AN INVESTIGATIONAL STUDY OF THE STURDINESS OF GEOPOLYMER CONCRETE MADE BY SUBSTITUTING MANUFACTURED SAND WITH NATURAL SAND

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ABSTRACT
In the world, concrete is the material that is most frequently used for construction. Portland cement consumption increases as a result of the increased demand for concrete as a building material. An environmentally friendly alternative to regular Portland cement is geo-polymer. By combining ingredients like fly ash, grounded granulated blast furnace slag (GGBS), fine aggregate, and coarse aggregate with sodium hydroxide solution, sodium silicate solution (NaOH and Na2SiO3), or potassium hydroxide, potassium silicate solution (KOH and K2SiO3), it is possible to create geo-polymer concrete that is then properly cured. Alkaline liquid is a mixture of sodium hydroxide solution and sodium silicate solution. This study's research focuses on substituting the fine aggregate material in geo-polymer concrete with Msand. Complete 100% replacement of natural sand with manufactured sand and compare the results witch GPC natural sand and GPC witch Msand and its durability. When exposed to sulphate, and acidic environment and assessment were made with normal Ordinary Portland Cement (OPC) concrete. In total four tests were conducted to determine acid and sulphate resistance of geo- polymer concrete witch Msand. The tests involved concentration for a period of 30 to 60 days into 5% solution of sodium sulphate, 5% solution of magnesium sulphate, 5% solution of sulphuric acid and 5% solution of phosphoric acid. The progression of weight loss and compressive strength loss were studied. The most major degradation of compressive strength and weight were determined in 5% of acid solution. The minimum strength dissimilarity and weight loss were found in the 5% of sulphate solution. The Ordinary PC concrete deteriorated more in acid as well as in sulphate solution in compared with geo-polymer concrete, thus geo-polymer concrete is more durable than the OPC concrete.
Keywords: Binding material, GPC, Manufactured sand, degradation, deteriorated

INTRODUCTION

The most adaptable building material used worldwide is concrete. Concrete was increasingly being used. The manufacture of cement requires the release of significant amounts of greenhouse gases, such as carbon dioxide, into the atmosphere, making the cement sector the second-largest generator of greenhouse gases. Around 1 tonne of carbon dioxide is produced in the manufacture of 1 tons of cement. Carbon dioxide is produced when lime stone, clay, and other materials are burned at 1500°C. Concrete is the material that can accommodate a variety of requests for things like homes, bridges, highway pavements, commercial buildings, water-carrying and retaining structures, etc.

GEO- POLYMER

Davidovits (1978) father of geo-polymer .Geo-polymer is a advanced family of cementations materials that is way more environmental good natured due to its less emission of CO2 gas and energy consumption. Geo-polymers can be used as cementations material that utilize high siliceous materials like fly ash, Ground Granulated Blast furnace slag(GGBS), Silica Fume (SF),Rice Husk Ash (RHA), and Metakaolin (MK) for binding which can produce an eco-friendly material. These materials available with less cost and only for transportation it costs. By expanding the Molarities the strength of GPC were also increases. Geo-polymer is an inter mix result of aluminum and silicon. It is manufactured by geochemistry process.
Alkaline solution is worn as the binding material for geo-polymer concrete. Alkaline solution is made using sodium hydroxide (NaOH) and sodium silicate (NasiO3) solutions. Fly ash based geo-polymers use fly ash as the substance which react as source of silicon and aluminum for reaction by an alkali to make silicon and aluminum atoms to form geo-polymer paste. Geo-polymer materials are generally low density due to the active of micro sized and Nano sized pores within the end products.

MATERIALS USED FOR GPC:

Fly ash (Class F):-The greater part of fly ash used, in a consequence from the burning of pulverized coal to generate electricity at power stations. Fly-ash mainly contains silica, alumina and minor amounts of oxides such as iron (Fe), sodium (Na), calcium (Ca), magnesium (Mg) and potassium (K). But major chemical constituents in class-F fly ash are alumina and silica, combined occupies supplementary than 90% of fly ash and low in calcium. Where as in class F fly ash low in calcium. The class-F fly ash used in our work is secure from National Thermal Power Project (NTPC) Vijayawada, ANDHRA PRADESH.

GGBS (ground granulated blast-furnace slag):-GGBS is a consequence from the producing of iron. Molten slag is drain off from the blast furnace through out the production of molten iron. If it is cooled quickly, the powdered material has inactive pneumatic properties. These utilize at a temperature of about 1,500 degrees centigrade and are fed with a attentive manage mixture of iron-ore, coke and limestone. The iron ore is minimized to iron and the endure materials form a slag that floats on the surface of the iron. This is separated from separate hopper and collected in the cyclone filters. In this operation the temperature used to be reduced and moved to storage silo from here the transportation is carried. This slag is frequently drained off as a molten liquid and it is to be used for the production of GGBS.

RAW MATERIALS

Alkaline solution: A combination of the sodium hydroxide and sodium silicate solutions was used as the alkaline liquid to activate Fly ash and GGBS. Sodium hydroxide pellets and sodium silicate solution used in this study are shown. Sodium based solutions were chosen because they were cheaper than Potassium based solutions. The sodium hydroxide solids were either a technical grade in flake or pellets. The sodium hydroxide flakes were obtained from SREE chemical agencies gollapudi, Vijayawada and fusion chemicals & products pvt.Ltd.Telangana.

Manufactured sand: Manufactured sand is used as secondary material of fine aggregate and which is collected from stone crusher. Manufactured sand has not been used much in India for that basis that normally squeeze sand is blistering ,badly graded ,rough textured,contain excess of dust hence they result in production of poor concrete for the given design frame work. In this operation stone is crushed in 5 dissimilar crusher's stages to get M-sand.

OBJECTIVE OF THE STUDY

- To develop the proper blend proportion for geo-polymer concrete and renewal of natural sand with M-sand in geo-polymer concrete.
- To study the behavior of GPC and to know compressive strength andsplit tensile strength GPC made with M-sand
- Concrete cubes, cylinders specimens made with Fly ash and GGBS.
- To evaluate the different strength and durability properties of geo- polymer concrete mixture replaced with Manufactured sand
- Different Types of Durability tests were to be done and compared with OPC

LITERATURE REVIEW

- The mixture of fly ash (FA) and ground granulated blast-furnace slag (GGBS) is produces high-strength geo-polymer concrete
- Low calcium Class F (ASTM) dry fly ash is more preferable for the geo-polymer concrete due to affluent in silicon and aluminum ,Compressive strength of the geo-polymer concrete is higher while comparing with ordinary Portland cement
- Increasing the percentage of fine quality in concrete by adding together M-sand reduces the porosity.
- By adding M-sand to concrete enlarge the compressive strength.
- The addition of basalt fiber can considerably develop deformation and energy combination capacities of geo-polymer concrete.

Use of steel fibers in different volume portion in concrete can increase the ductility factor and load carrying capacity of specimens.

- Steam curing is very efficient for geo-polymer concrete specimens.
- Strength of GPC increases if curing time is improved

- Geo-polymer concrete has high resistance to acid attacks.
- Geo-polymer concrete resist heat for long time.
- Curing temperature and nature of alkaline solution.

Alkaline activator concentration, are the most significant stricture necessary for optimization of Geo-polymer mortar specimens of elevated temperature as they affects physical-mechanical properties and microstructure at superior temperature.On the source of accessible literature on geo-polymer concrete for the most part of the works done in the past have been by means of only Fly ash as a source material. Very few numbers of works has been done on Fly ash and GGBS-based geo-polymer concrete. From the literature survey, replacement of natural sand witch M-sand in to the geo-polymer concrete will improve the properties of GPC.

METHODOLOGY MANUFACTURE OF GEOPOLYMER CONCRETE:

Davidovits (2002) recommended that it is preferable to mix the sodium silicate solution and sodium hydroxide solution collectively at least one day before adding the solution to the solid constituents. Fly ash and GGBS- based geo-polymer concrete was dark in color, and concrete was cohesive. Segregation and bleeding were occurred when water satisfied in the mixture is high. From the initial work, it was determined to observe the following standard process of mixing in all further studies. Mix sodium hydroxide solution and sodium silicate solution jointly at least one day previous to adding the liquid to the dry materials. The fly ash, GGBS was sieved from 90 Microns sieve without any lumps. The aggregates have to be arranged in soaked-surface dry condition. Mix all dry materials in the pan mixer for about three minutes. The alkaline liquid has to be varied with the super plasticizer and the additional water, if any Add the liquid constituent of the mixture at the end of dry mixing, and maintain the wet mixing for another four minutes.

COST ANALYSIS

Cement has a very efficient moving and transportation system in our country which makes its transportation cost less. GGBS and coal ash currently doesn't have such a system. To regulate this end product, the transportation of these materials is said to be in the similar behavior as cement. Standard contents accuse from Indian Railway website is measured for this analysis. Local market price for NaOH and aggregates were considered in this study. The cost per quantity and total cost is mentioned in Table 3.10. Only fly ash-GGBS based concrete are used for this study.

Materials	cost
GGBS	1.5
Fly Ash	1
Coarse Aggregate 0.43	0.43
Fine Aggregate	1.55
Water	0.1
NaOH	80
Sodium Silicate	10

The total cost of geo-polymer concrete (Rs 4153.38) for cubic meter . The cost of OPC concrete exist taken as of ready mix plant cost since now a days for industrial or domestic construction were made by using RMC plants. It is easy and 20% less than OPC based concrete (Rs 3300). This concentrated cost is mostly due to the assumptions made for the transportation of coal ash, GGBS and sodium silicate. If we are not considering the ready mix cost and if we takenversine material means it costs around (Rs 5500.00) based up on distance the cost of materials were changed. The transportation cost plays a major roll.

RESULT ANALYSIS

Compressive strength after Alkaline test

No. of Days	OPC concrete (%)	Geopolymer concrete (%)
0 days	41.3	64.7
30 days	35.3	61.2
60 days	31.6	56.3

Compressive strength after sulphate attack test

No. of Days	OPC concrete (%)	Geopolymer concrete (%)
0 days	41.3	64.7
30 days	36.3	60.3
60 days	31.1	58.07

Compressive strength after chloride attack test

No. of Days	OPC concrete (%)	Geopolymer concrete (%)
0 days	41.3	64.7
30 days	3213	59.6
60 days	30.6	57.3

Compressive strength after Acid resistance test

No. of Days	OPC concrete (%)	Geopolymer concrete (%)
0 days	41.3	64.7
30 days	34.6	58.3
60 days	30.8	55.3

CONCLUSION

The research described here included an experimental investigation on the performance of geo-polymer concrete using fly ash and GGBS-based geo-polymer concrete specimens as a substitute to natural river sand used in sand manufacture. The base material for geo-polymer concrete was low calcium (ASTM Class F) dry fly ash from the thermal power plant in Vijayawada, Andhra Pradesh. 50% GGBS and 50% Fly ash were used in the mix design as a complete substitute of cement. The geo-polymer concrete's strength is increased by the use of GGBS. In this investigation, M-sand is employed in place of fine aggregate entirely. Alkaline solution was created by combining sodium silicate solution with sodium hydroxide solution. One day must pass after making this alkaline solution before combining it with dry materials. The silicon and aluminum in fly ash reacted with alkaline solution to the form geo-polymer paste that bound the loose aggregate and un-reacted materials to produce the geo-polymer concrete. Geo-polymer Concrete based on fly ash gain a very high compressive strength in the first few hours of alkali activation (40-50 MPa after 24 hours)The aggregate consisted of coarse aggregate of maximum size 20 mm and fine aggregate confirming to zone II. The mix proportion and manufacturing process used to make the geo-polymer concrete were based on the earlier studies available on geo-polymer concrete.

Total 70 geo-polymer concrete cubes were made and tested for compressive strength and for durability. In this 12 cylinders and 12 beams are made with Fly ash and GGBS M-sand geo-polymer concrete and 36 more cubes are made with OPC concrete to compare the test results of durability.These cubes ,cylinders and beam tested for compressive ,flexure and shear behavior of geo-polymer concrete. Test results of these specimens are compared with the test results of M-sand specimens.

The cost analysis wereconsidered based upon market price. If we use commercial grade inset of laboratory grade the cost of sodium hydroxide and sodium silicate were reduced to 25% of actual price. By using M-sand instead of natural sand reduce the cost.The strength variation also more than compared with OPC concrete.

The major conclusion drawn from this research is presented below:

Geo-polymer concrete in structural applications has led to the total elimination of cement from concrete, which finally becomes “Green Concrete”

The fly ash, once consider as waste material, has originated significance through Geo-polymer concrete in construction industries and become a valuable material

The increase in the absorption of sodium hydroxide from 8 M to 12M increased the viscosity and reduced the fresh properties of SCC mix.

The increase in the NaOH molarity increased the compressive strength of SCGC

- By replacement of natural sand with M-sand reduces the cost of concrete and no side effects
- Geo-polymer concrete can be prepared at comparable cost with OPC based concrete provided transportation system for raw materials is well established.
- While the addition of M-sand improved the loading capacity significantly, the improvement was marginal for ultimate load. The voids were reduced to 20% because M-sand contains of dust particles.
- Energy absorption capacity increases in the cylinders and beams with M-sand compared to natural sand.
- Its resistance against sulphate and acid attack makes it suitable to be used for construction in abrasive soils where ground water contains considerable amount of sulphate salts
- The compressive strength increased up to 25% for the durability

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