

Strength Studies on Geo-Polymer Concrete by Using Quarry Dust

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Abstract: The Major problem the world is facing today is environmental pollution. In the construction industry mainly the production of portland cement will cause the emission of pollutants results in environmental pollution. We can reduce the pollution effect on the environment, by increasing the usage of industrial by- products in our construction industry. geopolmer concrete is such a one and in the present study, to produce the geo-polymer concrete the portland cement is fully replaced with fly ash and the fine aggregate is replaced with quarry dust and bottom ash and alkaline liquids are used for the binding of materials. The alkaline liquids used in this study for the polymerization are the solutions of sodium hydroxide (Naoh) and sodium silicate (na2sio3). Different molarities of sodium hydroxide solution i.e. 8m, 10m and 12m are taken to prepare different mixes.

I. INTRODUCTION

For the construction of any structure, Concrete is the main material. Concrete usage around the world is second only to water. The main ingredient to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest menace to the human race on this planet today. The production of cement means the production of pollution because of the emission of CO₂ during its production. There are two different sources of CO₂ emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO₂. In India about 2,069,738 thousands of metric tons of CO₂ is emitted in the year of 2010. The cement industry contributes about 5% of total global carbon dioxide emissions. And also, the cement is manufactured by using the raw materials such as limestone, clay and other minerals. Quarrying of these raw materials also causes environmental degradation. To produce 1 ton of cement, about 1.6 tons of raw materials are required and the time taken to form the limestone is much longer than the rate at which humans use it. But the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So to overcome this problem, the concrete to be used should be environmental friendly.

II. OVERVIEW GEOPOLYMER CONCRETE QUARRY DUST

A comparatively good strength is expected when sand is replaced fully with or without concrete admixtures. It is proposed to study the possibility of replacing sand with locally available crusher waste without sacrificing the strength and workability of concrete. Coarse aggregate of 20mm maximum size is used in Reinforced cement concrete work of all types of structures. This is obtained by crushing the stone boulders of size 100 to 150mm in the stone crushers. Then it is sieved and the particles passing through 20 mm and retained on 10mm sieve known as coarse aggregate. The particles passing through 4.75mm sieve are called as quarry dust. The quarry dust is used to sprinkle over the newly laid bituminous road as filler between the bitumen and coarse aggregate and manufacturing of hollow blocks. Based on this experimental investigations, it is found that quarry dust can be used as an alternative material to the natural river sand. The physical and chemical properties of quarry dust satisfy the requirements of fine aggregate. It is found that quarry dust improves its mechanical property of concrete if used along with super plasticizer. Usage of quarry dust, it will also reduce the cost of concrete.

III. LITERATURE REVIEW

Djwantoro Hardjito, Steenie E Wallah, Dody M.J. Sumajouw, and B.V. Rangan(1992) describes the effects of several factors on the properties of fly ash based Geopolymer concrete, especially the compressive strength. The test variables included were the age of concrete, curing time, curing temperature, quantity geo-polymer of super plasticizer, the rest period prior to curing, and the water content of the mix. They concluded that compressive strength of concrete does not vary with age, and curing the concrete specimens at higher temperature and longer curing period will result in higher compressive strength. They also concluded Naphthalene-based super plasticizer improves the workability of fresh geopolymer concrete.

D.M.J.SumajouwD.HardjitoS.E.WallahB.V.Rangan (2007) presents the results of experimental study and analysis on the behaviour and the strength of reinforced Geo polymer concrete slender columns. They concluded that heat-cured low-calcium fly ash- based geopolymer concrete has excellent potential for applications in the precast industry. The products currently produced by this industry can be manufactured using geo polymer concrete. The design provisions contained in the current standards and codes can be used in the case of geo polymer concrete products.

IV. MATERIAL ANALYSIS

Aggregates are the major ingredients of concrete. They constitute 70-75% of the total volume; provide a rigid skeleton structure for concrete, and act as economical space fillers. The aggregates form the main matrix of the concrete. The aggregate particles are glued together by the fly ash and water paste with cement and water the entire matrix binds together into a solid mass called concrete. Aggregates influence the properties of concrete such as water requirement, cohesiveness and workability of the concrete in plastic stage, while they influence strength, density, durability, permeability, surface finish and colour in hardened stage. It is therefore significantly important to investigate the various properties of aggregates. Aggregates are generally inert and broadly divided into two categories, i.e. fine and coarse, depending on their size. Aggregates with grain size below 4.75mm are termed fine aggregates and above 4.75mm are termed as coarse aggregates. I.S.383-1963 defines the requirement of aggregates.

V. MIX DESIGN ANALYSIS

The mix proportions given by NALloyd and BV Rangan (2010) is taken as a reference one, several trial mixes are prepared with fly ash and constant molarity of NaOH as 2M. The mix which gives high workability is taken as the final one and the project continues with the final one. The trial mixes are as follows.

The trial mixture proportion is as follows:

Combined aggregates = 1848 kg/m³, GGBS =408kg/m³,

Sodium silicate solution=103kg/m³,

Sodium hydroxide solution = 41 kg/m³ (2M solution).

20mm aggregates = 910kg/m³,

12mm aggregates =390kg/m³,

Fine sand = 554 kg/m³

The geo-polymer concrete is wet-mixed for four minutes and cured at 60°C for 24 hours in a hot air oven after casting. Commercially available super plastic zero about 0.75 % of mass of GGBS, i.e. 5kg/m³ is added to the mixture to facilitate ease of placement of fresh concrete. In this manner, by changing the quantities of aggregates and by increasing the fines in the mixture the final mix is as follows. The total volume occupied by the aggregates (Coarse and fine aggregates) is assumed to be 65%.The alkaline liquid to GGBS ratio is taken as 0.30. The quantities of all ingredients are kept constant as given in table-4.1 except the molarity of NaOH is changed in each mix. Assume the density of geo-polymer concrete as 2500 kg/m³. Assume the volume of combined aggregates occupied 70% of the mass of concrete, i.e. .0.70 x 2500 =1750kg/m³.

In this, The mass of fine aggregates + coarse aggregates =1750kg/m³

Coarse Aggregate = 60% of 1750 =1 050kg/m

Quarry dust = 20% of 1750 = 350kg/m

Bottom ash = 20% of 1750 = 350 kg/m

Mass of Alkaline liquid and Fly ash= 2500- 1750 = 750 kg/m

Assume,

Mass of fly ash=60%of750=450kg/m

Mass of alkaline liquid=40%of750kg/m =300kg/m

Take the ratio of sodium silicate solution-to- sodium hydroxide solution by mass as 2;

The mass of sodium hydroxide Solution = 100kg/m³;

The mass of sodium silicate Solution = 200kg/m³;

The mass of super plasticizer = 0.75X450

VI. CONCLUSION

Based on the experimental work reported in this study, the following conclusions are drawn. Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly ash & quarry dust based geopolymer concrete. The mix GP3 gives higher compressive strength, as it has high molarity of NaOH. The fresh fly ash-based geo- polymer concrete is easily handled up to 120 minutes without any sign of setting and without any degradation in the compressive strength.

VII. SCOPE FOR FUTURE WORK

As geo-polymer concrete technology is a new one, there is a lot of scope to work on this topic. In the present study we used fly ash as a binder instead of cement. We recommended to extend this topic by using by products like rice husk ash, GGBS, pulverized fuel ash etc. And also, investigation of Long term properties like durability, creep, drying shrinkage may also gives the suitability of geo-polymer concrete in the field. To implementing such a method the durability can be increased and strength of the material can also be increased. The most important thing is that cement can be made to increase the striking property of the materials can be increased in proper quantity.

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