Analysis and Testing of Concrete Using Various Parameters

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Abstract— As we know that concrete is the main construction material across the world and the mostly used in all types of civil engineering works. This topic is beneficial to use different additives so it will be beneficial as well as solve many environmental problems. To minimize the carbon emission and improve the strength of concrete for specific type of uses this thesis is prepared. As rapid construction activities all over the world rapidly increase the construction cost and carbon emission which ultimately causes the exploitation of natural resources. So by indentifying different additives we conserve the material and ultimately reduces the cost of construction. As aggregate represents about 70-80% of concrete components so it will be beneficial to recycle the aggregate for construction works and also to solve the environmental problems. To minimize the problem of excess of waste material it is a good step to utilize the recycled aggregates provides that the desired final product will meet the standards. The constructions industry new building materials with improved properties are required for satisfying the new utilization domains for modern construction or for repair works. The application of polymer on concrete has significantly progressed in the last 30 years. Polymers are either incorporated in a cement-aggregate mix or used as single binder. The composites made by using polymer along with cement and aggregates are called polymer-modified mortar or polymer-modified concrete, while composites made with polymer and aggregates are called polymer mortar or polymer concrete, depending on the maximum size of aggregate granule. 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 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 cm2 /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. 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. In 2005, 216 million tonnes of saleable aggregate was produced; corresponding 55 million tonnes of quarry fines and 24 million tonnes of quarry waste were also produced. The need to minimize fines production is driven by the Aggregates Levy (which has priced quarry fines out of the market in favour ofrecycled aggregate) and the Landfill Tax (which has made it expensive to dispose of fines). Future developments are likely to be driven by the need to respond to climate change .New crusher designs will be more automated, offer improved energy efficiency, have a greater production capacity and improved reliability.

Keywords: Testing of Concrete, Concrete Parameters

I. INTRODUCTION

A. General

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:

1) Batching
2) Mixing
3) Transporting
4) Placing
5) Compacting
6) Curing
7) Finishing

B. Special Concrete:

1) Fibre Reinforced Concrete:

Fibre reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres that character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities.

The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the early 1900s, asbestos fibres were used in concrete, and in the 1950s the concept of composite materials came into being and fibre reinforced concrete was one of the topics of interest. There was a need to find a replacement for the asbestos used in concrete and other building materials once the health risks associated with the substance were discovered. By the 1960s, steel, glass (GFRC), and synthetic fibres such as polypropylene fibres were used in concrete, and research into new fibre reinforced concretes continues today.

2) Polymer Concrete:

In the composition of polymer concrete there is not cement: the aggregates are bonded by the resin. Function of the type of polymer it can obtain concretes with synthetic resin, concretes with plastic resin or simple concrete with resin. The composite does not contain hydrated cement paste. Polymer concrete presents some advantages compared to the cement Portland concrete such as: rapid hardening, high mechanical strengths, improved resistance to chemical attack, durability, etc. One of the most important disadvantages is the high cost of resin that limited the use domains of polymer concrete. The performances of polymeric concrete depend on the polymer properties, type of filler and aggregates, curing temperature, components dosage, etc. The aggregates can be silicates, quartz, crushed stone, gravel, limestone, calcareous, granite, clay, etc. Near the aggregate, the filler is very important. Different types of fine materials can be used such as fly ash, silica fume, phosphor-gypsum, cinder, etc.

The different ingredients used for casting the concrete are as follows:

C. 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.

1) 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.

In the past, fly ash was generally released in to the atmosphere, but pollution control equipment mandated in recent decades now need that it be captured prior to release, fly ash is usually stored at coal power plants or placed in landfills. About 43% is recycled, often used as a pozzolan to produce hydraulic cement or hydraulic plaster or a partial replacement for Portland cement in concrete production.

2) 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.

3) Quarry fines:

In 2005, 216 million tonnes of saleable aggregate was produced; corresponding 55 million tonnes of quarry fines and 24 million tonnes of quarry waste were also produced. The need to minimize fines production is driven by the Aggregates Levy (which has priced quarry fines out of the market in favour of recycled aggregate) and the Landfill Tax (which has made it expensive to dispose of fines). Future developments are likely to be driven by the need to respond to climate change .New crusher designs will be more automated, offer improved energy efficiency, have a greater production capacity and improved reliability.

D. 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.

1) 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.

2) 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.

3) 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 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.

4) 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.

II. LITERATURE REVIEW

Brooks et.al. (2000)after studying the effect of silica fume, metakaolin, fly ash and ground granulated blast furnace slag on setting times of high strength concrete, they concluded that there was increase in the retarding effect up to 10% replacement of cement by Metakaolin and as the percentage replacement is increased, the retarding effect is reduced.

A. Meta-kaoline:

M.Frias, M.I.Sanchezderojas, J. Cabrera (2000)In their experimental work, the influence of the pozzolanic activity of the Meta-kaolin(MK) on the hydration heat has been studied in comparison to the behaviours of other traditional pozzolanic materials such as flyash and silica fume. The results revealed that MK mortars produce a slight heating increase when compared to a 100% Portland cement mortar, due to the high pozzolanic activity of MK. With respect to the hydration heat, MK-blended mortar showed closer behaviours to silica fume than to fly ash.

Xia Oquian and Zongjinli (2001)studied the stress–strain relationships of concrete containing 0% to 15% of Meta-kaolin at an incremental rate of 5%. They concluded that incorporation of Meta-kaolin up to 15% has increased the tensile and compressive strength and also peak strain is increased at increasing rate of Meta-kaolin up to 15%. Incorporation of Meta-kaolin has slightly increased the compressive elasticity modulus.

Poon et al (2001)investigated the rate of pozzolanic reaction of Meta kaolin in high performance cement mortars. They studied the hydration progress of Meta-kaolin in terms of its compressive strength, porosity and pore size distribution. They concluded that the higher pozzolanic reactivity results in a higher rate on strength development and its pore structure refinement for the cement pastes at earlier ages.

B. Silica fumes:

Shannag (2000)designed and studied very high compressive strength of 69 to 110 MPa along with incorporation of locally available natural pozzolana and silica fume. He concluded that 15% replacement of cement with silica fume along with 15% natural pozzolan gave relatively higher strength than without natural pozzolan.

C. Fly Ash:

It is generally agreed that class F fly ashes delay setting and reduce early strength of concrete significantly, the effect increasing with replacement amount.

Majko and Pistilli 1984, Class C fly ashes have mixed effects on setting and early strength gain. Often these have been shown to delay setting, as much as 4-6 hours at high replacement levels.However, some class C ashes have been shown to reduce setting times (Dodson 1981; Naik and Singh 1997) or have no effect (Naik and Ramme 1987).

Naik and Singh (1997) states that some class C ashes participate in cementatious reactions in addition to pozzolanic reactions, altering their setting behaviour. It has been suggested that this may also disrupt the optimal gypsum content of the cement, causing accelerated and sometimes even flash setting.

D. GGBS:

Most of the producers of ready-mixed concrete that use GGBF slag do so in proportions of 50% of total cementations material when the weather is warm and the GGBF slag is highly active (Wood 1981). Not only is this blend convenient, but with a highly active GGBF slag this blend usually produces the greatest strength and most favourable cost to benefit ratio.

Increases in setting times are correlated with an increase in bleeding (Kanazawa et al. 1992). Slag replacement is generally observed to decrease early strength, often not “catching up” with control mixes until 90 days (Mailvaganam et al. 1983). This effect is highly dependent on the curing temperature.

III. MATERIALS & METHODOLOGY ADOPTED

A. Material’s

1) 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.

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

Table 1: TYPICAL PROPERTIES

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%

a) 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.

2) 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

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

Table 2: CHEMICAL PROPERTIES OF GGBS

a) Physical Properties:

Mean particle size	5 - 30 micron
Colour	Off-white
Odour	Odourless when dry but may give rise 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
Water solubility at 20°C	<1g/l

b) 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.
- To minimise the risk of alkali-silica reaction in concrete: Combinations of Portland cement with 50% or more CEMblend GGBS are recommended by BRE Digest 330: Alkali - silica reaction in concrete and BS 8500: Concrete - Complementary British Standard to BS EN 206-1 for use with high reactivity aggregates, including Greywacke.

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%

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 pozzolonic and hydraulic the result is denser pore structure and higher strength gain

a) 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)

b) 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.

B. METHODLOGY ADOPTED

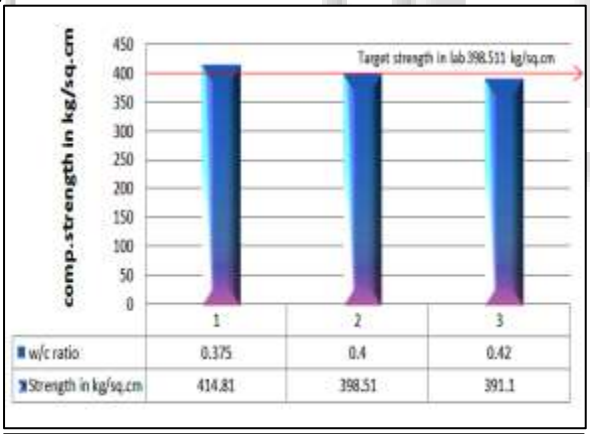
o determine particle size distribution of Aggregates:

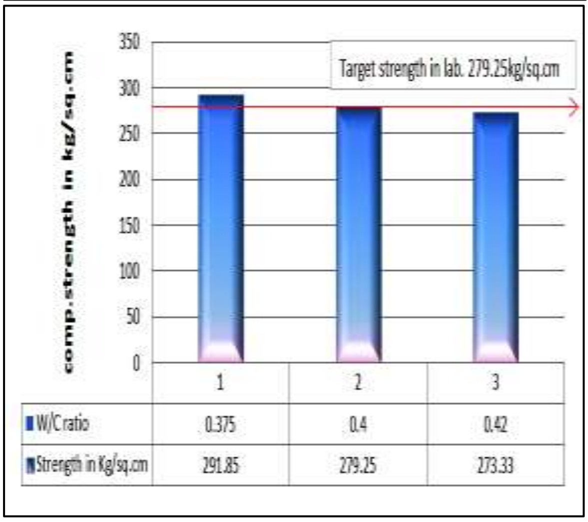
1) The test sample is dried to a constant weight at a temperature of 110 + 5ºC and weighed.
2) The sample is sieved by using a set of IS Sieves 40mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm.
3) On completion of sieving, the material on each sieve is weighed.
4) Cumulative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

IV. RESULT AND CONCLUSIONS

A. Results:

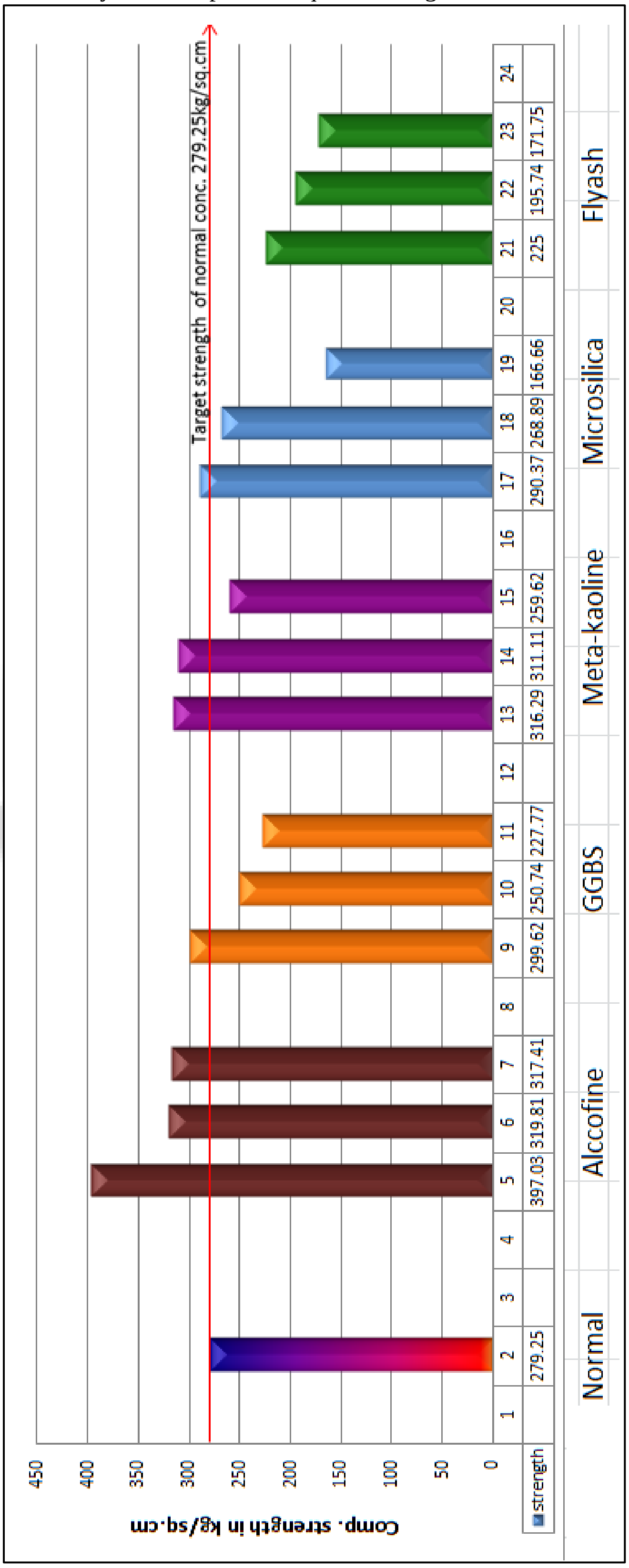
1) Graph of strength of normal concrete after 7 days with diff. W/C ratio

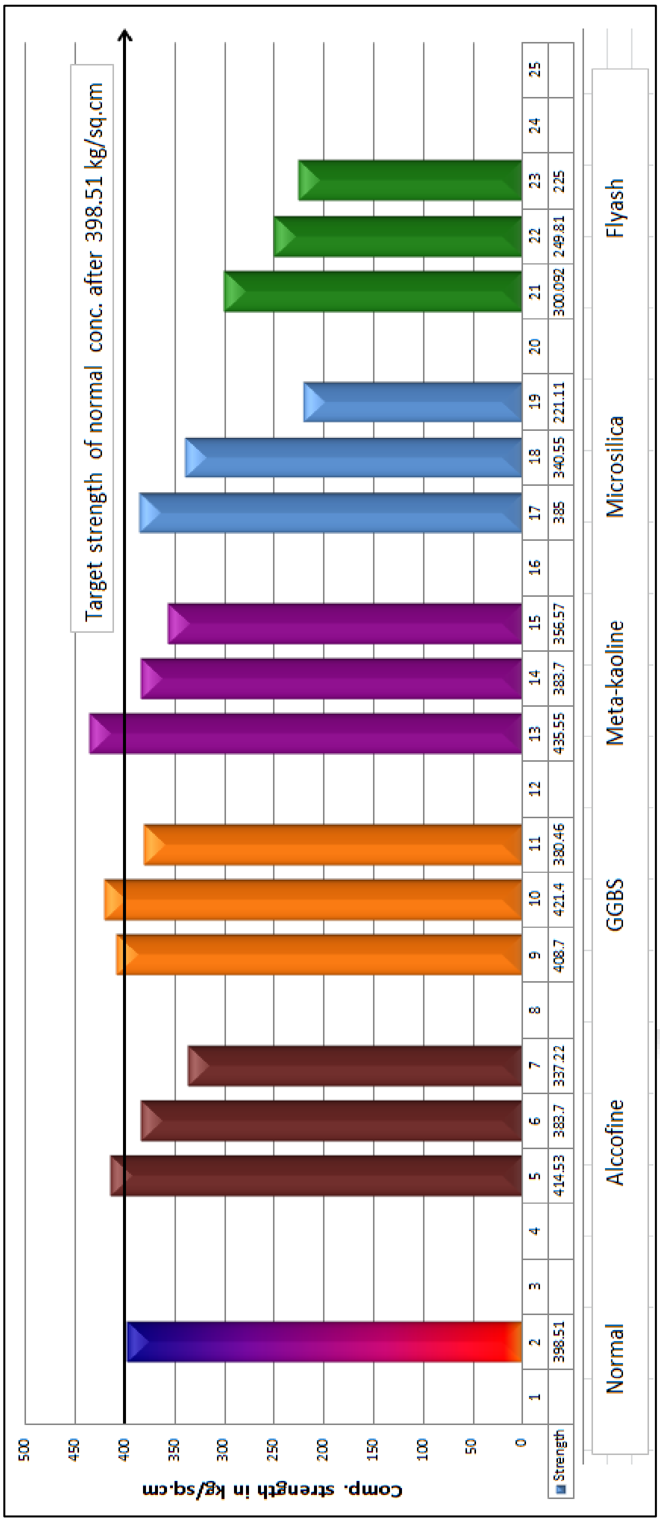




2) Graph of strength of normal concrete after concrete after 28 days

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.





B. 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.

1) 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.

2) 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.

3) 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, 383.70kg/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.

4) 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.

5) 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.

V. 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.
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.

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