



# **“EXPERIMENTAL STUDY ON EFFECTS ON PROPERTIES OF CONCRETE WITH PARTIALLY REPLACEMENT OF CEMENT AND NATURAL SAND BY METAKAOLIN AND ROBO SAND ”**

Ashish Kumar 1, ,Pushpendra Kumar Kushwaha2, Jiji M Thomas 3,Mithun Kumar Rana 4

M.Tech Research Scholar1, Assistant Professor2,3,4

Civil Department

RKDF College of Engineering Bhopal, India

**Abstract** Concrete is considered to be the most widely used and versatile material of construction all over the world. One of the important ingredients of conventional concrete is natural sand or river sand, which is on the verge of exhausting due to abundant usage. In this content Metakaolin was a pozzolanic material used in wide range in replacement of cement. Metakaolin is dehydroxylated aluminum silicate, due to its pozzolanic activity the strength properties and durability properties of concrete increases and reduction in Porosity and Permeability also. In this present investigation partial replacement of cement with metakaolin at 0%, 5%, 10%, 15% and replacing natural sand with 50% ROBO sand. The mechanical properties of concrete i.e. compressive strength, split tensile strength and flexural strength are studied of concrete made with replacement of MK-RS and results are compared with conventional concrete. In this work totally six mixes are prepared with M20 and M25 grade concrete mix and average of three specimens were tested for 7 days, 14 days and 28 days for each mix.

**Keyword –** Metakaolin, conventional concrete, ROBO sand, Fly ash, Bottom Ash, pozzolanic material

## INTRODUCTION

Concrete is a widely used material in the world. More than ten billion tonnes of concrete are consumed annually. Based on global usage it is placed at second position after water. Conventional concrete, a versatile material is a mixture of cement, sand, aggregate and water. Aggregate content is a factor, which has direct and far-reaching effects on the quality of concrete. Unlike water and cement, which do not alter any particular characteristic except in the quantity in which they are used, the aggregate component is infinitely variable in terms of shape and grading. High quality aggregate, both coarse and fine for concrete, is of extreme importance. Aggregates occupy 65 to 80% of the total volume of concrete and affect the fresh and hardened properties of concrete. Out of the total composition of concrete, the fine aggregate consumes around 20 to 30% of the volume. To reduce the consumption of cement partial replacement of cement with some supplementary cementitious materials like Metakaolin, fly-ash, bottom ash, rice husk, GGBS and silica fume etc., are used in concrete mix. Metakaolin is a dehydroxylated form of clay mineral Kaolin. Stone having high percentage of kaolinite are known as china clay (or) kaolin was traditionally used in manufacture of porcelain i.e. ceramic material.

## METAKAOLIN

Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Metakaolin is a valuable admixture for concrete/cement applications. Rocks that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of Metakaolin is smaller than cement particles but not as fine as silica fume



Appearance of Metakaolin

## LITERATURE REVIEW

Thaniya Kaosol (2010) has made study on the reuse of concrete waste as crushed stone for concrete masonry units. The main objective was to increase the value of the concrete waste, to make a sustainable and profitable disposal alternative for the concrete waste. Attempts were made to utilize the concrete waste as crushed stones in the concrete mix to make concrete blocks. Various percentages of crushed stones have been tried the amount (i.e. 0%, 10%, 20%, 50% and 100%). From the results they found concrete waste can be used to produce concrete block masonry units.

M.R. Ganesamoorthy and Dr. S. Arivalagan.2017, he studies Experimental Behavior of Composite Infilled Column by using Silica fume & Metakaolin, in this paper The experimentation is performed for different water cement ratio of 0.35 to 0.5% for in composite column of Square and Circular Section.

N Venkat Rao and B Suresh,2018 Evaluation of Engineering Properties of Concrete by the Partial Replacement of Natural River Sand by Robo Sand, he study the strength of concrete has been evaluated by replacing natural or river sand with Robo sand at various proportions i.e., 0%, 25%, 50%, 75% and 100% for M40 grade of concrete with water cement ratio of 0.38. The durability of the concrete on cubes in acid immersion is also determined.

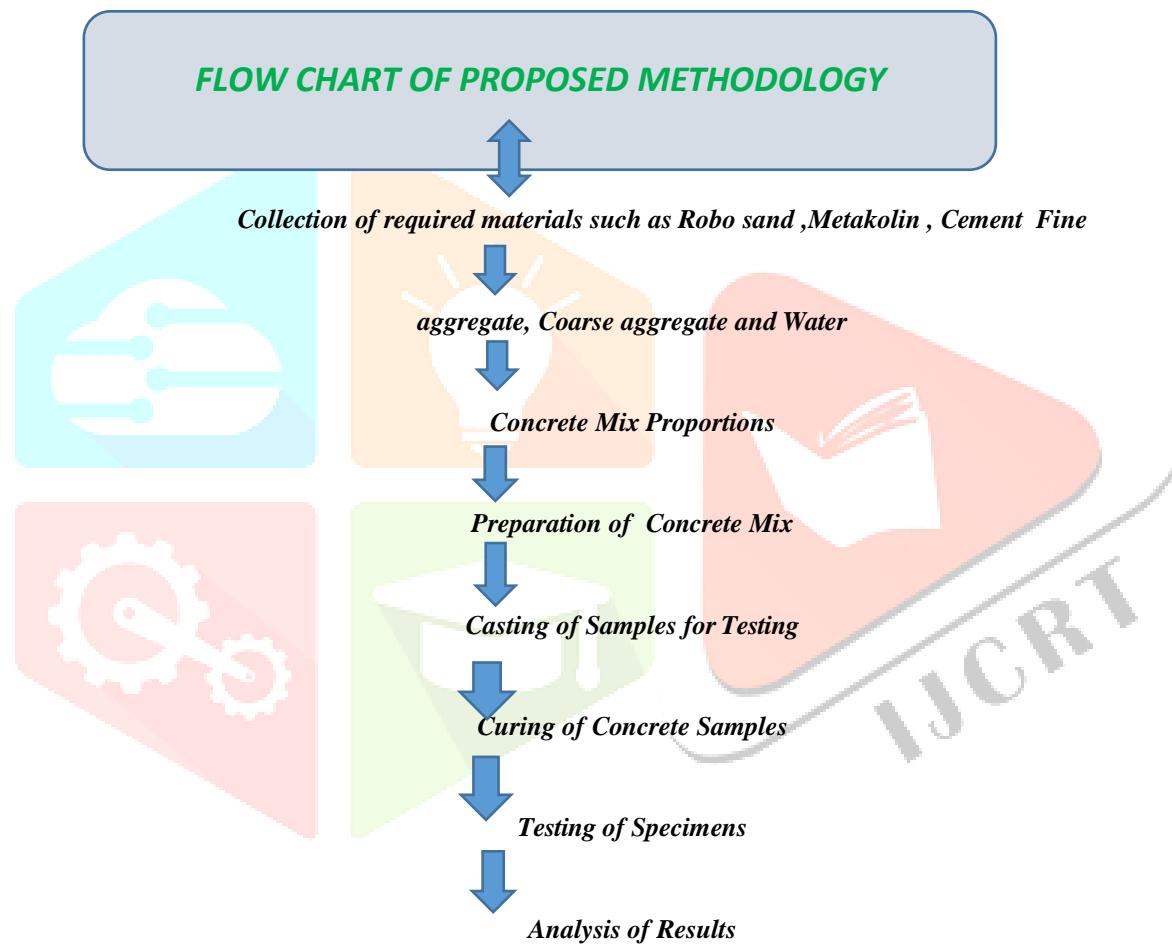
Dr Sanjeev Nukala,2019 in this paper he study the Strength Appraisal of Fiber Reinforced Concrete by Replacing 40% of Ordinary Portland Cement (OPC) with Mineral Admixtures Fly Ash, GGBS and Metakaoline

## OBJECTIVE

The objectives of the research work are outlined as below.

- To determine the fresh property i.e. workability of M20 and M25 grade concrete by partially replacing cement with metakaolin and Natural sand with ROBO sand.
- To study the effect of Metakaolin and ROBO sand on hardened properties of concrete such as compressive, Split tensile and Flexural strength of concrete at 7, 14 and 28 days
- 

## METHODOLOGY



## Material used in experiment

- Cement
- Metakaolin
- Aggregate (Coarse Sand)
- ROBO Sand
- Water

### Cement

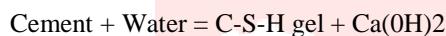
Cement in general can be defined as a material which possesses very good adhesive and cohesive properties which make it possible to bond with other materials to form a compact mass. Cement used in present investigation i.e. Ordinary Portland Cement of 43-Grade .

### Metakaolin

Metakaolin is brought from **India Mart** having more than 55% of SiO<sub>2</sub> and Specific gravity 2.5 and finer than Cement.

Chemical formula of Metakaolin is Al<sub>2</sub>O<sub>3</sub>.2SiO<sub>2</sub>.

Chemical reaction as follows



### Fine Aggregate ( sand)

Locally available river sand was used as a Fine aggregate.



## Robo sand

Stone dust produced from stone crushing zones appears as a problem for effective disposal. Hence in this work stone dust is used in the concrete as partial replacement of the sand. The main purpose of this work is to waste minimization. The study focuses to determine the relative performance of concrete by using stone dust. Stone dust was collected from local stone crushing units Bhopal.



ROBO SAND

## Course Aggregate

The aggregate to be used for cement concrete work should be hard, durable and clean. The aggregates should be completely free from lumps of clay, organic and vegetable matter, fine dust, etc. the presence of all such debris prevents adhesion of aggregates and hence reduces the strength of concrete. In this work two aggregate of sizes 20 mm and 10 mm were used from locally available from Piplani Bhopal

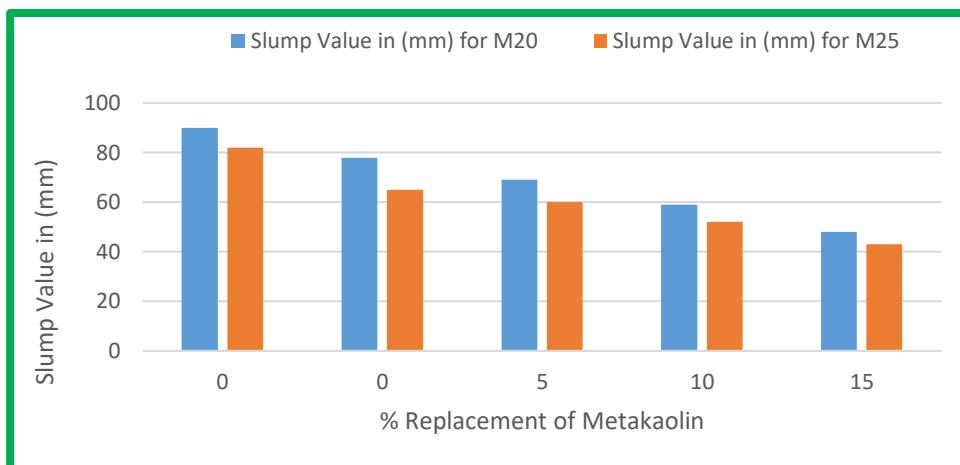


## RESULTS AND DISCUSSION

### Workability Test

Slumps of M-20 and M-25 with Metakolin and Robo sand

In this work the workability is tested by slump test. When the concrete is freshly mix then it is tested by filling the fresh concrete in the slump cone. The workability is measured by removing the slump cone and measured the subsidence of the concrete this value is called the slump value of the concrete

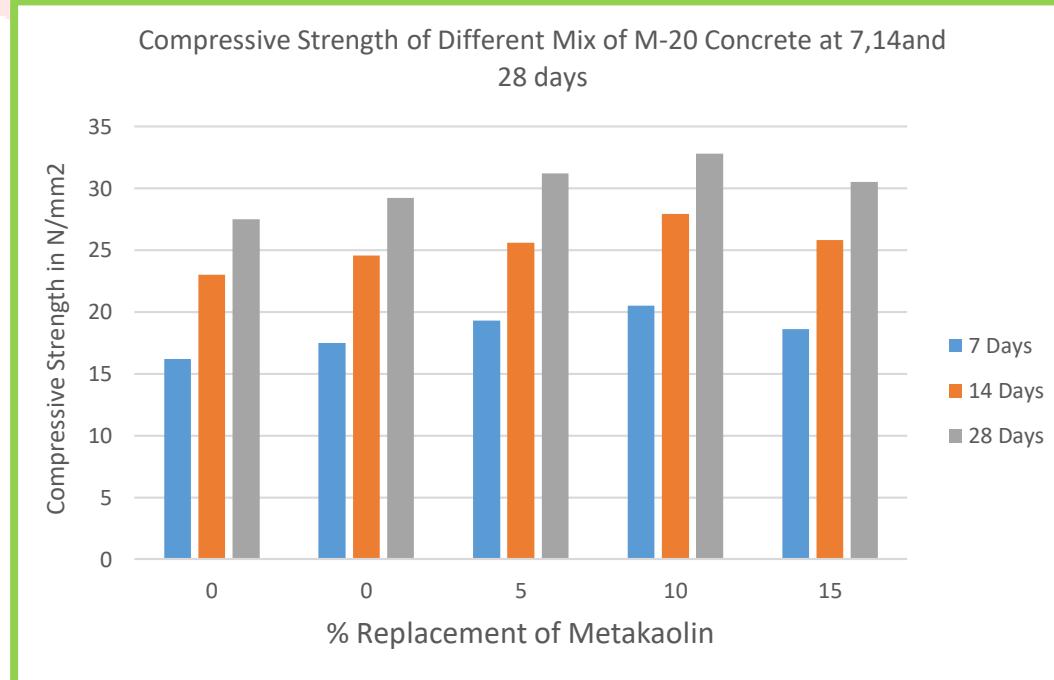


Slumps of M-20&M-25 at different percentage of MK and RS

From the experiment analysis ,The workability of different concrete mixes decreases as compared to the control mix.The workability of the different concrete mixes due to more fineness of Metakaolin The voids present in the concrete are filled with Metakolin. From the experiment it was found that Robo sand is not affect the workability of concrete

#### COMPRESSIVE STRENGTH

The effect of Metakaolin and ROBO sand used in the present study on compressive strength of concrete for M20 &M25 grade of concrete with varying dosages as 0%, 5%, 10% and 15% of Metakaolin replacing cement by v/eight and natural sand with 50% ROBO sand at 7 days, 14 days and 28 days

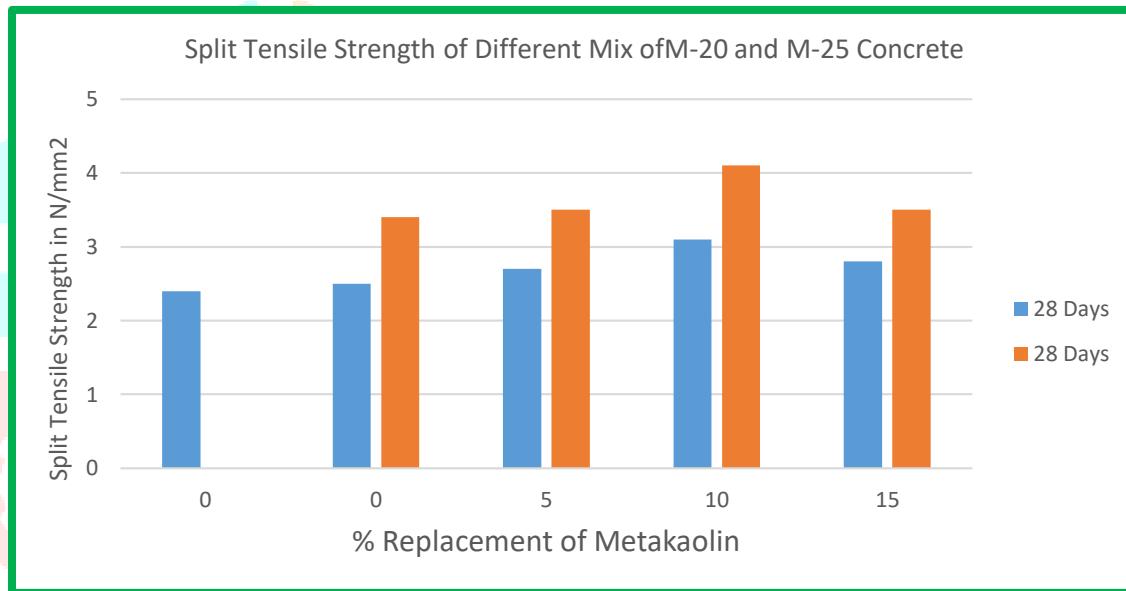


Effect of Metakaolin and ROBO sand on compressive strength of concrete at  
7-days, 14-days and 28 days

From the above table is seen that the compressive strength in M 20 & M25 grade of concrete at 7, 14, and 28 days increases when the percentage of the Metakaolin from 0% to 10% with 50% ROBO sand. At 10% replacement of Metakaolin strength observed to be maximum and after strength is decreasing. The strength increase at 28 days is up to 18%, for M20 grade of concrete and strength increase at 28 days is up to 11%, for M25 grade of concrete.

### SPLIT TENSILE STRENGTH

Split Tensile Strength of Different Mix of M-20&M-25 Concrete. The effect of Metakaolin and ROBO sand used in the present study on Split Tensile strength of concrete for M20&M25 grade of concrete with varying dosages (0%, 5%, 10% and 15%) of Metakaolin replacing cement by weight and natural sand with 50% ROBO sand at 28 days

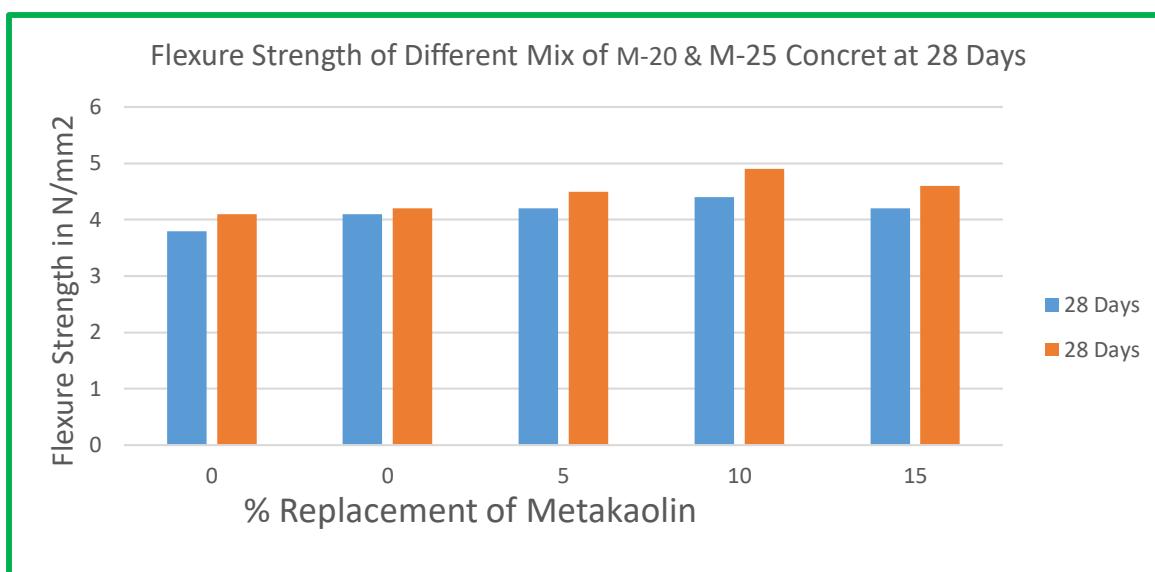


Effect of Metakaolin and ROBO sand on Split tensile strength of concrete at  
28-days for M20 and M25

From the test results it has been observed that the Split tensile strength of M20 and M25 grade concrete increases gradually up to 10 % of Metakaolin with 50 percentage of Robo sand, At 10% replacement of Metakaolin strength observed to be maximum and after strength is decreasing. At 28 day Maximum split tensile strength of M20 & M25 grade of concrete is 3.1 N/mm<sup>2</sup> and 4.1 N/mm<sup>2</sup>,

### FLEXURAL STRENGTH

The effect of Metakaolin and ROBO sand used in the present study on Flexural strength of concrete for M20& M25 grade of concrete with varying dosages as 0% 5%, 10% and 15% of Metakaolin replacing cement by weight and natural sand with 50% ROBO sand at 28 days



### Effect of Metakaolin and ROBO sand on Flexure Strength of concrete at 28-days for M20 and M25

From the test results it has been observed that the Flexure Strength of M20 and M25 grade concrete increases gradually up to 10 % of Metakaolin with 50 percentage of Robo sand, At 10% replacement of Metakaolin strength observed to be maximum and after strength is decreasing. At 28 day Maximum Flexure Strength of M20 & M25 grade of concrete is 4.4 N/mm<sup>2</sup> and 4.9 N/mm<sup>2</sup>,

### CONCLUSION

On the basis of experimental investigation of the present research study, the following conclusions have been drawn.

- The workability of different concrete mixes decreases as compared to the control mix. The workability of the different concrete mixes due to more fineness of MK. The voids present in the concrete are filled with MK. The workability is not affected due to the ROBO sand,
- At 28 day Maximum compressive strength of M20 & M25 grade of concrete is 32.2 N/mm<sup>2</sup> and 35.2 N/mm<sup>2</sup> at 10% of Metakaolin with 50% of Robo Sand .
- From the test results it has been observed that the Split tensile strength of M20 and M25 grade concrete increases gradually up to 10 % of Metakaolin with 50 percentage of Robo sand, At 10% replacement of Metakaolin strength observed to be maximum and after strength is decreasing. At 28 day Maximum split tensile strength of M20 & M25 grade of concrete is 3.1 N/mm<sup>2</sup> and 4.1 N/mm<sup>2</sup>,
- From the test results it has been observed that the Flexural strength of different concrete mixes, increases at all ages in comparison of the control mix. At 10% replacement of Metakaolin strength observed to be maximum and after strength is decreasing. At 28 day Maximum Flexural strength of M20 & M25 grade of concrete is 4.4 N/mm<sup>2</sup> and 4.9 N/mm<sup>2</sup>

## REFERENCE

[1] VenuMalagavalli and Rao, P.N. 2010. "High Performance Concrete with GGBFS and ROBO Sand". International Journal of Engineering Science and Technology, 2(10), 5107-5113.

[2] Venkata sairam kumar.N, Dr.B.Panduranga Rao, Krishna Sai.M.L.N, 2013,"Experimental study on partial replacement of cement with quarry dust". IJAERS,Vol:2(3),136-137

[3] Hemant Chauhan, 2011, "Effect of Activated Fly ash in Metakaolin based cement", Proceedings of National Conference on Recent Trends in Engineering & Technology, BVM Engineering College, Gujarat, India.

[4] Supriya K.Nalawade, Hemalata K.Munot, Balkrishna Dawari, 2011,"Properties of concrete with metakaolin and fly ash as partial replacement to cement". IJESE, Vol:4(6)

[5] Muthupriya P, Subramanian K and Vishnuram B.G, 2011, "Investigation on behavior of high performance reinforced concrete columns with metakaolin and fly ash as admixture", International J. of Adv. Engg. Tech., 2(1): 190-202

[6] Kannan V and Ganesan K, 2012, "Strength and water absorption properties of ternary blended cement mortar using rice husk ash and metakaolin", Scholarly J. of Engg. Research, 1(4): 51-59.

[7] M.R. Ganesamoorthy and Dr. S. Arivalagan. Experimental Behavior of Composite Infilled Column by using Silicafume & Metakaolin. International Journal of Civil Engineering and Technology, 8(1), 2017, pp. 203–208

[8] N Venkat Rao and B Suresh, Evaluation of Engineering Properties of Concrete by the Partial Replacement of Narutal River Sand by Robo Sand, International Journal of Civil Engineering and Technology, 9(4), 2018, pp. 737–743.

[9] Dr Sanjeev Nukala, Strength Appraisal of Fiber Reinforced Concrete by Replacing 40% of Ordinary Portland Cement (OPC) with Mineral Admixtures Fly Ash, GGBS and Metakaoline, International Journal of Civil Engineering and Technology 10(2), 2019, pp. 1347–1354.

[10] IS 2386 – 1963: Methods of Test for Aggregates for Concrete.

[11] IS 10262 – 2009: Recommended Guidelines for Concrete Mix design.

[12] IS 13311(Part 2) – 1992: Method of non-destructive testing of concrete methods of test.

[13] IS 10262-2009 - "Concrete Mix Proportioning - Guidelines", Bureau of Indian Standard, New Delhi.

[14] IS 383-1970 - "Indian Standard Specification for coarse and fine aggregates from natural sources for concrete. Second Revision", Bureau of Indian Standards, New Delhi.