EFFECT OF CALCINED KAOLIN ON HIGH STRENGTH CONCRETE ALONG WITH ZEOLITE POWDER

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ABSTRACT

The rapid increase in construction work coupled with a renewal of interest in wide range of concrete performance has created more challenges in the construction industry. These challenges cannot be met by designing mix proportions based on existing codes and methods of concrete mix design. Several methods and codes are available to serve as guide for mix design of NSC, HPC. It needs of concrete market and the economic and ecological needs, several researchers, all over the world, studied the beneficial effect of different types of SCM which reduce the use of cement and decrease the emission of CO_2 *and also cost effective.*

In this research we use eco-friendly and cost effective material Calcined kaolin and zeolite replace individual and combined as cement replacement material with constant silica fume content by weight of cement and understand the effect of material in high strength concrete of grade M60,M70 and M80 with use of high range water reducers by weight of water. We perform the test of fresh and hard property of concrete then perform durability test and find optimum amount for M60, M70 and M80.

Keyword: *High strength concrete, calcined kaolin,zeolite*

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1 Introduction

The premature deterioration of concrete structures in aggressive environment has led to the development of high performance concrete in many fields such as, runway in airport, railway sleepers, nuclear reactor, prestressed concrete bridges, high-rise buildings, offshore platforms, chimneys, and silos etc. In this regard concrete with low permeability (or) higher impermeability is considered as durable concrete. This in turn improves the resistance of concrete against the penetration of harmful substances such as chloride ions, sulphate ions, carbon dioxide, water and oxygen.

The rapid increase in construction work coupled with a renewal of interest in wide range of concrete performance has created more challenges in the construction industry. Concrete with several properties may be desired such as high workability, medium workability, high strength, lightweight, insulation etc. These challenges cannot be met by designing mix proportions based on existing codes and methods of concrete mix design. Several methods and codes are available to serve as guide for mix design of NSC, HPC and lightweight concrete. However, these are just guide to arrive at first trial mix. Optimum mix proportions are obtained through testing of trial mixes and making adjustment accordingly. This is because these codes were developed based on experience with materials in certain parts of the world and may not be applicable to mix design in other parts of the world. Also, these codes do not address all issues regarding concrete mix design such as admixtures, transportation, and temperature effect

Supplementary Cementitious Materials

High performance concrete can be made, using Portland cement alone as a cementitious material. However, a partial substitution of Portland cement by one or combination of supplementary cementitious materials can be advantageous, not only from an economic point of view but also from a rheological and sometimes strength point of view.

Most supplementary cementitious materials have one feature in common: they contain reactive silica which in the presence of water, can combine with lime at room temperature, to form calcium silicate hydrate of the same type as that formed during the hydration of Portland cement. Basically, a pozzolanic reaction can be written in the following manner. This reaction is generally slow and takes several months for completion at the room temperature. However, the finer pozzolan reaction with lime was faster.

Pozzolan + lime + water = Calcium silicate hydrate

ROLE OF MINERAL ADMIXTURES

The presence of silica fume (SF) in the concrete mix improves workability and makes the mix more mobile, yet cohesive. This is the consequence of a better dispersion of the cementitious particles and due to the surface characteristics of the silica fume particles, which are smooth and absorb little water during mixing. The workability of concrete containing silica fume is more sensitive to variations in the water content of the mix than ordinary mix, as the fineness of silica fume reduces bleeding of concrete. The mix containing silica fume has very low penetrability and good resistance to penetration by chloride ions and thereby reduces freeze and thaw effect

The incorporation of metakaolin improves strength of concrete significantly. The research conducted on metakaolin indicated that the optimum level of replacement lies somewhere between 5% and 10%. Research studies have confirmed the partial replacement of cement by metakaolin contributes to the strength of concrete due to the filler effect, and the acceleration of hydration of cement due to its pozzolanic reaction. Moreover, metakaolin concrete have exhibited strength, slightly greater than silica fume concrete mixes at the same levels of cement replacement by the pozzolans

The influence of zeolite on the properties of fresh concrete depends upon the shape of the zeolite particles. A concrete mix containing zeolite is cohesive and has a reduced bleeding capacity. The action of zeolite is similar to that of superplasticizer with respect to water demand. The zeolite disperses and absorbs the particles of portland cement. Zeolite in the mix has a retarding effect, typically of about 1 hour, caused by the release of sulphur trioxide ions present at the surface of the zeolite particles. Because of this retarding effect, only initial setting is delayed, the time interval between setting and final setting being unaffected. It is proved that the addition of zeolite improves the dispersion of the portland cement particles, improving their reactivity. The reaction took place within the pores of the cement paste and on the surface of zeolite particles. Using zeolite in concrete will increase the setting time compared with an equivalent grade of normal concrete.

2. Material and Testing details

Material used in this experiments are silica fume, calcined kaolin and zeolite minerals mixed with fine and coarse well graded aggregates of maximum size 20mm and cement and portable water and superplastisizer(1.5% to 2% by weight of water)
.M60,M70 and M80 standard size cube and beam are casted in lab. After the casting of specimen cube are cured in water tank for 28 days.7 days and 28 days compressive cube test with 3000KN machine capacity and 28 days flexural two point bending beam test are perform.workability of concrete is measured by slump cone test method and targeted slump in 75-100 mm.
Silica fume content 5% of cement which is constant and Calcined kaolin and zeolite are take 5%,10% and 15% and 5%,10% respectively by weight of cement, percentage of Calcined kaolin and zeolite content are selected from pilot study.Durability parameter are also part of study which is perform in form of water penetration.

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SR NO.	NAME OF PROPERTIES	SILICA FUME	KAOLIN	ZEOLITE
1	Specific gravity	2.9	2.4	2.2
2	Mean grain size(µm)	<1	2.5 to 4.5	2 to 200
3	Specific surface area(m2/kg)	20,000	10000	320
4	Silicon dioxide(SiO2)	92%	59%	70%
5	Aluminium oxide(Al2O3)	1%	43%	14%
6	Iron oxide (Fe2O3)	0.5%	1%	1%
7	Calcium oxide(Cao)	-	0.15%	1.5%
8	Magnesium oxide(Mgo)	1.6%	0.15%	0.15%
9	Sulphite (SO3)	0.05%	-	0.5%
10	Sodium oxid (Na2O)	-	0.01%	1.3%
11	Potassium oxide (K2O)	-	0.10%	10%
12	LOI	1%	1%	1.5%

- **Mix Design per m3 of concrete**

SR NO.	NAME OF INGREDIANT	M 60	M 70	M 80
1	BINDER (cement +silica	441.2 kg	446 kg	510.3 kg

	fume)			
2	WATER	145.6 kg	146.1 kg	153.3 kg
3	FINE AGGREGATE	745 kg	729.3 kg	694.5 kg
4	COARSE AGGREGATE	1218 kg	1192.6 kg	1192.6 kg
5	ADMIXTURE	2.1 kg	2.1 kg	3.06 kg
6	DENSITY	2550 kg	2555 kg	2551 kg
7	W/C RATIO	0.33	0.30	0.33

3. RESULT OF EXPERIMENT

1. COMPRESSIVE CUBE TEST RESULT (Mpa)

Mix Proportion	M 60		M 70		M 80	
CURING TIME	**7 DAYS**	**28 DAYS**	**7 DAYS**	**28 DAYS**	**7 DAYS**	**28 DAYS**
Normal	55.45	64.75.75	58.2121	74.10	55.80	81.25
K5	56.05	66.58	59.10	77.25	56.10	84.65
K10	57.10	67.20	60.80	79.25	56.75	82.05
K15	56.45	65.10	59.40	75.25	57.45	86.80
Z5	56.50	66.31	60.40	76.80	55.25	82.25
Z10	55.05	64.25	57.50	75.10	56.80	85.10
K5Z5	56.16	64.92	58.42	74.25	55.91	82.45
K5Z10	56.70	64.81	59.10	76.25	56.05	83.10
K10Z5	56.20	65.10	60.20	78.15	56.85	84.95
K10Z10	58.10	68.25	61.10	80.15	57.10	85.95
K15Z5	55.80	65.80	60.80	79.25	58.25	87.10
K15Z10	55.40	65.50	60.45	78.25	57.90	86.15

2. FLEXTURE STRENGTH TEST RESULT (Mpa)

Mix Proportion	M 60	M 70	M 80
CURING TIME	**28 DAYS**	**28 DAYS**	**28 DAYS**
Normal	6.12	6.30	7.68
K5	6.52	6.65	7.75
K10	6.93	6.98	7.53
K15	6.38	6.50	7.98

Z5	6.45	6.57	7.61
Z10	6.25	6.40	7.84
K5Z5	6.25	6.45	7.25
K5Z10	6.10	6.71	7.32
K10Z5	6.38	6.95	7.45
K10Z10	6.98	7.10	7.60
K15Z5	6.65	6.91	8.01
K15Z10	6.45	6.82	7.60

3.WATER PENETRATION TEST RESULT(MM)

Mix Proportion	**M 60**	**M 70**	**M 80**
CURING TIME	**28 DAYS**	**28 DAYS**	**28 DAYS**
Normal	18	17	15
K5	14	13	11
K10	11	10	9
K15	8	7	7
Z5	16	15	14
Z10	12	11	10
K5Z5	15	14	12
K5Z10	13	12	10
K10Z5	11	11	9
K10Z10	9	10	8
K15Z5	7	8	7
K15Z10	6	7	6

4. CONCLUSIONS

- Using local kaolin and cement for low w/c ratio high strength concrete can be developed.
- Optimum replacement of kaolin with respect to compressive strength is 10% for M60 and M70 while it increase for M80 for 15% due to increase binder content and dilution effect of partial replacement. .

- Increase the Calcined kaolin content reduced water penetration depth which is parameter of durability due to filler effect of calcined kaolin which reduced the porosity of the concrete.
- 5% of zeolite is optimum with respect to compressive strength for M60 and M70 grade, which is increase 10% for M80 grade which followed same behavior as calcined kaolin.
- Combined use of kaolin and zeolite is give beneficial effect on compressive strength then individual use.
- Durability increase with increase the mineral content which is due to micro filler effect of cementing material.

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6. REFERENCES

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