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Review on Properties, Performance, and Application of Geopolymer Concrete

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ABSTRACT. *Concrete infectious together with normal Portland cement (PC) is notable on the planet for its reliability, durability, and versatility. PC concrete is the second most used material next to water. Even though OPC is so popular in construction, it is not ecofriendly due to enormous energy consumption in its production and due to emission of enormous CO_2.This is a serious challenge to sustainable development. Endeavors are expected to build up a natural amicable structural designing development material for limiting the emission of greenhouse gases to the environment. The Endeavour to develop an environment friendly concrete had offered many alternatives. One eminent among them is zero cement concrete. Zero Cement Concrete is an improved version of Geo-polymer Concrete wherein the thermal activation of the binding materials such as GGBS and FA are done with the help of alkaline solution namely (NaOH) and (Na_2SiO_3). Contrasting to (PC), the creation of geopolymers has a relatively higher quality of strength, durability, and workability. This current paper is a review on geopolymer concrete properties.*

Keywords: Geo-Polymer, Fly Ash, Steel Slag, GGBS, Alkaline Solution, Durability, Strength.

1. INTRODUCTION

The concrete is most utilized substance at antiquated days and it was normal that the creation of bond would be expanded since that One and a half billion tons in 1995 into two and a half billion in 2020. Bond generation contribute almost 7% of world an Earth-wide temperature boost because of emanation of ozone harming substances, for example, CO_2 to the climate. It is fundamental to locate a substitute material for concrete. The innovation zero cement concrete (geopolymer concrete) found as option for the issue. Zero Cement Concrete is an enhanced variant of Geo-polymer Concrete. Is a creative, eco-accommodating development material. Geopolymer is used as substitution of bond concrete and it was first founded by the instructor Davidovits in 1978 where he gathers the mineral folios with invention piece like that zeolites anyway with an ill-defined microstructure [1].

For Sustainable improvement, the solid business needs to investigate elective covers to Portland concrete. In light of the fact that: The creation of 1 ton of bond transmits around one ton of carbon dioxide to the environment. Preserve characteristic crude materials. Since the generation of one ton of bond expend 1.5 ton of crude materials. Bond creation is very vitality escalated enhancing the strength of cement for progressively financial advantage (the cost of fly slag according to the geo-polymer Concrete investigate to become around (10% to 30 %) less expensive the normal portland bond concrete) [2].

For the principle constituent Of the present GPC is the ASTM Class F fly slag (a side-effect from coal let go warm plants) is the ASTM Class F fly fiery remains (a side-effect from coal-terminated warm plants) in light of its availabilities in the most parts of the world. The thickness of geopolymer solid (Zero Cement Concrete) is near a thickness of typical weight concrete by and by, which changes in the range 2200-2600 kg/m^3 [3].

Geopolymer concrete does not require any water for lattice holding Coarse and fine totals in the GPC establish around 75-80 % of the mass of GPC and an amalgamation of the sodium silicate and sodium hydroxide compounds are commonly used for antibacterial fluids [4].

Rather than Portland bond, modern side-effect materials wealthy In silicon Si & aluminum Al, for example, fly fiery remains, rice-husk powder, silica smoke, slag, and other comparative materials are added to respond with very antacid fluid to deliver folios (gel). The polymerization procedure might be helped by applying heat. The geopolymer gel link the free coarse aggregate and fine aggregate with the other material together for the shape of Zero Cement Concrete (geopolymer concrete). The compound response time frame is significantly quick [4]. "Geopolymers are synthesized by the reaction of a solid aluminosilicate powder with alkali hydroxide/alkali silicate" [5]. The graphical demonstrated the form The Fly Ash-according to Geopolymer over the Concrete as seen in the Fig 1.

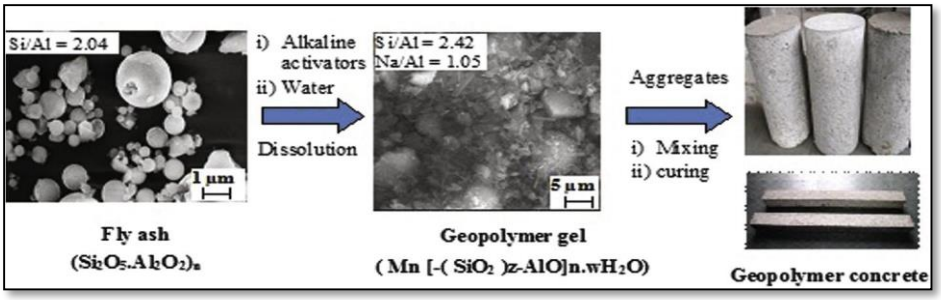

Fig - 1: Fly ash conversion with geopolymers concrete [5].

In any case, the proposed tool for adjusting and stabilizing geopolymers substance is as follows. The decomposition of silicon & aluminum iotas through, The exporter substance from the activity of OH particles, transportation or introduction or buildup of antecedent particles for Unilateral. Polymersation of monomers into polymeric structures [6].

1.1 Form of Geopolymer

Geopolymer it can take three basics form (Fig 2):

- Poly sialate : it has (Si-O-Al-O)
- Poly sialate siloxo : it has (Si-O-Al-O-Si-O)
- Poly sialate disiloxo it has (Si-O-Al-O-Si-O-Si-O)

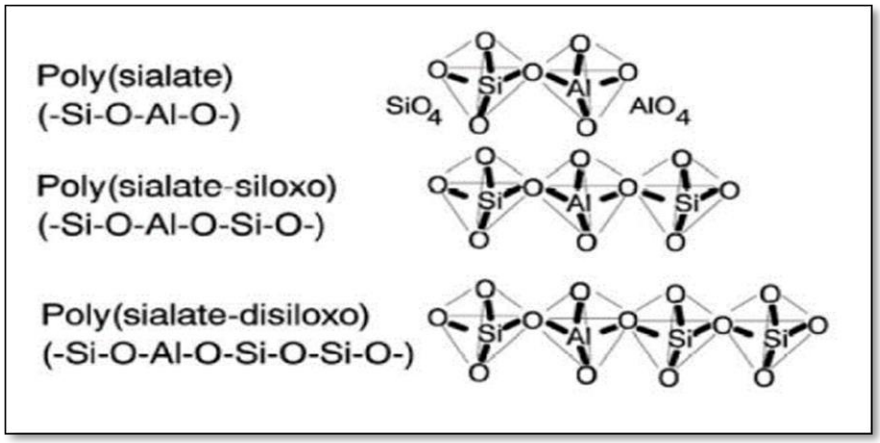

Fig - 2: Chemical Structures of Polysialates [7]

The combination of the geopolymer is like normal zeolitic substance, but with amorphous microstructure rather than crystalline [7]. The SEM has utilized to research the superficies of Fly Ash previously and after getting react with alkaline solution. After it react, it results in surface roughness as appeared in Figs. 3,4 5, 6.

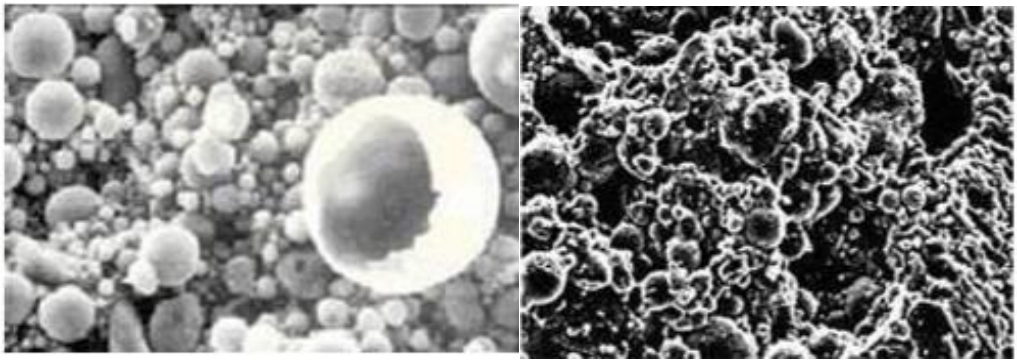

Fig - 3: The fly Ash before interactive with the NaOH [8]. **Fig -4:** The fly ash after interactive with NaOH [8].

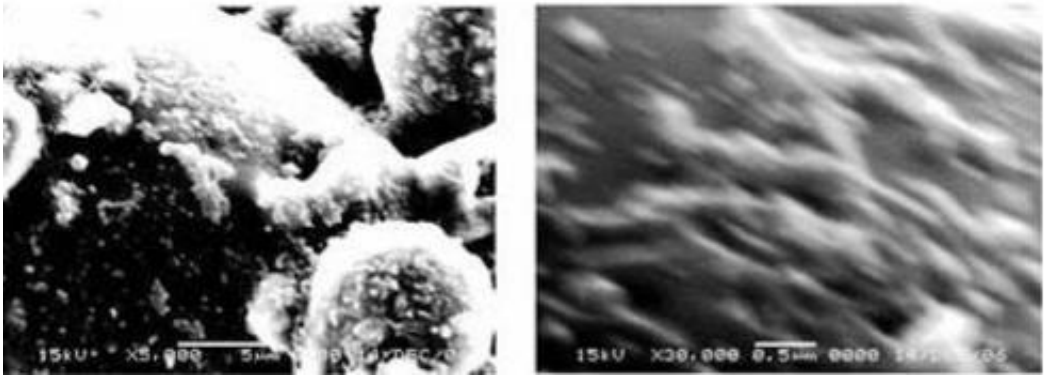

Fig. 5: Fly ash after reacting with NaOH (x5000 and x30 000) [8].

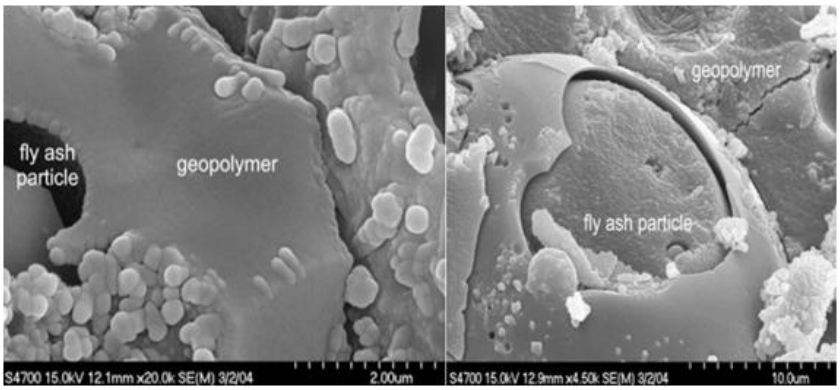

Fig. 6: Microstructure of geopolymer (SEM) [9].

2. MATERIAL USED

The fly ash: Class F (low calcium) fly ash which is a modern side-effect from power plant age. The fineness of Fly Ash majorly affects the quality of Zero Cement Concrete (geopolymer concrete). As the fineness of fly ash remains increment the quality of GPC increment on account of increasingly surface territory with more Si-Al bond for polymerization [10].The different chemical composition types of fly ash are shown in Tables 1,2,3,4,5.

Table. 1: Fly ash chemical composition [10].

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	P_2O_5	TiO_2	LOI
Fly ash	53.71	27.20	11.17	1.90	-	0.36	0.54	0.30	0.71	1.62	0.68

Table. 2 : Chemical composition of Portland cement and fly ash [11].

Main oxides	Portland cement:* %	Fly ash: %
CaO	61.7	5.0
SiO2	21.2	54.8
Al_2O_3	4.6	31.7
Fe_2O_3	1.8	3.8
Na_2O	0.1	0.8
K_2O	0.7	0.8
MgO	4.3	1.1
SO_3	2.0	0.3
Loss on ignition	0.8	0.8

Table. 3: Chemical composition of class C and class F fly ash [12].

Chemical composition of FA	SiO2	Fe2O3	Al2O3	CaO	K2O	Na2Oeq	SO3	MgO	LOI
Class C	20.7	32.0	9.01	27.1	2.51	1.00	1.61	2.05	2.97
Class F	55.23	10.17	25.95	1.32	1.59	1.59	0.18	0.31	5.25

Table. 4: Chemical composition and physical properties of cement and fly-ash [13].

Chemical composition/physical properties	Cement	Fly-ash
Silica (SiO2, %)	22.93	57.60
Alumina (Al2O3, %)	4.29	21.90
Iron oxide (Fe2O3, %)	2.89	2.70
Calcium oxide (CaO, %)	66.23	7.80
Magnesium oxide (MgO, %)	1.92	1.68
Sulfur trioxide (SO3, %)	0.35	0.41
Sodium oxide (Na2O (eq), %)	0.70	1.05
Free calcium oxide (CaO (f), %)	0.64	–
Chloride (Cl, %)	0.006	–
Loss on ignition (LOI, %)	1.70	7.05
Density (g/ml)	3.12	2.06
Specific area (m /kg)	343	355

Table. 5 : Chemical composition of class F fly ash [14].

Component	Percentage
SiO2	49.45
Al2O3	29.61
Fe2O3	10.72
CaO	3.47
MgO	1.3
K2O	0.54
Na2O	0.31
TiO2	1.76
P2O5	0.53
Mn2O3	0.17
SO3	0.27
LOI	1.45

LOI: Loss on Ignition

- Water: Refined water was utilized for the planning of sodium hydroxide arrangement
- Aggregates: Coarse and fine totals utilized if there should arise an occurrence of (OPC) can be utilized in the event of Geo-polymer concrete (GPC).
- Super plasticizers: Super plasticizers is likewise used to expand the usefulness of cement.
- Alkaline solution: As indicated by Prof. J. Davidovits the basic fluid ought to be made preceding one day before blending in light of the fact that at the season of blending of Na_2SiO_3 with NaOH arrangement it creates a colossal measure of warmth and the polymerization happens by responding with each other, which will go about as a fastener in the geopolymer concrete.
- Sodium Hydroxide: NaOH is available in market in pellets or pieces outline with 96% to 98% flawlessness where the cost of the thing depends upon the excellence of the material.
- The arrangement of NaOH was framed by dissolving it in water with various molarities. It is suggested that the NaOH arrangement ought to be made 24 hours before throwing and ought to be utilized with 36 hours of blending the chips with water in light of the fact that after that it is changed over to semi-strong state.
- The specific gravity of (Sodium Hydroxide = 1.16)
- Sodium Silicate: It is otherwise called water glass which is accessible in the market in gel shape.
- The specific gravity of (Sodium Silicate = 1.57)
- Si The most reasonable As basic activators since it control broke up aslo in part polymerized silicon which responds effortlessly, joins into the response items [15].

Salt silica response causes continuous yet serious weakening of solidified Portland bond concrete as far as its quality misfortune, breaking, volume development and so forth. It includes the response between the OH particle inside the Pore arrangement inside The solid grid & responsive Si of the total [16].

3. MIXING OF ZERO CEMENT CONCRETE

Geopolymer cement can be delivered by accepting the standard strategies used in the fabricating of OPC. In the study they have mixed the fly Ash powder with aggregates and combined to dry in an ordinary limit blender for around three minutes (Fig.7). In the GPC mixing design: coarse aggregate + fine aggregate = 77% of the total mixture inside concrete. This value is similar to the regular concrete, where the value of aggregate is about 70 to 80 percent. For fine aggregates, the value is similar to normal concrete, which is equal to 30% of total ingredients [17].

The fluid segment of the blend it was add to the dry substance & the blending proceeded typically for an additional 4 min (Fig.8). the new Concrete become dealt with more than 2 hours with no indication Of precision & with no debasement in the compressive quality. The crisp cement was thrown and compact by the typical techniques utilized on account of Portland bond concrete [18].

Fig -7: Mixer used in the manufacture of geopolymer [19].

Fig- 8: Liquid component addition [19].

4. WORKABILITY OF GEOPOLYMERS CONCRETE

The workability of new geopolymers Concrete was really poor and the blend was stiffer than the OPC because of absence of water content, and the durable of sodium silicate utilized as a soluble arrangement. The usefulness of the crisp cement was estimated by methods for the regular droop test. Water assume critical job to enhance workability of Geopolymer concrete, however expanding the measure of water increment the porosity in cement because of the dissipation of water amid relieving at a raised temperature. And expanding the measure of water antagonistically influence the compressive quality. The serviceable stream of Geopolymers Mortars were in the scope of 110% to 135% +or – 5 to enhance The Workabilty, super plasticizer is included [20] and slump test is performed for testing. (Fig. 9). Also, workability is affected with the variation in water -solid ratio (Table 6)

Fig - 9: Slump test [20]

Table - 6: Data for design water to solid ratio and the effect on the strength and workability [21].

Water-to-geopolymer solids ratio, by mass	Workability	Design compressive strength (wet-mixing time of 4 minutes, steam curing at 60oC for 24 hours after casting), MPa
0.16	Very Stiff	60
0.18	Stiff	50
0.20	Moderate	40
0.22	High	35
0.24	High	30

5. CURING

A couple of undertakings have been looked at the impact of characteristic allay provision on the setting of geopolymer adhesive. Hardjito (2005) evaluated “Geopolymer concrete specimens should be wrapped during curing at elevated temperatures in a dry environment (in the oven) to prevent excessive evaporation that unlike the small geopolymer paste specimens, which can easily be wrapped by placing a lid on the mould. A suitable method was needed for large size geopolymer concrete specimens and extensive trials revealed wrapping of concrete specimens by using vacuum bagging film is effective for temperatures up to 100 ˚C for several days of curing also tighten the film to the concrete moulds. A quick lock seal was utilized , although the later was used in all further experimental work due to its simplicity and economics and finally preliminary tests also revealed that fly ash-based geopolymer concrete did not harden immediately at room temperature when the room temperature was less than 30 ˚C, the hardening did not occur at least for 24 hours .Also, the handling time is a more appropriate parameter (rather than setting time used in the case of OPC concrete) for fly ash-based geopolymer concrete” [22].

There are two method for curing:

1- Dry oven curing. (Fig .10)
2- Steam curing inside camber of steam curing (Fig.11)

After the relieving time frame, the test examples were left in the molds for something like six hours so as to maintain a strategic distance from an extraordinary change in the natural conditions. Subsequent to demolding, the example was into air dry In the research facility unto day of testing [23].

Fig -10: Dry oven curing [22]

Fig -11: Steam curing [22]

The beginning of warmth relieving of geopolymer cement can be deferred for a few days. Which is known as a rest period truth be told, such a postponement in the beginning of warmth restoring generously expanded the compressive quality of geopolymer solid this might be because of the geopolymerisation that occur before beginning of warmth relieving. Warmth restoring of fly fiery remains based geopolymer concrete for the most part suggested Heat relieving generously helps the synthetic response that happens in the geopolymer glue [24].

Both relieving Time & restoring temperatures impact The Compressive quality Of Geopolymer Concrete. Longer restoring Time enhanced The Polymerization procedure bringing about most high Compressive righteousness [25].

6. STRNGTH OF GEOPOLYMER CONCRETE

As the proportion for sodium silicate & sodium hydroxide by the mass increment, outcome in the highest Compressive quality Of strength Geopolymer Concrete. The impact for w/s proportion on geopolymer quality advancement, is like OPC concrete. At the period at the low water content is utilized inside the geopolymer blends, The basic activators focus will in general increment in the framework. Along these lines, the accessible high alkalinity could quicken the geo-polymerisation procedure, and increment the solid's last quality [26].

6.1 HARDENED PROPERTIES OF FRESH GEOPOLYMER CONCRETE

GPC mix proportion was declared with high quality compressive strength up to 80 MPa Generally the GPC mixed such as water, aggregate, chemical and Pozzolanic materials due to high compressive strength and reducing the CO2 Emission from environments and activating agent quality, water/Na_2O extent, alleviating time, reestablishing temperature, and setting time of hydration [27].

GPC was declared with high quality “compressive strength up to 80 MPa. The typical properties of geopolymer solid mixes used by the properties of mixes were analyzed with respect to water-geopolymer strong quantity” [28] activating agent quality, water/ Na_2O extent, alleviating time, reestablishing temperature, and age setting. The rheological parameters, for instance, yield weight and plastic thickness were attempted over hang preliminary of bond to review its usefulness mishap and stream lead [29].

The rheological parameters, for instance, yield weight and plastic thickness were attempted over hang preliminary of bond to review its usefulness mishap and stream lead. Product force gives starting defense from stream gotten From The contact amongst The solid particle whilst the plastic consistency administers The stream next it is begun happening on account of viscous scattering in view of the advancement of water in the sheared material [30].

When the GPC mixed with Fly ash the compressive strength is growth round about 30 to 80 MPA. The water demand geopolymer 0. 18 and for suitable proportion 90 c. By increasing the ratio of solid-water-geopolymer, the compression quality of GPC virtually equals the significant relationship between compression quality and water-to-concrete proportion foe the Portland concrete. The compressed quality Of the geopolymer concrete remains with the period, which is removed after 24 hours at high temperatures [31].

Olivia (2008) evaluated the compressive strength "OPC and geopolymer concrete are shown in Table 7 also the high slump of geopolymer mixes were achieved by addition of super plasticizer also. Although the slump values are higher than 200mm for the geopolymer concrete and the compressive strength values are different for each mixture and shows that geopolymer concrete has high workability for compressive strength than 30 MPa addition .It was found that an increase of amount of water will improve the workability but decrease the strength of concrete when the water content is increased drastically also it will tend to produce bigger crystals of geopolymer and decrease the specific surface area of concrete" [31].

Table -7: the hardened Properties of the fresh and compressive strength for GPC [31]

Mixture no	Slump(mm)	Compressive strength	
		7 days	28 days
C1	200	-	34.09
C2	80	39.68	47.50
GP1	260	30.92	34.86
GP2	230	38.32	41.36
GP3	270	67.09	67.53
GP4	270	-	25.28
GP5	260	45.96	48.06
GP6	240	24.19	25.44
GP7	260	32.45	36.13

7. DURABILITYOF GEOPOLYMER CONCRETE

One of the significant issues related to Portland Concrete its lengthy haul toughness that was dependably been an issue versus aggressiveness environment. the solidness of Fly Ash, slag GGBS & GPC incorporates protection from Cl, HSO4, corrosive, and protection from defrosting. Durability is firmly identified with the Micro-structure & The relocation conduct Of particles From Fly Ash - Based Geopolymer. This is Can be balanced By Alkali reaction, restoring & expansion of Cl % Si exhaust combined amid The readiness Of Fly powder Based Geopolymer. In perspective of this, several investigations were being done to comprehend the conduct of geopolymers presented to these conditions [32].

7.1 Resistance to Chloride

Fly ash-based GPC were exposed to extreme ecological status utilizing chloride in a test examination directed by Bhagia Maria Joshy et al. (2014). The test built up that this geopolymer concrete has great protection from chloride attack. At the time of sampling for 90 days, no harm was observed in sodium solutions, respectively. As well there was no huge changes In The volume & in the test sample strength next into introduction time Of Ninety Days. This outcome demonstrates The Geopolymer Concrete is according to sea water region. At the point When equal the normal Portland Concrete, with Geopolymer concrete had brilliant mechanistic Characteristics & Durability. Because of it is amazing Compressive Strength, Geopolymer Concrete is reasonable For basic applications. The Compressive Strength misfortune round about (8 to 41 %) When This Geopolymer Concrete were presented to Sodium Chloride [33].

7.2 Resistance to Acid

The opposition offered by geopolymer cement to sulphuric corrosive was examined by Kumaravel S et al. (2013) by submerging into mixture for 90 days. The mixture was kept at room temperature and stirring was done accurately. So as to keep up the convergence of the mixture through the trial period, normal substitution is done. At the point when corrosive fixation expands, the heaviness of GPC diminishes. Indeed, even following Ninety days of submersion In corrosive, Same impact is Reflected [34].

The toughness of Geopolymer against forceful compound condition was explored by Neetu Singh et al (2013). When tested with sulphuric acid attack, there was loosestrife In The Compressive Strength. The gauge retrogression is based in two main factors namely The concentrations of alkali solution & The duration for periphrasis. But, when compared with resistance of Portland cement concrete against sulphuric acid attack, the performance of GPC is much better. When exposed to sulphuric acid attack, GPC cubes undergo only erosion of surface whereas deposition of White stratum of gypsum crystal happened in the acid insecure face of OPC specimen. The lower calcium content in the source material of GPC concrete is main possible factor for its better performance compared to OPC concrete when exposed to sulphuric acid attack. The calcium content in OPC concrete is much higher due to lime being one of source material. Hence it is well established by this study this study that GPC concrete has excellent mechanical properties and durability against aggressive environment compared to OPC concrete [35].

There was a study by Suresh Thukchom & al. 2009 on resistance Of Fly Ash based Geopolymer Mortars subjected for 10 % sulphuric acid, immersed for 18 weeks along with 5%-8% NaOH. The outcomes demonstrated that the losses Of Compressive quality were 28 % wail Na2O 8 % & 52 % When Na2O 5 % Along these lines, Its built up That Geopolymer Mortars had Better toughness & astounding mechanistic setting beneath sulphite corrosive condition [36].

7.3 Resistance to Sulphate

The varieties are influenced of the accompanying to evaluate the trial results in structure morphology b) compressive quality c) dynamic flexible modulus d) weight and e) volume according to Tang L et al. (2014). (SEM) procedure were utilized for consider The assault for sulfate on The microstructure of the example. Harm component amid disintegration practicability it can clarified via powerful versatile Modulus also to evaluate The obstruction for the Concrete to sulfate offensive, the most real measures proposed its dynamics flexible Modulus. a good reluctance on the geopolymer concrete sulfate attack is mostly a direct result of the accompanying two angles [37].

There were experimental investigations on performance of fly ash based geopolymer concrete done by Bhagia Maria Joshy et al. (2014) by subjecting it to severe environmental status and the outcomes built up the geopolymer concrete protection from sulfate attack is a good status. Indeed, even after introduction of these examples for up to Ninety Days for Sodium sulfate arrangement, the harm is not be to the surface and the Compressive quality misfortune round about 7% to 38% when presented to sodium sulfate [33].

Kumaravel S et al. (2013) investigated the resistance of geopolymer concrete to sulphates. The cylinders are prepared with different concentration of 12M, and 14 Mole of NaOH. Geopolymer concrete was tested with different concentration of NaOH for sulphate resistance. When compared to initial weight, there were increase of 6%, 7%, 4% and 10% in specimen of 8M, 10M, 12M and 14M respectively. The compressive strength of GPC specimens immersed in Na_2SO_4 about 90 days is reduced. The 8M, 10M, 12M, and 14 Mole specimens show reduction in strength of 11%, 16%, 10% and 18% respectively with respect to control specimen. From this, it is found that salt resistance of geopolymer concrete made from 12M NaOH concentration showed the least reduction in weight and strength when compared to 8M, 10M and 14M NaOH concentration used for GPC [34].

There was an investigation conducted to study the effects of aggressive chemical environment on durability of GPC by Neetu Singh et al (2013). The test result established that the GPC (heat cured fly ash based) has excellent resistance to sulphate attack. Even after exposure up to 90 days, there is no major reduction in mass and the compressive strength. When exposed to sulphate salt for various periods up to 90 days, the decreased in GPC is lesser compared to OPC which confirmed its significant resistance to sulphate attack [35].

7.4 Freeze-thaw resistance

Degirmenci (2018) evaluated the freeze and throwing of GPC " After 25 cycles, body disruption or deformation could not be detected in geopolymer specimens and the influence of freeze-thaw test on the weight loss of NZ based geopolymer mortar is larger than that on the weight loss of GGBS and FA based geopolymer mortars also after 25 cycles of freeze-thaw, the weight losses were 22.9 %, 8.46 % and 5.16 % for NZ, FA and GGBS specimens respectively, for Na2SiO3/NaOH:1.0 while the weight losses were 15.34 %, 5.30 % and 4.11 % for NZ, FA and GGBS specimens respectively, for Na2SiO3/NaOH:3.0 and addition of FA and GGBS to NZ-based mortar by 50 % reduced the weight loss of mortars. Besides, the Na2SiO3/NaOH ratios of alkaline activator solution were found to be effective on weight loss. As the Na_2SiO_3 / NaOH ratios of the alkaline activator solution increase, the weight losses of geopolymer mortars decrease" [38].

The compressive strength rates of the sample "were smaller after 25 of freeze-thaw cycles as compared with the values obtained for the specimens without any freeze-thaw test. The residual compressive strength values of NZ-based geopolymer mortars were found to be lower than the residual compressive strength values of FA-based and GGBS-based mortars after the action of the same cycles of freeze-thaw. The strength of the NZ-based geopolymer specimens after 25 freeze-thaw and the Na_2SiO_3 /NaOH ratios of the alkaline activator solution used to prepare geopolymer mortars have an effect on both weight loss and residual strength of the specimens subjected to freeze-thaw test although. As the Na_2SiO_3 / NaOH ratios increased, the weight and strength losses of the specimens exposed to 25 of freeze-thaw cycles decreased" [38].

8. BENEFITS OF GEOPOLYMER CONCRETE

Geopolymer is superior to typical cement in numerous perspectives, for example, compressive quality, introduction to forceful condition, usefulness and presentation to high temperature.Geopolymer concrete has several economic benefits over conventional Portland cement concrete. Geopolymer concrete is cost effective against the conventional Portland cement concrete which has similar performance [39].

It acts as a low-carbon and lesser energy consumption material and is a better alternative to traditional cement concrete and also reduces the carbon dioxide CO2 emission and other environmental pollutions. Rock based geopolymer achieves 59% of energy needs whereas slag based geopolymer achieves 43% reduction in energy needs than a conventional concrete. Carbon emissions are also lower in geopolymer where reduction in 80% and 70% of carbon emission is achieved for rock based and slag based geopolymer respectively [39].

Further the recent research focuses on the low drying shrinkage, low creep, resistance of sulfate attack or acid attack, acid resistance and fire resistance which may yield additional economic benefits while utilizing geopolymer concrete in infrastructure applications [39].

The main benefits of geopolymer concrete over conventional concrete are:

- High compressive strength
- High abrasion resistance
- Rapid setting and quick hardening
- Fire resistance (up to 1000ºC)
- Less emission of toxic fumes under heating
- High resistance to different acids and salt solutions attacks
- Less deleterious alkali-aggregate reactions
- Low shrinkage and thermal conductivity
- High surface resistance etc.

9. LIMITATIONS

Albeit various geopolymer frameworks have been suggested, they are hard to work with and require extraordinary consideration in their production. Moreover, a danger related with the high alkalinity of the enacting arrangement might occur, and high alkalinity additionally requires more preparation, bringing about expanded vitality utilization and ozone depleting substance age. Moreover, the polymerization response is extremely delicate to temperature and for the most part needs geopolymer concrete be restored at lifted temperature under an entirely controlled temperature routine (Hardjito et al. 2004; Tempest et al. 2009; Lloyd and Rangan 2009). In numerous

regards, these actualities may constrain the down to earth utilization of geopolymer concrete in the transportation foundation to precast applications. [40,41,42].

Extensive research is in progress to create geopolymer frameworks that address these specialized obstacles, making a low typified energy, low carbon-dioxide fastener that has comparable properties to portland concrete. Furthermore, present research is concentrating on the improvement of easy to understand geopolymers that don't require the utilization of exceptionally harsh initiating arrangements.

10. APPLICATIONS OF GEOPOLYMER CONCRETE

High-early Concrete strength is a typical for geopolymer cement upon dry-warmth or steam relieved, albeit surrounding temperature restoring is feasible for geopolymer concrete. It is utilized to create precast railroad sleepers, sewer funnels and so on so forth [43].

10.1 Pavements

Aldred (2012) explained “a typical light pavement, 900 meters long by 5.5 meters wide as shown in Fig.12, was cast using Grades 25 MPa and 40 MPa and the variety of construction procedures were used to assess pump compared with chute placement, saw cutting compared with wet formed tooled joints, manual compared with power troweling also noticeable difference to GP concrete is that the geopolymer concrete had no available bleed water rising to the surface that .To maintain adequate surface moisture for screeding, floating and troweling operations as well as provide protection against drying, an aliphatic alcohol based surface spray was used throughout the entire placement period ” [43].

Fig - 12: “Placing of pavement using geopolymer concrete” [43].

10.2 Retaining Wall

For a personal residence a total over that were used in a retaining wall is fifty 40 MPa geopolymer precast panels. It was designed to keep a 3 meter of earth pressure; the panel length was about 6 meters and have 2.4 meters wide. Before sending the precast panel to site for the installation, it was cast in Toowoomba as shown in Fig. 13 and it cured beneath ambient conditions [43].

Fig - 13: Precast geopolymer retaining walls for a private residence [43].

10.3 Precast Bridge Decks

The Murarrie Plant site bridge is considered as the primary constructional geopolymer's applications. Made up of pultruded fiberglass girder it is a composite bridge structure which is acting compositely by a geopolymer bridge deck which is of grade 40. It brought to the site for the assembling in 2009 and this bridge was prefabricated at CFT factory in Wagners Toowoomba as seen in Fig.14. With continual concrete mixer truck loadings and there is no sign of distress and since that date the bridge has been in service successfully [43].

Fig - 14: Installation of prefabricated bridge at Murarrie concrete batching industry [43].

10.4 Precast Beams

In order to "Grade 40 geopolymer to produce 33 x precast floor beam-slab elements marks a significant milestone in modern geopolymer concrete and shows first application of modern geopolymer concrete into the structure of a multi-storey building, these precast floor beams form three suspended floor levels of the very innovative GCI building, which is a showcase for next generation sustainable building technologies and there are 2 sizes of beams which span 10.8 m (x 2.4 m wide) and 9.6 m (x 2.4 m wide) respectively also apart from being a structural floor element, the beams also are a major architectural feature, having an arched curved soffit and being specified as off form class 2 with a light white color as seen being lifted into place in Fig. 15 .Although the beams will also play a major part in low energy space heating with water pipes being placed inside them for temperature controlled hydronic heating of the building spaces above and below" [43].The view of this existing building is presented in Fig .16.

Fig - 15: Meter “geopolymer beam with vaulted soffit being craned into position” [43].

Fig - 16: The Global Change Institute as sustainable construction [43].

11. CONCLUSION

Geopolymer concrete is a modern concrete used worldwide it is useful for environment development. It provides plenty of benefits over ordinary Portland cement concrete. The cost of one ton of fly ash is negligible in comparison to the cost of one ton of ordinary Portland cement. Therefore, zero cement concrete (geopolymer concrete) is cost effective against Portland cement concrete. In addition, geopolymer concrete is a low-carbon alternative to Portland cement concrete. For example, the appropriate usage of one ton of fly ash earns approximately one carbon-credit that has a redemption value. Furthermore, the low drying shrinkage, the low creep, the excellent resistance to sulfate attack, good acid resistance, and excellent fire resistance offered by geopolymer concrete may yield additional economic benefits when it is utilized in infrastructure applications.

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