International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

Geopolymer Concrete by using Fly Ash, GGBS, Quarry Dust and 10mm Aggregate

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Abstract*: Geopolymer concrete is a type of concrete which is produced by reacting with a caustic activator to aluminum and silicate bearing material. Materials such as fly ash or iron and metal slag are commonly used, which helps to create a cleaner environment. Consistently 87 to 100 million tons of flyash are created from India's coal-based thermal power stations, and force is that way into a country's success and improvement. In India, power generation spends 70% of the nation's coal generation along these lines and produces 100 million tons of debris per year. The flyash is expected to stretch by 2012 to at least 175 million tonnes per annum. Now, having seen that debris is such a useful and valuable material that it is often used for a tremendous number of uses such as construction segments, concrete, dike development, raising, dykes, agribusiness and mine filling material. It's effectively acknowledged for scale usage as opposed to arranging at high dealing with costs. This content arrangement with geopolymer concrete to supply the geo-polymer concrete is completely supply with flyash and Ground granulated slag. Fine aggregate is replaced with powdered quarry and M.Sand. C oarse Aggregate (20 mm) is replaced with 10 mm Aggregate Sodi um hydroxide (NaOH) and sodium silicate (Na2Sio3) game plans are commonly used for polymerization. The use of fly-debris and GGBS help in diminishing the contamination by dispensing with carbon-dioxide and carbon monoxide gas which is created in assembling of concrete. This paper uses fly ash, GGBS, quarry dust and 10 mm aggregate with alkaline solution to analyze geopolymer concrete.

Keywords: Geopolymer concrete, Flyash, GGBS, Quarry dust, 10mm aggregate, M.Sand, alkaline solution.

I. INTRODUCTION

In 1950 chelokovski invented the concept of Geopolymer cement and in 1978 it was later published as a geopolymer by a French educator Davidovits. Geopolymer Concrete is an innovative material that substitutes conventional solids and does not include any quantity of OPC as a fastener. Rather, the binding properties are given by an alkaline reaction to a source material rich in silica. These silica and alumina gets for the most part broke up inside the soluble activator (NaOH) arrangement and polymerization process is experienced at that point. Likewise, the inventory of the stream sand has arrived at a disturbing state inside the present situation and has made a tremendous interest for a proportional in development segment and it's directed to a natural lopsidedness. So inside the housing industry there is a requirement for using ' clean sand. ' Since river sand is scarce, processed sand is an alternative to the river sand to address the demand problem. Actually, various projects including major sectors of government around the world have focused on the use of processed sand looking forward to its continuous gradation and zero impurity.Also it had been realized that the high strength alone won't be an efficient method of achieving high performance which the sturdiness of those materials in various environments needs a far better understanding to realize an appropriate solution. the use of huge quanties of commercial wastes presently available as pozzolanas in concrete showed the chances of obtaining very high strength concrete having much lower reactivity. the foremost noteworthy of those works is perhaps the introduction of mineral admixtures like ash, furnace slag, silica fume etc. With the utilization of both mineral admixture and super plasticizers, it's now possible to develop both high strength and high performance in concrete composition.

Manuscript received on February 10, 2020.
Revised Manuscript received on February 20, 2020.
Manuscript published on March 30, 2020.
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II. REVIEW CRITERIA

R. Nagajothi, S. Elavenil Report (2005) Concrete mix architecture for the M30 kit was rendered in compliance with Indian quality code (IS10262). Solid block (100x100 mm) and cylinders (150x300 mm) were casted and their separate mechanical properties were surveyed during multi-day relief periods by shifting the m point. Sand was resolved as 0 percent, 20 percent, 40 percent, 60 percent, 80 percent and 100 percent in the blend and the desired rate of replacement. The compressive quality and elastic split results expanded with expanded extent of m. Sand over the sand of the river. It was presumed that ideal rate was finished substitution of river sand by m. sand (100%).Pattanapong Topark-Ngarm et al.(2005) created a rare variety of geopolymer concrete by using exceptional fly ash with higher calcium content from the debris left over from the northern Thailand Mae Moh power plant. For different molarities, the perspectives such as bond, setting time, and price angles were investigated. The relief technique used consisted of two methodologies to restore precise warmth 60 ±2 ° C over a 24-hour cycle, while the other was conventional restoration at 23±2 ° C.The results showed that the use of high calcium-based fly ash,

reinvigorated expanded qualities along with more notable holding attributes between solid and rebar. Likewise, the equivalent's new properties indicated that the setting time was reduced in the range of 28-50minutes, as the degree of calcium content in the blend was high.

Gaurav Nagalia et al.(2008) involved various alkaline solutions such as NaOH, KOH,Ba(OH)2 for making geopolymer concrete by combining both class C fly ash (9.43 percent Calcium oxide) and class F (1.32 percent Calcium oxide) and casting and curing specimens under various experimental conditions. The technique is X-ray diffraction (XRD), and electron microscopy scanning (SEM) Was involved in geopolymer matrix identification. They induced that the micro structural properties assumed considerable work on compressive quality and time esteems setting. It showed that high content of CaOs in fly ash came about in expanded quality geopolymer cement.Likewise, the outcomes demonstrated that, NaOH in correlation with other soluble base arrangements indicated huge outcomes regarding mechanical properties similar to Ordinary Portland Cement (OPC). The exploration additionally included micro structural level investigation including utilization of X-beam diffracted picture and examining electron microscopy examination alongside dispersive spectroscopy. The outcomes demonstrated the arrangement of NaAlSi3O8 and water causing hydration of silicates about expanded compressive quality attributes DjwantoroHardjito, Dody M.J. Sumajouw, Steenie E Wallah and B.V. Rangan (2001) describes the impacts of a few factors on the properties of Geopolymer Concrete based on fly ash, particularly the compressive quality. Testing variables included solid time, restoration time, temperature relief, super-plasticizer geo-polymer amount, rest period until relief, and water substance of the mix. They concluded that the compressive strength of cement does not fluctuate with age, and that the reconstruction of solid examples at higher temperatures and longer relief times would result in higher compressive quality. Additionally, they have finished super-plasticizer based on Naphthalene which improves the usefulness of crisp geopolymer concrete.D. M. J. Sumajouw D. Hardjito S. E. Wallah B. V. Rangan (2007) presents the experimental study and research on the behavior and quality of reinforced people. Geopolymer thin layers of concrete. They argued that warmth restored low-calcium fly ash-based geopolymer concrete has amazing potential for prefabricated business applications. The items that this industry is delivering right now can be manufactured using geopolymer concrete. Because of solid geopolymer items, the structure arrangements contained in the present gages and codes can be used. Shuguang Hu, Hongxi Wang, GaozhanZhang ,Qingjun Ding(2007) they arranged three fix materials by utilizing concrete based, geo-polymeric, or geo-polymeric containing steel slag. They presumed that the geo-polymeric materials would be advised to fix attributes than concrete based fix materials, and the expansion of steel slag could improve altogether the scraped area obstruction of geopolymeric fix. By methods for examining electron microscopy (SEM) it can likewise be reasoned that the steel slag was completely retained to participate in the soluble base enacted response and be immobilized into the indistinct alumino silicate geopolymer network Christina K. Yip, John L. Provis, Grant C. Lukey, Jannie S.J. Van Deventer(2008) The compressive strength of matrices prepared with mainly amorphous calcium silicates (blast furnace slag) or containing crystalline phases specifically developed for reactivity (cement) in this low alkalinity paper is much higher than when the calcium is supplied as crystalline silicate minerals. They concluded that the compressive strength of matrices containing natural (crystalline) calcium silicates is improving with increased alkalinity, however the opposite trend is observed in matrices synthesized with processed calcium silicate sources. Calcium plays a lesser role at high alkalinity in affecting the nature of the final binder, since it forms precipitates rather than hydrated gels. Thus, the different sources of calcium silicate will not have a significant impact on the mechanical properties of those matrices. Therefore, the effects on geo-polymerization of different calcium silicates are seen to depend most significantly on two factors: Zhu Pan, Jay G. Sanjayan , B. V. Rangan(2009) they inferred that the ductility of the mortars has a significant relationship to this quality conduct. They arranged the examples with two diverse fly remains, with qualities running from 5 to 60 MPa, were researched. They reasoned that the quality misfortunes decline with expanding flexibility, with even quality additions at significant levels of malleability. This relationship is credited to the way that mortars with high pliability have high ability to suit warm contrary qualities. It is accepted that the two restricting procedures happen in mortars

III. OBJECTIVE OF THE STUDY

Our point is to have a replacement fastener as opposed to Cement in Concrete. The approach of reasoning is during the get together of concrete, better amounts of CO2 is launched into ecosystem and causes heating. at some point of this admire Geopolymer concrete is produced by using replacing cement with Geopolymer binder which consists of Flyash and alkaline liquids and also fine aggregate is replaced with quarry dirt as it's most economical than fine aggregate

IV. GEOPOLYMERCONCRETE

New era GPC may be a promising technique and eco friendly alternative to OPC. Geopolymer is produced via a polymeric response of alkaline liquid with supply cloth of herbal minerals or substances with out cement Geopolymer concrete was first introduced by Joseph Davidovits (1978). Davidovits Proposed that a alkaline may be utilized for the response with silicon and aluminum during a source material of debris, silica, slag, rice husk debris, red mud etc. The reaction takes place during this case called Polymerization process and thus he stamped the term ‘Geopolymer’ to represent the binders. For geopolymer, the source supported alumina-silicate should be rich in silicon (Si) and aluminum (Al). The alkaline liquids that are normally supported sodium or potassium which are soluble alkali metals. In geo polymerization, the foremost common alkaline liquids are the mixture sodium hydroxide and soluble glass or sodium silicate.

Geopolymer are utilized in many fields thanks to their various properties of high compressive strength, low shrinkage, acid resistance, fire resistance and high durability.
Studies of most of the Geopolymer concrete are done under heat cured regime. At the temperature ranges from 60^0C to 90^0C for 48 hrs, the polymerization process is fast.

A. Fly Ash

Fly ash is made by the consuming of coal a side-effect of mechanical coal.The cementations properties of debris were found in late nineteenth century and it's been generally used in concrete assembling for more than 100 years. It generally replaces between 20 and 80 per cent of the traditional hydraulic cement

B. Ground-granulated blast-furnace slag

Ground-granulated impact heater slag (GGBS or GGBFS) is acquired by extinguishing liquid iron slag (a side-effect of iron and steel-production) a heater to supply a polished, granular item that is then dried and ground into a fine powder. Ground -granulated furnace is very cementations and high in CSH (calcium silicate hydrates) which may be a strength enhancing compound which increases the strength, durability and appearance of the concrete.

C. Quarry Dust

Presently a-days the M.sand has become rare and expensive. Consequently we are compelled to consider elective materials. The Quarry residue might be utilized in the spot of river sand completely. The world wide consumption of fine aggregate in concrete production is very high, and several developing countries have encountered difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years.. To beat the pressure and interest, specialists and professionals in the development ventures have recognized some elective materials, for example, fly debris, slag, limestone powder and siliceous stone powder. In India endeavors have been made to replaced river sand with quarry dust. The successful utilization of quarry dust as fine aggregate would turn this waste material that causes disposal problem into a valuable resource. The usage can residue strain on deliver of natural fine gregate mixture, so that you can additionally reduce the fee of concrete.

D. Fine Aggregate

The other type of aggregates are those particles passing the 9.5 mm sifter, predominantly passing the 4.75 mm strainer, and overwhelmingly held on the 75 µm (No. 200) strainer are called fine aggregate. For expanded usefulness and for economy as reflected by utilization of less concrete, the fine aggregate ought to have an adjusted shape. The reason for the fine aggregate is to fill the voids

E. Coarse Aggregate (10mm)

Coarse aggregate of most extreme size of 12mm and which are perfect, solid, tough and liberated from any pernicious substance is utilized. The test on coarse aggregate behaviors as indicated by IS:383-1970.Those particles that are overwhelmingly held on the 4.75 mm (No. 4) strainer and will go through 3-inch screen, are called Coarse Aggregates. The coarse aggregate the more conservative the blend. Using aggregates larger than the maximum size of coarse aggregates .

F. Alkaline Solution

The alkaline liquid commonly used in geopolymerisation is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate. Xu and van Deventer (2000) observed that the addition of sodium silicate solution to the sodium hydroxide solution as the alkaline liquid enhanced the polymeric reaction.

Sodium silicate

Sodium silicate is the normal name for a compound sodium meta-silicate, Na2SiO3, otherwise called fluid. Sodium carbonate and silicon dioxide respond to shape sodium silicate and carbon dioxide

Sodium hydroxide

Sodium hydroxide is an inorganic compound with the substance equation NaOH. It is a white strong and profoundly scathing metallic base and soluble base salt which is accessible in pellets, drops, granules. Sodium hydroxide is dissolvable in water, ethanol and methanol. Like the hydration of sulphuric corrosive, disintegration of strong sodium hydroxide in water is a profoundly exothermic response wherein a lot of warmth is freed, representing a danger to security through the plausibility of sprinkling; Hand gloves is suggested while planning sodium hydroxide arrangement. The subsequent arrangement is generally lackluster and scentless with dangerous inclination upon contact with different salts.

F. Steel fiber

Steel fiber for reinforcing concrete is characterized as short, discrete lengths of steel strands with a perspective (proportion of length to width) from around 20 to 100, with various cross-areas, and that are adequately little to be haphazardly scattered in an unhardened solid blend utilizing the standard blending strategies. A specific measure of steel fiber in cement can cause subjective changes in cement's physical property, significantly expanding protection from splitting, effect, weakness, and bowing, constancy, solidness, and different properties.

G. Molecular weight for alkaline solution

Sio_2
Si has 1 atom, o has 2 atoms
Atomic mass; si = 28.0855 amu; 2o= 2x15.999 = 31.998 amu
Total = 60.08 amu

$Na_2 0$
Na has 2 atoms, o has 1 atoms
Atomic mass ; 2Na = 2 x22.989 amu = 45.978 amu
O = 15.999 amu ; Total = 61.97 amu

$Na_2 0$
H has 2 atoms, o has 1 atoms
Atomic mass ; 2H= 2x1.00794 amu = 2.01588 amu;
o = 15.999 amu; Total = 18.01318 amu

H. Preparation of Alkaline Liquids

Right now geo-polymer concrete is blends of fluctuating molarities of Sodium hydroxide (8M, 10M, and 12M). The sub-atomic load of sodium hydroxide is 40. To plan 8M for example 8 molar sodium hydroxide arrangement, 320g of sodium hydroxide drops are gauged and they can be broken up in refined water to shape 1 liter arrangement. For this, volumetric jar of 1 liter limit is taken, sodium hydroxide chips are added gradually to refined water to get ready 1liter arrangement. The sodium silicate arrangement and the sodium hydroxide arrangement were combined in any event one day before use to set up the alkaline liquid with the steel fibers

I. Manufacturing and Curing Of Geo-Polymer Concrete

The regular technique utilized really taking shape of ordinary cement is embraced to plan geo-polymer concrete. To start with, the quarry dust, coarse aggregate and fly ash a proposal combined dry mix for three-four minutes and in a while the primary arrangement which is a combination of Sodium hydroxide and Sodium silicate with steel fibers. The blending is done around 6-8 minutes for appropriate holding of the considerable number of materials. For the relieving of geo-polymer solid shapes, the 3D squares are set in direct daylight.

V. BENEFITS OF GEOPOLYMER CONCRETE

Geopolymer is superior to ordinary cement in numerous perspectives, for example, compressive quality, presentation to forceful condition, usefulness and introduction to high temperature. Geopolymer concrete has a few monetary advantages over traditional Portland concrete cement. Geopolymer concrete is financially savvy against the regular Portland concrete solid which has comparable execution. It goes about as a low-carbon and lesser vitality utilization material and is a superior option in contrast to customary concrete cement and furthermore decreases the carbon dioxide CO2 emanation and other ecological contaminations. Rock based geopolymer accomplishes 59% of vitality needs though slag based geopolymer accomplishes 43% decrease in vitality needs than a regular cement. Carbon outflows are additionally lower in geopolymer where decrease in 80% and 70% of carbon discharge is accomplished for rock based and slag based geopolymer individually.

VI. CHARACTERIZATION TESTS FOR MATERIALS

According to the requirements, the chemical composition and mineralogical investigations should be carried out for the materials as follows:

X-ray diffraction (XRD) – Identifying crystalline materials and composition X-ray fluorescence (XRF) – Identifying minerals, sediments and fluids particles• Energy dispersive X-ray Analysis (EDX) – Identifying elemental analysis or chemical• characterization of samples. Field Emission Scanning Electron Microscopy (FESEM) – Identifying Quantitative• compositions of samples in the field.

VII. INVESTIGATION ON MATERIAL TESTING

Tests to be conducted to determine the Mechanical properties of the concrete

- ✓ Compression test
- ✓ Split Tensile test
- ✓ Flexural strength test
- ✓ Impact strength test
- ✓ Surface hardness test
- ✓ Modulus of Elasticity

Tests to be conducted to determine the Durability properties of concrete

- ✓ Water absorption test
- ✓ Sorptivity test
- ✓ Rapid chloride penetration test
- ✓ Permeability
- ✓ Acid resistance test

VIII. RESULT

Geopolymers are inorganic materials that form long-range, covalently bonded, non-crystalline (amorphous) networks, usually ceramic ones. Fragments of obsidian (volcanic glass) are a part of some geopolymer mixtures.Polymers are either organic materials, i.e. carbon based, or inorganic polymers, e.g. silicon based polymers. Experimental results demonstrated an improvement in the compressive strength of geopolymer concrete as the hooked steel fibers increase. The maximum compressive force obtained on the 14th day was up to 87.83 MPa. Geopolymer concrete density is in range from 2466 kg / m3 to 2501 kg / m3.

IX. CONCLUSION

A diagram of geopolymer is introduced along with its processing parameters. It concluded that Geopolymer concrete has highly strengthened. It has replaced with GGBS and Flyash. Wasted materials are used in the components of buidings investigations. For curing has given better results by direct sunlight. Investigation is progressively impervious to consumption, rigid qualities. The shrinkage is additionally less contrasted with standard cement. Consequently, considering these basic points of interest it might be presumed that, in not so distant future Geopolymer cement may locate a powerful interchange to standard concrete cement. It improves the mechanical behavior of concrete. and enhance the durability of concrete.

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Dr. S. Arivalagan is a Professor and Dean of Civil department in Dr.M.G.R Educational and Research Institute. He has completed Doctor of science in the year of 2013. In 2010, he has done post doctoral fellowship in the University of Malaya. Before that, he has completed Ph.D in Anna university for the year of 2008. He has completed master of Engineering in Structure and Bachelor of Engineering in civil engineering He has a teaching experience of over 30 years. At present, under his supervision, nine scholars are pursuing their Ph.D. He has published 20 papers in Scopus Indexed Journal, more than hundred papers in UGC listed and other journals and also presented papers in both National and International conferences. He was a Doctoral Committee Member. He is the journal reviewer of Civil Engineering.