Experimental Investigation on Concrete by Replacement of Metakaolin as Cement and Pumice Aggregates as Coarse Aggregates

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Abstract

In this study, Cement concrete is prepared by using cement and metakaolin as a binder, sand as fine aggregate and pumice stone as coarse Aggregate. Bureau of Indian Standard (BIS) method is used to proportionate the concrete. The concrete and constituent mortar cubes are casted by different ratio and proportion and cured. The cubes are tested at various ages to find the compressive strength. The main cause of the fracture on the concrete cubes are through the pumice aggregate. The law of mixtures are used to compute the characteristic strength of the aggregates. In this project to compare the different ages of strength are to be analysed for the improvement of compressive and tensile strength. The mortar strength can be altered by adjusting the water-cement ratio. This method can be used to re-proportion the concrete by the law of mixtures and Abrams' law as basis. Abrams' law is a concept in civil engineering. The law states the strength of a concrete mix is inversely related to the mass ratio of water to cement. As the water content increases, the strength of concrete decreases.

Keywords — *light weight concrete, pumice, metakaolin.*

I. INTRODUCTION

High-purity kaolin materials are fired under controlled methods to make our metakaolins. These functional fillers are used in building and refractory applications for their pozzolanic behavior and fine particle size.Metakaolin's pozzolanic reactivity means it can react with calcium hydroxide in cement-based products. It is a dehydroxylated aluminum silicate. Its general formula is Al2O3.2SiO2. It is an amorphous non-crystallized material made up of lamellar particles.Metakaolin is used as an additive to hydraulic binding agents (concretes, mortars and coatings) made from Portland cement or lime. Calcined kaolin (such as **Argical™**) offers superior reinforcement, excellent extrusion and compression set, all important properties in the design of rubber compounds and articles.Calcined kaolin is chemically inert and our grades have low heavy metal content which is an advantage when making pharmaceutical stoppers. As the natural aggregates Pumice, mineral aggregate and volcanic ash can be mentioned. Pumice is of igneous rocks and forms when molten material enters the sea and a fast cooling occurs. This black rock contains wide open pores and with smaller grains its density increases and approaches the density of igneous rock.

II. OBJECTIVES

- To find the strength due to replacement of metakaolin and pumice stone.
- To compare the results of using metakaolin and pumice to conventional concrete.
- To produce better and low cost replacement product without compromising the strength of the concrete.

III. ADVANTAGES AND DISAVANTAGES

A. Advantages

- Increase the mechanical properties as well as durable properties of the concrete.
- Minimize the usage and limits the over extraction of the conventional coarse aggregates.
- Cost effective when compared to conventional coarse aggregates

B. Dis-Advantages

- Metakaolin is having some unpurified impuritiesin nature.So too much caring in mixing process proportion.

IV. LITERATURE REVIEW

Incorporation of Metakaolin in Concrete: A Review Abhishek Jandiyal (2014)**,**On the basis of study it is seen that metakaolin replacement has a good influence on strength parameters. It can be replaced up to 25% and optimum is at 10%.The increase of compressive strength varies between 5-38% for M20 grade,2-37% for M30 grade,3-13% for M40 grade and 3-18% for M50 grade of concrete. The increase of split tensile strength varies between 5-36% for M20 grade,2-13% for M30 grade,2-34% for M40

grade and 2-26% for M50 grade of concrete. The increase in cost for 10% replacement varies between 11-13% for all grades of concrete.

Metakaolin the Best Material For Replacement of Cement In Concrete Felixkala .T (2016)The strength of all metakaolin concrete mixes over shoot the strength of OPC.15% cement replacement by metakaolin is superior to all other mixes.The increase in metakaolin content improves the compressive strength and split tensile strength up to 15% cement replacement. The results encourage the use of metakaolin, as a pozzolanic material for partial replacement in producing high performance concrete.

Effect of Metakaolin on The Properties of ConcreteMohan N.Shirsath (2017)Metakaolin concrete increases the compressive and flexural strength effectively as compared with conventional concrete.Workability decreases as percentage of metakaolin in concrete increases. The strength of concrete increases with increase in metakaolin content up to 15% replacement of cement .As the percentage of metakaolin powder in concrete increases, workability of concrete decreases.

Properties of Pumice Light Weight Aggregate Mutku Raphael .N (2012) pumice aggregates meet the physical properties of concrete aggregates. Pumice can effectively be used as light weight aggregates. The concrete which can be produced with these aggregates satisfies the requirements of low light weight concrete. Further that the concrete produced can safely be used for the construction of domestic houses, where loads are light and high strength is not required. The pumice aggregates available in this country have a potential to produce commercially low light weight concrete. There is an abundant resource on naturally occurring light weight aggregate for commercial exploitation. Other physical and mechanical properties of aggregates, reveal that the dry bulk density of light weight aggregate is in the allowable range, however it is close to the maximum.

Experimental Study on Light Weight Aggregate Concrete with Pumice Stone, Silica Fume and Fly Ash As a Partial Replacement of Coarse Aggregate M K M V Ratnam (2014) By using 20% of light weight aggregate as a partial replacement to natural coarse aggregate the compressive strength is promising. The density of concrete is found to decrease with the increase in percentage replacement of natural aggregate by pumice aggregate. The compressive strength of concrete is found to decrease with the increase in pumice content. With the addition of mineral admixtures, the compressive, split tensile and flexural strengths of concrete are increased. Light weight aggregate is no way inferior to natural coarse aggregate and it can be used for construction purpose. When trying with silica fly ash and silica fume there are so many results which leads to good strength.

Fibre Reinforced Light Weight Aggregate (Natural Pumice Stone) Concrete Sivalinga Rao. N and Ratha Rathna Kumari Y (2014) The density of concrete is found to decrease with the increase in percentage replacement of natural aggregate by pumice aggregate. The compressive strength of concrete is found to decrease with the increase in pumice content. The compressive strength of pumice concrete is seen to increase with the fiber content**.** The split tensile strength of blended concrete is found to vary from 3.50 to 1.22 Mpa with the replacement of natural aggregate by pumice from 0 to 100%.The strain energy values stored in slabs varies are observed to vary 156671.68 to 52307.96 units with the replacement of natural aggregate by pumice from 0 to 100%.The optimum value is achieved at the combination of 20% pumice content with 1.5% of fibber content.

V. MATERIAL TESTING RESULTS

Table I : Test result of cement

S.No.	Properties	Value
1.	Fineness	2.41%
2.	Specific Gravity	3.15
3.	Initial Setting time	20 minutes
4.	Final Setting time	600 minutes

Table II : Test result of Coarse Aggregate

S.No.	Properties	Value
1.	Impact value	7.45%
2.	Crushing value	13.90%
3.	Water absorption	1.80%
4.	Specific gravity	2.66

Table III : Test result of Fine aggregate

S.No.	Properties	Value
1.	Finess Modulus	2.89
2.	Zone	II
3.	Plasticity Index	6.23
4.	Specific gravity	2.67

TablE IV : Test of Fresh Concrete

S.No.	Properties	Value
1.	Slump Value	50
2.	Flow percent	80%
3.	Compaction factor	83%

VI. EXPERIMENTAL INVESITIGATION

A. *Preparation and Casting of Specimen*

This study included a preparation cube samples (150 × 150 × 150 mm) for compressive strength test and samples of cylinder (150 mm diameter × 300 mm height) for split tensile strength test. For each mix, 3 cubes were tested for compressive strength at 7 days 14 days and 28 days of curing, 3 samples of cylinder were tested for split tensile strength for 7 days, 14 days and 28 days of

MIX	Compressive strength (N/mm^2)		
	7th day	14th day	28th day
Conventional	10.22	13.60	14.98
M1	10.14	13.49	14.97
M2	10.35	13.60	15.09
M3	11.12	14.28	16.20

curing.

These proportions are mixed in concrete instead of natural fine aggregates. M15 Concrete of mix ratio 1:2:4 is prepared and casted with proper compaction. The cube specimens were test for 7th, 14th and 28th for investigate its compressive strength and split tensile

MIX	Tensile strength (N/mm^2)		
	7th day	14th day	28th day
Conventional	2.18	2.92	3.55
M1	2.16	2.74	3.41
M2	2.35	3.10	3.64
M3	2.82	3.22	3.88

strength.

VII.RESULT

- The compressive strength of M3 Mix concrete is much higher than that that of other mix samples.
- The compressive strength of conventional concrete is 14.98 N/mm^2 while in case of metakaolin with pumice concrete it give upto 16.20 N/mm^2
- The compressive strength of conventional concrete is 14.98 N/mm^2 while in case of metakaolin with pumice concrete it give up to 16.20 N/mm^2
- Similarly, the M3 Mix is observed to be have higher compressive strength that other mixes.
- Normal concrete have 3.55 N/mm^2 of tensile strength but the metakaolin with pumice concrete show higher tensile strength of 3.88 N/mm^2
- While the conventional concrete exhibits 7.1 of permeability, the metakaolin with pumice concrete shows just 0.7 of water permeability.

VIII. CONCLUSION

- ✓ Higher compressive and tensile strength are found in the concrete mix with replacement of 20% metakaolin and 35% of pumice aggregate.
- ✓ The compressive and tensile strength has increased above 100% of nominal strength by the usage of metakaolin and pumice.
- ✓ The porosity of metakaolin with pumice concrete is high but on the other hand it have very low permeability.
- ✓ Pumice aggregate is easily available.
- ✓ Metakaolin will reduce the demand of cement content in concrete.
- ✓ Its is suggested to use this concrete in water ways and as floating concrete.

REFERENCES

[1] Muralitharan R S and Ramasamy V "study on partial replacement of cement as metakaolin and light weight aggregat in concrete", IJRASET, 2016.
[2] M.S.Shetty, 'Concrete Technology' Chand & co Ltd, India.
[3] IS 4031 – Part 1 to 4, Method of physical test on cement.
[4] IS 2386 – Part 1 to 7, Method of test of aggregates.
[5] IS 10262 – 2009, Guidelines for concrete mix design proportioning.
[6] www.grapedia.com/7-lab-test-on-aggregates/