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Behaviour of Concrete with Partial Replacement of Cement by Different Mineral Admixtures and Partial Replacement of Fine Aggregate by Optical Fiber

O. Chiranjeevi[1], M. Siva Chennakesava Rao[2]

[1]PG Student, [2]Assistant Professor,

[1,2]Department of Civil Engineering, NRI Institute of Technology, Pothavarappadu, Andhra Pradesh, India

ABSTRACT

Concrete is so far the most widely used construction material today. This project deals about the influence of Fly ash, GGBS (Ground Granulated Blast furnace Slag), Silica Fume, and Metakaoline as partial replacement of cement and Optical Fiber as fine aggregate in normal concrete mix. Fly ash, GGBS (Ground Granulated Blast furnace Slag), silica fume, Metakaoline is used as partial replacement to the cement; Optical Fiber is used as partial replacement to fine aggregates. Mix design is to be prepared for M25 concrete grade and different proportions to which Fly ash, GGBS (Ground Granulated Blast furnace Slag), Optical Fiber, Silica Fume, Metakaoline can be used. For this 3 trail mixes with varying proportions are used. The mix design is to be prepared for M25 concrete grade. The trail mixes are replacement of cement by Fly ash, GGBS, Silica Fume, Metakaoline as 10%, 15%, 20% individually and also replacement of fine aggregate by optical fiber by 2%, 4%, 6% respectively with above cement replacing percentages. For hardened properties of concrete specimens were tested at the age of 7 days and 28days of curing in water. Casting cubes of size 150mm×150mm×150mm, for the determination of compressive strength of concrete. In which mix proportion, the compressive strength gets the maximum, that mix proportion is considered for the casting of beams to find out the flexural strength of that beam.

KEYWORDS: *Concrete, Fly ash, GGBS (Ground Granulated Blast furnace Slag), Optical Fiber, Silica Fume, Metakaoline*

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INTRODUCTION

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as cement fond. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer.

When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

Famous concrete structures include the Hoover Dam, the Panama Canal, and the Roman Pantheon. The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire. The Colosseum in Rome was built largely of concrete, and the concrete dome of the Pantheon is the world's largest unreinforced concrete dome. Today, large concrete structures (for example, dams and multi-storey car parks) are usually made with reinforced concrete.

After the Roman Empire collapsed, use of concrete became rare until the technology was redeveloped in the mid-18th century. Today, concrete is the most widely used man-made material (measured by tonnage).

Many types of concrete are available, distinguished by the proportions of the main ingredients below. In this way or by substitution for the cementitious and aggregate phases, the finished product can be tailored to its application. Strength, density, as well chemical and thermal resistance are variables.

Aggregate consists of large chunks of material in a concrete mix, generally a coarse gravel or crushed rocks such as limestone, or granite, along with finer materials such as sand.

Cement, most commonly Portland cement, is associated with the general term "concrete." A range of other materials can be used as the cement in concrete too. One of the most familiar of these alternative cements is asphalt concrete. Other cementitious materials such as fly ash and slag cement, are sometimes added as mineral admixtures (see below) - either pre-blended with the cement or directly as a concrete component - and become a part of the binder for the aggregate.

To produce concrete from most cements (excluding asphalt), water is mixed with the dry powder and aggregate, which produces a semi-liquid slurry that can be shaped, typically by pouring it into a form. The concrete solidifies and hardens through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone-like material.

Chemical admixtures are added to achieve varied properties. These ingredients may accelerate or slow down the rate at which the concrete hardens, and impart many other useful properties including increased tensile strength, entrainment of air and water resistance.

Reinforcement is often included in concrete. Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension, typically steel rebar.

Mineral admixtures are becoming more popular in recent decades. The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation, and the discovery that such materials often have complementary and valuable properties. The most conspicuous of these are fly ash, a by-product of coal-fired power plants, ground granulated blast furnace slag, a byproduct of steelmaking, and silica fume, a byproduct of industrial electric arc furnaces. The use of these materials in concrete reduces the amount of resources required, as the mineral admixtures act as a partial cement replacement. This displaces some cement production, an energetically expensive and environmentally problematic process, while reducing the amount of industrial waste that must be disposed of. Mineral admixtures can be pre-blended with the cement during its production for sale and used as blended cement, or mixed directly with other components when the concrete is produced.

The *mix design* depends on the type of structure being built, how the concrete is mixed and delivered, and how it is placed to form the structure.

METAKAOLIN:

Metakaolin is one of the Pozzolanic materials used in concrete as a binder replaced by cement. Metakaolin is a dehydroxylated form of the clay mineral kaolinite. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. 100% to 50% vary of proportions are taken to make an experimental study on geopolymer concrete. Aiswarya S, et al (2013) made a “Review on Metakaolin in Concrete” where cement can be replaced effectively with Metakaolin and shows better results in case of durability. It reduces the setting time of pastes as compared to control mixtures. Metakaolin is used `as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for metakaolin vary from 50% to up to 100%. Paiva.H et al (2012) determined the effect of Metakaolin on strength of concrete. The work concluded that use of HRWRA was very essential in concrete containing fine particles like Metakaolin to achieve well dispersion and better results. ErhanGuneyisi et al (2012) made an investigation to determine the effectiveness of metakaolin (MK) and silica fume (SF) on the mechanical properties, shrinkage, and permeability related durability of high performance concrete. Mechanical properties were evaluated by means of compressive and splitting tensile strength. Water absorption and gas permeability tests were carried out to find out the permeation characteristics of the concrete with Metakaolin. The experimental results showed a considerable increase in the compressive strength properties of blended concrete than the control mix for different water cement ratios. VikasSrivastava et al (2012) investigated the suitability of GGBS and metakaolin combination in production of concrete.

The specimens where cast and tested on 7th, 14th and 28 days. The 28th day compressive strength of concrete generally increased with the Metakaolin content for at all types of geopolymer concrete. The 7th day compressive strength of concrete was found to decrease with the increase in Metakaolin content for all types of geopolymer concrete. Dojkov.I et al (2013) experimentally studied the reaction between Metakaolin-$Ca(OH)_2$-water and Fly ash- $Ca(OH)_2$-water. It was clear that during the initial period of curing (up to 7 days),Metakaolin combined lime with a very high rate. The reaction between Fly ash-$Ca(OH)_2$-water was taking place at a moderate rate in the initial age as compared with Metakaolin-$Ca(OH)_2$-water. The experimental results justified the possible combined use of Metakaolin-GGBS in concrete industry.

Formation of Metakaolin:

The T-O clay mineral kaolinite does not contain interlayer cations or interlayer water. The temperature of dehydroxylation depends on the structural layer stacking order. Disordered kaolinite dehydroxylates between 530 and 570°C, ordered kaolinite between 570 and 630°C. Dehydroxylated disordered kaolinite shows higher pozzolanic activity than ordered. The dehydroxylation of kaolin to metakaolin is an endothermic process due to the large amount of energy required to remove the chemically bonded hydroxyl ions. Above the temperature range of dehydroxylation, kaolinite transforms into metakaolin, a complex amorphous structure which retains some long-range order due to layer stacking. Much of the aluminum of the octahedral layer becomes tetrahedrally and pentahedrally coordinated. In order to produce a pozzolana (supplementary cementitious material) nearly complete dehydroxylation must be reached without overheating, i.e., thoroughly roasted but not burnt. This produces an amorphous, highly pozzolanic state, whereas overheating can cause sintering, to form a dead burnt, nonreactive refractory, containing mullite and a defect Al-Si spinel. Reported optimum activation temperatures vary between 550 and 850°C for varying durations; however the range 650-750°C is most commonly quoted. In comparison with other clay minerals kaolinite shows a broad temperature interval between dehydroxylation and recrystallization, much favoring the formation of metakaolin and the use of thermally activated kaolin clays as pozzolans. Also, because the octahedral layer is directly exposed to the interlayer (in comparison to for instance T-O-T clay minerals such as smectites), structural disorder is attained more easily upon heating. Kaolin is a phyllosilicate, consisting of alternate layers of silica and alumina in tetrahedral and octahedral coordination, respectively. This electrically neutral crystalline layer structure, which is a common characteristic of clay minerals, leads to a fine particle size and plate like morphology and allows the particles to move readily over one another, giving rise to physical properties such as softness, soapy feel, and easy cleavage [Kingery, 1976]. Kaolinite is the mineralogical term for hydrated aluminum disilicate, $Al_2Si_2O_5(OH)_4$, the primary constituent of kaolin (40-70%).Other minerals comprising kaolin include quartz, muscovite-like micas, and rutile.

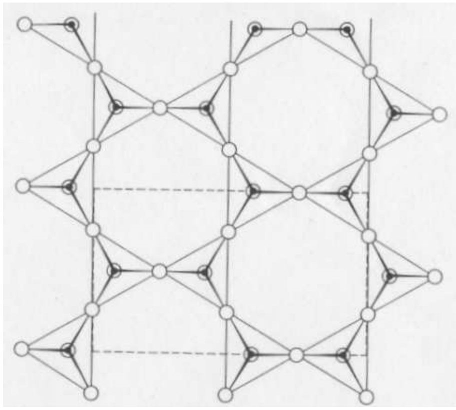


Fig-1.1: Atomic arrangement of Si_2O_3

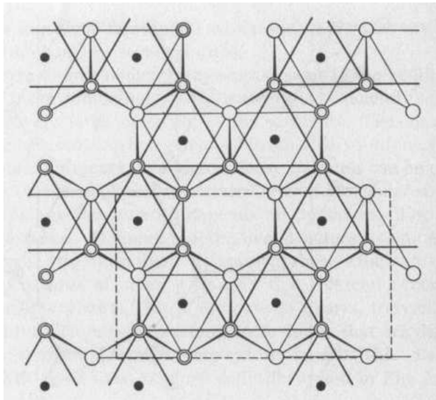


Fig-1.2: Atomic arrangement AlO(OH)2

Physical Properties of Metakaolin:

Physical Properties of Metakaolin:

Specific Gravity	2.40 to 2.46
Physical Form	Powder
Color	Baby Pink
Specific Surface	8-15 m²/g

Fig-1.3: Metakaoline

Chemical Composition of Metakaolin:

Chemical Composition of Metakolin

SiO2	51-53%	CaO	<0.20%
Al2O3	42-44%	MgO	<0.10%
Fe2O3	<2.20%	Na2O	<0.05%
TiO2	<3.0%	K2O	<0.40%
SO4	<0.5%	L.O.I	<0.50%

GROUND GRANULATED BLAST FUNRACE SLAG:

Ground-granulated Blast furnace Slag (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. Since GGBS is a by-product of steel manufacturing process, its use in concrete as improving the sustainability of the project. This is provided that the slower setting time for casting of the superstructure is justified. GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 0% to up to 50%. The main components of blast furnace slag are CaO (30-50%), SiO_2 (28-38%), Al_2O_3 (8-24%), and MgO (1-18%). In general increase in CaO content of slag results in raise of slag basicity and an increase in compressive strength.

Physical properties of GGBS

Colour	Off-white powder
Bulk density (loose)	1.0–1.1 tonnes/m^3
Bulk density (vibrated)	1.2–1.3 tonnes/m^3
Relative density	2.85–2.95
Surface area	400–600 m^2/kg Blaine

Chemical Properties of GGBS:

Chemical Composition of GGBS

Oxide	%
CaO	36.77
SiO_2	30.97
$Al2O_3$	17.41
MgO	9.01
SO_3	1.82
Fe_2O_3	1.03
Na_2O	0.69
K_2O	0.46

GGBS

SILICA FUME:

Silica fume, also known as **microsilica**, (CAS number 69012-64-2, EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high performance concrete.

It is sometimes confused with fumed silica (also known as pyrogenic silica, CAS number 112945-52-5). However, the production process, particle characteristics and fields of application of fumed silica are all different from those of silica fume.

When silica fume is added to concrete, initially it remains inert. Once portland cement and water in the mix start reacting with each other (hydrating), primary chemical reactions produce two chemical compounds: Calcium Silicate Hydrate (CSH), which is the strength producing crystallization, and Calcium Hydroxide (CH), a by-product also called free lime which is responsible for nothing much other than lining available pores within concrete as a filler or leaching out of inferior concrete. Pozzolanic reaction occurs between silica fume and the CH, producing additional CSH in many of the voids around hydrated cement particles. This additional CSH provides the concrete with not only improved compressive, flexural and bond- strength but also a much denser matrix, mostly in areas that would have remained as small voids subject to possible ingress of deleterious materials.

The transport properties through the silica fume concrete medium are dramatically curtailed, i.e. liquid compounds and even electrical currents experience a diminished capability to migrate, resulting in very low permeability and high electrical resistivity. Silica fume's benefits are already evident in the fresh concrete state before it begins to harden. Its small particle size which is 100 times finer than ordinary portland cement complements the finess modulus of concrete and provides a ball-bearing effect, which improves thixotropic behavior, in effect modifying concrete viscosity. Because of the high surface area of silica fume particles affecting the mobility of water within concrete, segregation and bleeding of concrete are virtually eliminated. Rheological benefits inherent in silica fume concrete allow for custom-tailoring concrete placement methods, such as very high cohesive workability, ability of fluid concrete to hold slope,and/ or long distance pumping of concrete.

Current availability and use for silica fume:
Global consumption of silica fume exceeds 1 million tonnes per annum. Silica fume is generally dark grey to black or off-white in colour and can be supplied as a densified powder or slurry depending on the application and the available handling facilities. For use in the UK, it is normally supplied as slurry, consisting of 50% powder and 50% water. In powder form silica fume is available in bulk, large bags and small bags. If required in bags, these can be tailored to suit the customers' needs for handling and batch weight per cubic metre of concrete. Other applications include fibre cement, gypsum cement, refractory mortars and castables and in the use of specialisedultra high strength precast sections where strengths of over 200 N/mm2 can be designed.

The research carried out by Bentz et al, indicated that curing conditions have significant effect on the degree of hydration of cement. They showed that for specimens (initially cured at 100% relative humidity (RH) for 6 or 12 h) exposed to 90% RH, hydration process discontinued as all remaining capillary water was lost due to evaporation. Whilst curing under sealed condition, in particular for concretes with W/C ratio of 0.4 or over, or keeping the surface as saturated were adequate.

Fig-1.9: Silica Fume

OPTICAL FIBRE:
An optical fiber is a flexible, transparent fiber made by drawing glass (silica) or plastic to diameter slightly thicker than that of a human hair.

Several ways of producing translucent concrete exist. All are based on a fine grain concrete (ca. 95%) and only 5% light conducting elements that are added during casting process. After setting, the concrete is cut to plates or stones with standard machinery for cutting stone materials.

"Fiberglass reinforced plastics" or FRPs (commonly referred to simply as fiberglass) use textile grade glass fibres. These textile fibres are different from other forms of glass fibres used to deliberately trap air, for insulating applications (see glass wool). Textile glass fibres begin as varying combinations of SiO_2, Al_2O_3, B_2O_3, CaO, or MgO in powder form. These mixtures are then heated through direct melting to temperatures around 1300 degrees Celsius, after which dies are used to extrude filaments of glass fibre in diameter ranging from 9 to 17 µm. These filaments are then wound into larger threads and spun onto bobbins for transportation and further processing. Glass fibre is by far the most popular means to reinforce plastic and thus enjoys a wealth of production processes, some of which are applicable to aramid and carbon fibres as well owing to their shared fibrous qualities.

Roving is a process where filaments are spun into larger diameter threads. These threads are then commonly used for woven reinforcing glass fabrics and mats, and in spray applications.

Fibre fabrics are web-form fabric reinforcing material that has both warp and weft directions. Fibre mats are web-form non-woven mats of glass fibres. Mats are manufactured in cut dimensions with chopped fibres, or in continuous mats using continuous fibres. Chopped Fibre glass is used in processes where lengths of glass threads are cut between 3 and 26 mm, threads are then used in plastics most commonly intended for moulding processes. Glass Fibre short strands are short 0.2–0.3 mm strands of glass fibres that are used to reinforce thermoplastics most commonly for injection moulding.

As a subset of plastic FR plastics are liable to a number of the issues and concerns in plastic waste disposal and recycling. Plastics pose a particular challenge in recycling because they are derived from polymers and monomers that often cannot be separated and returned to their virgin states, for this reason not all plastics can be recycled for re-use, in fact some estimates claim only 20% to 30% of plastics can be recycled at all. Fibre-reinforced plastics and their matrices share these disposal and environmental concerns. In addition to these concerns, the fact that the fibres themselves are difficult to remove from the matrix and preserve for re-use means FRP's amplify these challenges. FRP's are inherently difficult to separate into base materials, that is into fibreand matrix, and the matrix is difficult to separate into usable plastics, polymers, and monomers. These are all concerns for environmentally-informed design today. Plastics do often offer savings in energy and economic savings in comparison to other materials. In addition, with the advent of new more environmentally friendly matrices such as bioplastics and UV-degradable plastics, FRP will gain environmental sensitivity.

LITERATURE REVIEW
R. Naga Lakshmi (2013) made an experimental study on characteristics on M25 concrete with partial

replacement of cement with fly ash and coarse aggregate with coconut shell. She states that the slump of the concrete increased as the percentage of coconut shell increases and decrease in comparison with the conventional concrete. The compaction factor increased as the percentage of coconut shell increases and increased in comparison with the conventional concrete. 20% of cement replaced with fly ash and 10%, 20%, 30% of coarse aggregate replaced with coconut shell resulted that the compressive strength is reduced when compared with the conventional concrete.

Madaraboyina Naga Ramu and Kavin Raj (2016) published a paper Strength Assessment of Concrete by Partial Replacement Cement with Metakolin&Flyash. The states that Plain concrete may be a brittle material and fails suddenly. Addition of Metakaoline& Fly ash to concrete changes its brittle mode of failure into a additional ductile one and improves the concrete plasticity. The compressive strength and flexural strength of concrete will increase with Metakaoline fly ash content. It's adjusted to 15 August 1945 replacement if we tend to replace cement by quite 15 August 1945 strength starts reducing. Thus it invariably preferred to Usage Meta kaolin & ash with 100% replacement of cement and it provides us higher result. Both the physical and chemical properties of Metakaoline and cement are in compliance with the standard. Cement replacement up to 13% with metakaolin leads to increase in compressive strength for M-35 grade of concrete. From 17% there is decrease in compressive strength for 3, 7 and 28 days of curing period.

Dr. Rajamanya V. S., Kulkarni N. K. (2015)made an experimental investigation onstrength properties of metakaoline& fly ash plane cement concrete. They came to know that plain concrete is a brittle material and fails suddenly. Addition of Meta kaolin & Fly ash to concrete changes its brittle mode of failure into a more ductile one and improves the concrete ductility. The compressive strength and flexural strength of concrete increases with meta kaolin & fly ash content. It is true up to 15% replacement if we replace cement by more than 15% strength starts reducing. Therefore it always preferable to use Meta kaolin & Fly ash with 10% replacement of cement and it gives us better result.

DhanalaVinay, GottalaAnirudh (2016) compared a study on m25 concrete with partial replacement of cement with fly ash and coarse aggregate with coconut shells in acid and water curing. They concluded the study Coconut shell concrete with 25% replacement of coconut shells, with this increase of fly ash from 15-25% shows a marginal decrease in concrete strength. But the replacement of coconut shells in place of aggregates and addition of fly ash to cement will increase the strength properties of concrete compared to the normal concrete. At constant fly ash increase in coconut shell concrete shows a decrement in compressive strength. However, the strength superior to the designed value of concrete. Coconut shell concrete in acid curing with 20% replacement shows a higher strength than conventional concrete. Coconut shell concrete of 20% and the 15% fly ash addition shows increase in split tensile strength. Coconut shell concrete of 20% and the 20% fly ash addition shows increase in Flexural strength.

SundarKumar, S. Vasugi (2013) summarized the development of low concentration alkali activator geopolymer concrete mixes and the results of tests conducted to determine the mechanical properties such has compressive

Parthiban. K, K. Saravanarajamohan presented the influence of the various proportions of GGBS (0-100%) on Fly Ash based GPC; the effect of the amount of Alkaline Activated Solution (AAS) in the mixture of GPC on their compressive strength is studied under ambient temperature conditions.

Palaniappan. A, S. Vasantha (2013) discussed the results of an experimental investigation and compare on the mechanical properties of different binder composition (17 TO 20 % replacement of cement by ground granulated blast furnace slag (GGBS)) of Geopolymer Concrete Composites (GPCC). The test results show that GGBS concrete shown increase in compressive strength of 13. 82% as compared with conventional concrete.

Abdul Aleem et al (2012) made a "Review On Geopolymer Concrete" which can be used under conditions similar to those suitable for ordinary portland cement concrete. These constituents of Geopolymer Concrete shall be capable of being mixed with a relatively low-alkali activating solution and must be curable in a reasonable time under ambient conditions.

Gokulram. H, R. Anuradha (2012) presented the results of an experimental investigation and compare on the mechanical properties of different binder composition (100% replacement of cement by ASTM class F Fly ash (FA) and ground granulated blast furnace slag (GGBS)) of Geopolymer Concrete Composites (GPCC). The study analyses of polypropylene fibre on the mechanical properties of hardened GPCC.

JipingBai and AlbinasGailius (2009) developed statistical models for predicting the consistency of concrete incorporating Portland cement, Fly ash and Metakaolin from the experimental results of standard consistency tests. The effect of variations of pozzolanic replacement materials including Fly ash and Metakaolin replacement levels up to 40% and 50% respectively were tried. Consistency parameters were found out from the best fit models. Values of consistency were calculated by the proposed models and gave a good agreement with observed experimental data. It indicated that the models were reliable, accurate and can be used in practice to predict the consistency of Portland cement-Fly ash-Metakaolin blends.

Eva Vejmelkova et al (2010) experimentally studied a set of parameters of high performance concrete (HPC) with metakaolin including basic physical characteristics such as mechanical properties, fracture-mechanical properties, durability characteristics, hydraulic, thermal properties and chloride binding characteristics. The experimental results showed that the replacement of Portland cement by 10% Metakaolin as an optimal amount leads in most cases either to improvements or at least does not significantly impair substantial properties of the analyzed HPC. Basic physical properties and heat transport and storage properties are very similar to common HPC, mechanical and fracture mechanical properties were improved, water- and water vapor transport parameters were substantially reduced, frost resistance was better, resistance against de-icing salts was found to be slightly worse but still meets very well the required criteria. It is reported that the chemical resistance of concrete with 10% of Metakaolin instead of Portland cement in distilled water and HCl is better than for Portland cement concrete.

Mix Design for M25 grade Concrete:
The design parameters and the quantity of Cement, C. A, F. A are tabulated below:

Specific gravity for materials

Characteristic Strength (f_{ck})	M_{25}
Specific gravity of cement 53 Grade	3. 15
Specific gravity of C. A	2. 64
Specific gravity of F. A	2. 64
Zone	2
Size of C. A	20 mm

As per the IS code 10262-2008 the mix design has been done with the above input data. Therefore the quantity of C. A, F. A and cement can be calculated in kg/m3.

Mix proportion

Ingredients	Kg/m^3
OPC 53 grade cement	480
Coarse Aggregate	1227. 52
Fine Aggregate	690. 48
Water content	192(Liters)

Mix design Ratio:

1	:	1.13	:	2. 55	:	0. 4
PPC		F. A		C. A		Water content

RESULTS AND DISCUSSION

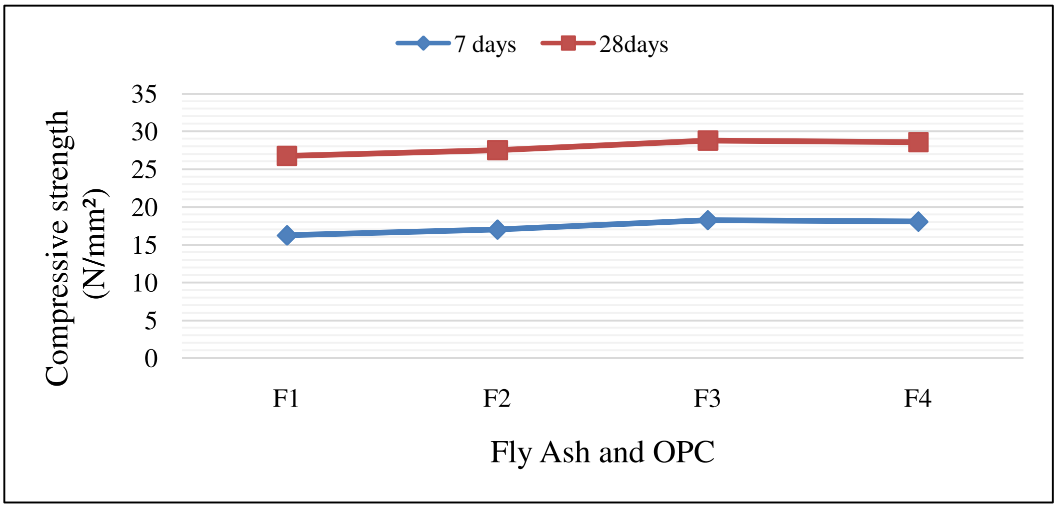
The cubes, specimens are tested in compressive testing machine to determine compressive strength age of 7, and 28 days. The figure 5 shows a graphical and table 13 shows tabular representation of various strengths which were cured with water.

COMPRESSIVE STRENGTH:

Cement by fly ash:

Table -compressive strength using fly ash

Trail	Mix ID	Fly Ash by cement %	OPC 53 grade %	Optical Fiber %	F. A %	Strength (N/mm2) 7days	Strength (N/mm2) 28days
1	F1	0	100	0	100	16. 25	26. 75
2	F2	10	90	2	98	17. 01	27. 51
3	F3	15	85	4	96	18. 26	28. 76
4	F4	20	80	6	94	18. 07	28. 57



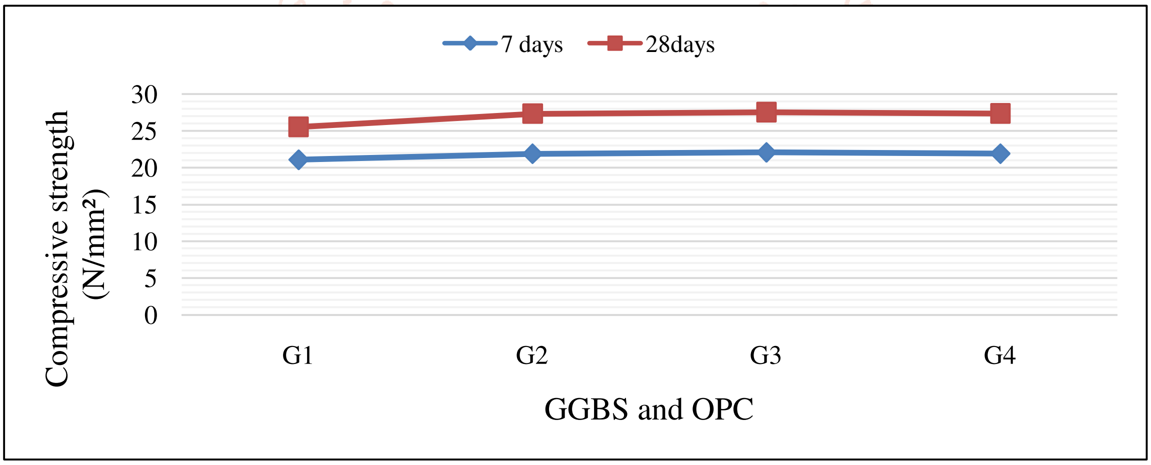
Graph -*Cement by fly ash*

The compressive strength of concrete with different proportions is casted of age 7 and 28 days and a graph is plotted between "Fly Ash with OPC" (x-axis) Vs Compressive Strength (y-axis). From the graph we can say that the proportion F1, F2, F3 has a steady increase in strength and slightly reduced to F4. Proportion F3 has a maximum strength of 28. 76N/mm2 within 28 days.

Cement by GGBS:

Table:

Trail	Mix ID	GGBS by cement %	OPC 53 grade %	Optical Fiber %	F. A %	Strength (N/mm2) 7days	Strength (N/mm2) 28days
1	G1	0	100	0	100	21. 07	25. 535
2	G2	10	90	2	98	21. 87	27. 335
3	G3	15	85	4	96	22. 07	27. 535
4	G4	20	80	6	94	21. 89	27. 35



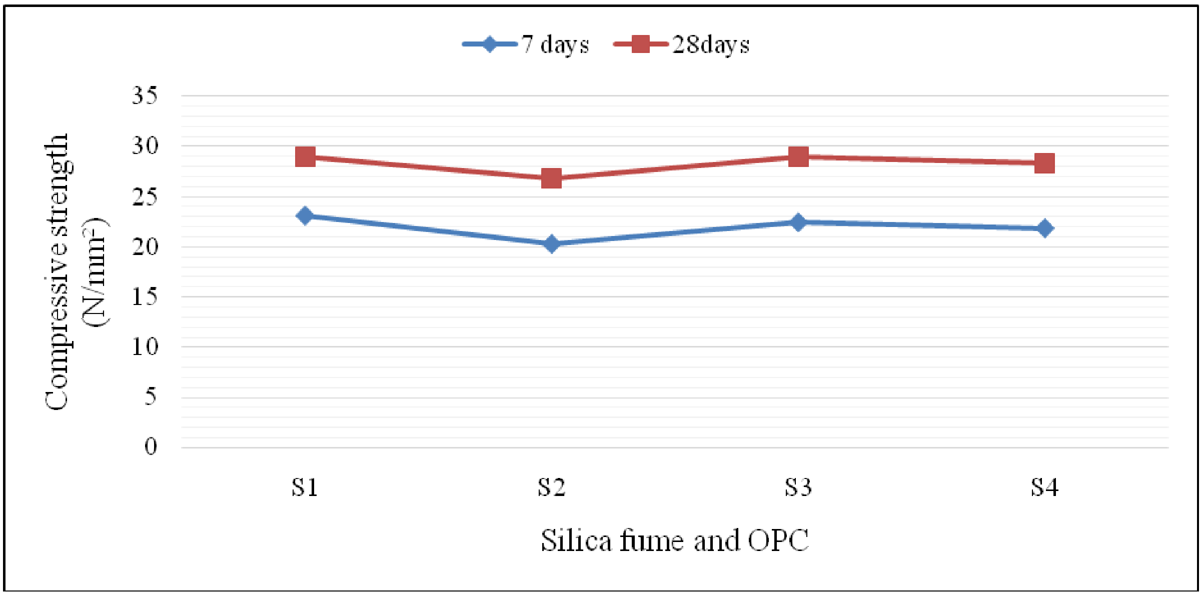
Graph -*Cement by GGBS*

The compressive strength of concrete with different proportions is casted of age 7 and 28 days and a graph is plotted between "Fly Ash with OPC" (x-axis) Vs Compressive Strength (y-axis). From the graph we can say that the proportion G1, G2, G3 has a gradual increase in strength and slightly reduced to G4. Proportion G3 has a maximum strength of 27. 53N/mm2 within 28 days.

Cement by silica fume:

Table- Cement by silica fume

Trail	Mix ID	Silica fume by cement %	OPC 53 grade %	Optical Fiber %	F. A %	Strength (N/mm2) 7days	Strength (N/mm2) 28days
1	S1	0	100	0	100	23. 10	29. 01
2	S2	10	90	2	98	20. 33	26. 81
3	S3	15	85	4	96	22. 45	28. 96
4	S4	20	80	6	94	21. 87	28. 35



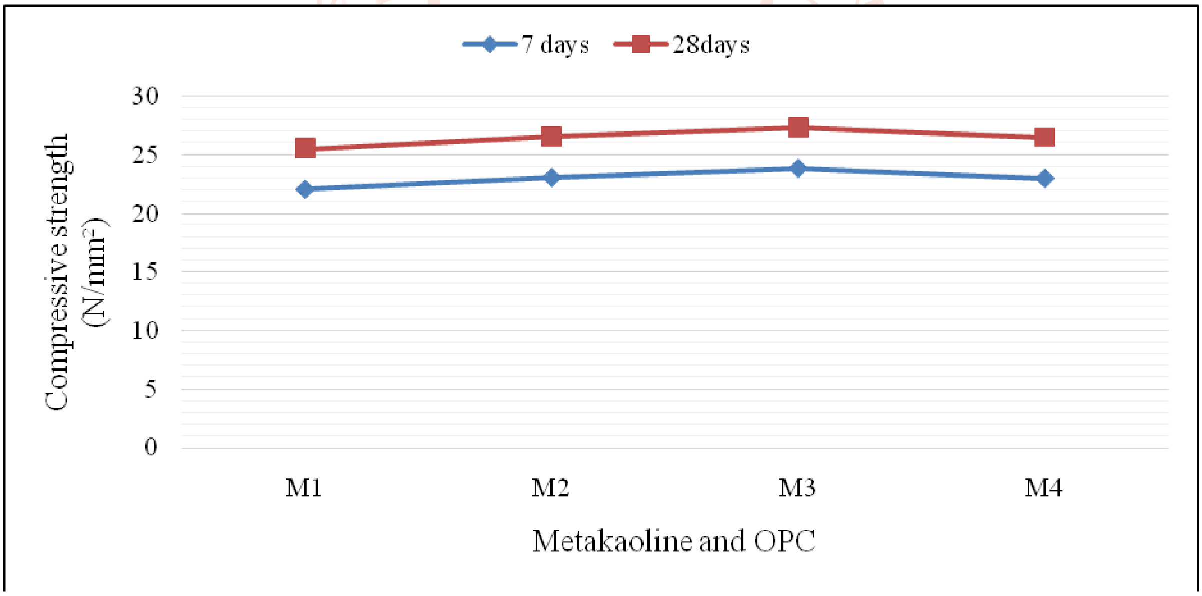
Graph -*Cement by silica fume*

The compressive strength of concrete with different proportions is casted of age 7 and 28 days and a graph is plotted between "Fly Ash with OPC" (x-axis) Vs Compressive Strength (y-axis). From the graph we can say that the proportion S2 stands lowest rate of strength and increased to S3. Proportion S1 has a maximum strength of 29. 011N/mm2 within 28 days.

Cement by Metakaolin:

Table- Cement by Metakaolin

Trail	Mix ID	Metakaoline by cement %	OPC 53 grade %	Optical Fiber %	F. A %	Strength (N/mm2) 7days	Strength (N/mm2) 28days
1	M1	0	100	0	100	22. 07	27. 53
2	M2	10	90	2	98	23. 08	28. 54
3	M3	15	85	4	96	23. 86	29. 32
4	M4	20	80	6	94	23. 01	28. 47



Graph -*Cement by Metakaolin*

The compressive strength of concrete with different proportions is casted of age 7 and 28 days and a graph is plotted between "Fly Ash with OPC" (x-axis) Vs Compressive Strength (y-axis). From the graphical presentation we can say that M3 has a highest rate of compressive strength i. e. 29. 32N/mm2 for 28 days where as M1 has low.

CONCLUSION

- From the graph it is concluded that Partial replacement of cement with Metakaoline obtained more strength compared to other pozzolanic materials.
- The compressive strength at the age of 7 days, the mix containing 15% cement replacement of Metakaoline and 4% F. A replacement with fiber optics shows marginal improvement which varies from 38. 5% to 100%.
- The compressive strength at the age of 28 days, the mix containing 15% cement replacement of Metakaoline and 4% F. A replacement with fiber optics shows marginal improvement which varies from 29. 1% to 77%.
- The proportion of Fly Ash, GGBS, Metakaoline of 3rd triali. e 15% replacement with cement and 4% replacement of fiber optics with F. A gives maximum compressive strength at the age of 28 days.
- Replacement Aggregates RC Beam shows better resistance against first cracking load than NCR beam and its factor is1. 07.
- NCR Beam shows better resistance against Ultimate load than Replaced Aggregates RC Beam and its factor is1. 05.
- From the test results Replaced Aggregates RC Beam shows 30% & 26% more deflections under first cracking load & Ultimate load than the NCR Beam respectively. However it is within the permissible limits according to the IS codes.
- All the beams are failed in flexural mode by yielding of the tensile steel followed by the crushing of concrete in the compression face.
- Replaced Aggregates RC Beam and NCR beams shows similar crack pattern, but Replaced Aggregates RC Beam exhibit wider cracks with a closer spacing compared to NCR beam irrespective of loading.
- From all mineral add mixtures, the investigation shows that Metakaoline replacement gives maximum compressive strength and fly ash gives minimum.
- From the experimental study, Replaced Aggregates RC Beam possesses improved flexural strength than conventional concrete hence it is recommended that Replaced Aggregates RC Beam elements can be used as structural concrete works.

REFERENCES

[1] AswathyKurian, Binu M Issac, SoumyaAnand. An Experimental Study on Geopolymer Concrete with the Partial Replacement of Coarse Aggregate with Laterite. Internation Conference on Science, Technology and Management. 2015 september.

[2] Madaraboyina Naga Ramu, Kavin Raj. P. Strength Assessment of Concrete by Partial Replacement Cement with Metakolin&Flyash. 2016 Oct; 8(15), 2954-2958.

[3] DhanalaVinaya, GottalaAnirudh. Comparative Study On M25 Concrete With Partial Replacement Of Cement With Fly Ash And Coarse Aggregate With Coconut Shells In Acid And Water Curing. 2016 Nov; 4(3), 533-540.

[4] Naga Lakshmi R. Experimental study on strength characteristics on M25 grade concrete with partial replacement of cement with fly ash and coarse aggregate with coconut. 2013 Jan; 4(1).

[5] SwapnilSamrit, PiyushShrikhande, M. V Mohod. Use of Fly Ash as a Partial Replacement of Cement in Concrete Pavements. 2016; 60-65.

[6] Dilip Kumar Singha Roy, AmitavaSil. ffect of Partial Replacement of Cement by Silica Fume on Hardened Concrete. 2012 Aug; 2(8), 472-475.

[7] Rajamanya V. S, Kulkarni N. K. Strength Properties of Metakaoline and Fly Ash Plane Cement Concrete. 2015 Dec; 2(9), 115-119.

[8] AnuragVerma, DishaSrivastava, Neelesh Kumar Singh. A Review on Partial Replacement of Cement by Fly Ash and Effect of Steel Fibers. 2017 May; 14(3), 104-107.

[9] RatodVinod Kumar, KoudaganiVenkatesh. Compressive Strength of Concrete by Replacing Cement with Silica Fume for M20 Grade. 2016 Apr; 5(4), 352-356.