generally favored added substances in concrete.

Pervious cement is an uncommon kind of cement with a high porosity utilized for solid flatwork applications that permits water from precipitation and different sources to go straightforwardly through, in this manner diminishing the spillover from a site and permitting groundwater re-energize. It likewise called as Porous concrete, Permeable concrete, No fines concrete and Porous asphalt. Pervious cement is generally utilized in stopping zones, territories with light traffic, Residential roads, Pedestrian walkways and nurseries. It is a significant application for manageable development. Metakaolin will be added at various rates or percentages such as 1%,1.5%,2%,2.5% by the heaviness of concrete.

To make concrete cubes and cylinders at every percent. The effect of metakaolin at various percents in pervious concrete will be finding by conducting compression test.

KEYWORDS: *Metakaolin, Porous Concrete or Pervious Concrete, Compresstion Strength, Split Tensile Strength*

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I. INTRODUCTION

Pervious cement is a unique sort of cement with a high porosity utilized for solid flatwork applications that permits water from precipitation and different sources to go straightforwardly through, consequently decreasing the spill over from a site and permitting groundwater re-energize. It likewise called as permeable concrete, penetrable concrete, no fines concrete and permeable asphalt. Pervious cement is made utilizing huge totals with almost no fine totals. The solid glue at that point covers the totals and permits water to go through the solid chunk. Pervious cement is generally utilized in stopping territories, regions with light traffic, private roads, passerby walkways, and nurseries. It is a significant application for reasonable development and is one of many low effect improvement methods utilized by manufacturers to ensure water quality.

1.1. Aim

To find the strength behavior of pervious concrete at various percents of metakaolin and compare with the unmodified pervious concrete.

1.2. Research Objectives

- To achieve economy in concrete construction and to utilize metakaolin in an effective environment friendly manner.
- To meet the scarcity of cement and fine aggregates in future.
- To meet the strength improvement in pervious concrete.
- To determine the effect of material proportion on the engineering properties of the pervious concrete.
- Investigate the performance characteristics of the pervious concrete such as porosity, compressive strength, andinfiltration rate.

II. LITERATURE REVIEW

2.1. Effect of Fly Ash and Metakaolin On Pervious Concrete Properties- Nikhil Saboo, Shekhar Shivhare, Krishna Kumar Kori, Anush K. Chandrappa (2019)

The literature is reviewed on effect of fly ash and metakaolin on pervious concrete properties. In this study, supplementary cementitious materials are the by products of productions which processes all from industries, several environment concerns and it is imperative to utilize for partial replacement. The research was done by the author to determine the porosity, density, compressive strength, and permeability by doing various tests. The replacement of fly ash was found to be between 5 and 15%. And as result, cement can be partial replaced by SCMs, which not only increases the workability but as well aid in achieving higher strength with lesser cement contents rendering optimal solution for usage of industrial by-products. Different method were performed like specimen preparation and curing, determination of density and porosity, permeability and compressive strength. with increase in porosity, density reduced and permeabilityincrease.

The following are result researched by the author to explore the discussion to find the improvements by replacing with fly ash and metakaolin.

- To investigate the effect of fly ash, metakaolin, and curing condition on the properties of pervious concrete.
- Addition of 2% of metakaolin reduced the porosity and increased the density.
- The rate of change in properties was higher between replacement levels of 5 and 15% for fly ash.
- Increasing cement content to produce higher strength pervious concrete, cement can be partial replaced by SCMs, which notonly increases the workability.
- Achieving higher strength with lesser cement contents rendering optimal solution for usage of industrial by-products.

2.2. Experimental Analysis on High Strength Pervious Concrete-Ch. Hari Sai Priyanka1(2017)

The author researched on experimental analysis on high strength pervious concrete. As use of pervious concrete has increased significantly in the last several years, perhaps largely because it is considered an environmentally friendly, sustainable product.

This study describes the work done on determining the strength characteristics of pervious concrete, the further all the analysis was done by doing the strength tests and and comparing the characteristics of the high strength pervious concrete and conventional concrete samples. The objective was to determine the compressive strength test, split tensile strength test to determine its properties. Cubes were casted of size 150 x 150 x 150 mm for the tests. This paper also evaluates the suitability of pervious concrete for other applications such as buildings, bridges etc. the compressive strength was conducted on the compression testing machine. The tensile was determined for concrete cylinder of size 150mm dia and 300mm height.

Following conclusion are:

- The low paste content mixtures are found to have approximately 25% lower compressive energy absorption as compared to highpaste content mixtures of the same strength.
- Water absorption values for high strength pervious concrete is higher than the normal concrete.
- The strength results of normal concrete, pervious concrete and high strength pervious concrete and normal concrete is compared.
- The strength of high strength pervious concrete is lesser than normal concrete, but water absorption is more for high strengthpervious concrete.

2.3. Use of Pervious Concrete in Road Pavement-Suraj F. Valvi, Anil P. Thoke, Abhijit A. Gawande, Manoj B. Godse, Prof. D. D Shelke(2017)

In this study the authors researched on the use of pervious concrete in road pavement. As pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. In this study the main aim was to determine the compressive strength and permeability of the pervious concrete with casting cubes of size 150mm x 150mm x 150mm for 28 days of curing. As the durability and permeability are the important properties of pervious concrete. Pervious concrete is also used to pass through there by Reducing the Runoff from a site and Recharging Ground Water Levels. Where 43 grade of cement was used. As per IS-269-1989, fineness of cement was determined. For consistency, IS 4031 part 2 was used. Many other IS codes were used in this study to improvise work to check the results on compressive strength and permeability.

Based on the conclusions authors analyzed the study mentioned below:

- To produce high compressive strength, the smaller size of coarse aggregates should be taken.
- Pervious concrete is more suitable in rural areas as per rural requirements. Mainly to reduce the storm water runoff, to increasethe ground water level.
- To get high compressive strength of pervious concrete not always depends upon the higher strength and workability.
- The use of admixtures like fly ash and silica fume, the strength of pervious concrete increases.
- OPC 53 grade cement has highest compressive strength (12.71 N/mm2) compared to any other mix proportion.
- Pervious concrete obtained by removing the fine aggregate wholly (0%) and partially as 10% and 20% replacing the coarseaggregate get higher strength.

2.4. Experimental Study on Implementation of Pervious Concrete in Pavements- Nishith M N, Gururaj Acharya, Shaik Kabeer Ahmed(2016)

The author research on the Study Experimental Study on Implementation of Pervious Concrete in Pavements. This study is based to obtain the compressive strength, flexural strength and abrasion value and porosity value of pervious concrete. The main objective of this study is to provide and improve the strength of pervious concrete. To determine the goals that needs to achieve for porosity, permeability, and strength in porous concrete mixes. The cubes for determining the tests were casted at the age of 7, 14 and 28 days of curing.

- At the age of 7, 14, 28 days, the minimum compressive strength id obtained at 0% fine aggregates.
- At 10% of mix provide high strength thus compressive strength is maximum.
- As curing period increase the compressive strength was also increased.
- The porous voids will be crested on not using more fine aggregates.
- Porosity is max at 10% fine aggregate usage with super plasticizer, and minimum at 0% fine aggregate without using superplasticizer.

III. RESEARCH MATERIALS AND METHODOLOGY

3.1. Materials for Trial Mix

3.1.1. Cement- Ordinary Portland Cement, grade 43 confirming to IS 8112: 1989 is used in this project.

3.1.2. Aggregates- Locally available crushed stone coarse aggregates of nominal size 10mm and 20mm are used for the trial. Followingtable shows the physical properties of coarse aggregates.

Table 1 Physical properties of coarse aggregate

Size	Specific Gravity	Water Absorption %	Flakiness Index %	Elongation Index %	Crushing Value%	Impact Value %
10. Mm	2.89	1.06	9.36	14.46	11.66	5.56
20. mm	2.90	1.01	8.10	10.52	12.25	5.39

3.1.3. Metakaolin – Specific Gravity -2.56 and Initial and Final setting time are 63 minutes and 640 minutes.

3.1.4. Water- For casting and curing water used is free from organic matter and portable water is used as per clause no. 5.4 of IS 456- 2000.

3.2. Methodology

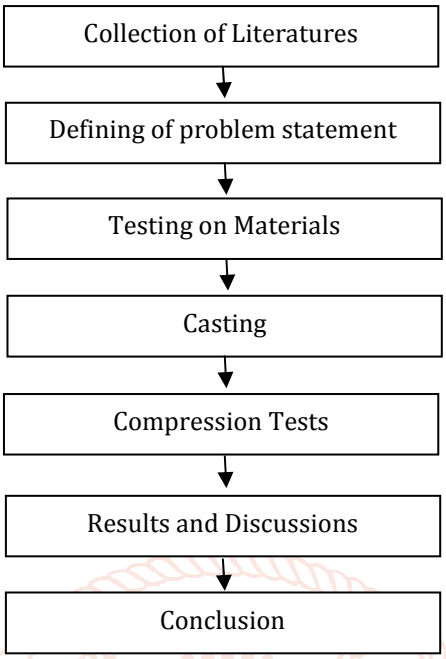

Figure 1 Methodology

IV. TESTING

4.1. Compression Test

Compression test is used to find out the characteristics of the concrete block. It gives the compressive strength of the concrete block. Compressive strength is the ability of material or structure to carry out the loads on its surface without any crack or deflection. The value of compression test depends upon the water-cement ratio, cement strength, quality of concrete material, quality control during the production of concrete. The compression is done after the mixing, placing, and curing of concrete block, the specimens are tested after the 7 or 28 days of curing. To obtain the proper reading of compressive strength the blocks should completely dry. To obtain the more proper value of compressive strength, take the average value of three blocks.

V. RESULTS AND DISCUSSION

5.1. Compressive Strength Results

Table 2 Comparison of Compressive Strength for different Mix

Mix / %of Metakaolin	Water- Cement Ratio	Day of Curing	
		7 day	28 day
Mix-1, 1%	0.40	6.93 N/mm²	18.28 N/mm²
Mix-2, 1.5%	0.40	7.0 N/mm²	19.06 N/mm²
Mix-3, 2%	0.35	8.6 N/mm²	21.20 N/mm²
Mix-4, 2.5%	0.35	11.06 N/mm²	22.53N/mm²

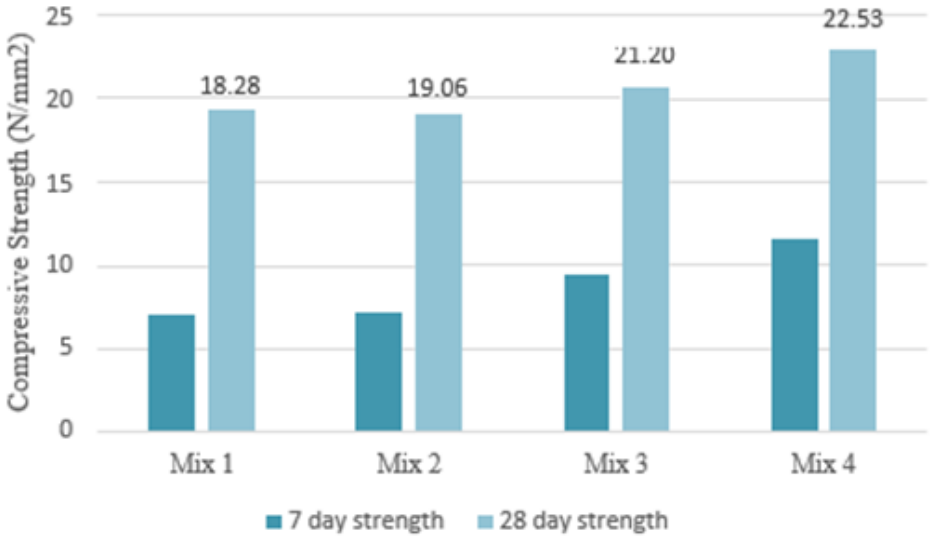

Figure 1 Comparison of Compressive Strength for Different Mix

VI. SCOPE OF STUDY

If the compressive strength of pervious concrete is increased successfully, then it can be used to construct pervious concrete pavement instead of a rigid pavement of conventional concrete, which will be very beneficial. It can be used to avoid the accumulation of water over road pavements, which leads to traffic delay so it helps to reduce traffic density during the rainy season. Pervious concrete, if usedon pavement will help to reduce the quantity of runoff water, enhance skid resistance, and can further be used as a tool for rainwater harvesting to increase groundwater level.

VII. CONCLUSION

- Compressive strength of pervious concrete depends upon the porosity of concrete, binder material (a type of cement), showed huge influence on the strength of pervious concrete.
- Using up to 2% Metakaolin as a cement replacement has the same effect as using pure concrete for making pervious concrete.
- Following terms plays a crucial role in the strength of pervious concrete:
- Size of coarse aggregate
- Water-cement ratio
- Aggregate to cement ratio
- The void ratio and unit weight are two important parameters of pervious concrete in the context of mix design.
- The porosity is directly proportional to the void ratio. As the void ratio increases porosity also increases.
- Compressive strength and permeability are inversely proportional to each other. As the porosity increases, compressive strengthdecreases.
- We also concluded that reduction in aggregate size, decreases the porosity, because of its inter-relation with no fine aggregateproperty.
- Compressive strength and void ratio are inversely proportional as the void ratio increases, compressive strength decreases.
- Also, the reduction of aggregate size affects the compressive strength of pervious concrete. More strength is achieved as theaggregate size decreases.
- Pervious concrete pavement is unsuitable for heavy-duty roads..
- We concluded that aggregate of size 10-12.5 mm gives the good compressive strength and optimum porosity in perviousconcrete.

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