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CHARACTERISTICS AND COMPARISON OF STRENGTH OF CONCRETE MADE WITH M25 AND M30 GRADE VARYING WITH DIFFERENT PERCENTAGES OF METAKAOLIN

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ABSTRACT

Now a days the partially replacement of Ordinary Portland cement with pozzolana has been increasing widely. Most commonly used pozzolanaare fly ash, silica fume,metakaolin, and ground granulated blast furnace slag. A pozzolana is a material which, when combined with calcium, exhibits cementitious properties. Pozzolana arecommonly used as an addition to cement concrete mixture to increase the long-termstrength and other material properties of cement concrete and in some cases to reducethe material cost of concrete. Recent researched aimed at energy conservation in the cement and concrete-industry has in part, focused on the use of less energy intensive materials such as flyash, slag and silica fume. Of the some attention has been given to the use of natural pozzolana like Metakaolin as possible partial replacement for cement. Amongst thevarious methods used to improve the strength, Durability and resisting power of thetemperature, and to achieve high performance of the concrete, the use of Metakaolina relatively new approach, the chief problem with its extreme fineness andhighwater requirement when mixed with cement.

The present work focuses on investigating mechanical properties of M25&M30grade cement concrete with partial replacement of cement by Metakaolin by replacingcement viz. 0%, 5%,10% and 20%. The cubes, cylinders and prisms are tested forcompressive strength, split tensile strength and flexural test All together 4 mixdesignations have been casted and each mix comprises of 6 cubes, 3 prisms, 3cylinders are casted and tested for7, 14, 28days of curing duration.

Keywords:*Pozzolana,flyash,silica-fume,metakaolin,compressive strength, split tensil strength,flexural test,SP 430 CONPLAST,Cement,Fineaggregates&Coarse aggregate.*

I.INTRODUCTION

Metakaolin is a recent addition in the list pozzolanic materials. It is a thermally activated alumino-silicate produced from kaolinite clay through a calcining process. Unlike other pozzolanas, Metakaolin is a primary product, not a secondary product or by product. This allows the manufacturing process to be structured to produce the optimum characteristics for the Metakaolin, ensuring the production of consistent product and consistent supply. The white color another advantage making it popular. Metakaolin enhances strength and

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durability of concrete through three primary actions which are the filler effect, the acceleration of the ordinary Portland cement (OPC) hydration and pozzolanic reaction with calcium hydroxide (CH). The particle size of metakaolin is a smaller than cement particle, but not as fine as silica fume. The meta prefix in the term is used to denote change. It is a barrowing from Greek meaning after, along with, beyond. It is used, and is recognizable, in the formation of compound words metabolic, metamorphosis. The scientific use of prefix is used for a combining from denoting the least hydrated of a series. In the case of metakaolin, the change that is taking place is hydroxyilization, brought on by the application of heat over a defined period of time.

II. IMPORTANCE OF METAKAOLIN

Metakaolin provides higher early strengths, which allows for earlier form stripping earlier processing and quicker turnaround. In addition, Metakaolin decreases porosity, increases compressive, tensile and flexural strengths, and it reduces drying shrinkage adds in finishability when it is towelled.Metakaolin is often used in concrete countertop mixes to boost the physical properties of the concrete. Metakaolin is a manufactured pozzolana that is designed to be a white substitute for silica fume. Metakaolin has similar effects on concrete as silica fume, permitting compressive strength of 10,000psi more.Metakaolin can also influence the the intensity and appearance of acid staining. The special characteristics of Metakaolin viz., super fineness, and high silica content etc. gave the scope for enhancing the normal cement concrete when mixed with cement as partial replacement. Considered have twice the reactivity of most other pozzolanas, Metakaolin is a valuable admixture for concrete /cement applications. Replacing Portland cement with 0 %- 20% (by weight) Metakaolin produces a concrete mix which exhibits favorable engineering properties. Metakaolin is often used in concrete countertop mixes to boost the physical properties of the concrete. Metakaolin is a manufactured pozzolana that is designed to be a white substitute for silica fume. Metakaolin has similar effects on concrete as silica fume, permitting compressive strength of 10,000psi more.

III. MATERIALS USED:

Metakaolin,Cement,SP 430 CONPLAST,Fineaggregates&Coarse aggregate

3.1 METAKAOLIN

Between 100 -200C, clay minerals lose most of their adsorbed water. Between 500 -800C kaolinite becomes calcined by losing water through dehydroxilization. The dehydraoxilization kaolin to metakaolin is an endothermic process due to the large amount of energy required to remove the chemically bonded hydroxyl ions. Above the temperature range, kaolinite becomes metakaolin, with a two dimensional order in crystal structure. In order to produce a pozzolanic (supplementary cementing material) nearly complete dehydroxilization must be reached without overheating, i.e thoroughly roasted but not burnt. This produce an amorphous, highly pozzolanic state, whereas over heating can cause sintering, to form the dead burnt, non reactive refractory, called mullite and properties of metakaolin are shown in table 1.

3.2 CEMENT

Ordinary Portland cement available in local market of standard brand was used in the investigation. Care has been taken to see that the procurement made from a single batch and is stored in airtight containers to prevented is being effected by atmosphere, monsoon moisture and humidity. The cement is tested for its various

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proportion as per IS 4031-1988. The specific gravity was 3.10 and fineness was 3200m2/Kg and the cement confirm to 43 Grade.

IV. COARSE AGGREGATE

Machine crushed angular granite metal of maximum size of 20mm retained on 4.75mm I.S sieve conforming to IS 383-1970 was used in the present investigation .It is free form impurities such as dust, clay particles and organic matter etc. The coarse aggregate is also tested for its various properties.

V. FINE AGGREGATE

The locally available river sand was used as fine aggregate in the present investigation .The sand is pre from clayey matter, salts and organic impurities .The sand is tested for its various properties like specific gravity, fineness modulus, bulk density etc. in accordance with IS 2386-1963.Fine aggregate passing through 4.75 mm IS sieve and retained on 0.075mm IS sieve was used. It confirms to grading zone-11 of IS 383-1970. The specific gravity and fineness modulus are found to be 2.50 and 2.79.


Fig 1:MetakaolinFig 2:Cement


Fig. 3 Coarse Aggregate   Fig.4 Fine Aggregate

IV. OBJECTIVE OF THE PROJECT

The Experimental investigation is planned as under:

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1. To find the properties of the materials such as cement, sand, coarse aggregate, water and Metakaolin.
2. To obtain Mix proportions of OPC concrete for M25&M30 by IS method (10262-2009).
3. To calculate the mix proportion with partial replacement such as 0%, 5%, 10% and 20% of Metakaolin with OPC.
4. To prepare the concrete specimens such as cubes for compressive strength, cylinders for split tensile test, prisms for flexural strength and also cubes for temperature studies in laboratory with 0%, 10%, 20% and 30% replacement of OPC with Metakaolin for M25grade concretes.
5. specimensare cured for 7 days, 14 days and 28 days.
6. To evaluate the mechanical characteristics of concrete such as compressive strength, split tensile strength, flexural strength.
7. To evaluate the Temperature studies of M25&M30 grade concrete of cement with metakaolin.
8. To evaluate and compare the results.

Table 1: Properties of Metakaolin

PROPERTIES	RESULTS
Average particle size, µm	1.5
Specific Gravity	2.65
Physical form	Off – White Powder
Bulk Density(Kg/m³)	710 kg/m³

V. TESTS CONDUCTED ON CONCRETE

5.1 Compression test:

Cast iron steel moulds having cube size of 150mm X 150mm X 150mm are used for to find out the compressive strength. For each mix proportion 3 cubes are prepared and these are tested at an age of 7,14,28 days.

5.2 Split Tensile Strength:

For split tensile strength, cast iron moulds having 100mm diameter and 300mm high are used.For each mix proportion 3 cylinders are prepared and these are tested at an age of 7,28days.

Then the tensile strength f_{ct} of the specimen was calculated by using the formula,

f_{ct}= 2P / (Π X Ld)

Where

P = Maximum load in Newton‘s applied to the specimen.

L = Length of the specimen in mm

D = Cross setional dimension of the specimen in m

5.3 Flexural strength of Concrete

The dimensions of each specimen were noted before testing. The test specimen was marked for third point load. Before placing the specimen in the testing machine the bearing surfaces of the supporting and loading rollers

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were wiped off clean and any loose sand or other material was removed from the surfaces of the specimen and then placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould, along two lines spaced 13.33cm apart. The axis of the specimen was carefully aligned with the axis loading device. The load was applied through two similar steel rollers, 38mm in diameter, mounted at the three pointsof the supporting span that is spaced at 13.33cm centre to centre. The load was applied with out shock and increased continuously at a rate of 180 kg/min until the specimen failed. The maximum load applied to the specimen during the test was recorded.

(i) If a> 13.33 cm

fb = (pxl) / (b x d2)

(ii) If a> 13.33 cm

fb = (3pxa) / (b x d2)

Where

b = measured width in cm of specimen

d = depth in cm of the span on which the specimen

l = length in cm of the span on which the specimen

p = maximum load in kg applied to the specimen

Fig. 5 placing a specimen in compression testing machine

Fig.6 placing a specimen in split tensile testing machine

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VI. RESULTS

Tests are conducted for concrete reducing cement content and using some meatakaolinand normal mix of M25 and M30 with and the compressive strength ,split tensile strength and flexural strength are studied for 7,14,28 days of curing .in this work OPC 53 and three different type proportions are used the results tabulated anddiscussions have been made.

TABLE 2:COMPRESSIVE STRENGTH OF CONVENTIONAL CONCRETE AND GEOPOLYMER CONCRETE

Age of curing (days)	Compressive strength (N/mm^2)							
	Normal concrete		Geopolymerconcrete (Metakaolin)					
	M25	M30	M25			M30		
			5%	10%	20%	5%	10%	20%
7	21.86	23.61	23.05	24.5	26	29.59	29.33	30.95
14	29.3	33.33	31.3	33.1	36.2	36.11	35.76	37.24
28	32.83	36.63	35	37	40	41.37	43.68	45.32

TABLE 3: SPLIT TENSILE STRENGTH OF CONVENTIONAL CONCRETE AND GEOPOLYMER CONCRETE

Age of curing (days)	Split Tensile strength (N/mm^2)							
	Normal concrete		Geopolymerconcrete (Metakaolin)					
	M25	M30	M25			M30		
			5%	10%	20%	5%	10%	20%
7	1.6	2.19	1.45	1.82	1.94	1.88	1.97	2.11
14	2.1	2.49	2.4	2.2	2.4	2.35	2.48	2.67
28	2.9	3.2	2.9	3.6	3.8	2.94	2.98	3.15

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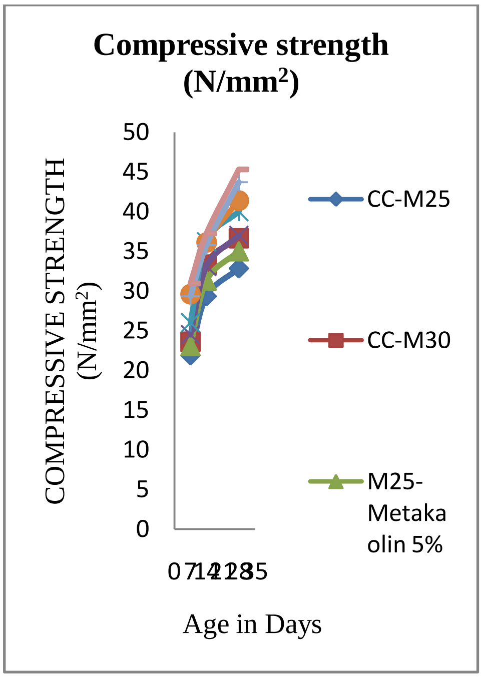
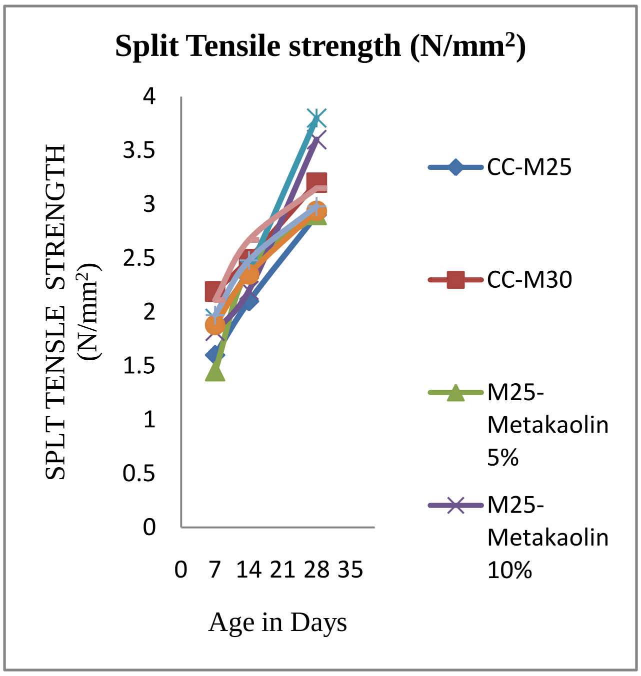
TABLE 4: FLEXURAL STRENGTH OF CONVENTIONAL CONCRETE AND GEOPOLYMER CONCRETE

Age of curing (days)	Flexural strength (N/mm^2)							
	Normal concrete		Geopolymerconcrete (Metakaolin)					
	M25	M30	M25			M30		
			5%	10%	20%	5%	10%	20%
7	1.95	1.97	2.2	2.55	2.45	2.1	2.61	2.7
14	2.6	3.1	4.1	3.19	3.5	4	3.72	3.83
28	3.9	4	4.4	4.95	5.1	4.5	4.9	5

VII. GRAPHS





Above two graphs shows the Compressive & Split Tensile Strengths made with M25&M30 gradevarying with different percentages of Metakaolin

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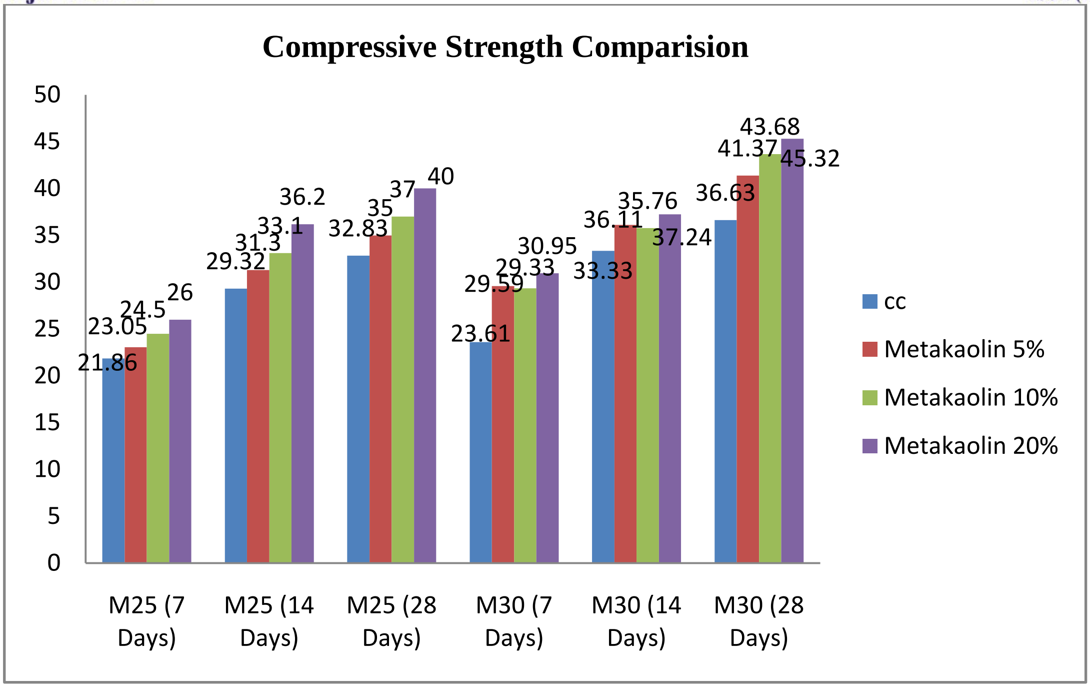

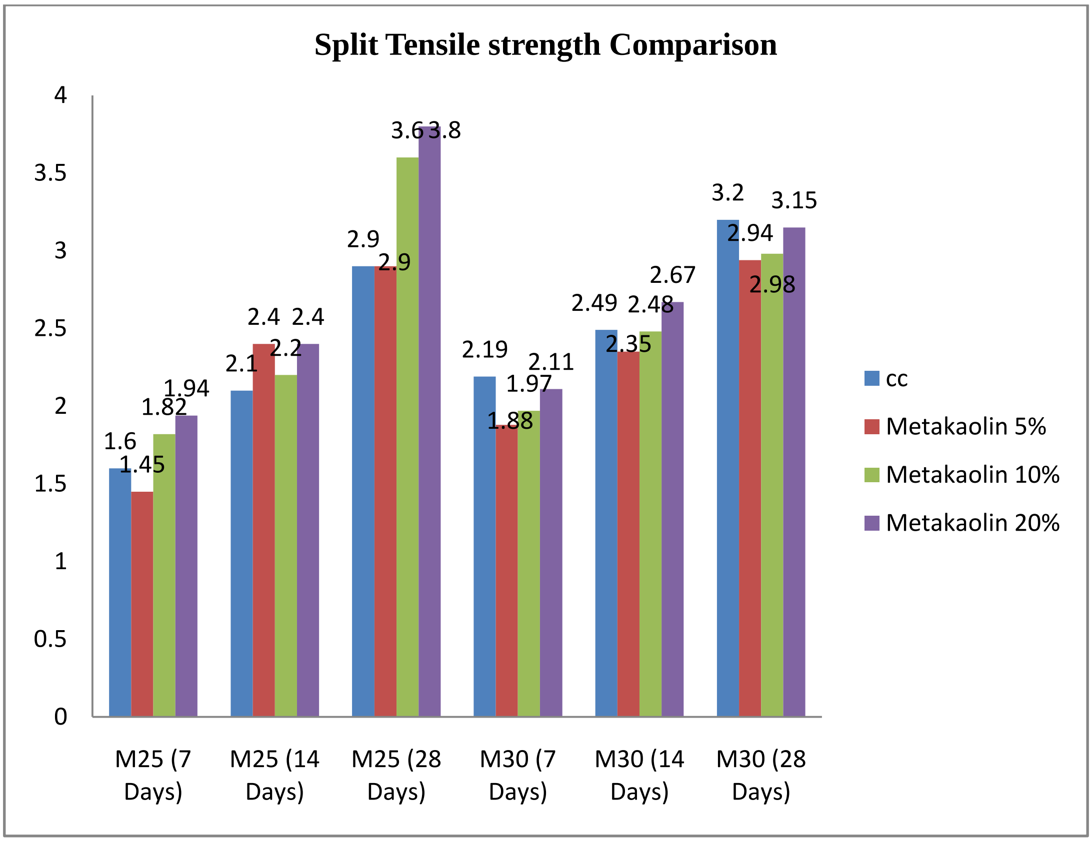

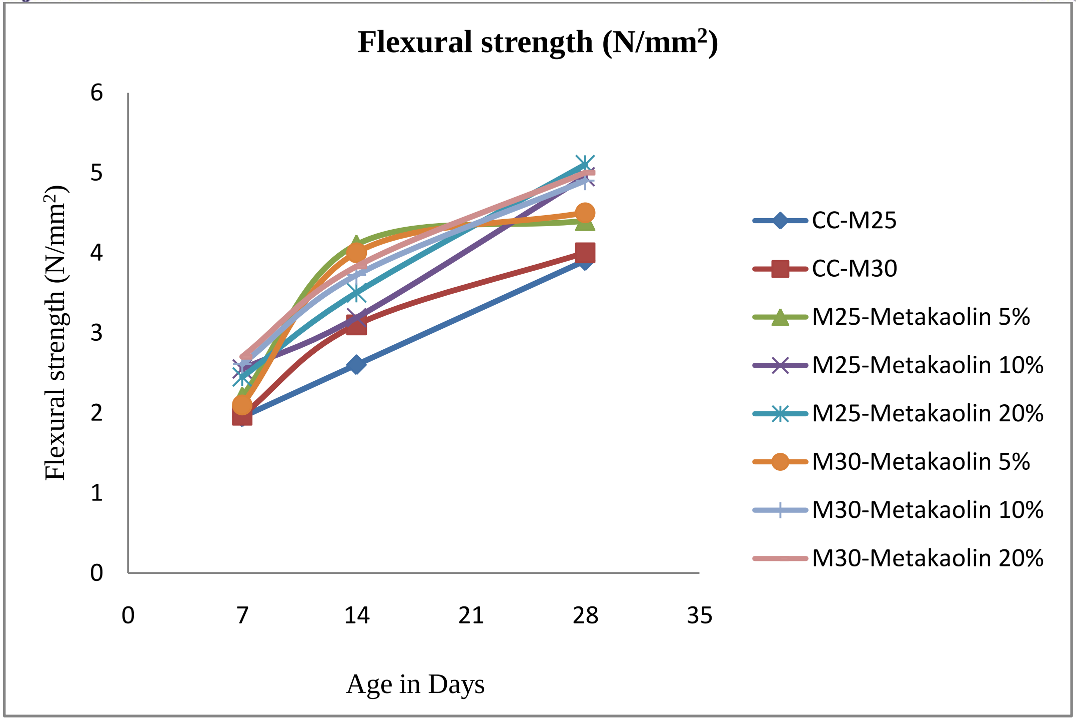

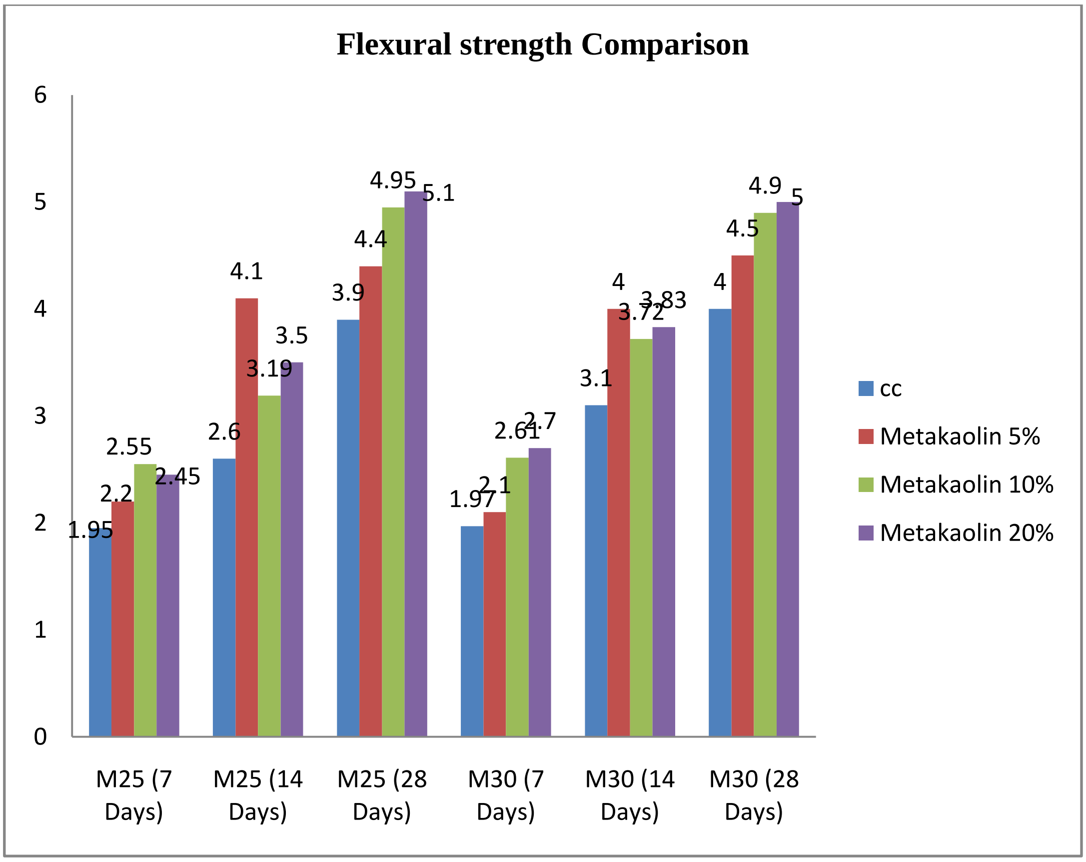

Above two graphs represents the Flexural Strength of concrete made with M25&M30 grade varying with different percentages of Metakaolin

VIII. CONCLUSIONS

Based on the analysis of experimental results and discussion there upon the following conclusions can be drawn

1. By increasing the grade of Concrete i.e., M25 to M30, strength results are increased.
2. The Compressive strength of concrete increased when cement is replaced by Metakaolin for M25 grade of concrete. At 20% replacement of cement by Metakaolin the concreter attained maximum compressive strength for M25 grade of concrete.
3. The split tensile strength of concrete is increased when cement is replaced with Metakaolin. The split tensile strength is maximum at 20% of replacement.
4. The flexural strength of concrete is also increased when the cement is replaced by Metakaolin. At 20% replacement, the flexural strength is maximum.
5. Workability of concrete decreases with increase in Metakaolin replacement level.
6. Compressive strength ,Split,Tensile strength and flexural Strength of concrete increased more with 20% addition Metakaolin to M30 grade Concrete.
7. From experimental results concluded that if we use Metakaolin as a Geopolymer,it can possesses excellent Strength characteristics and durability for aggressive environment compare to conventional concrete.

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