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STUDY ON THE PHYSICAL PROPERTIES OF CONCRETE PREPARED WITH PARTIAL REPLACECEMENT OF CEMENT BY WASTE MATERIALS

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Abstract: *Cement concrete is the most broadly used construction material in the world. Maintenance and repair work of concrete structures is an increasing problem involving the significant expenditure. As a result of study carried out worldwide, it has been made possible to process the material to satisfy more strong performance requirements, especially durability. To reduce the expenditure for making of concrete we should consider the industrial waste materials for partial replacement of cement with supplementary cementitious materials like alccofine, GGBS and meta-kaoline. We consider these materials because these are available at very low cost. For this purpose we prepared number of samples by the various mixes with variable percentage of these materials in the mix. After the selection of the mix on these prepared specimens we perform workability and compressive strength test in the laboratory. By these tests we come to know that when we replace cement by Alcofine up to 10% the compressive strength increases 414.53 but after this range of addition it starts reducing the strength. when we replace cement by GGBS up to 15% the compressive strength increases 421.40 but after this range of addition it starts reducing the strength and same when we replace cement by Meta-kaoline up to 10% the compressive strength increases 448.44 but after this range of addition it starts reducing the strength.*

General Terms or Keywords Used – Alccofine, GGBS, Meta-kaoline, Compressive strength, workability.

1. INTRODUCTION

1.1 Conventional Concrete:

The popularity of Cement concrete is very high in the world of construction. Concrete is a composite material which is made by the different combination of material like cement, aggregate and water in defined proportion in such a way that concrete can fulfil all the need of the job particularly in regards as its workability, strength, durability and economy. In our scenario, It is generally prepared at the construction sites and so it is very important to handle it carefully and it is very necessary to take care of it so that it can fulfil all the technical requirements. So supervision is important at every stage of manufacturing.

Following are the stages of manufacturing concrete:

a) Batching
b) Mixing
c) Transporting
d) Placing
e) Compacting
f) Curing
g) Finishing

1.2 Supplementary cementing materials (S.C.M.):

Supplementary cementing materials (SCMs) such as Meta-kaolin, Alccofine and GGBS are increasingly used in recent years as cement replacement material. They help to obtain both higher performance and economy. These materials increase the long term performance of the concrete through reduced permeability resulting in improved durability.

Meta-kaolin:

Meta-kaoline is the dehydro-oxylated from of clay mineral kaolinite. Rocks that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of meta-kaoline is smaller than cement particles. Meta-kaoline is high performance, high strength and light weight concrete. It is increase compressive strength, flexural strength, durability and resistance of chemical attack. Meta-kaoline is reduce permeability and shrinkage, due to particle packing making concrete denser.

GGBS:

Ground granulated blast furnace slag is a produce by iron and steel making industry. The iron ore, and consequence, the slag is not pure production. In the iron ore, lot's of unwanted components are mixed. So removed these unwanted components, the iron ore is mixed with lime stone and quick stone prior to burning at temperature 1500 to 1600 degree centigrade. The iron ore is reduced it iron and remaining materials from a slag that floats on top of the iron. After the molten iron is tapped off, the remaining molten slag which consists of siliceous and aluminous residue in then rapidly water-quenched, resulting in the formation of a glassy granulate. This glassy granulates is dried and ground to the required size which is known as Ground granulated blast furnace slag (GGBS. GGBS is environment friendly construction material. It's high performance concrete and batter water impermeability characteristics as well as increase resistance to corrosion and sulphate attack. The service life of a structure is enhanced and the maintenance cost reduced.

When the GGBS is use as a replacement of cement the water requirement reduces to obtain the same slump. Therefore GGBS is best applicable in the marine structure or concreting in the saline environment.

This slag suitable for the use in combination with Portland cement in concrete, particular uses include concrete containing reactive aggregates, Large pours to reduce the risk of early-age thermal cracking, Concrete exposed to sulphates or aggressive ground & Concrete exposed to chlorides.

Alccofine:

Alccofine is a new generation, ultrafine, low calcium silicate product, manufactured in India. It has distinct characteristics to enhance 'performance of concrete' in fresh and hardened stages. It can be considered and used as particle substitute for silica fume as per the result obtained. Tow type of alccofine one is alccofine 1203 and it's also known as alccofine with low calcium silicate and second is alccofine 1101, it's also known as alccofine with high calcium silicate. Alccofine 1203 is slag based Supplementary cementing materials having ultra fineness with optimized particle size distribution. The performance of alccofine is excellent to all the other admixtures. It's reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance.

2. LITERATURE REVIEW

2.1 Alccofine:

Alok Kumar(2016)-workability and strength of concrete using OPC (43 grade). Alccofine 1206 has been added to OPC which varies from 5% to 15% at interval of 5% by total weight of OPC and partial replacement of OPC (43 grade) by Alccofine 1206 which varies from 5% to 15% at interval of 5% by total weight of OPC. A total eighteen mixes (trial mix, control mix and variation mix) were prepared for grade M25 of concrete. This study investigates the performance of concrete mixture in terms of Compressive strength for 7days and 28 days, Flexural strength of beam 28 days and Splitting tensile strength of Cylinder for 28 days respectively of M-25 grade concrete. The addition levels of OPC by Alccofine 1206 were 5%, 10% and 15% where addition levels of 1% super-plasticizer was used in all the test specimens for better workability at lower water-binder ratio and to identify the sharp effects of Alccofine1206 on the properties of concrete.

M.S. Pawar et al (2013)-This study is a decrease in cracking and micro structural defects.In this case explores the use of the Alccofine powder to increase the quantity of the fines and hence accomplish self – compatibility. It is focuses on similarity of the properties of SCC with flyash and Alccofine to that of standard one.With flyash the main changeable is proportion of Alccofine keeping cement, flyash, water, coarse aggregate, fine aggregate and super plasticizer contents constant.

Abhijitsingh Parmar, Dhaval M Patel (2013)the study ofsubstitute binders, or cement alternative materials, has been carried out for decades. Explore has been conducted use of fly ash, volcanic ash volcanic pumice; pulverized-fuel ash blast slag and silica fume as cement substitute material. Fly ash and others are pozzolanic materials since of their response with lime liberated during the hydration of cement. The main aspirin of this case is to get the cheap and eco-friendly High Strength Concrete(HSC). The fresh concrete test carried out for ruling properties of this concrete at Harden period.

Malvika Gautam, Dr.Hemant Sood (2017)alccofine is a freshproduction micro fine concrete material and this is significant in respect of workability as well as strength. Also, alccofine is simple to use and it can be supplementary directly with cement. The ultrafine particle of alccofine provides superior and soft surface finish. As well as cost is apprehensive, for high strength concrete the expenditure of concrete mix prepared with alccofine is less than the concrete not including alccofine. The benefit of alccofine other than strength is that it also lowers the water/binder ratio. Alccofine material increases the strength both in compression and flexure to a large extent

2.1Meta-kaoline:

M.Narmatha, Dr. T.Felixkala (2016) Meta-kaolin looks to be a shows potential supplementary cementitious material for high performance concrete. Properties of concrete with meta-kaolin is mostly preferred additives in high performance concrete. A probable lower cost, due to great accessibility in our country itself may be advantages to meta-kaolin usage in HPC. The replacement amount of meta-kaolin is to be used was 5%, 10%, 15% and 20% by the weight of cement. To construct this cubes and cylinders to find out the strength and durability of concrete. The results show that the replacing mix upto turn over last percent mustnote and achieve on strength in comparing with mixer without meta-kaolin.

Aiswarya, Prince Arulraj, Dilip (2013) Meta-kaolin is a dehydroxylated aluminium silicate. It is a formless non-crystallized material, constituted of lamellar particles. On the current research works using Meta-kaolin, it is obvious that this is a very efficient pozzolanic material and it efficiently enhances the strength parameters of concrete. This research the use of meta-kaolin as supplementary cementitious material in concrete. A complete literature survey is carried out and presented here.

Satyendra Dubey, Rajiv Chandak,R.K. Yadav (2015) This study deals with the properties of concrete by varying percentage alternative of meta-kaolin in M-25 grade of concrete. The mix M1,M2,M3 and M4 be obtained with replacing 0,5,10 and 15 percent mass of cement by Meta-kaolin. The test results indicated to admixture meta-kaolin when used at optimum amount tend to add the strength of the concrete mix when compared with conventional concrete.

CH Jyothi Nikhila1 and J D Chaitanya Kumar (2015) The investigational work has been carried out as partial alternative of cement with MK in M70 grade of concrete at 0%, 10%, 15%, 20%, 25% and 30% of replacements. The mix design be made creation the use of Erntroy empirical Shacklock's method. Cubes are tested for durability studies by H2SO4 and HCL of 0.5% and 1% concentrations. Cubes, cylinders and prisms are tested for temperature study at 15% replacement. The specimens be heated to dissimilar temperatures of 100oC, 200oC, 300oC, 400oC and 500oC for three dissimilar durations of 1, 2 and 3 h at each temperature. Conclusions are complete from the different results and the consultation there on to identify the effect of partial alternative of cement by MK in the design concrete mix. The results conclude that, the use of Metakaolin Concrete (MKC) has better performance of concrete under different conditions.

2.2GGBS:

J.Vengadesh Marshall Raman(2017)- The cement has been replaced by GGBS consequently in the series of 0%, 25%, 30%, 35%, and 40% by weight of cement for M-30mix. After iterative trial mixes the water/cement ratio (w/c) be certain as 0.40. Self-compacting Concrete mixtures produced, tested and compared in conditions of compressive, split tensile strength and flexural strength with the conventional concrete for 7,14,28 days. It is found that, 25% of GGBS can be replaced and strength obtained is equal to the conventional concrete.

Ishwar Chandra Thakur (2016)-Based on present work we initiate that GGBS in concrete improves workability, compressive strength, flexural strength, split tensile strength and decreases the density & water absorption characteristics of tough concrete. As a result, the cost of concrete decreases. Also, GGBS leads to the significant decrease in the amount of cement which enables the decrease in CO2 emission and decrease in energy consumption in manufacture of cement.

S. Arivalagan(2014) From this study, it can be concluded that, since the grain size of GGBS is less than that of ordinary Portland cement, its strength at early ages is low, but it continues to gain strength over a long period. The optimum GGBFS alternative as cementation material is categorized by high compressive strength, low heat of hydration, resistance to chemical attack, superior workability, good durability and cost-effectiveness.

Kasu Naveena ,K. Anantha Lakshmi , (2017) This paper presents the use of ground granulated blast furnace slag (GGBS) on strength improvement of concrete and the use of GGBS and mineral admixture meta-kaolin. Tentative investigation conducted by whole substitute of slag with cement and partial alternative of slag and mineral admixtures by weight in the form of 3cubes by using M30 grade. Results of GGBS with concrete are compared through the results of partial alternative of GGBS and mineral admixtures. A whole cubebecast, and compressive strength of the concrete specimens were determined at curing age of 3, 7, 28 days. Test results explain that strength increases with the increase of slag up to optimum value and the strength increases by adding up of mineral admixture meta-kaolin.

3. MATERIAL AND METHODOLOGY

1. Meta-kaoline:

Meta Cem grades of Calcined clays are reactive aluminous silicate pozzolan formed by calcining very pure hydrous China clay. Chemically Meta Cem combines with Calcium Hydroxide to form Calcium Silicate and Calcium Alluminate Hydrates. Unlike other natural pozzolan MetaCem is water processed to remove uncreative impurities producing an almost 100 percent reactive material. The particle size of MetaCem is significantly smaller than cement particles. IS 456:2000 recommends use of Meta-kaolin as Mineral admixture.

Table No 3.1:- Properties of Meta-kaolin

Specific Gravity	2.40 to 2.60
Physical Form	Powder
Colour	Off white, Gray to Buff
Brightness	80-82 Hunter L
BET	15 m2/gram
Specific Surface	8 – 15 m2/g.

Benefits

MetaCem is a thermally structured, ultrafine Pozzolan which replace industrial by products such as Silica fume / Micro silica. Commercial use of Meta-kaolin has already begun in several countries worldwide. Blending with Portland Cement MetaCem improves the properties of Concrete and Cement products considerably by:

- ✓ Increasing Compressive & Flexural Strength
- ✓ Providing resistance to chemical attack
- ✓ Reducing permeability substantially
- ✓ Preventing Alkali-Silica Reaction
- ✓ Reducing efflorescence & Shrinkage

- **Application:**

High Performance, High Strength and Lightweight concrete, Industrial-Commercial floor, Marine concrete, Precast Concrete for Architectural, Civil, Industrial and Structural, Shotcreting, Fibre cement &Ferro cement products, Glass Fibre Reinforced Concrete, Mortars, Stuccos, Repair Material, Pool Plasters.

2. GGBS:

Ground Granulated Blast Furnace Slag (GGBS): GGBS is obtained by quenching molten iron slag (a by-product of iron and steel making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS is used to make durable concrete structures in combination with ordinary port land cement and/or other pozzolanic materials.

GGBS has been widely used in Europe, and increasingly in the United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years. Use of GGBS significantly reduces the risk of damages caused by alkali-silica reaction, higher resistance to chloride, and provides higher resistance to attacks by sulphate and other chemicals. GGBS is procured from visage steel plant (VSP).

Fig : GGBS

The fineness modulus of GGBS using Blaine's fineness is 320 m^2/kg and other properties of GGBS given in table as below

Table No 3.2:- PROPERTIES OF GGBS

Chemical Properties	GGBS (%)
Calcium oxid	40
Silica	35
Alumina	13
Magnesia	8

- Physical Properties:

Specific gravity	2.9
Colour	Off-white
Bulk density	1200 kg/m3
Fineness	350 m2/kg

Applications:

CEM blend GGBS is normally combined with Portland cement in the concrete mixer. Guidance on the appropriate combination for different applications is available in BS 8500: Concrete - Complementary British Standard to BS EN 206-1 and from the contacts overleaf. Combinations of CEM blend GGBS and Portland cement are recommended for many applications including:

- Large concrete pours: Combinations of Portland cement with high proportions of CEM blend ggbs (typically around 70%) can significantly reduce the temperature rise in large concrete pours and hence reduce the risk of early-age thermal cracking.

- Concrete exposed to the ground: BRE Special Digest 1: Concrete in aggressive ground indicates that combinations of Portland cement with 66% or more of CEM blend GGBS demonstrate comparable sulphate resistance to sulphate Resisting Portland cement in practically all situations.

- To improve the resistance of concrete to reinforcement corrosion when exposed to chlorides from sea-water or other sources.

Typically the strength development will be as shown in the following table:

Table No 3.3:- Strength achieved as percentage of 28-day strength

Age	0% GGBS	50% GGBS	70% GGBS
7-days	75%	45 to 55%	40 to 50%
28-days	100%	100%	100%
90-days	105 to 110%	110 to 120%	115 to 130%

3. Alccofine:

Alccofine is nothing but ultrafine slag. Alccofine performs in superior manner than all other minerals admixtures. Due to high CaO content, alccofine 1203 triggers two way reactions during hydration pozzolanic and hydraulic the result is denser pore structure and higher strength gain

- Classifications of Alccofine

Alccofine 1100 series – High calcium silicate products (cement base)
Alccofine 1200 series – Low calcium silicate products (slag base)

Alccofine 1300 series – Alumino silicate products (fly-ash based)

Fig 3: Alccofine

- Optimum Particle Size Distribution

Use of alccofine 1203 enhance the performance of concrete in terms of durability due to its superior particle size distribution

Alccofine 1203 has particles range 0.1 to 17 microns means average particle size is 4 microns

Table No 3.4: Chemical Properties

CaO	SiO_2	SO_3	Al_2O_3	Fe_2O_3	MgO	Cl
61-64	21-23	2-2.4	5-5.6	3.8-4.4	0.8-1.4	0.03-0.05

Table No. 3.6: Setting Time

Initial setting time	Final setting time
60-120	120-150

- Advantages:

  - ✓ Durability is improved.
  - ✓ Strength gain is improved.
  - ✓ Improves the workability and cohesiveness.
  - ✓ Better retention of workability.
  - ✓ Reduces segregation.
  - ✓ Lowers the heat of hydration.
  - ✓ Improves the flow ability.
  - ✓ Many decorating effects such as corrosion, carbonation and sulphate attack may be minimized or stopped.

Table No 3.6: Application

SCM alccofine 1203	High rise structure Marine structure Ports
Grouting alccofine	Tunnels Dams Bridges Underground work's

Methodology

1. Procedure to determine particle size distribution of Aggregates:

i) The test sample is dried to a constant weight at a temperature of 110 + 5°C and weighed.
ii) The sample is sieved by using a set of IS Sieves 40mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm.
iii) On completion of sieving, the material on each sieve is weighed.
iv) Cumulative weight passing through each sieve is calculated as a percentage of the total sample weight.
v) Fineness modulus is obtained by adding cumulative percentage of aggregates retained on each sieve and dividing the sum by 100.

2. Procedure to determine water absorption of Aggregates

i) The sample should be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 and 32°C.
ii) After immersion, the entrapped air should be removed by lifting the basket and allowing it to drop 25 times in 25 seconds. The basket and sample should remain immersed for a period of 24 + ½ hrs afterwards.
iii) The basket and aggregates should then be removed from the water, allowed to drain for a few minutes, after which the aggregates should be gently emptied from the basket on to one of the dry clothes and gently surface-dried with the cloth, transferring it to a second dry cloth when the first would remove no further moisture. The aggregates should be spread on the second cloth and exposed to the atmosphere away from direct sunlight till it appears to be completely surface-dry. The aggregates should be weighed (Weight 'A').
iv) The aggregates should then be placed in an oven at a temperature of 100 to 110°C for 24hrs. It should then be removed from the oven, cooled and weighed (Weight 'B').

Formula used is Water absorption = $\frac{(A - B)}{B} \times 100\%$.

3. Procedure to Determine the Specific Gravity of Fine-Grained Aggregate:

i) The density bottle along with the stopper, should be dried at a temperature of 105 to 110°C, cooled in the desiccators and weighed to the nearest 0.001g (W_1).

ii) The sub-sample, which had been oven-dried should be transferred to the density bottle directly from the desiccators in which it was cooled. The bottles and contents together with the stopper should be weighed to the nearest 0.001g (W_2).

iii) Cover the soil with air-free distilled water from the glass wash bottle and leave for a period of 2 to 3hrs. for soaking. Add water to fill the bottle to about half.

iv) Entrapped air can be removed by heating the density bottle on a water bath or a sand bath.

v) Keep the bottle without the stopper in a vacuum desiccators for about 1 to 2hrs. Until there is no further loss of air.

vi) Gently stir the sand in the density bottle with a clean glass rod, carefully wash off the adhering particles from the rod with some drops of distilled water and see that no more soil particles are lost.

vii) Repeat the process till no more air bubbles are observed in the sand-water mixture.
viii) Observe the constant temperature in the bottle and record.

ix) Insert the stopper in the density bottle, wipe and weigh (W_3).

x) Now empty the bottle, clean thoroughly and fill the density bottle with distilled water at the same temperature. Insert the stopper in the bottle, wipe dry from the outside and weigh (W_4).

xi) Take at least two such observations for the same soil.

$$\text{Hence, Specific gravity} = \frac{(W_2 - W_1)}{[(W_4 - 1) - (W_3 - W_2)]}$$

4. Procedure to determine workability of fresh concrete by slump cone test:

i) The internal surface of the mould is thoroughly cleaned and applied with a light coat of oil.

ii) The mould is placed on a smooth, horizontal, rigid and non-absorbent surface.

iii) The mould is then filled in four layers with freshly mixed concrete, each approximately to one-fourth of the height of the mould.

iv) Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section).

v) After the top layer is rodded, the concrete is struck off the level with a trowelss.

vi) The mould is removed from the concrete immediately by raising it slowly in the vertical direction.

vii) The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.

viii) This difference in height in mm is the slump of the concrete.

5. Procedure to determine workability of fresh concrete by compacting factor test:

i) The sample of concrete is placed in the upper hopper up to the brim.

ii) The trap-door is opened so that the concrete falls into the lower hopper.

iii) The trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder.

iv) The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades.

v) The concrete in the cylinder is weighed. This is known as weight of partially compacted concrete.

vi) The cylinder is filled with a fresh sample of concrete and vibrated to obtain full compaction. The concrete in the cylinder is weighed again. This weight is known as the weight of fully compacted concrete.

Workability	Compaction factor
Very low	0.75-0.80
Low	0.80-0.85
Medium	0.85-0.92
High	Above 0.92

$$\text{Compacting factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}$$

4. MIX DESIGNING ANDOBSERVATIONS

1. Testing of coarse and fine aggregate for sieve analysis:

The test for sieve analysis of coarse and fine aggregate are conducted as per the above procedure and the results are tabulated as below.

For coarse aggregates:

Sieve	40 mm	20mm	10m m	Pa n
% passing 12mm	100	99.09	18.55	00
% passing 20mm	100	18	00	00

Fig: 1 Sieve analysis of coarse aggregate

For fine aggregates:

Sieve	4.75 mm	2..36 mm	1.18 mm	600 µ	300 µ	150 µ	Pan
% passing	78.24	59.13	17.22	10.02	20.36	0.32	00

Fig: 2 Sieve analysis of fine aggregate (Sand)

2. Testing of coarse and fine aggregate for Computing the water of aggregates:

Formula used is Water absorption = $\frac{(A-B)}{B}\times 100\%$.

For coarse aggregate 20mm:

A= 504.5 gm
B=498.00gm
% of water content $=\frac{(504.5-498)}{(498.00)}\times(100\%)$
=1.30

For coarse aggregate 12mm:

A= 1107 gm
B=1095 gm
% of water content $=\frac{(1107-1095)}{(1095)}$ x 100%
=1.095

For fine aggregate sand:

A= 504.70 gm
B= 501.10 gm
% of water content $=\frac{(506.70-501.10)}{(501.10)}$ x 100%
=1.117

3. Testing of coarse and fine aggregate for computing specific gravity

The specific gravity G of the 20mm agg.:

W_1 = 696gm
W_2 =1296gm
W_3 =1970gm
W_4 =1574gm

$$=\frac{(W2-W1)}{[(W4-1)-(W3-W2)]}$$

$$=\frac{(1296-696)}{[(1574-696)-(1970-1296)]}$$

G_{20mm} = 2.94

The specific gravity G of the 12mm agg.:

W_1 = 696gm
W_2= 996gm
W_3= 1771gm
W_4= 1574gm

$$G_{12mm}=\frac{(W2-W1)}{[(W4-1)-(W3-W2)]}$$

$$=\frac{(996-696)}{[(1574-696)-(1771-996)]}$$

= 2.91

The specific gravity G of the sand:

W_1 =696gm
W_2 =996gm
W_3 =1760gm
W_4 =1574gm

$$G_{sand}=\frac{(W2-W1)}{[(W4-1)-(W3-W2)]}$$

$$=\frac{(996-696)}{[(1574-696)-(1760-996)]}$$

= 2.63

4. Method of Mix Design:

Mix design procedure: As per I.S. 456 -2000
Target strength: M-30
Material supplied: 1) Cement (P. P. C.)
2) Sand
3) Aggregate

1) Collection of data from laboratory.
A) Sand: Physical properties like sieve analysis, water absorption, specific gravity.
B) Coarse aggregates: Physical properties like sieve analysis, water absorption, specific gravity.

2) Decide target strength of mix design (f_t)

$$f_t = f_{ck} + t \cdot s$$

Where,
f_t = Target compressive strength of concrete at 28 days.
f_{ck} = characteristic compressive strength of concrete at 28 days.
t = statistical coefficient based on number results expected to be lower than the compressive strength.
s =standard deviation based on degree of control.

$f_t = f_{ck} + t \cdot s$
$f_t = 30 + (1.65 \times 6)$
f_t= 39.9 N/mm^2

3) Determination of Water Cement Ratio:
From graph for strength of 39.9 N/mm^2
W.C. Ratio is = 0.375
= 0.40
= 0.42

4) Determination of water content and sand content:
From IS code; For maximum size of agg. 25 mm:
Water Content is 180 Kg/m^3 and
For Sand = 33%

5) Adjustment of water content for change in condition:

Desired grading (according to Zone B between standard curve 2nd and 3rd) from graph attached here with.

Water content for change in condition:

$$\text{Water content} = 180 + \frac{180 \times 1.5}{100}$$

$$= 182.7 \text{ kg/m}^3$$

6) Cement content:

We have,

W/C ratio = 0.375

Water = 182.7 kg/m^3

Hence, Weight of cement $= \frac{182.7}{0.375}$

$= 487.2$ kg

Absolute volume of water and cement per cubic meter of concrete:

Volume of water is $\frac{182.7kg}{1000} = 0.1827$ m^3

Volume of cement is $\frac{487.2}{3.15} \times \frac{1}{1000} = 0.1546$ m^3

Total volume $= 0.3373$ m^3

a. Mix proportion by weight:

Water	Cement	Sand	C.A 12mm	CA 25mm
182.7	487.2	627.52	510.99	723.14
0.375	1.0	1.179	0.743	1.808

b. Mix proportion by Volume:

Cement	Sand	C.A 12mm	CA 25mm
0.3373	0.2386	0.1756	0.2485
1.0	0.6115	0.3484	0.8387

c) Quantity per bag of cement by weight

Water	Cement	Sand	C.A 12mm	CA 25mm
0.375	1.0	1.179	0.743	1.808
18.75	50	58.95	37.15	90.4

d) The quantities' per batch of one cement bag are:

Water	Cement	Sand	CA 12mm	CA 25mm
18.75	50	59.83	37.15	90.4

e) Concrete Mix Design

Trial mix	W/C ratio	Ingredient content in Kg					Mix proportion by weight				Compressive strength in Kg/cm²			
		Water	Cement	Sand	12 mm aggr.	25 mm aggr.	Cement	Sand	12 mm aggr.	25 mm aggr	28 days field required	7 days lab required	7 days lab observed	28 days lab observed
M 1	0.375	182.7	487.2	627.52	510.99	723.14	1.000	1.288	1.05	1.484	300	266.14	294.85	413.85
M 2	0.40	182.7	456.75	636.46	518.56	733.61	1.000	1.394	1.135	1.606	300	266.14	281.25	398.66
M 3	0.42	182.7	435.00	643.04	523.80	741.18	1.000	1.478	1.205	1.703	300	266.14	275.33	393.25

f) Concrete Mix Design Recommended

Trial mix	W/C ratio	Ingredient content in Kg					Mix proportion by weight				Compressive strength in Kg/cm²			
		Water	Cement	Sand	12 mm aggr.	25 mm aggr.	Cement	Sand	12 mm aggr.	25 mm aggr	28 days field required	7 days lab required	7 days lab observed	28 days lab observed
M 2	0.40	182.7	456.75	636.46	518.56	733.61	1.000	1.394	1.135	1.606	300	266.14	281.25	398.66

g) Mix Proportion for 1kg of cement and cementitious material

Change in condition	Water content adjustment
1) For sand conform to Zone II	Nil
2) For increase in Compaction Factor 0. 44 0. 45 0. 46	 + 1. 5 % + 1. 5 % + 1. 5 %

Mix	Water	Cement	SCM	Sand	12mm aggr.	25mm aggr.
Mix-1	0.4	0.95	0.5	1.272	0.803	1.949
Mix-2	0.4	0.9	0.10	1.272	0.803	1.949
Mix-3	0.4	0.85	0.15	1.272	0.803	1.949
Mix-4	0.4	0.8	0.20	1.272	0.803	1.949

Fig: Mixing material and Filling of cubes

5. Result of slump cone test carried out in laboratory

All the tested concrete mixes gave the "Zero slump" as the mix is rich mix of M-30

Fig: 4.6 Slump Cone test

Test results of compressive strength of sample with Alccofine

S.No.	QUANTITY OF MATERIAL (%)	7 DAYS STRENGTH (Kg/cm²)	28 DAYS STRENGTH (Kg/cm²)
1	0	281.25	398.66
2	5	363.70	400.00
3	10	397.03	414.53
4	15	319.81	383.70
5	20	317.41	337.22

Test results of compressive strength of sample with GGBS

S.No.	QUANTITY OF MATERIAL (%)	7 DAYS STRENGTH (Kg/cm²)	28 DAYS STRENGTH (Kg/cm²)
1	0	281.25	398.66
2	5	290.52	430.74
3	10	299.62	436.29
4	15	250.74	421.40
5	20	227.77	380.46

Test results of compressive strength of sample with Meta-kaoline

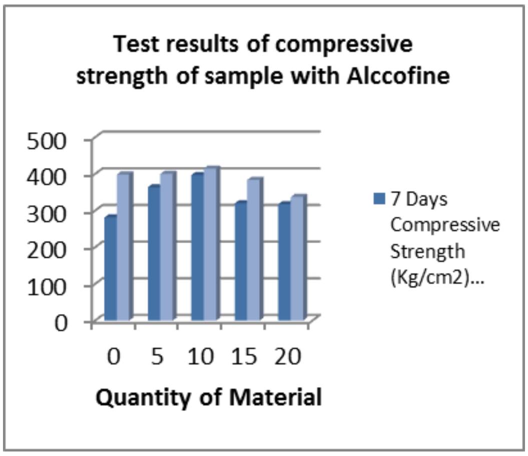
S.No.	QUANTITY OF MATERIAL (%)	7 DAYS STRENGTH (Kg/cm²)	28 DAYS STRENGTH (Kg/cm²)
1	0	281.25	398.66
2	5	310.10	439.11
3	10	316.29	448.44
4	15	307.33	383.70
5	20	259.62	356.57

Fig 4.7: Compressive Strength Test

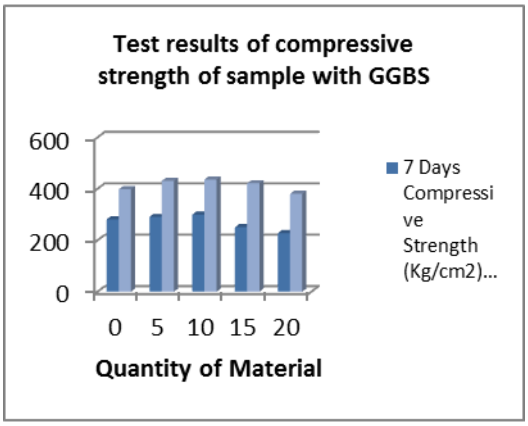
5. RESULTS AND DISCUSSION

1 Results:

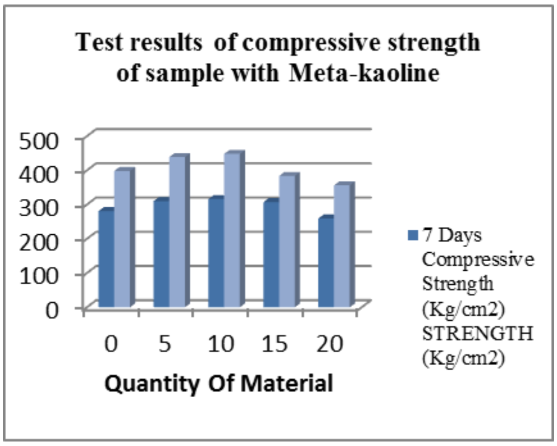
Graph 5.1: for test result of compressive strength of sample with Alccofine



Graph 5.2: for test result of compressive strength of sample with GGBS



Graph 5.3: for test result of compressive strength of sample with Meta-Kaoline



5.2 Discussion:

The different ratios of water cement such as 0.375, 0.4 and 0.42 were prepared and kept them for seven days so as to measure the strength of the mixture and the values which obtained are 294.85 kg/cm^2,281.25kg/cm^2,275.33kg/cm^2 respectively and the same process is carried out for 28 days and obtained values are 413.85kg/cm^2,398.66kg/cm^2 and 393.25kg/cm^2.

After the whole process it is concluded that the ratio of water cement 0.4 is taken for design whose strength is 281.25kg/cm^2 for 7days and 398.66kg/cm^2 for 28days.

1 ALCCOFINE:

The alccofine was replaced with cement in a proportion of 5%, 10%, 15% and 20% for a ratio of water cement 0.4 and according to the workability criteria is concerned, medium workability is obtained at 5% and 10%, low workability is obtained at 15% and 20% from alccofine by compaction factor test.

After seven days, alccofine concrete cubes were tested on compressive testing machine. It gives 363.70kg/cm^2, 397.03kg/cm^2, 319.81kg/cm^2 and 317.41kg/cm^2 strengths for 5%, 10%, 15% and 20% of replacement.

The strengths of cubes which is measured by alccofine i.e. (5%, 10%, 15% and 20%) is higher than normal concrete strength that is 281.25kg/cm^2 after seven days.

In early stages it is noticed that it gives better result at 5% and 10% during seven days analysis and found the same strength is low at 15% and 20%.

After analysing for seven days, kept same mix ratio cube for twenty eight days and it observed that it gives surprising results and the ratios which were used for twenty eight days and their respective strength is measured such as 5%, 10%, 15% and 20% and for the same water cement ratio of 0.4 are 400.00 kg/cm^2,414.53 kg/cm^2,383.70 kg/cm^2 and 337.22 kg/cm^2.

It shows that the compressive strength of alccofine cubes for 5% and 10% is higher than normal concrete that is 398.66 kg/cm^2 and the strength of cubes for 15% and 20% is smaller than normal concrete strength at twenty eight days.

2 GGBS:

The GGBS was replaced with cement in a proportion of 5%,10%,15% and 20% for a ratio of water cement 0.4 and according to the workability criteria is concerned, medium workability is obtained for all the replaced mixes by compaction factor test.

After seven days analysis, it is noticed that the ratio of water cement 0.4 of GGBS was in proportion of 5%, 10%, 15% and 20%. The compressive strength were 290.52kg/cm^2, 299.64kg/cm^2, 250.74kg/cm^2 and 227.77kg/cm^2.

This shows the strength of cubes of GGBS for 5% and 10% replacement is higher than normal concrete that is 279.25kg/cm^2 and the strength of cubes for 15% and 20% replacement is smaller than normal concrete.
According to these results of GGBS, it is noticed that it gives better result 5% and 10% during seven days analysis. And same strength is low for 15% and 20%.

After analysing for seven days, kept same mix ratio cube for twenty eight days and it observed that it gives surprising results and the ratios which were used for twenty eight days and their respective strength is measured such as 5%, 10%, 15% and 20% and for the same water cement ratio of 0.4 are 430.74kg/cm^2, 436.29kg/cm^2, 421.40kg/cm^2 and 380.46 kg/cm^2.

It shows that the compressive strength of alccofine cubes at 5%, 10% and 15% is higher than normal concrete that is 398.66kg/cm^2 and the strength of cube at 20% is smaller than normal concrete strength at twenty eight days.

The strength of cubes of GGBS for 5% 10% and15% replacement is higher than normal concrete that is 398.51kg/cm^2 and the same for 20% replacement is smaller than normal concrete.

3 META-KAOLIN:

The meta-kaoline was replaced with cement in a proportion of 5%,10%,15% and 20% for a ratio water cement 0.4 and according to the workability criteria is concerned, medium workability for all the replaced mixes by compaction factor test.

After seven days, meta-kaoline concrete cubes were tested on compressive testing machine it give 310.10kg/cm^2,316.29kg/cm^2,307.33kg/cm^2 and 259.62kg/cm^2 strengths for 5%,10%, 15% and 20% of replacement.

The strengths of cubes measured by meta-kaoline i.e. 5%, 10% and 15% of the replacement are higher than normal concrete strength that is 281.25kg/cm^2 after 7 days and for 20% of the replacement, it is smaller.

In early stages it is noticed that it gives better result at 5%, 10% and 15% during seven days analysis and found the same strength is low at 20%.

After analysing for seven days, kept same mix ratio cube for twenty eight days and it observed that it gives surprising results and the ratios which were used for twenty eight days and their respective strength is measured such as 5%, 10%, 15% and 20% and for the same water cement ratio of 0.4 are 439.11 kg/cm^2,448.44 kg/cm^2,383.70 kg/cm^2 and 356.57 kg/cm^2.

It shows that the compressive strength of alccofine cubes for 5% and 10% is higher than normal concrete that is 398.66 kg/cm² and the strength of cubes for 15% and 20% is smaller than normal concrete strength at twenty eight days.

6. CONCLUSION AND RECOMMENDATION FOR FUTURE WORK

6.1 CONCLUSION

After the above calculation it is observe that the replacement of 5%, 10%, 15% and 20% of cement by different wastes material such as Alccofine, GGBS and Metakaoline. It is tested for workability and compressive strength after all these process the final conclusion are,

1) Using alccofine as an alternative material, it increases compressive strength and workability for 5% and 10%.
2) Using GGBS as an alternative material, it increases compressive strength and workability for 5%, 10% and 15%.
3) Using meta-kaoline as an alternative material, it increases compressive strength and workability increases up to 5% and 10%.

Thus, the conclusion occurs:

- Alccofine 10%
- GGBS 15%
- Meta-kaoline 10%

Even for high strength mix such as M-30.

6.2 RECOMMENDATION FOR FUTURE WORK

Further research and investigation were highly recommended and should be carried out to understand more mechanical properties of prepared concrete. Some recommendation for future studies are mentioned below:

1) The effect of addition of fibre in our concrete mix can be checked by preparing the test samples with addition of different fibres.
2) More investigations and laboratory tests should be done to study on the mechanical properties of our concrete mix. Such application of prepared concrete was recommended in testing on concrete slabs, beam and walls or conducting more tests such as abrasion, shatter, shear, impact, blasting or creeping of concrete.
3) The addition of various different admixtures in variable % can be checked.
4) The addition of other supplementary cementitious material like Rice Husk ash, Sugar Cane ash, Fly ash and their combination in concrete mix can also be checked for compressive strength, Flexural strength and Split tensile strength.

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