Review on Effect of Glass Fiber on Blended Cement Concrete

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Abstract— This paper presents use of glass fiber in blended cement concrete attracted the attention from construction industry. In the present study, the effect of addition of glass fiber on blended cement concrete such as fly ash based cement concrete and GGBS based cement concrete were studied. This paper reviews the current state of knowledge and technology of using fly ash, GGBS and Glass fiber. A detailed review on the various preparation techniques and the resulting properties of glass fiber are presented and the effect of glass fibers on the blended cement concrete properties is discussed in this paper.

Key words: Glass Fiber, Blended Cement Concrete

I. Introduction

Cement is the one of the major component used in the production of concrete. Concrete is used in structural & non-structural elements construction, like concrete can be used to build multi storied buildings, pavements, bridges, dams.

Concrete is the most widely used material in the world. It contains cement, aggregate (fine aggregate and coarse aggregate) and water. In construction industry it is the main constituent for the construction of structures. Generally concrete is weak in tension strong in compression. There are so many materials which are used in the place of cement. The materials such as fly ash, GGBS were also used in the preparation of concrete. these materials are durable and economical. Fly ash and GGBS production was in large scale now a days. So to overcome the disposal problems of these largely produced materials they were using in construction industry. These are also had same properties like cement and also in strength criteria.

Concrete is the primarily used material in the construction and concrete acts as a backbone for our infrastructure. When compared to all construction materials, concrete was treated with care and respect. And also working with concrete is safe. Also some additives such as admixtures or super plasticizers are also added into the mixture to improve the physical properties of the wet mix.

Concrete was used in famous structures like Hoover dam, Panama Canal and The Roman Pantheon. Earliest Romans used the concrete technology was widely used in the Roman Empire. And they built world's largest unreinforced concrete domes i.e. dome of the pantheon. Colosseum in Rome was built largely of concrete. Now a days we are constructing large concrete structures like dams & multistoried car parks are widely made or constructed with reinforced concrete.

II. Applications

Concrete is the most used material in the world. In construction world it is the main constituent for the construction of structures. Concrete prepared by cement and using natural aggregates they are nothing but fine aggregate and coarse aggregate. Because the fine aggregate fills the voids very efficiently compared with coarse aggregate and when we prepared it only with coarse aggregate the concrete composites contain so many voids so the strength should be less then the structure will be collapsed suddenly. So for good bonding between the materials such as cement, sand (fine aggregate), coarse aggregate we are using these materials and also they were durable and gives strength to the concrete. Normally concrete get strength at 7 days and the maximum strength attained at 28 days after that it will slowly increasing. Generally concrete was used in much major structural construction. The following are the applications of concrete they are

1) Concrete was used in mass concrete structures or large constructions. For example in dams, navigation locks and in large mat foundations. In large or mass concrete structures is the major composite used in structures so large amount of cement was used in the structures so due to the large amount of cement it produces the heat and in the process of cement hydration it associates expansion. So to prevent this heat of hydration while construction of large structures like dams post cooling process will take place during the construction.
2) The second most application of concrete is used as a surface finishing material. But when we are using this concrete in surface finishes the surface becomes porous and the appearance of the surface was not good. So to improve the appearance of this different finishes can be applied. These finishes have resistant against staining, water penetration and freezing. Polished concrete is the most popular effect for the flooring and table tops.
3) Pre-stressed concrete is very useful because it reduces the weight of the structure. It distributes the stress in structures to make optimal use of the reinforcement.

III. Environmental impact of concrete

In construction industry concrete is the major component and it is used to construct the structural components. In concrete cement is the major constituent which gives the bonding between the aggregates and it acts like binder. But due to the large usage of cement in concrete affects the environment very severely. After construction the cement will produce heat in this process more amounts of carbon dioxide and carbon monoxide will produce in large quantity in environment. So concrete is impact on environment is high due to usage of cement. And also when the building demolition dust was released into the environment it causes air pollution. While using cement in concrete it will also cause water pollution i.e. cement particles are very fine and even they are not visible. So while preparing the concrete mix cement was mixed with water and water will be polluted. So to reduce these pollutions or impact of concrete on environment some remedies have to be taken. And some of the environmental impacts of concrete were discussed below.

A. Carbon Dioxide Emissions and Climate Change

Construction is the second most industry which produces carbon dioxide while the concrete preparation. Cement is the main constituent which produces carbon dioxide in large scale quantity so due to cement use in concrete producing more emission of carbon dioxide into the environment. So by replacing this cement with the mineral admixtures like fly ash and GGBS will reduces the carbon dioxide emission into the environment. The usage cement is directly proportional to the carbon dioxide emission into the environment so by replacing cement with these admixtures will also reduces the carbon dioxide emissions into the environment. Due to this carbon dioxide emission into the environment the climate change will also change. There were so many changes will occur in environment and the climate change will also change. The monsoons were also occur in different seasons. So it has to be balanced.

B. Cement Production and Use

Cement manufacturing is also one of the major constituent for the carbon dioxide and carbon monoxide. While manufacturing the cement in the cement manufacturing plants the carbon dioxide will also produced due to the high temperatures were maintained to produce cement. So we have to reduce these carbon emissions in to environment. So the mineral admixtures were also used in the production of cement because these mineral admixtures like fly ash and GGBS will reduce the carbon emission and increase the strength, decrease density and increase durability of concrete.

And also there are some impacts on environment they are surface runoff, urban heat, and concrete dust, toxic and radioactive contaminations were also the environmental impacts of concrete. All these are also occur due to the usage of cement. All these impacts were also the major carbon emission producers.

By studying all the material properties and environmental impact of concrete and the benefits of the other cementitious materials it is better to replace the cement with the GGBS and Fly ash.

GGBS is very good durable material and fly ash has the self-healing ability so by considering all these points also to reduce the amount of GGBS and Fly ash, to reduce emission of CO_2 gases and green house gases into the environment causes urban heat, climate change etc. We know that concrete is week in tension and strong in compression so to strengthen the tension zone of concrete I am considering the use of glass fiber in concrete. Hence all these materials were chosen.

IV. MINERAL ADMIXTURES

Now a days concrete is the one of most commonly using material in worldwide for construction purpose. There are so many mineral admixtures are there and they are using in concrete by replacing cement. And these mineral admixtures gives good strength like cement based concrete. the cost is low and the availability of these admixtures was more. And in this chapter some of the mineral admixtures properties and chemical composition, uses and applications was discussed briefly.

A. Fly Ash

In today's Era energy planners are aiming to increase the use of oil, gas, nuclear and also renewable energy sources to meet the electricity demand in India. But till now coal based thermal power plants are the major sources of electricity generation and they will continue to dominate in the next few decades too. Disposal problem of fly ash is the one of major disadvantage of these coal based thermal power plants. Earlier they considered that fly ash is the waste and environmental hazardous material. But fortunately, the useful properties of fly ash begun to be known as raw material for various applications. NTPC, DST, CPRI, CSMRS, BARC, CBRI, etc are working with the ministry of environmental and forest and ministry of power, government of India. It is formulate a strategy to find out the proper use of this waste material. Then these days fly ash was very effective and economically used in building components such as bricks, doors, door-frames, etc. and fly ash is also used in raw material in agricultural and its potential will be fully exploited. Due these developments and applications fly ash was shifted from "Waste Material" to "Resource Material" category.

- In India 57% of the power was obtained by the coal-based thermal power plants. Fly ash is mainly generated from thermal power plants .Due to the combustion of powdered coal.
- Fly ash is classified into two types according to the type of coal used. Anthracite and bituminous coal produces fly ash classified as class F
- Fly ash is fine glass powder, the particles of which are generally spherical in shape and range in size from 0.5 to 100 µm.
- The primary difference between Class C and Class F fly ash is the chemical composition of the ash itself. While Class F fly ash is highly pozzolanic(silica oxide, alumina oxide and iron oxide), meaning that it reacts with excess lime generated in the hydration of portland cement, Class C fly ash is pozzolanic and also can be self cementing.

Fly ash is currently being utilized in various segments such as cement, asbestos-cement products and concrete manufacturing industries, land developments, road embankments, building products such as brick /tile/blocks. And only 3% of fly ash is utilized in other construction industry. In India

"Fly Ash Mission of Government of India" is the nodal agency which undertook the responsibility for safe disposal and gainful utilization of Fly Ash on sustainable basis.

For a variety of construction material fly ash could be used as a prime component. And it is pozzolanic material containing silica in good proportion.

B. Chemical Composition Of Fly Ash

Fly ash is the byproduct material so the chemical constituents can vary considerably but all the fly ash includes.

- Silicon Dioxide
- Calcium oxide (CaO) also known as Lime
- Iron (III) Oxide (Fe_2O_3)
- Aluminium Oxide (Al_2O_3)

Depending on source, coal may include one or more toxic chemical in trace amount:

- Arsenic , beryllium , boron , cadmium , chromium , cobalt , lead , manganese , mercury , molybdenum , selenium , strontium , thallium , and vanadium.

V. Different Types of Fly Ash Concretes

A. Ready –Mixed Fly Ash Concrete

The ready-mix concrete can be prepared by two processes they are proportioning of fly ash concrete mix and batching and mixing of different ingredients. It has the advantage of quality control, reduction in wastage, labor and supervision, and which are normally associated with concrete prepared at site.

CHEMICAL CONSTITUENTS	FLY ASH % BY MASS
CaO	0.372-27.68
SiO_2	27.88-59.46
Al_2O_3	5.23-33.99
Fe_2O_3	1.21-29.63
MgO	0.42-8.79
SO_3	0.04-4.71
NaO_2	0.2-6.9
K_2O	0.64-6.68
TiO_2	0.24-1.73
LOI	0.21-28.37

Table 1: Chemical Constituents Of Fly Ash

1) Material Procured from

Class-F Fly Ash from NTPC, Visakhapatnam. These chemical properties also collected from the NTPC.

Fig. 1: Fly Ash

B. Precast Fly Ash Concrete Units

Fly ash can be used in production of various types of precast building units such as solid and hollow core slabs, doors and window frames etc. it can also used in preparing flooring, roofing units, cored units, channel units and cellular units by partial replacement of cement.

C. Clay Fly Ash Bricks

Fly ash is also used in the production of bricks also because the fact that clay and fly ash is not much different in respect of their chemical composition. When fly ash is used in bricks 0.25 to 0.80 times of clay can be replaced by fly ash. The bricks are in lighter in weight as the density of fly ash is about one half of the clay.

D. Lime Fly Ash Bricks

Lime is using as a binder are having high strength possessing good quality.

E. Lime Fly Ash Cellular Concrete

This type of cellular concrete can be manufactured by a process involving mixing of fly ash, quick lime and gypsum in high speed mixer to form thin slurry. By using lime fly ash cellular concrete is considered excellent products for walling blocks and fabricated floor slabs. The bulk density of the product ranges from 500kg /cm^3 to 1300kg/cm^3.

So such blocks are used for load bearing walls up to three storied and partition walls in multi-storied buildings.

F. Cement

Fly ash is an artificial pozzolanic material can be used for manufacturing of Portland pozzalona cements as partly replacement of cement in mortar and concrete. The cement , mortar and concrete prepared by fly ash gives long term strength and low heat of hydration ,low permeability and hence more durability.

Indian coal has high ash content i.e. 35-38% and imported coal ash content 10-15%. Regarding this washing will help to reduce the ash content 7-8%. There are total 90 coal/lignite based thermal power plants. And it is provided by central electricity authority 2011-12 for providing electric power rapidly growing industrial as well as agricultural sectors. In which 70% of the electricity was generated from the coal based thermal power plants (source: India Energy book, 2012). In order to achieve the India economic growth of 8-9%, the country's total coal demand, has been forecasted increase in nearly 730 million tons in 2010-11 to 2000 million tons in 2031-32 approximately. And 75% of the coal would be from thermal power plant. Here are the some statistics from the India Energy Book, 2012.

G. Uses

- Portland cement and grout
- Brick and concrete masonry units (CMU)
- Embankment / structural fill and mine reclamation
- Road sub base
- Soil stabilization
- Flowable fills (controlled low strength material)
- Waste stabilized and solidification
- Raw feed for cement clinkers
- Aggregate
- Asphalt concrete mineral filler

Numerous agricultural applications In the above table demand of coal in the coming decades so the generation of fly-ash increase tremendously and the consumption rate is 54.33% per annum (Central Electricity authority 2011-12). The rate of the consumption should be increased gradually to maintain a production-consumption balance. And another table shows the generation and utilization of fly-ash for the year 2010 and 2011 in India which aware us the contemporary consumption rate. In the financial year 2016-17 fly ash is expected to increase the production around 300-400 million tons per year. The large amount of fly-ash produced if not utilized in right quantity will be hazardous to environment. In the cement sector the utilization is approximately same in 2010 and 2011. In roads and embankments percentage of utilization of fly-ash was increased from 11.65% to 13.02%. Otherwise other sector has decrease in percentage of utilization of fly-ash which decreases the overall percentage utilization in financial year 2011-12.

Sector	2005-06	2006-07	2011-12	2016-17	2021-22	2026-27	2031-32
Electricity (A)	310	341	539	836	1040	1340	1659
Iron & steel	43	43	69	104	112	120	150
Cement	20	25	32	50	95	125	140
Others	53	51	91	135	143	158	272
Non-Electrical (B)	116	119	192	289	350	403	562
Total of (A)+(B)	426	460	731	1125	1390	1743	2221

Table 2: Projected Coal Demand (Million Tons) (Source: India Energy Book, 2012)

Since 1996-97 to 2010-11 increase in fly-ash production is observed so the consumption (9.63% in 1996-97 to 54.53% in 2011-12, reported by Central Electricity Authority 2011-12). India achieved the fly-ash utilization in 2009-10 and 54.53% in 2011-12. A lot of effort should require achieving 95-100% utilization. And continuous effort has been made by Department of Science and Technology, Government of India to increase the scale of utilization of fly-ash.

VI. GGBS (Ground Granulated Blast Furnace Slag)

Ground granulated blast-furnace slag (GGBS or GGBFS) is obtained by heating molten iron slag 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 the concrete durable with the combination of ordinary Portland cement and/ or other pozzolanic material. The major use of GGBS are in the production of quality-improved slag cement, namely they are called Portland blast furnace cement (PFBC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging from typically from 30 to 70% and in the production of ready-mixed or site-batched durable concrete.

Concrete made with GGBS cement sets more slowly than ordinary cement concrete but it gains more strength than ordinary cement concrete over a long period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required.

Use of GGBS reduces the risk of damage caused by alkali-silica reaction provides higher resistance to chloride and also reducing the risk of reinforcement corrosion and provides higher resistance to attacks by sulfate and other chemicals. The replacement levels for GGBS vary from 30 to 85%. In most of cases it is typically used from 40 to 50%. Concrete made with GGBS cement has a higher ultimate strength than concrete made with ordinary Portland cement. It has high calcium silicate content than concrete made with OPC and reduced content of free lime, which does not improve or affect the strength of concrete.

Fig. 2: Ground Granulated Blast Furnace Slag

Density (g/cm^3)	Glass content (%)	Specific Surface Area (cm^2/g)
2.91	98	10070

Table 3: Physical Properties Of Ggbs

SO_3	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	T-S
0.12	33.5	14.5	0.49	43.1	5.5	0.22	0.40	0.95

Table 4: Chemical Composition Of Ggbs

A. Durability of GGBS

GGBS is the routinely specified in concrete to provide protection against both sulfate attack and chloride attack. To protect against chloride attack, GGBS is used at a replacement level of 50% in concrete. Chloride attack occurs in reinforced concrete in marine environments and road bridges where the concrete is exposed to splashing from road de-icing salts. It was used in the construction of bridge piers and abutments for protection against chloride attack. In such instances the use of GGBS increases the life of the structure by up to 50% had only Portland cement have been used. GGBS generates less heat of hydration than Portland cement. This reduces the thermal gradients in concrete, which prevents the occurrence of micro-cracking which weakens the concrete and reduces its durability.

VII. Glass fiber

Today GLASS FIBERS are the most versatile industrial materials. Glass fibers are readily produced from raw materials, which are available in unlimited supply. All the glass fibers discussed here are derived from the composition containing silica. They show hardness, transparency, resistance to chemical attack, stability and inertness. The desirable properties such as strength, flexibility, stiffness. These glass fibers are used in the manufacture of structural composites, printed circuits boards and a wide range of special purpose products.

Fig. 3: Glass fiber

A. Glass Fiber Types

Generally glass fibers are classified into two categories, low-cost general-purpose fibers and premium special-purpose fibers. Overall 90% all glass fibers are general purpose products. These glass fibers are called by E-glass and these are subjected to ASTM specifications (ref). Remaining glass fibers are premium special purpose products. Some glass fibers are designated by the letter which indicates that special property of that fiber.

B. General Purpose Glass Fibers

The general purpose glass fibers are E- glass fibers and S-glass fibers. Now a days glass fibers and the fabric materials are used in ever increasing varieties for a wide range applications.

The data book (ref) available and that book covers all commercially available E-glass fibers, whether employed foe reinforced, filtration, insulation, and also in other applications.

C. Special Purpose Glass Fibers

The special purpose glass fibers are S-glass fibers, D-glass fibers, A-glass fibers. A companion data book is available and that book covers all commercially available high strength glass fibers including S-glass fibers and all silica or quartz glass fibers.

Composition	Wt %
SiO_2	52-56
B_2O_3	4-6
Al_2O_3	12-15
CaO	21-23
MgO	0.4-4
TiO_2	0.2-0.5
Na_2O_3	0-1
F_2O_3	0.2-0.4
F_2	0.2-0.7

Table 5: Chemical Composition Of E-Glass Fiber

VIII. LITERATURE REVIEW

In this chapter the literature related to the present study is delineated.

A. Glass Fiber

Deitz et. al (2003) investigated to determine the compression strength, their ultimate strength and young's modulus they casted forty – five glass fiber reinforced polymer rebars. The rebars having the outside diameter 15mm and the lengths varying from 50 to 380 mm. while doing the crushing test of glass fiber reinforced rebar the ultimate compressive strength was failed and it is approximately half of the ultimate strength of the tensile strength. And they found that there was no change in young's modulus in compression and also in tension.

Asokan et al. (2010) studied on scope for recycling glass fiber reinforced plastic waste. The suitability of recycling glass fiber for improving the concrete performance for structural and non-structural components. By adding the reinforced plastic waste and 2% super plasticizer it improves the mechanical properties such as compreeion, tension, flexure and water absorption. They also reported that the quality of concrete composite products depends on the the quality of glass fiber reinforced plastic waste and the manufacturing process. Finally they said that there is a scope for this work and it can be used or recommended to the impact of alkali silica reaction and long-term durability of glass fiber reinforced plastic waste powder admixed concrete to confirm the environmental significance for commercial exploitation of glass fiber reinforced plastic waste used in concrete.

Rabadiya and Vaniya (2015) investigated the concrete made from glass fiber and RCA as partial replacement of coarse aggregate and they studied on the mechanical properties of concrete and also the flow ability test i.e nothing but the workability tests were also conducted.they also studied on the replacement of RCA with coarse aggregate by different percentages to make different grades of concrete. They observed that the addition of glass fiber reduces the workability. When RCA mixed with glass fiber gives higher flexural and split tensile than the conventional concrete. The replacement of used RCA and glass fiber in concrete, the mechanical properties like split and flexure was increasing compared with the normal concrete.

Yimin Yao et al., (2016), studied on the thermal conductivity of functionalized Al_2O_3 filled glass fiber reinforced polymer composites. They stated that the packing density of electronic devices was rapidly increasing the thermal conductivity of glass fiber reinforced polymer composites. They studied the effect of interfacial state on the thermal conductivity of functionalized Al_2O_3 was to be effective filler to fabricate thermally conductive GFPR composite. The highest thermal conductivity is up to 1.07 w/mk by adding 70 wt% amino groups- Al_2O_3.

Chung-Hyeon Ryu et al., (2016) investigated on the non-destructive evaluation of hidden multi-delamination in a glass-fiber-reinforced plastic composites using terahertz spectroscopy. They stated that the THz-TDS imaging system will be an alternative method for detecting inner multi-delamination in composite structures. And by using this they determined the delamination thickness of top, middle, bottom as 96.52, 109.03, 107.40 micrometers respectively. In z-direction the delamination was less than 5% error when compared to the actual values.

Mehran khan and Majid Ali (2016) studied the glass and nylon fibers in concrete and they finally concluded that when compared to GFRC and NFRC, glass fiber reinforced concrete gets higher values of mechanical properties of concrete i.e. the GFRC is the better to use in constructions.

Ali Ates (2016) investigated that the mechanical behavior of the soil was determined by unconfined compressive strength tests. By using glass fiber the cement increases the mechanical strength of sandy soil and reduces the displacement at failure and brittle behavior was noticed. And they finally got maximum strength at 3% glass fiber content and decreases the mechanical properties of cement and sandy soils.

Siamak Motahari and Amin Abolghasemi(2015) studied that the fire resistance of silica aero gel/ glass fiber is measured and it also influences the solution pH4 shows higher fire resistance compared to those solutions having pH 8. At the surface of the gel it causes more shrinkage due to the presence of Si-OH. The resistence to fire of the composites were get at the long period of time. And they finally concluded that the aging can affects the composites about fire. When time increases then it becomes very strong aero gel. Since the thicker bridges can cause less shrinkage that means it have less porosity. And also it was against to the fire resistance.

B. Fly Ash

Pipat Termkhajornkit et al. (2009) investigated on the compressive strength, porosity, chloride diffusion coefficient, hydration reaction and hydrated products were considered by the self-healing ability of fly ash-cement. In this study it was concentrate on the behavior of self-healing ability of fly ash cement after shrinkage cracking occurs. The amount of shrinkage cracks was measured by the amount of total porosity. The samples which containing fly ash have high compressive strength than the ordinary cement at the age of 28 days. The reduction of total capillary pores is higher in fly ash cement pastes than those in normal cement pastes at 28 days. If there is an increase in fly ash ratio in concrete then there is also increase in capillary pores. The samples which have 25% fly ash content have significantly lower chloride diffusion than in normal cement. They also reported that the hydration of cementitious material was increases when the amount of fly ash increases. And they finally concluded that the mix which contains fly ash has the self-healing ability and the cracks were also taking place form shrinkage.

Berndt (2009) studied and he reports that the partial replacement of cement and recycled aggregate improves the sustainability of the concrete. 50% of GGBS was replaced with cement gives the best result i.e. mechanical properties and durability either use natural or recycled aggregates. They stated that RCA and concrete containing slag was not considerably detrimental to strength. And it can produce a compressive strength of 40MPa and that mixture suitable for many structural applications including with turbine foundations. By adding small amount of fly ash or RCA there is an increase in permeability coefficient and chloride diffusion coefficient and also the values are satisfactory for durable concrete, but in case of elastic modulus it was reverse. And they finally concluded that all sources of fly ash were not mandatory to increase the properties of concrete at high replacement levels and it have recommended mix proportion before use in construction projects.

Sujitra Onutai et al., (2015) studied that they were described that the flyash and alluminium wastes are suitable for the geopolymer materials. And they studied the flyash and alluminium with five different ratios i.e. 100/0 , 90/10, 80/20, 60/40 , 40/60. NaOH solutions concentrations were 5, 10 and 15M and the curing temperatures were used at room temperatures, 60-C and 80-C. They observed that at curing temperature of 80-C and at 10M concentration was suitable for geopolymerization when the alluminium waste content was 40 wt%. and they finally concluded that 40MPa of the bulk matrix strength was achieved for geopolymer.

Qingxin Zhao et al., (2016) studied on long age wet curing effect on performance of carbonation resistance of flyash concrete. They concluded that the in 90 days wet curing condition the concrete had the positive interfacial zone and it improves the anti-carbonation ability of concrete due to this there exists a negative effect of calcium hydroxide consumption which have an uncertain influence on the concrete’s anti-carbonation ability. when they were using high content fly ash and low W/B ratio or low fly ash content and high W/B ratio and it occupies the dominant position and effects the interfacial transition zone of concrete’s coarse aggregate, and improves carbonation resistence. 53.5% of average carbonation depth of fly ash concrete compared to the specimens cured under A condition. The W/B and fly ash were either low or high, it had the positive effect in dense interfacial zone and negative effect of calcium hydroxide consumption had little effect on the anti carbonation ability.11.5% of the average carbonation depth of fly ash concrete decreases under the A condition

Wei Wang et al., (2016) studied the effect of pore water saturation on the mechanical properties of fly ash concrete. They noticed that the rebound value, ultrasonic velocity and elastic modulus are had the same as compressive strength on replacement of fly ash. 0 to 0.45% replacement of fly ash has the average rebound value ,the ultrasonic velocity, the elastic modulus and the compressive strength were all maximum corresponding to fly ash replacement level of 15%.and they are also discussed the pore water saturation concept i.e. if the pore water saturation increases the rebound value and ultrasonic velocity decreases and the pore water saturation in less than 20% then the pore water saturation and rebound value and ultrasonic velocity are increases ,if the pore water saturation is in between 20% to 60% the rebound value decreases. The pore water saturation is above 80% then the pore water saturation remains stable irrespective of increase in pore water saturation. If pore water saturation is 20% to 60% the ultrasonic velocity slowly increases, and if above 60% the ultrasonic velocity increases rapidly. The fly ash replacement and pore water content greatly influences the mechanical properties of concrete. So precautions should be taken in the design of fly ash concrete in high humidity environments.

Hamdy K. Shehab et al., (2016) studied that at 50% replacement ratio they observed that the values of compressive strength, bond strength, splitting tensile strength and flexural strength at 28 days compared to mixtures produced from 0%, 25%, 75% and 100% replacement ratios. They were also noticed that the flexural strength, compressive strength, bond strength equals 10.98%,13.3%,16.18% respectively from compressive strength. They were observed that the flexural, splitting tensile, bond strength were 40.8 kg/cm2 , 49.58 kg/cm^2,61.04 kg/cm^2 at a cement replacement ratio of 50%, with binder of 350kg, activator solution ratio of 0.55%.

C. GGBS

Ganesh Babu and Sreerama Kumar (2000) studied on the supplementary cementitous materials usage in concrete this study was done because there so many improvements have done on concrete in economical point of view. They were also proposed a method to evaluate the efficiency of fly ash and the silica fume and also for the GGBS determination. By studying all these they finally reported that the strength efficiency was varying when they replacing the cement with the GGBS. So they finally want to get the equal strength of concrete at 28 days they considered the present study.

A.Oner , S.Akyuz (2007) studied that the compressive strength of the GGBS mixed concrete strength was increasing simultaneously by the amount of GGBS addition and this strength was increased up to 55% of GGBS usage. More than this % the concrete does not affect the strength of concrete.

Martin O'Connell, Ciaran McNally, Mark G. Richardson had investigated on the performance of concrete incorporating GGBS in aggressive wastewater environment (2012). The mineral admixtures such as GGBS is used in increasing the amounts in concrete and shown to provide concrete with durability in the particular environment. The usage of GGBS in cement replacement will also reduce CO_2 emission and has economical benefits.

Krishna Rao et al., (2015) have done with GGBS. They noticed that the cement was replaced with GGBS in different proportions and observed that when they reducing the GGBS content the mechanical properties of concrete were also reducing at the curing age of 3 days after that when the long periods of curing age they found that there was an increase in strength of concrete with water/cement ratio 0.45. after this the strength of the concrete was decreasing .So they finally concluded that the strength of the concrete was increasing with the increase in the curing age of the concrete.

Souvik Das et al., (2015) focused their study on marine structures and they find a problem that the whole world looking to restrain the marine structure from damages caused by the environment. And they tried to manage that problem by using glass fiber reinforced polymer (GFRP) sheets which are quite economical. So they are not done such an effective study on the usage of GFRP sheets in marine structures. So, they concluded some points that GGBS decreases the permeability of concrete as a result there is a decrease in chloride penetration. And when they retrofit the marine structures with the GFRP sheets the strength was significantly increases to on an average of 94%. And they also find a problem that the bond strength between the GFRP sheets and epoxy resins decreases with an increase in chloride levels. The tensile strength was induced by the temperature effects in the circumferential region of the composite.

Azadeh Attari et al., (2016) reported that the utilization of supplementary cementitious materials (SCM) in the concrete mix reduces the CO_2 foot print during generally to improve the durability. The characteristics like time dependant characteristics of concrete become more representative as SCM replacement levels were also more. Also they reported that the addition of GGBS in all the cases was reduce the risk of corrosion.

Jerzy Wawrzenczyk et. Al., (2016) studied the effect of ground granulated blast furnace slag and polymer microspheres on impermeability and freeze-thaw resistance of concrete. They reported that the increase of W/B ratio leads to the increase in water absorption and permeability, and to the decrease in compressive strength and frost resistance at different w/b ratio and binder containing the varying amounts of GGBS. And the change in the slag content in concrete had a minor effect on the water absorption and the strength of the concrete. And the addition of the slag had a significant effect on the reduction of permeability and improves the resistance of the specimens to the cycles of freezing and thawing.

Syed Asif Ali and Prof Shaik Abdullah (2014) performed the experimental study on partial replacement of cement by fly ash and GGBS.

– Optimum % of fly ash and GGBS found to be 40% and 9% respectively.
– Optimum value of compressive strength for M25 grade at 40% fly ash and 9% GGBS as partial replacement of cement was found to be 31.59N/mm2 at 7 days of curing and 45.47N/mm^2 for 28 days of curing.
– The optimum value of split tensile strength and flexural strength for M25 grade at 9% GGBS and 40% Fly Ash as partial replacement foe cement was found to be 12.78N/mm^2, 8.81N/mm^2 respectively at 28 days of curing.

D. Concluding Remarks

From all the investigations the cementitious materials GGBS and Fly ash are the good replacement materials and it emits less CO_2 emissions in to environment than the cement based concrete. And also the production of these materials such as GGBS and Fly ash was increasing every year. GGBS based concrete has good durability than normal concrete and it have low heat of hydration and the pores produced are also less. From the thermal power plants fly ash production was very high. If the disposal techniques are not appropriate then there is a hazardous to the environment. If these materials were mixed with air produces so many health problems. So these materials should be properly disposed. Hence by using these materials in construction industry will reduce the impacts on environment as well as the production of the materials were also controlled.

Glass fibers are also having good qualities and it increasing the mechanical properties of concrete. The compressive strength, split tensile strength and flexural strength of glass fiber replaced concrete has better results than normal concrete.

The effect of glass fiber on the normal concrete, GGBS concrete, Fly ash concrete with glass fiber was not studied till now. Hence the effect of glass fiber on compressive strength, split tensile strength, flexural strength with glass fiber on normal concrete, GGBS concrete, Fly ash concrete was investigated in this study.

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