Result Article

Study of Multi-Blend Concrete By Using Metakaolin and Silica Fume as Partial Replacement of Cement

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ABSTRACT

Concrete is the building material that is most frequently used globally. It can typically be made from materials that are readily available nearby, cast into a wide range of structural configurations, and operated with little maintenance. It is appealing in a variety of applications because it provides significant strength at a reasonably low cost. By adding chemical admixtures like water-reducing agents to concrete, it is possible to achieve high strength by reducing the water content. High strength requirements may not always be enough. It's also necessary to improve other qualities like workability, low permeability, and durability. Flyash, silica, and ggbs are just a few examples of the pozzolanic materials that are incorporated into concrete for this reason. The environmental effects of the cement production process can be reduced by lowering the cement content. Additionally, since the majority of these materials are industrial waste, disposal issues can also be resolved. To alter one or more of the properties of concrete in its fresh and hardened states, additives are added to the batch at any time during mixing or right after mixing. Modern concrete technology frequently uses mineral admixtures as a partial replacement for cement in concrete. In this review of the literature, We investigated the effects of METAKAOLIN and SILICA FUME on the properties of concrete in a variety of blends, including binary, ternary, and quaternary. among other things, effects like workability, strength development, and resistance to sulphate and alkali-aggregate reactions.

KEYWORDS

Metakaolin, Silica Fumes, Compression Test, Flexural Test. Workability

1. INTRODUCTION

Concrete is the building material that is most frequently used globally. It can typically be made from materials that are readily available nearby, cast into a wide range of structural configurations, and operated with little maintenance. It is appealing in a variety of applications because it provides significant strength at a reasonably low cost. By reducing the water content, chemical admixtures like water reducing agents can be used to make concrete stronger. High strength requirements may not always be enough, even when other qualities like durability, low permeability, and good workability need to be improved

Concrete is made with pozzolanic substances known as mineral admixtures, such as fly ash, silica, ggbs, etc., for this purpose. These admixtures are added to concrete, which improves its properties while also lowering its cement content. The environmental effects of the cement production process are minimised due to the reduction in cement content. Additionally, since the majority of these materials are industrial waste, disposal issues can also be resolved.

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2. LITERATURE REVIEW

Ayobami Busari (2019)

The interest and utilization of cement have prompted a ton of examination in working on its strength, solidness, life cycle, temperature impact and some more. Working on the strength and solidness of cement is extremely foremost in the development of essential foundation in a bid to make it feasible.

M. Jayasri (2021)

This paper presents the consequences of an exploratory examination on the mechanical properties of underlying substantial utilizing Steel fiber (SF), Polypropylene fiber (PF) and Metakaolin (MK). The impacts of these strands and MK on different properties of M30 grade concrete are contemplated. MK Steel fiber content and Polypropylene fiber content were shifted in rate by weight of concrete. Every one of the examples was water relieved and tried following 28 days. It is seen that huge improvement in the primary presentation of cement is accomplished by the expansion of 15% MK in typical cement.

Vijay Singh Rawat (2019)

Quick foundation advancement overall increases the interest for concrete. Because of extreme interest of concrete cement and at same time shortage of these significant parts of the development business, it is fundamental for discover elective enhancements of concrete and cement. In this respect, we have zeroed in on incomplete elective material of concrete cement. Fly debris and Metakaolin were tried for their execution in the concrete as an advantageous material. Concrete having 35 MPa Compressive strength was focused on in the trial examination.

B. Naresh Goud (2017)

Valuable cementitious materials like silicon oxide vapor, fly debris, slag, Rice Husk Debris and Metakaolin are used lately as concrete elective material for developing HSC with advanced usefulness, energy and strength with diminished porousness. This paper has been composed so as to make the capability of Metakaolin accessible to the development business at large.

R.M. Sawant (2015)

Due to overall infrastructural improvement, since twentieth century utilization of cement has colossally expanded which brought about weighty assembling of concrete. Creation of concrete outcomes in weighty ecological contamination because of emanation of CO2 gas.

Netravati T Shepur (2014)

Concrete is the most normally utilized material for development Different kinds of pozzolanic materials that further develop concrete properties have been utilized in concrete industry for quite a while. Metakaolin is a dehydroxylated aluminum silicate. It is a shapeless non solidified material, comprised of lamellar particles. From the late exploration works utilizing Metakaolin, it is obvious that it is a extremely successful pozzolanic material and it viably upgrades the strength boundaries of cement.

3. MATERIAL INTRODUCTION

3.1 Concrete

Cement concrete is one of the seemingly simple but actually complex materials. Many of its complex behaviors are yet to be identified to employ this material advantageously and economically. The behaviors of concrete with respect to long-term drying shrinkage, creep, fatigue, morphology of gel structure, bond, fracture mechanism and polymer modified concrete, fibrous Concrete are some of the areas of active research in order to nave a deeper understanding of the complex behavior of these materials. Ingredients of concrete

1. Cement
2. Fine Aggregate
3. Coarse Aggregate
4. Metakaolin
5. Silica Fumes
6. Water

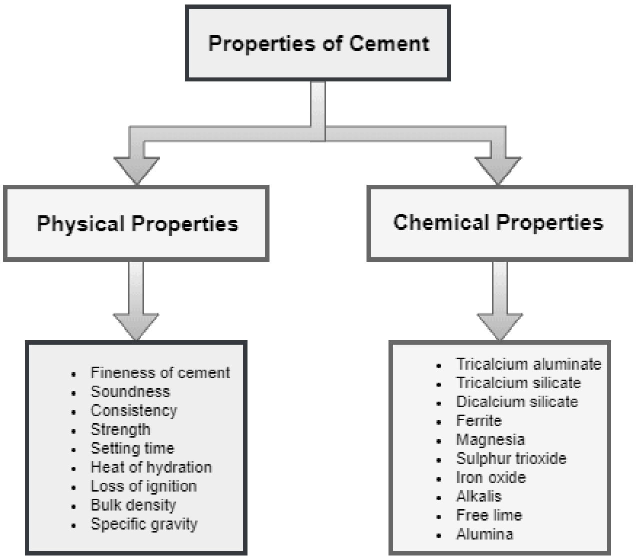
3.2 Cement

Cement is a popular binding material, is a very important civil engineering material. This article concerns the physical and chemical properties of cement, as well as the methods to test cement properties.

Fig 1 OPC ultra tech cement

Table no 1.1; compositions and compound percent in cement

Items	Normal	Rapid Hardening	Low Heat
(a) Compositions: Percent			
Lime	63.1	64.5	60
Silica	20.6	20.7	22.5
Alumina	6.3	5.2	5.2
Iron Oxide	3.6	2.9	4.6
(b)Compound :Percent			
C3S	40	50	25
C2S	30	21	45
C3A	11	9	6
C4AF	12	9	14



3.3 Aggregate

Aggregate' is a term for any particulate material. It includes gravel, crushed stone, sand, slag, and recycled concrete and geo-synthetic aggregates. Aggregate may be natural, manufactured or recycled.

3.3.1 Fine Aggregates

Fine aggregates are usually sand or crushed stone that are less than 9.55mm in diameter. Sand, crushed stones, ashes, cinder, etc. are the examples of the fine aggregate.

Fig. 2 fine aggregate (sand)

S. No.	IS Sieve Designation	percentage passing			
		Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
1	2	3	4	5	6
1	10mm	100	100	100	100
2	4.75mm	90-100	90-100	90-100	95-100
3	2.36mm	60-95	75-100	85-100	95-100
4	1.18mm	30-70	55-90	75-100	90-100
5	600µ	15-34	35-59	60-79	80-100
6	300µ	5-20	8-30	12-40	15-50
7	150µ	0-10	0-10	0-10	0-15

3.3.2 Coarse Aggregate

Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers.

Fig. 3 Coarse Aggregate

IS sieve designation		Percentage passing for single-sized aggregate of nominal size				
	63mm	40mm	20mm	16mm	12.5mm	10mm
80mm	100					
63mm	85-100	100				
40 mm	0-30	85-100	100			
20mm	0-5	0-20	85-100	100		
16mm				85-100	100	
12.5mm					85-100	100
10mm	0-5	0-5	0-20	0-30	0-45	85-100
4.75mm			0-5	0-5	0-10	0-20
2.36mm						0-5

Metakaolin

Metakaolin is a high-quality pozzolanic material. Metakaolin is one of the most widely used mineral admixtures these days. It helps concrete obtain both higher performance and economy. Metakaolin is produced by the calcinations of pure or refined kaolinite clay at a temperature between 650°C to 850°C. Kaolin clay is the raw material for the Metakaolin. Kaolinite clay is a mineral which is fine and white in colour and it is used in the manufacturing of porcelain. Kaolinite clay is also known as china clay or kaolinclay.

Chemical composition of Metakaolin

Chemicals	Percentage(%)
SiO2	62.62
Al2O3	28.63
Fe2O3	1.07
\MgO	0.15
CaO	0.06
Na2O	1.57
K2O	3.46

S.No.	Properties	Value
1	Physical form	powder
2	Colour	white /grey
3	Fineness	700 to 900 m^2/kg
4	Specific surface	8 to 15 m^2/g
5	Specific Gravity	2.5

Silica Fume

It has also been called silica fume, micro silica, amorphous silica and other similar names. Silica fume was also used for one of the flyovers at Mumbai where, for the First time in India 75mpa concrete was used in 1999. Binder, aggregates, water and in most cases with ready mixed concrete, one or more types in chemical admixtures.

Table-2.5. Physical properties of silica fume

S. No.	Properties	Values
1	Size	0.15 micron
2	Fineness	8.09
3	Specific gravity	2.25

Chemical properties	SF (%)
Al2O3	0.4
SiO2	97.1
Fe2O3	0.3
CaO	0.3
SO3	0.2
Na2O	0
L.O.I	1.7
MgO	0

Role of Silica Fume In Concrete

Silica fume is the result during the manufacture of silicon or of various silicon alloys. Silica fume, which contains more than 80% to 85% of SiO2 in amorphous form, is suitable to be used in cement andconcrete industries. The typical particle size of silica fume is around 0.1-0.5μm and the nitrogen BET surface is 20,000 m3 /kg. It is used increasingly in the world as a mineral admixture to produce high performance concrete. Silica fume is light and has a low bulk density of 250-300 kg/m3. It was utilizedfirst in 1970's as an additive

•It eliminates the growth of $Ca(OH)_2$ at the cement – aggregate interface, or transforms $Ca(OH)_2$ into$CaSiO_3$ hydrate by the pozzolanic reaction between silica and lime.

•It removes large pores at the cement – aggregate interface, making it denser.

As a result of these actions of silica fume, it gives significant improvement in mechanical properties and drastic improvement in durability and impermeability. While providing significantstrength and durability, silica fume can create an increase in water demand to reach specific workability levels due to the increase in specific area.

4. PROBLEM STATEMENT

From the above literature review the following conclusions can be drawn:

(i) Using of self-compacting concrete in place of normal mix slightly increases the shear capacity of beams.

(ii) Up till the maximum value the characteristics strength of concrete increases and after the optimum value the characterize strength decreases.

(iii) The split tensile strength and flexural strength also increases while there is decrease in water absorption capacity.

(iv) When the cement was replaced with Metakaolin and Silica Fume at various proportions then there is slight increase in the percentage of the characteristics strengths.

5. COCLUSION

The experimental investigations conducted on the behavior of concretes with METAKAOLIN and silica fume as partial replacements for cement.

In conclusion, the applications of nanosilica in concrete technology cannot be overemphasized as it greatly has influence on the properties of concrete and mortar both in fresh and hardened states. Also, nanosilica has been shown to fill the micro pores in concrete thereby improving its microstructural arrangement and thus producing a well dense concrete. Furthermore, metakaolin has been found to be unique amongst other pozzolans in terms of its satisfactory performance and most especially

The workability of concrete decreases with increment in partial substitution of cement using CCR, due to higher surface area and loss of ignition. NS addition to the concrete containing CCR further decreases the concrete's workability, thereby increasing water demand during mixing due to its very fine sizes.

- Thus the workability is improved by the partial replacement of the METAKAOLIN and silica fume with cement.
- The use of METAKAOLIN and silica fume as a replacement of cement helps to reduce the Energy consumption in the manufacturing of cement.

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