

A Study on Mechanical Properties of Modified Concrete using Rice Husk Ash and Metakaolin

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ABSTRACT : Concrete may be used for some special purpose for which special properties are more important than those commonly considered. Sometimes, it may be of great importance to enhance one of the ordinary properties. There is broad confirmation to demonstrate that solid materials and solid structures everywhere throughout the world are falling apart at a fast rate and that we can't guarantee their long haul strong administration life performance. It is winding up noticeably progressively evident that some human exercises and improvement rehearses are contrarily influencing the prosperity of the planet and putting future eras at risk. Public agencies are recognizing the paramount importance of adopting more "sustainable" practices and products those that preserve or enhance economic, environmental, and social well-being in designing, constructing, and maintaining public infrastructure.

Sustainable development hones require an audit of the present development works on, including winning procedures and wellsprings of crude materials. Squander materials and results that in the past have gotten practically no consideration, for example, Rice husk cinder and Metakaolin require assist thought.

This dissertation work aims at

- CO2 reduction
- Concrete industry use own waste Due to which there would be less materials being land-filled as waste.
- Mineral extraction can be reduced through the use of recycled and secondary aggregates.

KEYWORDS: Solid materials, Sustainable practices, Squander materials, Rice husk cinder, Metakaolin.

I. INTRODUCTION

The name solid originates from the Latin "concretus", (which means minimized or consolidated), the ideal latent participle of "concrecere", which intends to develop together ("con-" (together) and "crescere" (to grow)). This is a decent name for this material, as the compound hydration process, which mostly happens over the time size of hours and days, makes the material become together from a visco-versatile, malleable fluid into a hard, inflexible strong body. In our world today, concrete has become ubiquitous, and in fact it is hard to imagine modern life without it. It is used in almost all the fields of construction, thus satisfying one of the very important basic needs of life namely shelter. Concrete can be called as the —Backbone of the construction industry. Concrete is widely used in domestic, commercial, recreational, rural and educational construction. Communities

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around the world rely on concrete as a safe, strong and simple building material. This is because of what capability the concrete has within itself.

Concrete can be formed into an infinite number of shapes and can be used to construct an unlimited array of buildings with a multiplicity of attractive finishes. Concrete is fire-and termite-resistant, flood resilient, robust and strong; manufactured from abundant, naturally occurring and readily-available materials. It is durable and long lasting, without the release of toxic emissions. It is fire resisting and sound attenuating. Above all, concrete enhances our social fabric, is environmentally beneficial, and it is economical. Concrete really is the foundation upon which our modern societies and economies are built.

Sustainability becomes a key issue for the concrete industry. The industries now are committed to behave in a responsible way to improve sustainability performance and to deliver sustainable construction solutions. Works where replacement of cement by suitable materials without sacrificing much of the desirable properties were on focus, these materials are generally byproducts from other processes or natural materials. They may or may not be further processes for use in concrete. Some of these materials are called pozzolans, which without anyone else don't have any cementitious properties, yet when utilized with Portland concrete, respond to frame cementitious properties. For use in concrete, supplementary cementitious materials, at times alluded to as mineral admixtures, need to meet prerequisites of built up norms. They might be utilized separately or in blend in concrete. They might be added to the solid blend as mixed bond or as an independently grouped fixing good to go blended solid plant.

Some of the supplementary cementitious materials like Flu ash, Ground granulated blast furnace slag, Silica fume and some natural pozzolanas like Rice husk fiery debris (RHA) and Metakaolin (MK)

RHA is a general term portraying a wide range of slag created from copying rice husks. By and by, the kind of fiery remains changes extensively as indicated by the consuming method. The silica in the fiery debris experiences auxiliary changes relying upon the conditions (time, temperature and so on) of burning. At 550°C – 800°C nebulous powder is shaped and at temperatures more prominent than this, crystalline slag is framed. These sorts of silica have diverse properties and it is vital to create cinder of the right detail for the specific end utilize.

Rice husk slag has numerous applications because of its different properties. It is a fantastic separator, so has applications in modern procedures, for example, steel foundries, and in the produce of protection for houses and recalcitrant blocks. It is a dynamic pozzolan and has a few applications in the bond and solid industry. RHA is a dynamic pozzolan. The sort of RHA reasonable for pozzolanic movement is shapeless as opposed to crystalline. However development in the market for RHA to the steel showcase is restricted. Development in the market for RHA in the bond business seems, by all accounts, to be developing and is conceivably vast.

The expansion of RHA to bond has been found to upgrade concrete properties:

The expansion of RHA accelerates setting time, in spite of the fact that the water required is more prominent than for OPC. RHA bond has enhanced compressive quality because of its higher rate of silica. RHA bond has enhanced imperviousness to corrosive assault contrasted with OPC, thought to be because of the silica introduce in the RHA which joins with the calcium hydroxide and decreases the sum powerless to corrosive assault.

Later examinations have indicated RHA has utilizes as a part of the fabricate of cement for the marine condition. Supplanting 10% Portland bond with RHA can enhance imperviousness to chloride infiltration.

A few investigations have joined fly fiery remains and RHA in different extents. When all is said in done, concrete made with Portland bond containing both RHA and fly fiery debris has a higher compressive quality than concrete made with Portland bond containing either RHA or fly powder all alone.

Metakaolin (MK) :

Metakaolin (MK) is not the side-effect of a modern procedure nor is it totally characteristic; it is gotten from an actually happening mineral and is produced particularly to cement applications. Not at all like side-effect pozzolans, which can have variable structure, MK is created under

precisely controlled conditions to refine its shading, expel latent contaminations, and tailor molecule measure. MK has incredible guarantee as a supplementary cementitious materials (SCM), as it can enhance numerous properties of cement while additionally lessening concrete utilization. MK is a SCM that adjusts to ASTM C 618,

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Class N pozzolan details. The molecule size of metakaolin is littler than concrete particles, yet not as fine as silica smolder.

Objective of the Study:

In all the developing countries, cement is an essential construction material and the need for cement is increasing day by day. Due to its need, the manufacture of cement has increased ironically. The risks involved in the manufacture and distribution of cement has made it more costlier. And to meet the need more raw materials are used along with the manufacturing of cement. Continuous and enormous usage of concrete has led to cause adverse effects on the environment. Hence any replacement of cement by a suitable material without sacrificing much of the desirable properties such as strength, durability of concrete is worth carrying out.

Investigations on partial replacement of cement by fly ash, a product obtained by burning coal in thermal power stations, by rice husk ash, an agricultural waste obtained from the threshing of paddy, by silica fume, a byproduct from the manufacture of silicon or ferro-silicon metal, by GGBS, a non-metallic manufactured byproduct from a blast furnace when iron ore is reduced to pig iron, by metakaolin, a dehydroxylated form of the clay mineral kaolinite were carried out.

Keeping all these factors in mind, an investigation was made to explore the possibilities of using metakaolin as well as rice husk ash in M20 grade concrete for partial replacement of cement. The main objective was to find the compressive strength of cubes and the flexural strength of beams and to compare those with that of the conventional concrete.

The project mainly aims at:

- Minimizing the use of non-renewable resources.
- Using renewable resources in a sustainable manner.
- Minimizing impacts on the natural environment.
- Protecting bio diversity.
- Meet human needs fairly & efficiently.
- CO₂ reduction.
- Concrete industry use own waste due to which there would be less materials being landfilled as waste.
- Mineral extraction can be reduced through the use of recycled and secondary aggregates.
- New types of residual products used.

II. RELATED WORK

MIX PROPORTIONS:

In the present work, ordinary Portland cement of 53 grade Birla Super conforming to IS 12269:1987 has been used. Sand used was of fine granular material. The natural river sand bought was free from organic material, mica, loam, clay, oil and other deleterious substances. Coarse aggregate crushed stone of 20 mm maximum size and retained on IS 480 sieves has been used. Two different sizes of coarse aggregates were used. 60% of coarse aggregates passing through 20mm sieve size and 40% of coarse aggregate passing through 12.5 mm sieve size was used. The sieve analysis of coarse aggregates conforms to the specifications of IS 383: 1970 for graded aggregates and specific gravity. Clean potable water available in the laboratory is used for both mixing and curing of concrete.

The experimental work was carried out to know the behaviour of concrete for different percentage replacement of cement by supplementary cementitious materials (SCM). It mainly includes the mechanical properties namely compression tests on concrete cubes and mortar cubes and flexural strength tests on beams. Work was also carried out to known its workability details.

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Compression Test

Casting of cube specimens for compression test:

The steel cube moulds of size 150*150*150 mm were coated with oil on their inner surfaces and were placed on flat platform. The amount of cement, metakaolin, rice hush ash, sand, and coarse aggregates required for 20 cubes were weighed as per the mix design.

The materials were first dry mixed then mixed with water. The workability tests slump, compaction factor, vee-bee consistometer were conducted to ascertain the workability of the mix. Concrete was poured into the moulds in three layers each layer being compacted with 25 blows. The top surface was finished using trowel. After 24 hours concrete cubes were demoulded and the specimens were kept for curing.

Testing of cube specimens for Compressive Strength of concrete:

At each desired curing periods specimens were taken out of water and kept for surface drying. The cubes were tested in 3000kN capacity Digital Uni-axial compressive testing machine loaded at constant rate of loading at 145kg/cm²/min as per standard procedure explained in IS: 516-1959(1999) to get the `.

III. PHYSICAL PROPERTIES

Physical properties of Cement

Sl.no	Properties	Obtained values	As per IS12269-1987
1	Fineness(Blaine's air permeability test)	370 m ² /kg	Shall not be less than 225 m ² /kg
2	Soundness (by Le Chatelier's)	1.00 mm	Not more than 10 mm
3	1. Initial Setting Time	85.00 min	Not less than 30 min
	2. Final Setting Time	355.00 min	Not more than 600 min
4	Compressive strength	55	Not less than 53 N/mm ²
5	Standard Consistency	30 %	
6	Specific Gravity	3.15	

Physical properties of Metakaolin

TYPICAL PHYSICAL PROPERTIES	
Appearance	Cream ivory powder
Bulk Density (gm/cm)	0.416
Specific Gravity (gm/cm)	4.2 to 4.4

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Moisture on board @105c %	0.6
Loss of Ignition %	0.8
Sieve residue on 350 mesh	Nil
Particle size analysis (Sedigraph) d50	3.20 microns
Sio ₂ +Al ₂ O ₃ +Fe ₂ O ₃	97%
Specific Area M ² /gm	18-22
Pozzolonic reactivity Mg Ca [OH] ₂	1000-1150

Physical Properties of FA

Sl No	Property	Test Result
1	Specific gravity	2.66
2	Water absorption	0.6 %

Physical Properties of CA

S.No	Property	Test Result
1	Specific gravity	2.66
2	Water absorption	0.4 %

The mix design was carried out based on draft code IS: 10262: 2009. In this present work M-20 grade concrete was considered.

Mix Description	M-0	M-1	M-2	M-3
Metakaolin (%)	0	25 %	20%	15%
RHA (%)	0	5%	10%	15%

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Cement content(kg/m ³)	400	280	280	280
Water (kg/m ³)	180	220	220	220
Water cement ratio	0.45	0.55	0.55	0.55
Fine agg (kg/m ³)	573.27	573.27	573.27	573.27
Coarse agg (kg/m ³)	1213.61	1213.61	1213.61	1213.61

IV. EXPERIMENTAL RESULTS

Workability Test Details

Mix designation	Metakaolin (%)	RHA (%)	Compaction Factor (%)	Slump value (mm)	Vee – Bee Consistometer (in seconds)
M0	0	0	87.00	50	12
M1	25	5	87.20	45	18
M2	20	10	88.00	36	20
M3	15	15	90.02	34	21.2

Flexural Test Details:

Mix designation	MK (%)	RHA (%)	Avg. Flexural strength N/mm ²	
			28 days	56 days
M0	0	0	3.5	3.8

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M1	25	5	3.1	3.6
M2	20	10	3.0	3.3
M3	15	15	2.8	3.2

Test results of Compressive Strength of mortar cubes

Mix designation	Metakaolin (%)	RHA (%)	Avg. Compressive strength N/mm ²	
			28 days	56 days
m-1	25	5	22.02	26.62
m-2	20	10	16.51	17.81
m-3	15	15	8.90	12.11

V. CONCLUSION

From the above results, it can be concluded that metakaolin and rice husk ash can be effectively used in concrete. The inclusion of metakaolin has desirable effect on concrete mechanical properties which is comparable to normal concrete. The usage of MK and RHA in concrete as cement replacement materials will lessen the CO₂ being emitted during its manufacture and acts as a eco-friendly material reducing the Green house effect. Incorporation of these materials in cement helps in making it more economical.

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