Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Analysis and Testing of Concrete Using Various Parameters

[1]Deepak Kumar Bandewar, [2]Prof Gyanendra Singh

[1]P.G. Student, [1,2] Patel Institute of Engineering & Science Bhopal (MP) 462044, India

Abstract: **Now a days the necessity of high strength high performance concrete is increasing because of demands in the construction industry. Efforts for improving the characteristics of concrete over the past few years suggest that cement replacement materials along with chemical admixtures can improve the durability and corrosion characteristics of concrete. Cement is the most important role plays in concrete like binding material and can be bind other material together**

In this paper focuses (concern) on the experimental case study of using supply cementing materials (SCM) such as Meta-koalin. Alcco fine, GGBS Ground granulated blast furnace slag.

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.

Keywords: **GGBS Ground granulated blast furnace slag, Supplementary cementing materials SCMs, Concrete Using Various Parameters.**

1. INTRODUCTION

Normal Concrete:

Concrete is most widely used construction material in the world. Concrete is a composite material formed by the combination of (a) cement, (b) aggregate and (c) water in particular proportion in such way that concrete produce meets the need of the job on hand particularly as regards its workability, strength, durability and economy. In our country the concrete is generally prepared at the sites and therefore need to be carefully supervised and controlled in order that it performs the way it's technically expected to perform. Lot of care is to be taken in every stage of manufacturing of concrete.

The various stages of manufacturing concrete are:

Batching, Mixing, Transporting, Placing, Compacting, Curing, Finishing.

Waste material:

Due to sustained pressure of industrial and developmental activities, there are appreciable disturbances in the ecological balance of nature. As with most large manufacturing industries, by-product materials are generated. These industrial by-product and waste materials must be managed responsibly to insure a clean and safe environment. The concept of environmental geo-techniques has emerged as an answer to the need to understand the ecological problems, connected with Fly ash, CKD, Quarry fines, Silica fines.

Fly ash:

Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the gases. In an industrial context, fly ash usually refers to ash produced during combustion of coal. It is having a fineness of about 4000-

8000 cm^2 /g. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment's before the flue gases reach the chimneys of coal-fired power plants Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably.

It may include one or more of the following elements or substances in quantities from trace amounts to several percentage beryllium, boron, cadmium, chromium, chromium VI, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with dioxins.

CKD (Cement kiln dust):

Cement manufacturing is a critically important industry in the world worldwide production accounted for about 2.5 billion metric tons. Over the past several years dramatic advances have been achieved in the management and use of cement kiln dust, thus reducing its dependency on landfill disposal. Sustainability is the cornerstone of the cement industry, not only in the products that use cement, but also in its manufacturing process.

Many of the older, inefficient plants are being replaced by more modern plants or being renovated with new technologies to be more efficient as well as more environmentally friendly.

The majority of CKD is recycled back into the cement kiln as raw feed. In addition, new technology has allowed the use of previously land filled CKD to be used as raw feed stock. Recycling this by-product back into the kiln not only reduces the amount of CKD to be managed outside the kiln, it also reduces the need for limestone and other raw materials, which saves natural resources and helps conserve

Quarry fines:

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:

The necessity of high strength high performance concrete is increasing because of demands in the construction industry. Efforts for improving the characteristics of concrete over the past few years suggest that cement replacement materials along with chemical admixtures can improve the durability and corrosion characteristics of concrete. High Reactive Meta-kaolin (HRM), is a pozzolanic material that can be utilized to produce highly durable concrete composites. However, information to understand the behaviour of this mineral additive in concrete is insufficient. Some of the recent information is discussed in this paper highlighting the role of meta-kaolin in high strength high performance concrete.

GGBS (Ground-granulated blast-furnace slag):

GGBS is non-metallic product consist of silicates and aluminates of calcium and other bases. The molten slag is rapidly chilled by quenching in water to form glassy sand like grains, further the segrains ground to fineness less than 45μ. IS146:2000 suggest, GGBS obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used as part replacement of OPC provided uniform blending with cement is ensured.

When the GGBS is use as a replacement of cement the water requirement reduces to obtain the same slump. It also reduces the heat of hydration the main advantage of use of GGBS is reduction in permeability and increase resistance to chemical attack. 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 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. The raw materials are composed primary of low calcium silicates. The

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

processing with other select ingredients results in controlled particle size distribution (PSD). The computed blain value based on PSD is around 12000cm^2/gm and is truly ultrafine. Due to its unique chemistry and ultrafine particle size, ALCCOFINE1203 provides reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance. ALCCOFINE 1203 can also be used as a high range water reducer to improve compressive strength or as a super workability aid to improve flow.

Micro-Silica:

The extra amount of foundry dust was treated as a partial replacement for sand. Use of foundry dust in SCC resulted in high air content (7 - 10%) and low density of concrete due to reaction between foundry dust and the particular brands of chemical admixtures used. Further, with the increase in foundry dust content containing iron, the colour of concrete changed from dark gray to black. For the foundry silica-dust content of 20% and above, the requirement for high-range water-reducing admixture [HRWRA] increased; however, the amount of viscosity-modifying admixture [VMA]) decreased up to 33% up to the silica-dust content of 30%. It was concluded that foundry industry silica-dust material can be used for partial replacement of cement, fly ash, and sand in SCC. More extensive work is in progress.

2. MATERIALS COMPOSITION

Meta-kaoline:

MetaCem grades of Calcined clays are reactive allumino silicate pozzolanformed by calcining very pure hydrous China clay. Chemically MetaCem combines with Calcium Hydroxide to form Calcium Silicate and Calcium Alluminate Hydrates. Unlike other natural pozzolana 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 Metakaolin as Mineral admixture.

Table No 1:-TYPICAL PROPERTIES

PROPERTIES	UNITS	METACEM 85	TEST METHOD
Physical Form	-	Off white powder	-
Specific Gravity	-	2.5	ISO 787 / 10
Bulk Density	gm/ltr	300 ± 30	DIN 468
Average Particle Size	µ	1.5	Sedigraph
Residue 325 #	%	0.5 max	-
Pozzolan Reactivity - mg $Ca(OH)_2$	-	>1000	Chappel Test

- **BENEFITS:**

MetaCem is a thermally structured, ultrafine Pozzolan which replace industrial by products such as Silicafume / Microsilica. Commercial use of Metakaolin 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

- **CHEMICAL COMPOSITION - WT**

$SiO_2 + Al_2O_3 + Fe_2O_3$ > 96 %

Loss on Ignition < 1%

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

- **APPLICATION:**

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

GGBS:

Ground Granulated Blast Furnace Slag (GGBS): GGBS is obtained by quenchin 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 vizag steel plant (VSP).

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 2:- CHEMICAL PROPERTIES OF GGBS

Chemical Properties	GGBS (%)
SiO_2	34.06
Al_2O_3	18.8
Fe_2O_3	0.7
CaO3	2.4
SO_3	0.45
MgO	10.75
S	0.65
MnO	0.49
Na_2O	0.31
K_2O	0.98
Cl	0.008

- **PHYSICAL PROPERTIES:**

Mean particle size	5 - 30 micron
Colour	Off-white
Odour	Odourless when dry but may giverise to sulfide odour when wet
pH	When wet, up to 12
Viscosity	N/A
Freezing point	N/A
Boiling point	>1700°C
Melting point	>1200°C
Flash point	N/A (not flammable)
Explosive properties	N/A
Density at 20°C	2.4 - 2.8 g/cm3

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Water solubilityat 20°C <1g/l

- **APPLICATIONS:**

CEMblend 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 CEMblend 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 CEMblend GGBS express 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:

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%

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 pozzolonic 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)

- **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 03: PHYSICAL PROPERTIES:

Fineness (cm^2/gm.)	Sp. Gravity	Bulk density (kg/ m^3)	Particle distribution		
			D_{10}	D_{30}	D_{90}
8000	3.1	700-900	1.5	5	9

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table No 04:-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. 05

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

- **ADVANTAGES:**

✓ Durability is improved. Strength gain 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 detoriating effects such as corrosion, carbonation and sulphate attack may be minimized or stopped.

Table No 06 : APPLICATION

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

Micro-Silica:

Silica fume is a by-product of the ferro-silicon metals industry. Ferro-silicon metals are produced in electric furnaces for sealants, caulk, and other products. The emissions from the furnace are collected and termed silica fume. Silica fume particles are 1/100 the size of cement particles. They are not cementations but highlypozzolanic. ASTM C 1240 (ASTM, 2008) defines the requirements of silica fume that can be used in concrete.

Silica fume is usually categorized as a supplementary cementations material. This term refers to materials that are used in concrete in addition to portland cement. These materials can exhibit the following properties:

- **CHEMICAL PROPERTIES OF SILICA FUME:**

✓ Amorphous Silicon dioxide > 85%

✓ Trace elements depending upon type of fume

- **PHYSICAL PROPERTIES OF SILICA FUME:**

Particle size (typical): < 1 μm

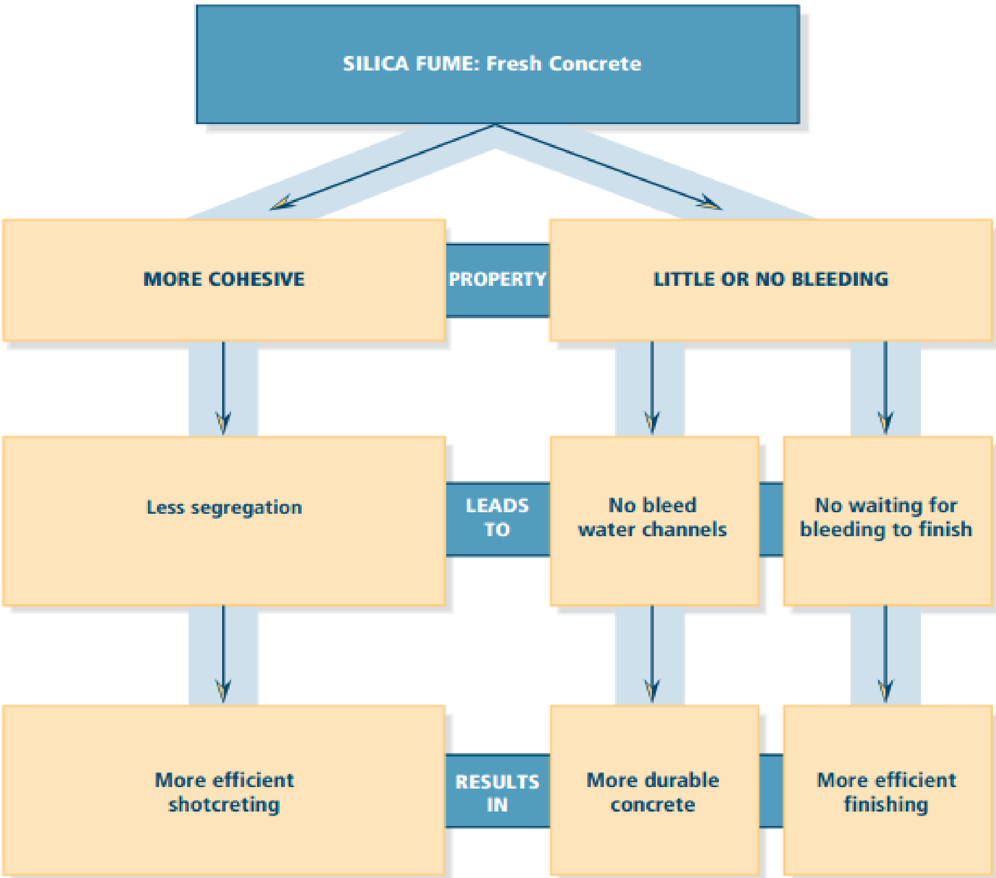
Bulk density (as-produced): 130 to 430 kg/m3

(Densified): 480 to 720 kg/m3

Specific gravity: 2.2

Specific surface: 15,000 to 30,000 m2/kg

- **Effects of silica fumes on concrete:**



Effects of silica fumes on concrete

Silica fume is frequently referred to by other names. This manual will use the term silica fume, as adopted by the American Concrete Institute. Here are some of the other names for silica fume:

- Condensed silica fume
- Micro silica
- Volatilized silica

SILICA FUME: Production

Fly-Ash:

According to the American Concrete Institute (ACI) Committee 116R, fly ash is defined as 'the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gasses from the combustion zone to the particle removal system' (ACI Committee 232 2004). Fly ash is removed from the combustion gases by the dust collection system, either mechanically or by using electrostatic precipitators, before they are discharged to the atmosphere. Fly ash particles are typically spherical, finer than Portland cement and lime, ranging in diameter from less than 1mm to no more than 150 µ

Fly ash is the most commonly used SCM. Fly ash is the residue collected from the flue gasesexiting the boiler of a pulverized coal generating station. The fly ash particles are collected inelectrostatic precipitators or bag houses and then transferred to a storage silo or sluice pond. Flyash has a spherical morphology and exhibits a rather wide range of bulk chemical compositions.This wide range of chemical composition has resulted in the creation of two classes of fly ash

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

inASTM specifications (*10*) and three classes of fly ash in Canadian Standard Association (CSA)ASTM specifications break fly ash in two classes based on SiO_2+Al_2O_3+Fe_2O_3 content.

- **USE OF FLY ASH IN CONCRETE:**

One of the efforts to produce more environmentally friendly concrete is to reduce the use of OPC by partially replacing the amount of cement in concrete with by-products materials such as fly ash. As a cement replacement, fly ash plays the role of an artificial pozzolan, where its silicon dioxide content reacts with the calcium hydroxide from the cement hydration process to form the calcium silicate hydrate (CS-H) gel. The spherical shape of fly ash often helps to improve the workability of the fresh concrete, while its small particle size also plays as filler of voids in the concrete, hence to produce dense and durable concrete.

3. MIX DESIGN AND OBSERVATIONS

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

Table No 08: For coarse aggregates:

Sieve	40 mm	20mm	10mm	Pan
% passing 12mm	100	99.09	18.55	00
% passing 20mm	100	18	00	00

Table No 09: For fine aggregates:

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

Testing of coarse and fine aggregate for computing water absorption of aggregates:

Formula used is Water absorption = × 100%.

For coarse aggregate 20mm:

A= 504.5 gm

B=498.00gm

% of water content = ×

=1.30

For coarse aggregate 12mm:

A= 1107 gm

B=1095 gm

% of water content =x 100%

=1.095

For fine aggregate sand:

A= 504.70 gm

B= 501.10 gm

% of water content =x 100%

=1.117

Testing of coarse and fine aggregate for computing specific gravity

The specific gravity G of the 20mm aggregate.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

$W_1 = 696$ gm

$W_2 =1296$ gm

$W_3 =1970$ gm

$W_4 =1574$ gm

=

=

$G_{20mm} = 2.94$

The specific gravity G of the 12mm agg.:

$W_1 = 696$gm

$W_2 = 996$gm

$W_3 = 1771$gm

$W_4 = 1574$gm

$G_{12mm} =$

=

= 2.91

The specific gravity G of the sand:

$W_1 =696$gm

$W_2 =996$gm

$W_3 =1760$gm

$W_4 =1574$gm

$G_{sand} =$

=

= 2.63

The test for specific gravity and water absorption of coarse and fine aggregate are conducted as per the above procedure and the results are tabulated as below

Table no.10:- Laboratory results for aggregates

Sample	% Passing through each sieve				Specific Gravity	Water absorbs.
	40 mm	20 mm	10 mm	4.75 mm		
12	100	99.09	18.55	0	2.91	1.67
20	100	18.00	0	0	2.94	1.30

Method of Mix Design:

Mix design procedure: As per I.S. 456 -2000

Target strength: M-30

Material supplied:

1) Cement (O. P. C.)

2) Sand

3) Aggregate

Step: 1) Collection of data from laboratory.

A) Sand: Physical properties like sieve analysis, water absorption, specific gravity.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

B) Coarse aggregates: Physical properties like sieve analysis, water absorption, specific gravity.

Step: 2) Decide target strength of mix design (f_t)

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

Where,

f_t = Target comp. strength of concrete at 28 days.

f_{ck} = characteristic comp. 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.

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

$$f_t = 30 + (1.65 \times 6)$$

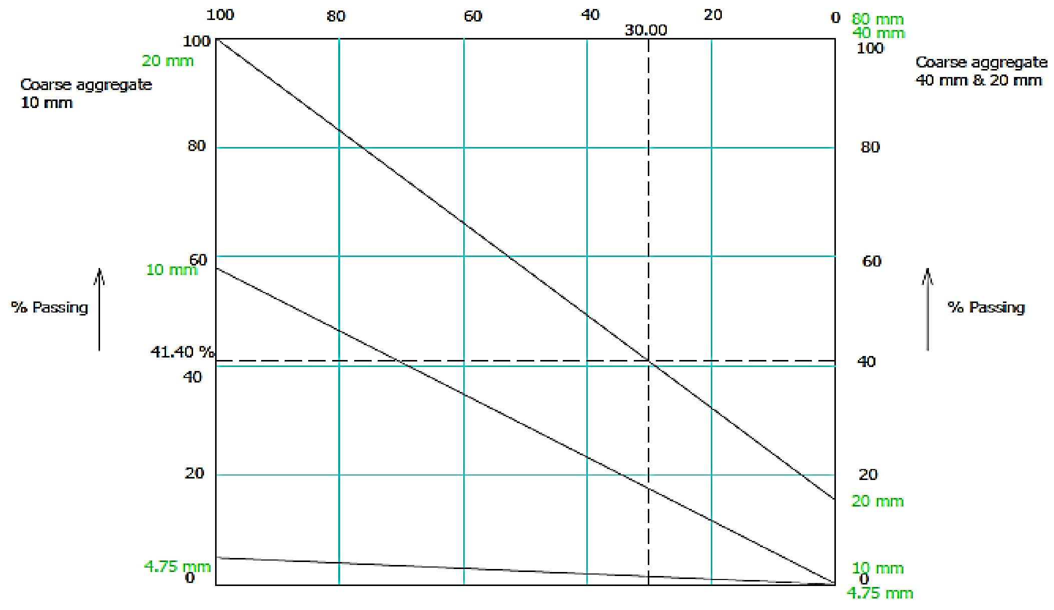
$$f_t = 39.9 \text{ N/mm}^2$$

Step: 3) Combining of all in aggregate 20mm nominal size by Graphical method.

Desired grading calculated from standard grading curve for 20mm aggregate curve

Table No :-11% of different ingredient calculated from the graph

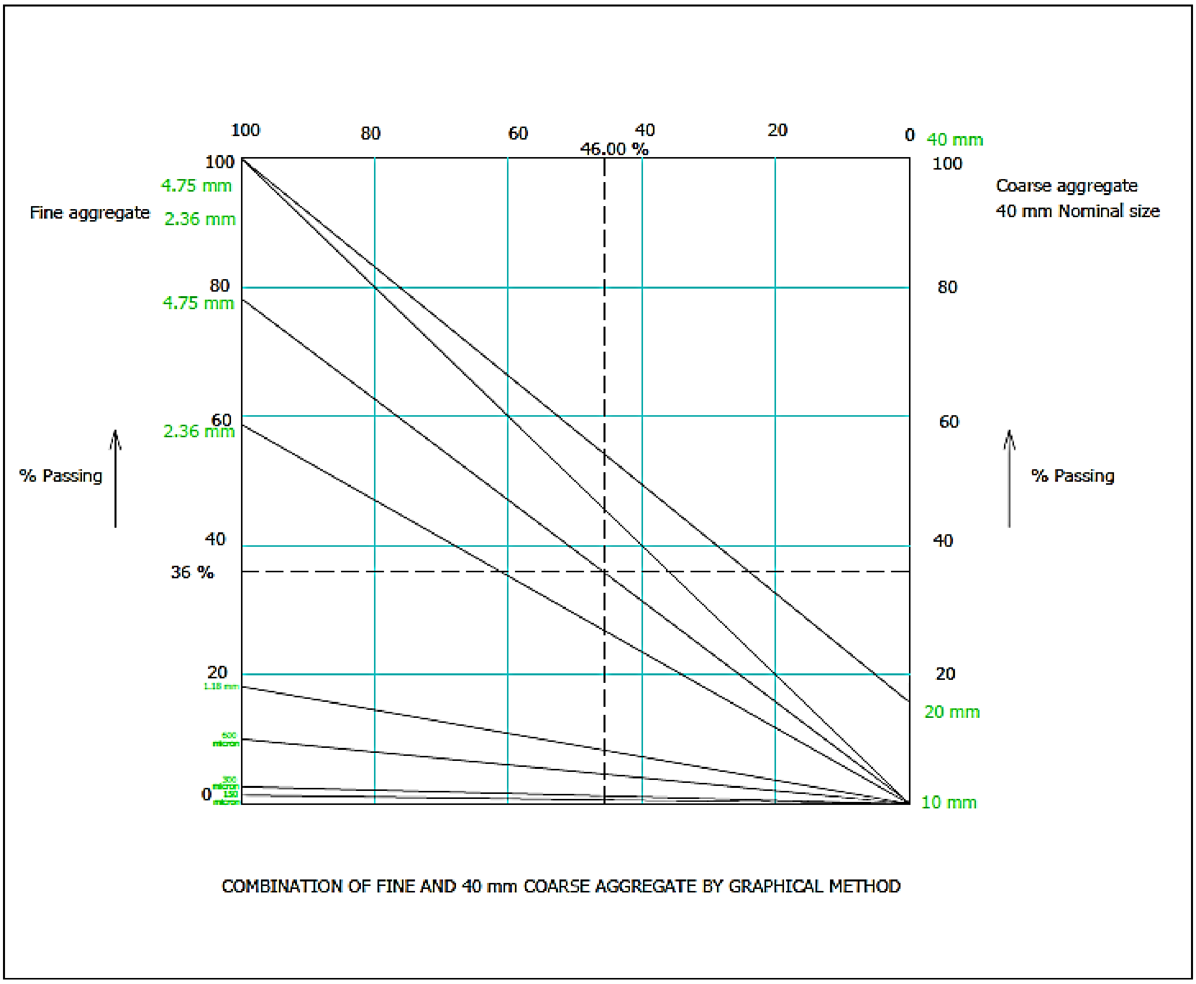
4.75& below	4.75-10	10-20	20-40
36%	12%	14.5%	37.5%
36%	26.5%		37.5%



COMBINATION OF COMIBNED 40-20 mm & 10 mm COARSE AGGREGATE BY GRAPHICAL METHOD

Grading of Coarse aggregate

ISSN 2394-7357
International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com



Grading of Fine aggregate

Step 4) 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

Step 5) Determination of entrapped Air:

For maximum size of aggregate 20mm is 2% by volume.

Hence, Aircontent in m^3 = 0.02m^3

Step 6) 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%

Step 7) 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.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table no: 12

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

Water content = 180+

= 182.7 kg/m^3

Step 8) Cement content:

We have,

W/C ratio = 0.375

Water = 82.7 kg/m^3

Hence, Weight of cement =

= 487.2 kg

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

Air is 2% by volume of concrete

Therefore Absolute volume of air = 0.0200 m^3

Volume of water is = 0.187 m^3

Volume of cement is ×= 0.1546 m^3

Total volume = 0.3573 m^3

Step 9) Quantities' of aggregate:

Total volume of aggregate = (1.000 – 0.3573)

= 0.6427 m^3

Absolute volume of sand (34%)

= 0.6427 × 0.34

= 0.2185m^3

Absolute volume of C.A. = 0.6427 – 0.2185

= 0.4242 m^3

Weight of sand = 0.2185 × 2.63 × 1000

= 574.655 kg.

Weight of coarse aggregate (12 mm) = 0.1245× 2.91 × 1000

= 362.295 kg.

Weight of coarse aggregate (25 mm) = 0.2997× 2.94 × 1000

= 881.118 kg.

a) Table No.13:- Mix proportion by weight:

Water	Cement	Sand	C.A 12mm	CA 25mm
182.7	487.2	574.655	362.295	881.118
0.375	1.0	1.179	0.743	1.808

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

b) Table No.14:- Mix proportion by Volume:

Cement	Sand	C.A 12mm	CA 25mm
0.3573	0.2185	0.1245	0.2997
1.0	0.6115	0.3484	0.8387

c) Table No .15:-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

Correction for water:

A) Extra water required for absorption in coarse aggregate 0.5%

127.55 ×= 0.63 kg.

B) Quantity of water to be deduction for free moisture present in sand at 1.5 %

58.95 × = 0.88 kg.

Actual quantity of water to be added per bag of cement:

= 18.75+ 0.63 – 0.88

= 18.50 kg.

C} Actual quantity of sand required to allow for mass of free moisture:

= 58.95 + 0.88

= 59.83 kg.

Table no :16:- The quantities' per batch of one cement bag are:

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

Table no : 17 Quantities of different ingredients:

Particulars	**Mix-1**	**Mix-2**	**Mix-3**
For W/c ratio	0.375	0.40	0.42
Total Volume considered (m^3)	1.00	1.00	1.00
Volume of air (m^3)	0.20	0.20	0.20
Volume of water (m^3)	0.1827	0.1827	0.1827
Weight of cement (kg) #	487.2	456.75	435
Volume of cement (m^3)	0.1546	0.1473	0.1403
Volume of sand + aggregate (m^3)	0.6427	0.6500	0.6570
Volume of sand (m^3)	0.2185	0.2210	0.2234
Volume of 12 mm aggregate (m^3)	0.1245	0.1261	0.1275
Volume of 25 mm aggregate (m^3)	0.2997	0.3029	0.3061
Weight of sand (kg)	574.655	581.230	587.542
Weight of 12 mm aggregate (kg)	362.295	366.951	371.025
Weight of 25 mm aggregate. (kg)	881.118	890.526	899.934

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table no. 18:-Actual design proportion for one bag of cement in Kg

Mix	**Water**	**Cement**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1	18.50	50	58.95	37.15	90.40	255.00
Mix-2	19.7340	50	63.60	40.15	97.45	270.934
Mix-3	20.7125	50	67.50	41.60	103.40	283.425

Table no. 19 :-Concrete Mix Design

Trial mix	W/C ratio	Ingredient content in Kg					Mix proportion by weight				Compressive strength in Kg/cm2			
		Water	Cement	Sand	mm aggr	mm aggr	Cement	Sand	mm aggr	25 mm aggr	days field requ	days lab requ	days lab obse	days lab obse
M 1	0.375	182.7	487.2	574.655	362.295	881.118	1.000	1.179	0.743	1.808	300	266.14	291.85	414.81
M 2	0.40	182.7	456.77	583.286	375.91	886.17	1.000	1.277	0.823	1.940	300	266.14	279.25	398.51
M 3	0.42	182.7	435.00	589.383	371.92	895.64	1.000	1.354	0.873	2.058	300	266.14	273.33	391.10

Table no 20: Concrete mix design recommended

Trial mix	W/C ratio	Ingredient content in Kg					Mix proportion by weight				Compressive strength in g/cm2			
		Water	Cement	Sand	12 mm aggr.	25 mm aggr.	Cement	Sand	12 mm aggr.	25 mm aggr	days field required	lab required	lab observed	28 days lab observed
M 2	0.40	182.7	456.77	583.286	375.91	886.17	1.000	1.277	0.823	1.940	300	266.14	279.25	398.51

Table No. 21:-Mix Proportion for 1kg of cement and cementatious material

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

Table No. 22:- Quantity required per 60kg (NormalConcrete)

Mix	**Water**	**Cement**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total wt.**
Mix-1	4.35	11.76	13.86	8.73	21.26	59.96
Mix-2	4.36	11.07	14.08	8.88	21.57	59.96
Mix-3	4.38	10.59	14.29	8.81	21.90	59.97

Table No. 23:- Quantity required per 60 kg (Alccofine)

Mix	**Water**	**Cement**	**Alccofine**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1(10%)	4.36	10.584	1.176	13.76	8.88	21.57	59.96
Mix-2 (15%)	4.36	9.409	1.661	14.08	8.88	21.57	59.96
Mix-3(20%)	4.36	8.472	2.118	14.29	8.88	21.57	59.96

Table No.24:-Quantity required per 60 kg (GGBS)

Mix	**Water**	**Cement**	**GGBS**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1 (10%)	4.36	10.584	1.176	13.76	8.88	21.57	59.96
Mix-2 (15%)	4.36	9.409	1.661	14.08	8.88	21.57	59.96
Mix-3 (20%)	4.36	8.472	2.118	14.29	8.88	21.57	59.96

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table No.25:-Quantity required per 60 kg (Meta-kaoline)

Mix	**Water**	**Cement**	**Meta-kaoline**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1 (10%)	4.36	10.584	1.176	13.76	8.88	21.57	59.96
Mix-2 (15%)	4.36	9.409	1.661	14.08	8.88	21.57	59.96
Mix-3 (20%)	4.36	8.472	2.118	14.29	8.88	21.57	59.96

Table No. 26:- Quantity required per 60 kg (Fly-ash)

Mix	**Water**	**Cement**	**Fly-ash**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1 (10%)	4.36	10.584	1.176	13.76	8.88	21.57	59.96
Mix-2 (15%)	4.36	9.409	1.661	14.08	8.88	21.57	59.96
Mix-3 (20%)	4.36	8.472	2.118	14.29	8.88	21.57	59.96

Table No.27 :- Quantity required per 60 kg (Micro-silica)

Mix	**Water**	**Cement**	**Micro-silica**	**Sand**	**12mm aggr.**	**25mm aggr.**	**Total aggr.**
Mix-1 (10%)	4.36	10.584	1.176	13.76	8.88	21.57	59.96
Mix-2 (15%)	4.36	9.409	1.661	14.08	8.88	21.57	59.96
Mix-3 (20%)	4.36	8.472	2.118	14.29	8.88	21.57	59.96

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.

Results of compaction factor test carried out in laboratory:

Table No : 28

Material used	**Weight of partially compacted concrete(W_1)**	**Weight of fully compacted concrete(W_2)**	**Compacting factor**	**Workability**
Alkofine	19.110	22.610	0.72	V .low
GGBS	20.500	23.100	0.88	Medium
Metakoline	20.500	22.210	0.92	Medium
Fly ash	22.000	24.00	0.91	Medium
Microsilica	18.377	21.810	0.84	Low

Testing Reports of 7days:

Table No: 29:- Normal concrete

CUBE SIZE	CUBE NAME	WEIGHT (gm)	LOAD (Kg)	STRENGTH (Kg/cm^2)	AVG
15X15 (w/c=0.375)	1	8700	64500	286.667	291.85
	2	8800	61500	273.333	
	3	8800	71000	315.555	
15X15 (w/c=0.4)	4	8800	60500	268.889	279.25
	5	8800	63000	235.556	
	6	8550	65000	333.333	
15X15 (w/c=0.42)	7	8750	63000	280.000	273.33
	8	8623	59625	265.000	
	9	8690	61875	275.000	

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table No.30:- Alccofine

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	A_1	8500	87750	390.00	397.03
	A_3	8730	92250	410.00	
	A_6	8852	88000	391.11	
15X15	B_1	8543	73125	310.00	319.81
	B_3	8110	69750	325.00	
	B_5	8494	73000	324.44	
15X15	C_1	8406	69750	310.00	317.41
	C_2	8693	72000	320.00	
	C_6	8837	72500	322.22	

Table No.31:- GGBS

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD (Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	D_1	8806	67500	300.00	299.62
	D_2	8640	69750	310.00	
	D_5	8845	65000	288.88	
15X15	E_3	8633	54000	240.00	250.74
	E_4	8650	56250	250.00	
	E_5	8785	59000	262.22	
15X15	F_3	8660	56250	225.00	227.77
	F_4	8633	56250	225.00	
	F_6	8555	52500	233.33	

Table No.32:- Meta-Kaoline:

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD (Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	G_2	8270.00	68625	305.00	316.29
	G_3	8466.00	70875	315.00	
	G5	8786.00	74000	328.88	
15X15	H_1	8416.66	72000	320.00	311.11
	H_2	8460.00	72000	320.00	
	H_5	8492.00	66000	293.33	
15X15	I_1	8483.33	56250	250.00	259.62
	I_2	8383.33	54000	240.00	
	I_5	8755.00	65000	288.88	

Table No.33:-Fly Ash

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD (Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	J_3	8646.66	47250	210.00	225
	J_4	8703.33	50625	225.00	
	J_5	8675.00	54000	240.00	
15X15	K_2	8386.66	39375	175.00	195.74
	K_4	8493.33	47250	210.00	
	K_5	8594.00	45500	202.22	
15X15	L_1	8445.00	38250	170.00	171.75
	L_3	8510.00	37687.5	167.50	
	L_6	8229.00	40000	177.77	

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table No.34:-Micro-silica

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD (Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	M_1	8320.00	65250	290.00	290.37
	M_2	8420.00	69750	310.00	
	M_5	8559.00	61000	271.11	
15X15	N_2	8263.33	65250	290.00	268.89
	N_3	8216.66	60750	270.00	
	N_6	8247.00	55500	246.67	
15X15	O_1	7450.00	28125	125.00	161.66
	O_2	7933.30	49500	220.00	
	O_5	7593.00	31500	140.00	

Testing reports of 28:

Table No.35:- Normal concrete

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15 (w/c=0.375)	10	8409.50	92000	408.88	414.81
	11	8706.00	88000	391.11	
	12	8784.50	100000	444.44	
15X15 (w/c=0.4)	13	8509.00	86000	382.22	398.51
	14	8766.00	90000	400.00	
	15	8639.00	93000	413.33	
15X15 (w/c=0.42)	16	8446.66	90000	400.00	391.10
	17	8633.33	85000	377.77	
	18	8610.00	89000	390.54	

Table No.36:- Alccofine

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	A_2	8360.00	95625	425.00	414.53
	A_4	8340.00	96250	427.50	
	A_5	8562.00	88000	391.11	
15X15	B_2	8660.00	69750	310.00	383.70
	B_4	8780.00	101250	450.00	
	B_6	8694.00	88000	391.11	
15X15	C_3	8233.33	95100	422.50	337.22
	C_4	7933.33	72750	322.50	
	C_5	7856.00	60000	266.67	

Table No.37:- GGBS

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD (Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	D_3	8593.33	102500	455.00	408.70
	D_4	8773.33	90000	400.00	
	D_6	8905.00	83500	371.11	
15X15	E_1	8833.33	99000	440.00	421.40
	E_2	8873.33	99750	442.50	
	E_6	8920.00	86000	382.22	
15X15	F_1	8613.33	88500	392.50	380.46
	F_2	8826.66	90000	400.00	
	F_5	8684.00	78500	348.89	

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Table No.38:- Meta-Kaoline:

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	G_1	8293.33	101000	448.89	435.55
	G_4	8316.66	100100	448.89	
	G_6	8625.00	92000	408.88	
15X15	H_3	8480.00	68000	302.22	383.70
	H_4	8376.66	100000	444.44	
	H_6	8049.00	91000	404.44	
15X15	I_3	8533.33	93000	412.50	356.57
	I_4	8373.33	98000	435.00	
	I_6	7934.00	50000	222.22	

Table No.39:- Fly Ash

CUBE SIZE	CUBE NAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	J_1	8586.66	73250	325.00	300.092
	J_2	8376.66	76000	337.50	
	J_6	8722.00	53500	237.77	
15X15	K_1	8603.33	69750	310.00	249.81
	K_3	8560.00	74250	330.00	
	K_6	8840.00	55000	244.44	
15X15	L_2	8296.66	56250	250.00	225
	L_4	8653.33	50750	225.00	
	L_5	8630.00	45000	200.00	

Table No 40.:- Micro-silica

CUBE SIZE	CUBENAME	WEIGHT(gm)	LOAD(Kg)	STRENGTH(Kg/cm^2)	AVG
15X15	M_3	8666.66	78750	350.00	385
	M_4	8333.33	100250	445.00	
	M_6	8500.00	81000	360.00	
15X15	N_1	8666.66	67500	300.00	340.55
	N_4	8666.66	93500	415.00	
	N_5	8200.00	69000	306.67	
15X15	O_3	7666.66	57500	255.00	221.11
	O_4	8000.00	61875	275.00	
	O_6	8000.00	30000	133.33	

4. RESULTS AND DISCUSSION

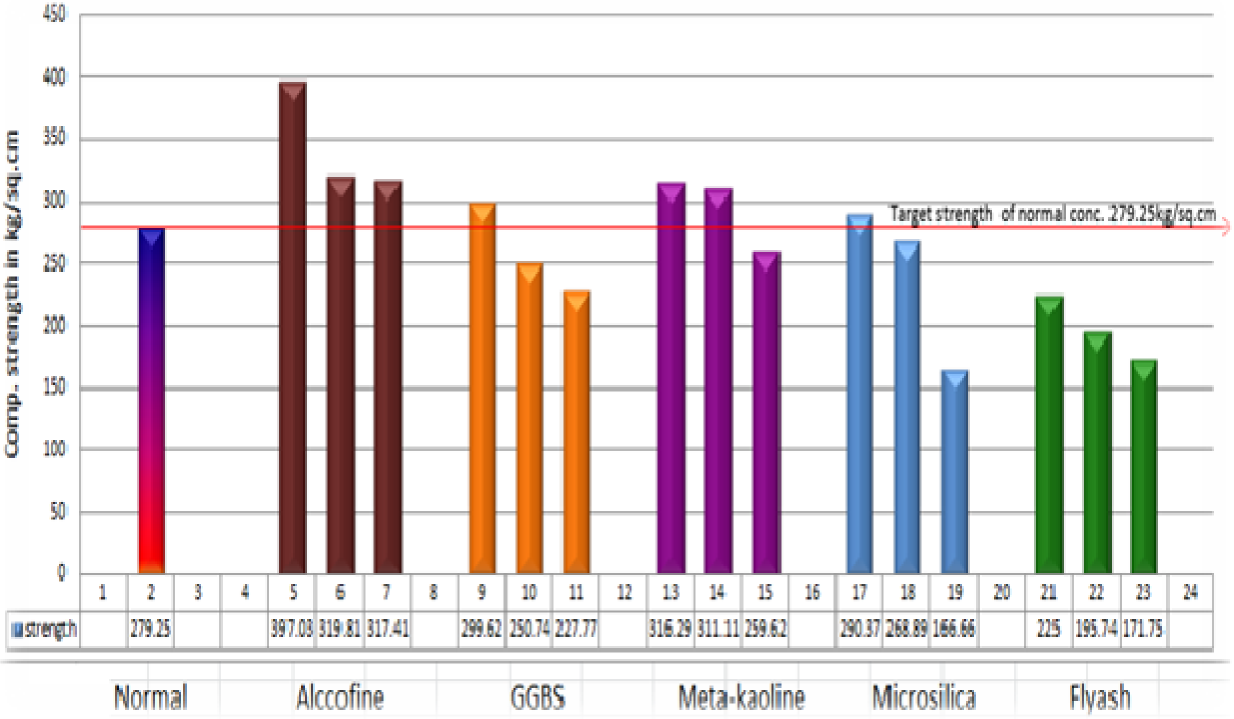
Results:

Graph of strength of normal concrete after 7 days with diff. W/C ratio

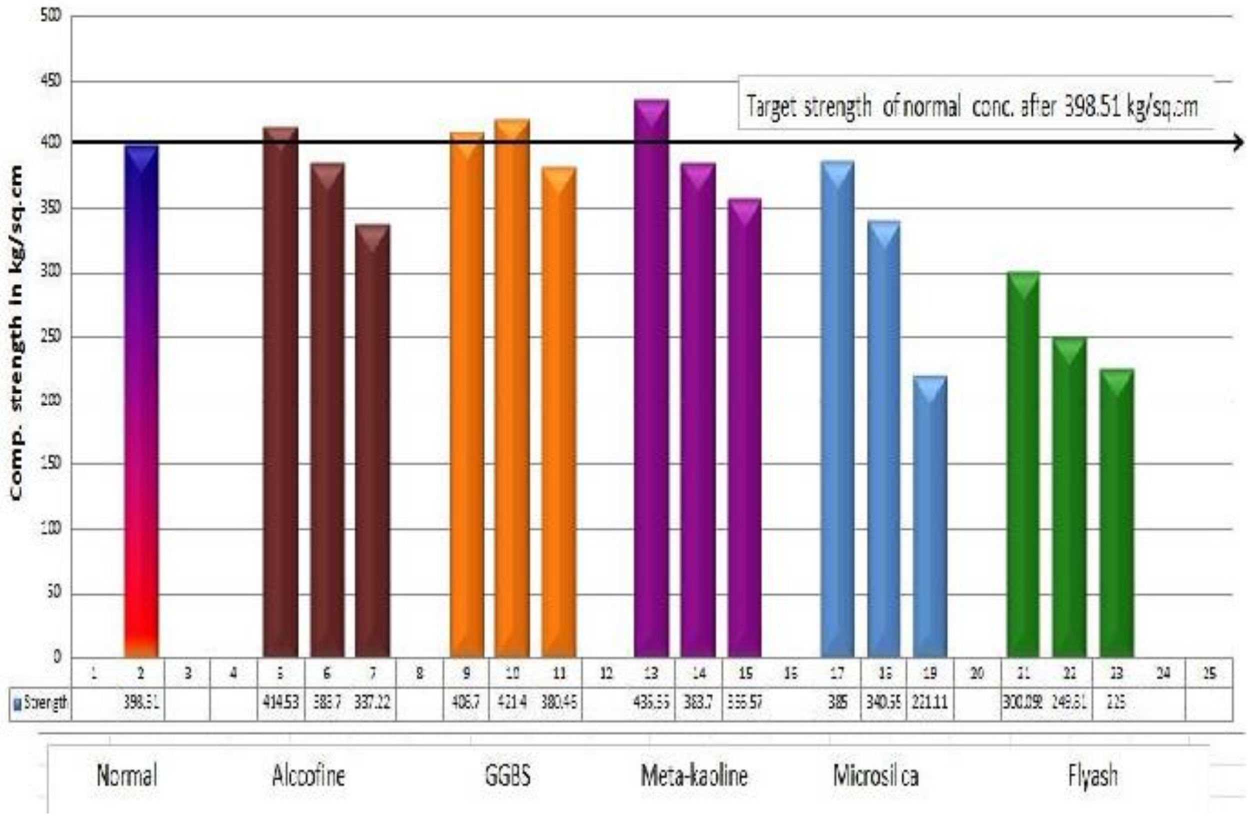
Graph of strength of normal concrete after concrete after 28 days

Out of these three mixes with different w/c ratio; mix with 0.4 w/c ratio is selected as it gives satisfactory result after 7 days and 28 days with respect to required strength.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com



Graph of **comparison of comp. strength of supplementry cementecious material concrete with norml concrete after 7 days**



Graph of comparison of comp. strength of supplementry cementecious material concrete with norml concrete after 28 days

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

Discussion:

The different mixes of water cement ratio of 0.375, 0.4, and 0.42 were prepared and the strength for 7 days of each mixes were 291.85 kg/cm^2,279.25kg/cm^2,273.33kg/cm^2 respectively and the same for 28 days were 414.81kg/cm^2,398.51kg/cm^2 and 391.10kg/cm^2.

Out of which mix of 0.4 was taken for design and the strength of which is 279.25kg/cm^2 for 7days and 398.51kg/cm^2 for 28days.

ALCCOFINE:

The alccofine was replaced with cement in a proportion of 10%,15% and 20% for a water cement ratio of 0.4 and as per the workability criteria is concerned we got medium workability for 10% replacement and low workability for 15 and 20% of replacement by compaction factor test.

The alccofine concrete cubes were tested after 7 days of casting on compressive testing machine it gives 397.03kg/cm^2,319.81kg/cm^2 and 317.41kg/cm^2 strengths for 10, 15 and 20% of replacement

The strengths of cubes of alccofine for all the replacement i.e. (10%, 15% and 20%) are higher than normal concrete strength that is 279.25kg/cm^2 after 7 days.

According to these results of 7 days it has been seen that alccofine gives better result for early stage strength. It also shows that out of the percentage of material replaced i.e. 10%, 15%, 20%, the mix containing 10% of cement replaced mix gives better strength than that of others.

After 28 days the same mix cubes were tested and we got some surprising results for the same replacement of cement i.e. 10%, 15% and 20% and for the same water cement ratio of 0.4 are 414.53kg/cm^2,383.70kg/cm^2 and 337.22kg/cm^2.

This shows that for the strength of cubes of alccofine for 10% replacement is higher than normal concrete that is 398.51kg/cm^2 and the strength of cubes for 15% and 20% replacement is smaller than normal concrete strength at 28 days.

GGBS:

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

As it is above stated the GGBS was replaced with cement in a proportion of 10%, 15% and 20% for a water cement ratio of 0.4 and the strength were 299.64kg/cm^2,250.74kg/cm^2 and 227.77kg/cm^2 after 7 days.

This shows the strength of cubes of GGBS for 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 7 days it has been seen that GGBS gives better result for early stage strength only with 10% of cement replaced mix. And the same is low for 15%, 20%, the mix.

For the same mixes with same water cement ratio the strengths were 408.70kg/cm^2, 421.40kg/cm^2 and 380.46 kg/cm^2 after 28 days.

The strength of cubes of GGBS for 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.

META-KAOLIN:

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

The meta-kaoline concrete cubes were tested after 7 days of casting on compressive testing machine it gives 316.29kg/cm^2,311.11kg/cm^2 and 259.62kg/cm^2 strengths for 10, 15 and 20% of replacement The strengths of cubes of meta-kaoline for 10% and 15% of the replacement are higher than normal concrete strength that is 279.25kg/cm^2 after 7 days and for 20% of the replacement, it is smaller.

According to these results of 7 days it has been seen that meta-kaolin gives better result for early stage strength with only upto 10 to 15 %. It also shows that out of the percentage of material replaced i.e. 10%, 15%, 20%, the mix containing 20% of cement replaced mix gives smaller strength than normal concrete

After 28 days the same mix cubes were tested and we got results of replacement of cement are 435.55kg/cm^2, 383.70 kg/cm^2 and 356.57kg/cm^2.

This shows that for the strength of cubes of meta-kaolin for 10% replacement is higher than normal concrete that is 398.51kg/cm^2 and the strength of cubes for 15% and 20% replacement is smaller than normal concrete strength at 28 days.

MICRO-SILICA:

The micro-silica was replaced with cement in a proportion of 10%,15% and 20% for a water cement ratio of 0.4 and as per the workability criteria is concerned we got medium workability for 10% replacement and low workability for 15% and 20% of replacement by compaction factor test.

As it is above stated the micro-silica was replaced with cement in a proportion of 10%, 15% and 20% for a water cement ratio of 0.4 and the strength were 290.37kg/cm^2,268.89kg/cm^2 and 166.66 kg/cm^2 after 7 days.

This shows the strength of cubes of micro-silica for 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 7 days it has been seen that micro-silica gives better result for early stage strength only with 10% of cement replaced mix. And low for 15%, 20%the mix. The strength for 20% is too small than any other mixes discussed above.

After 28 days the same mix cubes were tested and we got some surprising results for the same replacement of cement i.e. 10%, 15% and 20% and for the same water cement ratio of 0.4 are 385kg/cm^2, 340.55kg/cm^2 and 221.11kg/cm^2.

This shows that the strengths of all the cubes containing 10%, 15% and 20% of replacement is smaller than normal concrete strength at 28 days.

FLY-ASH:

The fly ash was replaced with cement in a proportion of 10%,15% and 20% for a water cement ratio of 0.4 and as per the workability criteria is concerned we got medium workability for 10% replacement and high workability for 15% and 20% of replacement by compaction factor test.

After testing the casted cubes in compression testing machine at 7 days it gives 225kg/cm^2,195.74kg/cm^2 and 171.75kg/cm^2 which are very low than normal concrete.

The strength of cubes of FLY-ASH for all the replacement i.e (10%, 15% and 20%) are lower than normal concrete strength that is 279.25kg/cm^2.This is may be because of cement already containing some fixed amount of FLY-ASH as per act of Indian Government.

Same cubes of fly ash containing same percentage of fly ash and same water cement ratio tested on compression testing machine the strengths were 300.92kg/cm^2, 249.81kg/cm^2 and 225kg/cm^2.

The strength of cubes of FLY-ASH for all the replacement i.e (10%, 15% and 20%) is lower than normal concrete strength that is 398.51kg/cm^2.

5. CONCLUSION

By conducting the study of 10%, 15% and 20% replacement of cement by different wastes and tested for workability and compressive strength we conclude that,

1) Using alccofine as a replacing material we get full design strength and workability for 10% of replacement.

2) Using GGBS as a replacing material we get full design strength and workability for even 15% of replacement.

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 2, Issue 2, pp: (29-50), Month: May - August 2015, Available at: www.noveltyjournals.com

3) Using meta-kaoline as a replacing material we get full design strength and workability for 10% of replacement.

4) For microsilica, it does no satisfy the partial replacement for cement, it may give good early strength but not the final one.

5) Using fly ash as a partial replacement it does not satisfy earlier strength, hence we cannot use in cement as it is already adopted by the Government of India. Further increase will surely collapse the strength of concrete.

Thus we conclude that we can replace cement by:

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

Even for high strength mix such as M-30.

REFERENCES

[1] Dr.En Yi Chen, En Grocoporation limited, Singapore 2nd Global Slag Conference and Exhibition, 20-22 November 2006 Bangkok Thailand, page no 2, 3

[2] High performance concrete with ggbs and robo sand of venumalagavelli Published By International Journal Of Engineering Science And Technology Vol. 2(10), 2010, 5107-5113

[3] The history of silica fume in concretefrom novelty to key ingredient in high performance concrete published by www.elkem.materials.no

[4] Concrete Technology by M. S. Shetty.

[5] Concrete Technology by Gambhir.

[6] Mr. J. T. Jangle,Testing Of Materials Volume 1, September 1991 page no 38-49, 64-79

[7] Mix Design Procedure from IS-456-2000.