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An Experimental work on Reactive Powder Concrete using Quartz Sand and Metakaolin

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Abstract*: Reactive Powder Concrete is a Concrete which does not have fine &coarse aggregate in it. It is due to the high cost in coarse aggregate and at the same time scarcity of the fine aggregate. RPC is also consists of fully a partially replacement of cement .so we are using partially replacement of cement. Where it is a special concrete and the microstructure is optimized by precise degree of all particles in the mix yield to maximum density. It consists of metakaolin, quartz-sand and cement. Here we are replacing coarse and fine aggregate by quartz-sand, and cement is partially replaced by metakaolin. And the percentage of meta kaolin is identified by trial and error method. In this we get the compressive, flexural & split tensile strength of RPC for 28 days.

Keywords: Reactive Powder Concrete, Durability, Mechanical and Physical Properties, Quartz-Sand, Metakaolin.

I. INTRODUCTION

Reactive Powder Concrete was developed in France in the year 1990's and the world's first Reactive Concrete Structure, the Sherbroote Bridge in Canada was erected in July 1997. Reactive Powder Concrete is a developing composite material which are Solid, Strong and Complex to environment. A Evaluation of the Physical, Mechanical and Durability properties of Reactive Powder Concrete & High Performance Concrete, Where Reactive Powder Concrete have better strength (Together Compressive and Flexural) and lower permeability compared to High Performance Concrete. It is an ultra-high-strength & high durability cementations composite with Reactive Powder Concrete advanced mechanical & physical properties. It consists of a special concrete where the microstructure is improved by accurate stage of all particles in the mix yield to extreme density.

Materials Collected

Quartz Sand

Quartz is a mineral which consists of oxygen and silicon tetrahedral and each oxygen is bond with two tetrahedral atoms. The chemical formula is Sio_2. It is the second most abundant mineral after feldspar.

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Quartz is of two types based on temperature if temperature is at normal condition it is known as alpha-quartz and temperature is high then it is known as beta-quartz. The temperature difference is significant at 876K it can also leads change in volume.

Quartz sand is a bi-product came from quartz mineral when it is exposed and collected to blasting there will be occurrence of some dust like powder known as quartz sand and this is used in for concrete for fine and coarse aggregate

Metakaolin

It is a by-product of clay mineral kaolinite. When kaolin is high in percentage than it is known as china clay. Its size is smaller than the cement particle size. So, it can be easily bond with other particles. Metakaolin can be formed from a variability of primary and secondary sources containing kaolinite

- High cleanliness kaolin deposits
- Paper sludge waste (if containing kaolinite)
- Oil sand tailings (if containing kaolinite)

The adsorption surface properties of the metakaolin can be accomplished by inverse gas chromatography analysis.

High reactive metakaolin is used in high performance concrete because based on the reaction of metakaolin the strength of the concrete and it also lessens the weakening of concrete by alkali silica reaction

Cement

Cement is a binding material used for bonding fine and coarse aggregate or any other minerals to attain its strength. It should be free from lumps and not exposed to environment for better storage.

The testing of cement was done as per characteristics of cement are IS 8112-1987.

- Grey in color.
- It is very good binding properties.

II. LITERATURE REVIEW

Anjankumar. M,et.al (2013) RPC having 5% replacement of cement having good compressive strength when compare to RPC for 28 days strength. When RPC replaces cement the 7- and 14-days strength of Reactive Powder Concrete is lower than normal mixers this is because of slow hydration of cementations matter at starting days. As finer than particles of materials the flexural strength RPC also increase with cement replaces.

AashishDubey, NemkumarBanthia (1998) Introduction of high reactive metakaolin into the mix results in that increase of toughness or energy absorption of high-performance concrete. When concrete required high toughness and durability the use of higher reactive metakaolin is advantages.

AssemAbdelalim, et.al (2008) Curing place a prominent role to attain maximum strength. Air curing effects the performance and didn't permit Reactive Powder Concrete to attain its target strength. RPC possess high durability when compare to normal concrete. So, it as high resistance to sulphate attack and drying shrinkage.

Collepardi.S, et.al (1997) Steam gives better results than normal curing in terms of higher strength lesser drying shrinkage and creep strain this improvement is due to more densified micro structure of cement matrix.

Jeganmurugan.P, et.al (2018) Reactive Powder Concrete is a concrete without coarse aggregate have high compressive flexural and Tensile strength. For the combined curing results of MFPC attain high strength compared to the other types of curing.

Kazunori Fujikake, et.al (2005) Reactive Powder Concrete performed as an elastic material up to the first cracking strength. The elastic modulus was identical irrespective of the loading rate.

III. MATERIAL INVESTIGATION & METHODOLOGY

Cement

Table- I: Physical Properties of cement

Sl. No	Content	Value
1	Specific gravity	3.14
2	Initial setting time (mins)	50
3	Final setting time (mins)	320
4	Consistency (%)	31

Quartz sand

Table II: Physical Properties of Quartz Sand

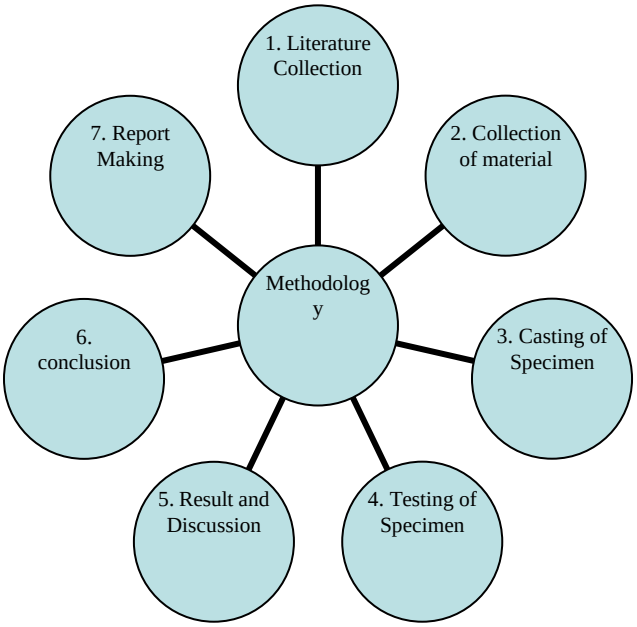
Sl. No	Content	Value
1	specific gravity	2.23
2	water absorption (%)	1.9
3	bulk density -kg/m^3	1.5x10^3
4	Fineness	2.7

Metakaolin

Table III: Chemical Composition

Material	Chemical Composition (%)							
	Sio_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	LoI
Cement	19.73	5.09	3.99	62.80	1.61	0.18	0.80	1.90
Metakaolin	52.00	46.00	0.60	0.09	0.03	0.10	0.03	1.00

Methodology



IV. RESULTS & DISCUSSION

a. Compressive Strength

It is defined as the resistance of a material to breaking under compression. Here in our project discussed the various proportion of Metakaolin is listed in Table IV.

Table – IV Compressive strength for Various Proportion of MetaKaolin

Proportion	Stress(MPa)	Average stress(MPa)
NC	30.84	32.25
	35.67	
	30.25	
10% MK	44.44	55.27
	59.94	
	61.44	
20%MK	45.61	48.84
	52.95	
	47.98	
30%MK	34.77	36.60
	36.77	
	38.28	
40%MK	25.87	34.91
	39.40	
	39.46	

b. Tensile Strength

Tensile strength defined as the resistance of a material to breaking under tension. Here in our project discussed the various proportion of Metakaolin is listed in Table V.

Table – V Tensile strength for Various Proportion of MetaKaolin

Proportion	Stress(MPa)	Average(MPa)
NC	10.91	12.2
	13.49	
10%MK	9.97	9.73
	9.49	
20%MK	13.79	15.55
	17.31	
30%MK	16.16	17.35
	18.54	
40%MK	6.84	10.52
	14.20	

c. Flexural strength

Flexural strength defined as the capability of a beam or slab to resist failure in bending. Here in our project discussed the various proportion of Metakaolin is listed in Table VI.

Table – VI Flexural strength for Various Proportion of MetaKaolin

Proportion	Stress(kN)	Average(kN)
NC	8	8
10%MK	16	16
20%MK	12.5	12.5
30%MK	17.5	17.5
40%MK	15	15

d. SEM Analysis

SEM ANALYSIS is a micro structural analysis. Here in our project various proportion of MK(Metakaolin) and Quartz sand as shown in figure 1,2,3,4.

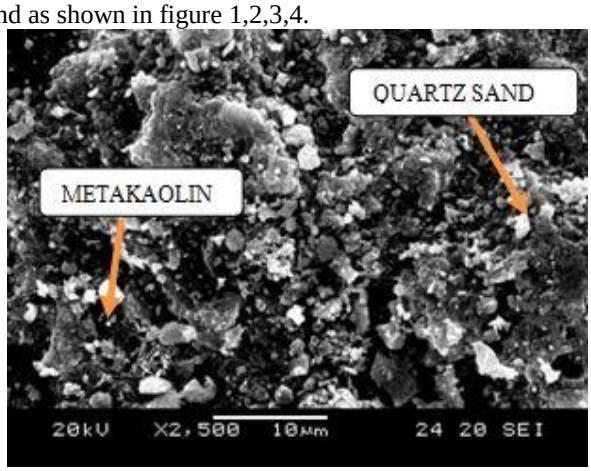


Fig 1. 10% Metakaolin with Quartz sand

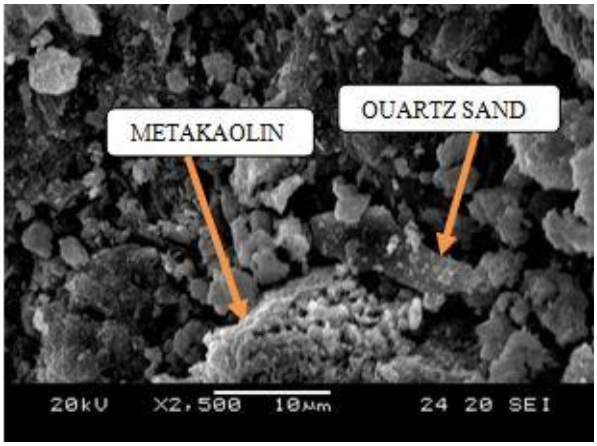


Fig 2. 20% Metakaolin with Quartz sand

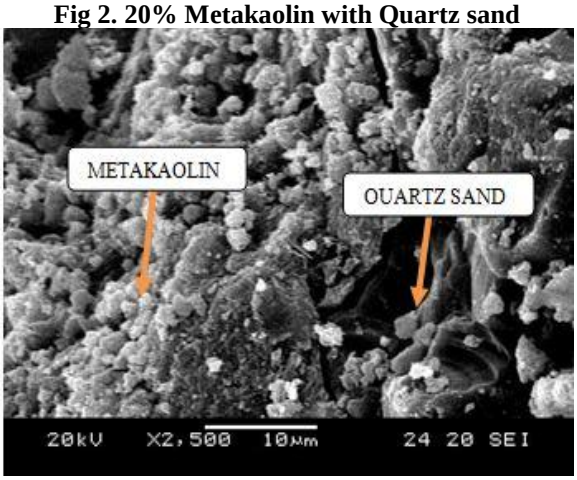


Fig 3. 30% Metakaolin with Quartz sand

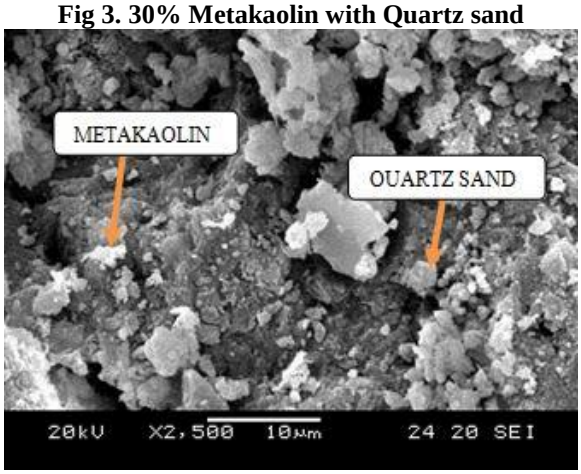


Fig 4. 40% Metakaolin with Quartz sand

V CONCLUSION

- The compression strength is greater for 10% and 20% replacement of cement with metakaolin when compare to the normal concrete at the same time the strength for 30% and 40% is decreased.
- The split tensile strength is greater for 20% and 30% replacement when compare to normal concrete and 10% and 40%.
- The flexural strength is greater for all 10%, 20%, 30%, 40% replacement when compare to the normal concrete.
- From the SEM analysis we get the bondage between the quartz sand and metakaolin is very strong when compare to the bondage of normal concrete.

- Due to its high strength the size of the column can decrease so area covered will be decreases with high resistance to the load.
- Self weight of the structure will be decreases due to decrease in its size of the structure.
- The cost of construction will be less when compare to normal concrete and at the same time it gives an environmental impact and resistance to the corrosion due to its high bond strength.

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