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PROPERTIES CHANGES BY ADDING EXPERIMENTAL WORK ON CONCRETE BY USING RICE HUSKASHANDMETAKAOLIN

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Abstract
This paper summarizes the comparison between properties of Rice Husk Ash (RHA) and Metakaolin when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with these mineral admixtures at 2%, 4%,6% and 8% by weight. 0% replacement served as the control. Compressive Strength test was carried out on hardened 150mm concrete cubes after at 7 & 28 days curing in water. Compression strength test confirms its suitability as a partial replacement mineral admixture.
Keyword: RHA, Metakaolin, OPC(Ordinary Portland Cement), Aggregates, Water and Compressive Strength Test

Introduction

Concrete is one of the substantially globally used material in the world. It's the mixture of cement, fine aggregate, coarse aggregate and water. The strength of concrete depends upon the constituents which are used in preparing this. The cost of constructional accoutrements increases day by day dueto huge demand of it.So the concrete engineers look towards the optional material that not only improves the strength of concrete but replaces the cement content which in turn reduces the cost of our construction work.The main advantage of incorporating the supplementary bonding material not only improves the strength but also help in preventing the pollution. It also improves the durability. Durability is linked to the physical, chemical and mineralogical characteristics of material and permeability.Several studies in the developing countries including Thailand, Pakistan and Brazil worked on the accoutrements like Rice Husk Ash and Metakaolin, these accoutrements not only enhance the characteristics of concrete but also contributes towards the green environment.

Rice Huskash

Rice hull ash is used in concrete construction as an alternative of cement. The incorporation of rice hull ash in concrete convert it into aneco-friendly supplementary cementitious material. The ensuing characteristics of the concrete are altered with the addition of rice hull

- The heat of hydration is reduced. This itself help in drying loss and smooth durabilityof the concrete mix.
- The reduction in the permeability of concrete structure. This will help in penetration of chloride ions, thus avoiding the spoilage of the concrete structure.
- There is a high increase in the chloride and sulfate attack resistance

Metakaolin

The reactivity of metakaolin is grounded on chemical composition and reactive surface. Largely reactive metakaolin has become available as a extensively reactive pozzolanic material in concrete. This type of material is not like other admixtures for example fly ash, blast furnace sediment, and silica smothers in terms of product because it's produced from high purity kaolin clay by calcinations at temperatures ranging from 700 to 800 o C. The average size of largely reactive metakaolin molecule, which is lower than cement molecules, is ranging from 1 to 2 and it's white in color which in return influences the color of the final product. Specific gravity of largely reactive metakaolin is 2.5

2.Aim Of Work And Literature

Aim

The aim of the study is to formulate ternary concrete and find out the effect of supplementary cementing material i.e., Rice hull ashRice hull ash and Metakaolin on strength parameter of ternary concrete.
The aim is achieved with the help of following objectives.
To design concrete blend by replacing cement with various proportions of Rice hull and Metakaolin
To determine the following strength parameters of various concrete samplesi) Slump Test ii) Compression Test iii) Split Tensile Test
To compare results of various blend designs and determine optimum blend design that can be used economically.

Literature Review

Ong et al. (2006) focused on the compressive strength performance of the blended concrete containing.different percentage of Metakaolin. They concluded that the cement is replaced accordingly with the percentage of 5 %, 10%, 15%, 20%, and 30% by weight. Concrete cubes are tested at the age of 1, 3, 7, and 28 days. In addition, the effect of calcination temperature to the strength performance is included in thestudy.Finally,thestrengthperformanceof Metakaolin-concreteiscomparedwiththeperformanceof concrete blended with silica fume and slag. The results show that the strength development of concrete blended with Metakaolin is enhanced. It was found that 10% replacement appears to be the optimum replacement where concrete exhibits enhanced compressive strength at all ages comparable to the performance of SF andGGBS.

Dinakar etal. (2013) studied the effect of Metakaolin Content on the characteristics of High Strength Concrete. This study presents the effect of incorporating Metakaolin (MK) on the mechanical and continuity characteristics of high strength concrete for a constant water/ binder ratio of0.3. MK blends with cement replacement of 5, 10 and 15 were designed for target strength and slump of 90 MPa and 100 ± 25 mm. From the results, it was observed that 10 relief position was the optimum position in terms of compressive strength. Beyond 10 replacement levels, the strength was dropped but remained higher than the control mix. Compressive strength of 106 MPa was achieved at 10 replacement.Splittingtensilestrengthandelasticmodulusvalueshavealsofollowedthesametrend.Indurabilitytests MKconcreteshaveexhibitedhighresistancecomparedtocontrolandtheresistanceincreasesastheMK percentage increases. This study has shown that the local MK has the implicit to produce high strength and high performanceconcretes..

Jayanti Rajput etal.(2013) have studied on the effect of RHA used as supplementing cementing material on the strength of mortar by partial replacement of OPC. Cement mortar paste were proportioned with varying dosages of RHA as partial replacement of OPC in the range of 5% to 30% by weight of cement. From the test results they concluded that This paper concluded that if roughly 10% of cement is replaced by equal quantity of RHA, there isn't any significant deprecation in the compressivestrength.

Dr. Abhay S. Wayal (2015) presents an overview of the work carried out on the use of RHA as partial replacement of cement in concrete and its effect on workability, compressive strength and chloride permeability of concrete. To produce environment friendly and durable concrete products incorporation of RHA as partial replacement of cement in concrete has gained importance. In the previous studies tests were carried on RHA concrete containing RHA as partial replacement in comparison with control concrete by varying replacement percentage. From the literature review it can be concluded that the workability of the fresh concrete mix decreases as the RHA replacement percentage in concrete increases. The required workability can be attained by good super plasticizer and proper mix design. The partial replacement of cement by RHA improves the compressive strength of hardened concrete whereas; the optimum replacement percentage varies in the studies. The chloride ion penetration of the concrete decreases as RHA percentage increases mainly due to pore refining capacity of RHA. From the above literatures the optimal replacement percentage was found to be ranging from 10% to 20%.

3. Material And Methodology

Cement

Cement is a dry fine substance made by calcining lime and complexion, mixed with water to form mortar or mixed with beach, clay and water to make concrete. It's a binder material. Once hardened, cement delivers sufficient strength to erect large artificial structures. Cement is sharp to essence and thus any essence in contact with cement should be erosion resistant. A normal type of cement that's used in the construction industry is also known as hydraulic cement because this fine substance is generally mixed with water before use. Cement should be applied over shells that have been gutted and are free of oil painting, dirt, grease or any other adulterant that affect relating with the endless structure. It's recommended to undercut all areas on which the cement is to be applied.

Cementhas the following advantages

- Provides durable, long- lasting repairs
- Sets and hardens fast, typically three twinkles after being mixed with water
- Cost-effective
- Very easy to use
- Can be used on perpendicular operations
- Doesn't erode or rust if erosion resistant material is used
- Doesn't shrink

Aggregates

Generally, aggregates engage 70 to 80% of the volume

of concrete and have an important influence on its properties. They're coarse material, deduced for the utmost part from natural gemstone (crushed gravestone, or natural gravels) and beach. In addition to their use as provident padding, aggregates generally give concrete with betterdimensional stability and wear resistance. In order to gain a good concrete quality,aggregates should be hard and strong, free of undesirable contaminations, and chemically stable.

FineAggregates

These are those which passes through IS sieve 4.75 mm.

- It should be strong and durable.
- It should not react with cement after mixing.
- Also, it should have a tough floor.
- It should not absorb greater than 5% of water.

CoarseAggregates

The aggregate which is retained over IS Sieve 4.75 mm is nominated as coarse aggregate. The coarse aggregates may be of following types-

- Crushed gravestone attained by crushing of clay or hard gravestone.
- Uncrushed gravel or gravestone performing from the natural decomposition of rocks.
- Incompletely crushed gravel attained as product of blending of over two types.

Water

Drinking water is good for making concrete. Water serves following purposes Water is used to prepare a plastic emulsion of the colorful constituents and to give plasticity to concrete. Water is also demanded for the hydration of the cementing accoutrements to set and harden during the period of curing.

Rice Husk Ash(RHA)

Rice milling generates a by- product known as husk. Rice hull ash is an seductive Pozzolona. Due to its low cost and high exertion it has a promising perspective in sustainable construction. The main element of the rice hull ash is silica, which is the element that governs the reactivity of the ash. The Rice Husk Ash is attained by burning the Rice Husk, attained from original manufactories, in stacks of 50 to 60 kg in open air. The entire procedure is shown below

- **Before BurningRiceHusk** **(B) After Burning Rice HuskAsh**

Metakaolin

The key in producing metakaolin for use as a supplementary bonding material, or pozzolan is to achieve as near to complete dehydroxilization as possible without overheating. Successful processing results in a disordered, unformed state, which is largely pozzolanic. Thermal exposure beyond a defined point will affect in sintering and the conformation of mullite, which is dead burnt and not reactive. In other words, kaolinite, to be optimally altered to a metakaolin state, requires that it's completely roasted but noway burnt..

4. Experimental Work

Thisdescribesthepropertiesofmaterialusedformaking-concretemixesdeterminedinlaboratory as per relevant codes of practice. Different materials used in tests were OPC, coarse aggregates, fine aggregates, rice husk ash

and Metakaolin. The description of various tests which were used in this study is given below:

Mixdesign

This describes the characteristics of material used for making concrete mixes determined in laboratory as per applicable codes of practice. Different material used in tests were OPC, coarse aggregates, fine aggregates, rice hull ash and Metakaolin. The description of different tests which were used in this study is given below
The concrete mix design was done by using IS 10262 for M-20 grade of concrete.

Design stipulations for proportioning

Gradedesignation	M20
Type of cementgrade	OPC 53 grade confirming to IS12269:1987
Maximum nominal sizeofAggregates	20 mm
Minimum cement contentkg/m3	320 kg/m3
Maximum water cementratio	0.55
Workability	75 mm (slump)
Exposurecondition	Mild
Degree ofsupervision	Good
Type ofaggregate	Crushed angular aggregate
Maximum cementcontent	450 kg/m3
Chemicaladmixture	Not
Sieveanalysis Coarseaggregate Fineaggregate	Coarse aggregate : Conforming to Table 2 of IS: 383 Fine aggregate : Conforming to Zone III of IS: 383

The mixture proportions used in laboratory for Experimentation are shown in table

Mix	%	w/c ratio	Water (Kg/m3)	Cement (Kg/m3)	Fine Aggregate (kg/m3)	Coarse Aggregate (Kg/m3)	RHA (Kg/m3)	Metakaolin (Kg/m3)
Control	-	0.50	186	372	562	1217	-	-
Rice Husk Ash	2	0.50	186	353.4	562	1217	18.6	-
	4	0.50	186	334.8	562	1217	37.2	-
	6	0.50	186	316.2	562	1217	55.8	-
	8	0.50	186	297.6	562	1217	74.4	-
Metakaolin	2	0.50	186	353.4	562	1217	-	18.6
	4	0.50	186	334.8	562	1217	-	37.2
	6	0.50	186	316.2	562	1217	-	55.8
	8	0.50	186	297.6	562	1217	-	74.4
Mixture of RHA and Metakaolin	2	0.50	186	353.4	562	1217	9.3	9.3
	4	0.50	186	334.8	562	1217	18.6	18.6
	6	0.50	186	316.2	562	1217	27.9	27.9
	8	0.50	186	297.6	562	1217	37.2	37.2

Results and Discussions

This presents a summary of the results obtained from laboratory tests that have been doneon the specimen. Tests were done on materials (cement, fine aggregates, coarse aggregates, RHA and METAKAOLIN), fresh and hardenedconcrete.

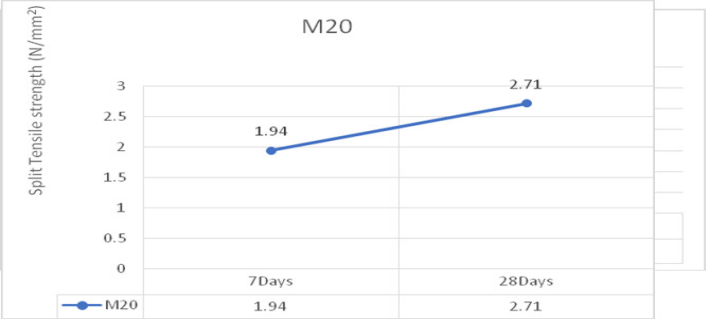
Compressive strength of control concrete in N/mm2

Grade of concrete	M20
7 Days	20.4
28 Days	30.93

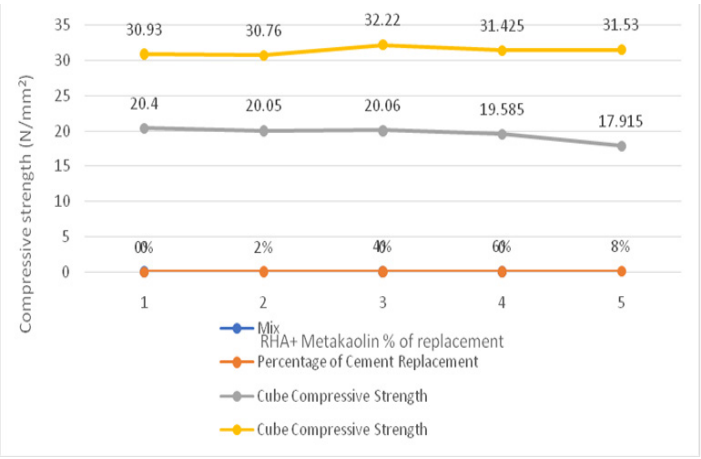
Split tensile strength of control concrete in N/mm2

Grade of concrete	M20
7 Days	1.94
28 Days	2.71

Compressive strength of Mix (RHA+Metakaolin) concrete

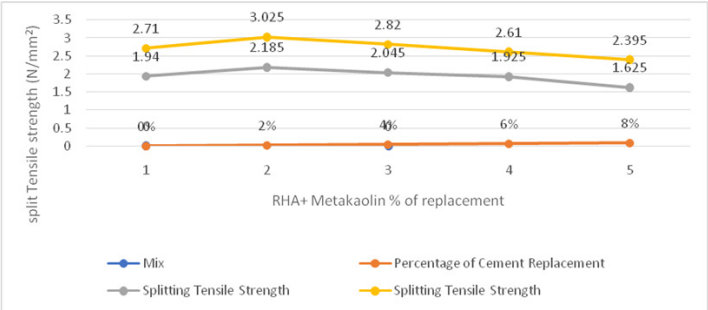


Mix	Percentage of Cement Replacement	Cube Compressive Strength (N/mm2)	
		7 days	28 Days
CONTROL	0%	20.4	30.93
MIX (RHA+Metakaolin)	2%	20.05	30.76
	4%	20.06	32.22
	6%	19.585	31.425
	8%	17.915	31.53



Split tensile strength of Mix (RHA+ Metakaolin) concrete

Mix	Percentage	Splitting Tensile Strength (N/mm2)	
		7 days	28 Days
M20	0%	1.94	2.71
MIX (RHA+WP-SA)	2%	2.185	3.025
	4%	2.045	2.82
	6%	1.925	2.61
	8%	1.625	2.395



Conclusions

The objective of this trial has been to estimate the possibility of successful replacement of cement with RHA, Metakaolin and MIX(RHA Metakaolin) in concrete. The conclusion drawn during the trials are as follows Thecompressivestrengthincreasesupto25%with8%replacementofcementbyMetakaolin. So,upto8%replacement itcanbeusedasasupplementarymaterialinM20gradeofConcrete.

- The split tensile strength increases up to 15% with 2% replacement of cement byMetakaolin.
- The above result shows that there is 8% increase in split tensile strength with 2 % RHA replacement. So,it ispossibletodesignM20gradeofconcreteincorporatingwithRHAcontent up to2%.
- As test results shows, the Mix (RHA + Metakaolin) can also be used as a replacement of cement.
- Controlmixwith4%RHAandMetakaolinshows5%increaseincompressivestrengthofM20 concrete.
- Controlmixwith2%RHAandMetakaolinshows30%increaseinsplittensilestrengthofM20 concrete.
- The study showed that the early strength of RHA, Metakaolin and Mix(RHA Metakaolin) concrete was found to be less and the strength increased with

age.

- The plasticity of RHA, Metakaolin and Mix(RHA Metakaolin) concrete has been found to drop with the increase in replacements.
- Based on the results of Split Tensile Strength test, it's accessible to state that there's substantial increase in Tensile Strength due to the addition of RHA, Metakaolin and Mix(RHA Metakaolin).
- Use of Metakaolin, Rice Husk Ash and Mix(RHA Metakaolin) in concrete can prove to be economical as it's non useful waste and free of cost.

7. References

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