An Expermetal Study on Concrete (M30) with Partial Replacement of Cement with Metakaoline

S Nazeer Ahmed[1], R Rama Krishna[2], S Ashok Kumar[3]
[1, 2, 3] Department of Civil Engineering
[1, 2, 3] Kakinada Institute of Technology & Science, Divili

Abstract- *Concrete is probably the most extensively used construction material in the world. The addition of mineral admixture in cement has dramatically increased along with the development of concrete industry , due to the conservation of cost saving , environmental protection and conservation of resources.*

In the present work , an experimental investigation was carried out , replacing cement with 10%,20%,30% and up to 100% in M30 grades of concrete . For improving the mechanical and durability properties of concrete by adding the metakolin . The test results are compared with conventional concrete. Fresh concrete properties viz. slump and compaction factor were carried out. Cubes of size 150mmx150mmx150mm were cast . The specimens were tested for compressive strength for 3days, 7 days, and 28 days of curing period. Results and conclusions are under progress.

Keywords- Cement, Metakaoline, Compressive strength

I. INTRODUCTION

Concrete is probably the most extensively used construction material in the world. The addition of mineral admixture in cement has dramatically increased along with the development of concrete industry, due to the consideration of energy saving, environmental protection and conservation of resources.

Nowadays there is an increasing trend of utilization of waste/non-conventional materials in cement and concrete matrices. These materials are often used as a part replacement of cement reducing the cost of construction.

To overcome the deficiencies associated with the use of Ordinary Portland Cement (OPC) alone in which damage caused by the extraction of raw material and carbon dioxide emission during cement manufacture have brought pressures to reduce cement consumption by the use of supplementary materials.

Metakaolin is a waste/non-conventional material which can be utilized beneficially in the construction industry. From the recent research works using Metakaolin is a evident that it is a very effective pozzolonic material and it effectively enhances the strength parameters of concrete. However, the workability is slightly compromised and durability of concrete is increases.

In the present work, an experimental investigation was carried out, replacing cement with 10%, 20%, 30% and 40% up to 70% in M30 grades of concrete. For improving the mechanical and durability properties of concrete and gives excellent compressive strength by adding the Metakaolin.

OBJECTIVES

- To enhance the reduction of calcium hydroxide content which results in a higher resistance to sulfate attack.
- To strengthen the reduction of CO_2 content and should be protected from environment.
- To examine the metakaoline compressive strength is higher than the conventional concrete.

II. LITERATURE RIEVIEW

ABRAR AWOL (2011) HAVE DONE THEIR RESEARCH ON USING MARBLE WASTE POWDER IN CEMENT AND CONCRETE PRODUCTION.They found that replacement of cement by marble waste powder at 5% range, in concrete production, results in comparable compressive strength as of concrete specimens without marble waste powder with slight slump reduction for both C-25 and C-50 classes. Increment of replacement ranges beyond 5%, in concrete production, results in reduction of compressive strength and slump and the replacement of sand by marble waste powder from 5-20% ranges, in concrete production, results in similar and mostly enhanced performance than the control concrete specimens; with similar compressive strength to the control specimens, with slump improvement and water permeability depth reduction than the control specimens in both C-25 and C-50 classes.

BABOORAI ET.AL(2011) have done their research on INFLUENCE OF MARBLE POWDER/GRANULES IN CONCRETE MIX .They found that using marble powder and granules as constituents of fines in mortar or concrete by partially reducing quantities of cement as well as other conventional fines in terms of the relative workability & compressive as well as flexural strengths. Partial replacement of cement and usual fine aggregates by varying percentage of marble powder and marble granules reveals that increased waste marble powder or waste marble granule ratio result in increased workability and compressive strengths of the mortar and concrete.

OMAR M. OMAR ET.AL (2012) have done their research on INFLUENCE OF LIMESTONE WASTE AS PARTIAL REPLACEMENT MATERIAL FOR SAND AND MARBLE POWDER IN CONCRETE PROPERTIES.They found that the replacement proportion of sand with limestone waste, 25%, 50%, and 75% were in the concrete mixes except in the concrete mix. Besides, proportions of 5%, 10% and 15% marble powder were replaced in the concrete mixes..The investigation test of compressive strength, indirect tensile strength, flexural strength, modulus of elasticity, and permeability. It was found that limestone waste as fine aggregate enhanced the slump test of the fresh concretes. But the unit weight concretes were not affected. However, the good performance was observed when limestone waste as fine aggregate was used in presence of marble powder.

III. METHODOLOGY

MATERIALS USED

- Cement
- Metakaoline
- Fine Aggregates
- Coarse Aggregates
- Water

CEMENT

Cement is binding material that has cohesive and adhesive properties in the presence of water. These consist primarily silicates and aluminates of lime obtained from limestone and clay.

FINE AGGREGATES

The size of the fine aggregate is below 4.75mm, natural sand is used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain that total percentage of clay silt, silt and other organic matters does not exceed the specified limit.

COARSE-AGGREGATES

The coarse aggregate used in this experimental investigation is 20mm size, crushed and angular in shape. The aggregates are free from dust before used in the concrete.

WATER

Water to be used in the concrete work should have following properties:

- It should be free from injurious amount of oil, acids, alkalis or other organic or inorganic impurities.
- It should be free from iron, vegetable matter or other any type of substances, which likely to have adverse affect on concrete or reinforcement.
- It should be quite satisfactory for drinking purpose which is used in mixing of concrete

METAKAOLINE ($Al_2O_3.2SiO_2.2H_2O$)

General the raw material in the manufacture of Metakaoline is kaolin clay. Kaolin (Al2 Si2O5 (OH)4) is a fine, white, clay mineral that has been traditionally used in the manufacture of porcelain. Kaolin's are classifications of clay minerals, which like all clays, are phyllosilicates, i.e. a layer silicate mineral

PRODUCTION

Metakaoline is obtained by calculation of pure or refined clay at temperatures of 650^0C- 900^0C and by grinding it subsequently to achieve a fineness of 700-900 m^2/kg, under controlled conditions produce an amorphous aluminosilicate that is highly reactive in concrete. This Process is called Dehydroxylation.

Highly reactive Metakaoline is made by water processing to remove un reactive impurities to make 100% reactive pozzolana, such a product white or cream in color purified and thermally activated is called High Reactive Metakaoline (HRM).

CHEMICAL REACTION

Cement + water = Calcium Silicate (Cementitious) + Calcium Hydroxide (Non Cementitious)

Calcium Hydroxide + Metakaoline = Calcium Aluminates (Cementitious) + Calcium Alumino Silicate (Cementitious)

PHISICAL PROPERTIES OF METAKAOLINE

PROPERTY	VALUE
Specific gravity	2.40-2.60
Colour	white
Physical form	powder
+325 mesh (45µm) Residue	<1%
Average particle size	<2.5µm
Surface area(cm2/gm)	150000-180000

CHEMICAL PROPERTIES OF METAKAOLINE

CHEMICALS	PERCENTAGE (%)
❖ Silicon Dioxide (SiO_2)	62.62
❖ Aluminium Oxide (Al_2O_3)	28.63
❖ Ferric Oxide (Fe_2O)	31.07
❖ Magnesium Oxide (MgO)	0.15
❖ Calcium Oxide (CaO)	0.06
❖ Sodium Oxide (Na_2O)	1.57
❖ Potassium Oxide (K_2O)	3.46
❖ Titanium Dioxide (TiO_2)	0.36
❖ **Loss of Ignition**	**2.00**

IV. RESULTS AND DISCUSSION

Compressive strength values for replacement of cement with Metakaoline

Table.4.1: 3-Days Compressive Strength Results

S. No	Cement Replacement with Metakaoline by (%Mix)	Compressive Strength(Mpa)
1	0	20.56
2	10	21.25
3	20	22.67
4	30	24.12
5	40	19.15
6	50	16.45
7	60	14.89
8	70	12.45

Graph.4.1: Graphical representaion of3 days compressive strength values for replacement of metakaoline

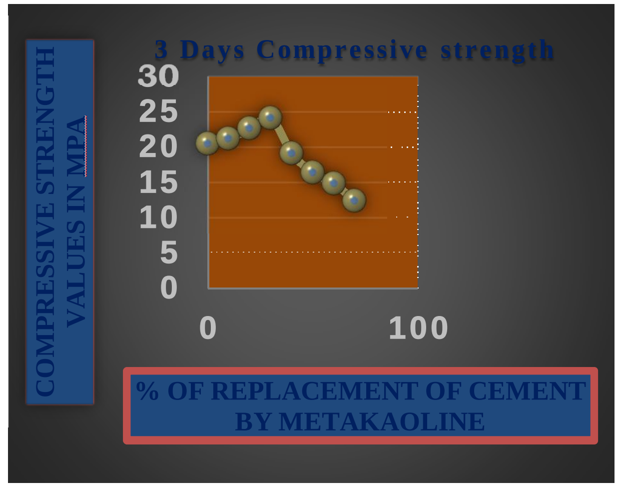


Table.4.2: 7-Days Compressive Strength Results

S. No	Cement Replacement with Metakaoline by (%Mix)	Compressive Strength(Mpa)
1	0	27.78
2	10	28.15
3	20	28.70
4	30	29.92
5	40	25.76
6	50	22.72
7	60	19.33
8	70	17.84

Graph.4.2: Graphical representaion of 7 days compressive strength values for raplacement of metakaoline

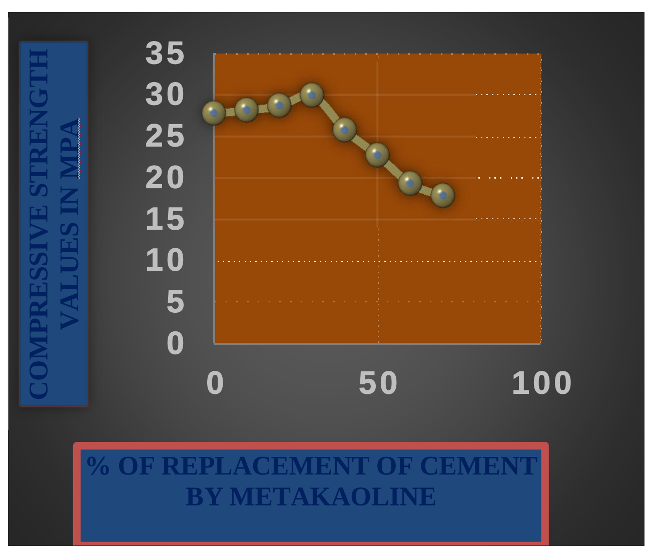


Table.4.3: 28-Days Compressive Strength Results

S.No	Cement Replacement with Metakaoline by(%Mix)	Compressive Strength(Mpa)
1	0	36.67
2	10	38.45
3	20	39.00
4	30	39.80
5	40	34.52
6	50	31.23
7	60	27.64
8	70	24.19

Graph.4.3: Graphical representaion of 28 days compressive strength values for raplacement of metakaoline

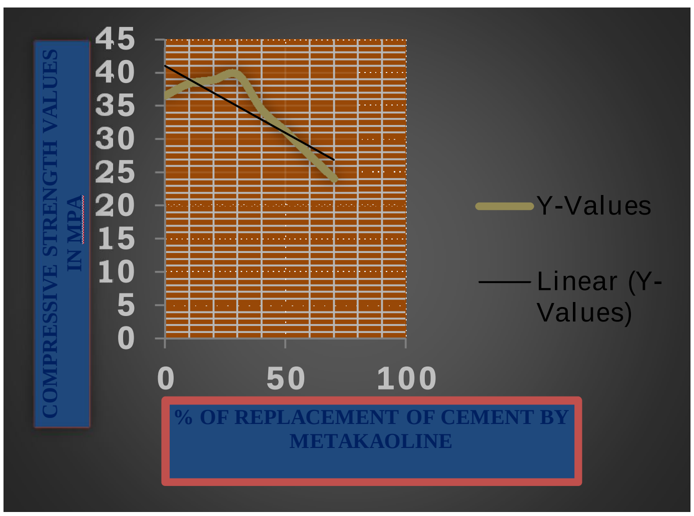
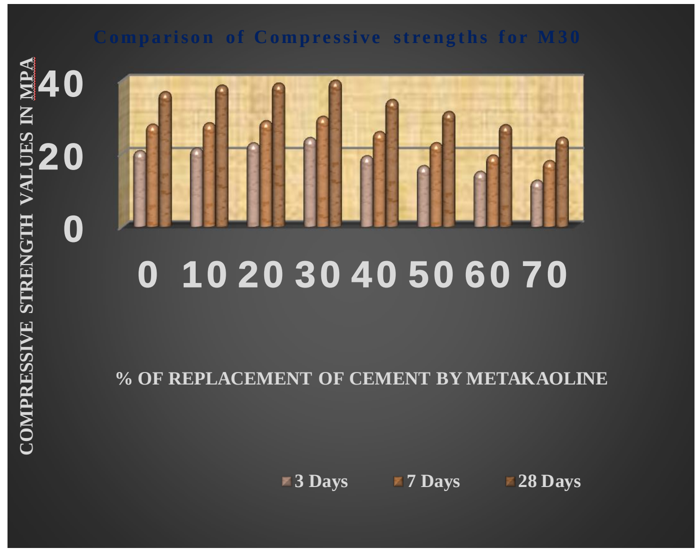


Table.4.4: Compressive Strength Results For Replacement of Cement by Metakaoline

Cement Replacement with Metakaoline by (%Mix)	3 Days	7 Days	28 Days
0	20.56	27.78	36.67
10	21.25	28.15	38.45
20	22.67	28.70	39.00
30	24.12	29.92	39.80
40	19.15	25.76	34.52
50	16.45	22.72	31.23
60	14.89	19.33	27.64
70	12.45	17.84	24.19

Graph.4.4: Graphical representaion of 3, 7 & 28 days compressive strength values for raplacement of metakaoline



V CONCLUSIONS

- From the above study we conclude that the compressive strength of the concrete cubes has gradually increased up to addition of 10% of Metakaoline.
- Compared to compressive strengths of 10%, 20% and 30% of addition of Metakaoline, the compressive strength of 40% to 70% metakaoline concrete has been decreased.
- Whereas comparing to traditional concrete, compressive strength of 30% has been increased.
- Hence for economical view 40% is preferable and in the perspective of compressive strength 30% is suggested.
- The gain in compressive strength is improved depending upon the replacement level of OPC by metakaoline.
- The metakaoline inclusion generally improves tensile strength, flexural strength, bond strength and modulus of elasticity. The quantum of increase in the individual properties depends upon replacement level.

The Metakaoline in concrete can allow major carbon dioxide reductions and also increase the service life of concrete structures

REFERENCES

[1] Shetty M.S:“Concrete Technology Theory and Practice” 3rd Edition S. Chand Company Limited, New Delhi - 1991.

[2] IS10262–1982 & 2009 Recommended guide lines for concrete mix design, Indian Standard Institution, New Delhi.

[3] IS 383-1970: specifications for the grading of aggregates.

[4] IS:456:2000 design and drawing of concrete structures code book should be used.