STUDIES ON GEO POLYMER CONCRETE WITH PARTIAL REPLACEMENT OF SAND BY QUARRY STONE DUST (QSD)

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ABSTRACT
Geo Polymer Concrete is produced with fly ash as the base material and is activated by alkaline solution to produce the binder which is rich in silica (Si) and Aluminium (Al) instead of using cement as binder. Geo Polymer Concrete possesses good strength and appearance as similar as conventional concrete made using Portland cement. From the review of available literature it is observed that there is no proper design procedure for Geo Polymer Concrete. With the conventional data available on Geo Polymers, the method that was adopted to develop a process of manufacture of fly ash based geo polymer concrete is rigorous trial-and-error method. In this study the solutions of sodium hydroxide (NaOH) and sodium silicate (Na₂SiO₃) are used as alkaline liquids for polymerization. In this work the molarity of alkaline solution is taken as 12.

In India, normal stream sand (fine aggregate) is customarily utilized in cement. In any case, developing natural limitations to the abuse of sand from waterway beds is prompting research for usage of an elective material for fine aggregates in the development business. This paper explores about utilizing quarry stone dust as a fine aggregate substitution material, as an option in geo-polymer concrete. This research work is concerned with exploratory examination on quality of geo-polymer concrete and discovering ideal level of substitution by supplanting fine aggregates from 0% to 100%. The comparison is done in terms of workability and strength with the conventional geo polymer concrete for all produced mixes. Ambient curing method was preferred in this
research work. Tests were carried out to assess the mechanical properties at the age of 7, 14 and 28 days.

**Keyword**: Geo Polymer Concrete possesses, Sand by Quarry

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1. INTRODUCTION

For the development of any structure, Concrete is the main material. The principle fixing to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest hazard to mankind on this planet today. The production of cement implies the creation of contamination due to the outflow of CO$_2$ amid its generation. In production of cement, emission of CO$_2$ takes place during two processes, first and major one is the operation of rotatory kiln by combustion of fossil fuels and second one is the chemical process of calcining limestone into lime in the cement kiln. In India the emission of CO$_2$ is 1.8 tonnes per capita in the year of 2017. The cement industry shares around 7% carbon dioxide discharges globally. And furthermore, the concrete is fabricated by utilizing the raw materials, such as, lime stone, clay and different minerals. Quarrying of these raw materials likewise causes ecological debasement. To produce 1000kg of cement, around 1600kg of raw materials are required and the rate of formation of limestone is much slower than the rate of utilization of it. Be that as it may, the interest of cement is expanding step by step in light of its simplicity of getting ready and manufacturing in a wide range of advantageous shapes. Therefore, the environmental friendly concrete should be produced to overcome this problem.

This research aims to have an alternative fine aggregate in geo polymer concrete. In this regard, geo polymer concrete is produced with alkaline activated fly ash as geo polymer binder and quarry stone dust is used as fine aggregate instead of natural sand because it is most economical. The results of experimental investigation are presented in this paper.

2. LITERATURE REVIEW

**Djwantoro Hardjito, et al (1992)** portrayed the impacts of a few factors on the properties of fly fiery remains based Geo Polymer concrete, particularly the compressive quality. The test factors included were the time of solid, relieving time, restoring temperature, amount geo-polymer of super-plasticizer, the rest time frame preceding relieving, and the water substance of the blend. They inferred that compressive quality of cement does not fluctuate with age, and relieving the solid examples at higher temperature and longer restoring period will result in higher compressive quality. They likewise finished up Naphthalene-based super-plasticizer enhances the usefulness of new geo-polymer concrete.

**D. M. J. Sumajouw et al (2007)** introduced the consequences of test study and examination on the conduct and the quality of fortified Geo Polymer concrete slim segments. They inferred that warmth restored low-calcium fly fiery debris based Geo Polymer concrete has incredible potential for applications in the precast business. The items at present delivered by this industry can be fabricated utilizing Geo Polymer concrete.


Shuguang Hu, et al (2007) prepared three repair materials by utilizing concrete based, geopolymeric, or geopolymeric containing steel slag fasteners. They presumed that the geopolymeric materials would do well to repair attributes than concrete based repair materials, and the expansion of steel slag could enhance altogether the scraped area obstruction of geopolymeric repair. By methods for checking electron microscopy (SEM) it can likewise be inferred that the steel slag was completely ingested to partake in the alkaliactivated response and be immobilized into the undefined aluminosilicategeopolymer network.

Zhu Pan and B. V. Rangan(2009) reasoned that the malleability of the mortars has a noteworthy connection to this quality gain/misfortune conduct. They arranged the examples with two diverse fly fiery remains, with qualities running from 5 to 60 MPa, were explored. They inferred that the quality misfortunes diminish with expanding pliability, with even quality increases at abnormal amounts of flexibility. This relationship is credited to the way that mortars with high malleability have high ability to suit warm incongruencies.

Christina K. Yip, et al (2008) exhibited the compressive quality of networks arranged with overwhelmingly undefined calcium silicates (impact heater slag) or containing crystalline stages particularly produced for reactivity (concrete) is significantly higher than when the calcium is provided as crystalline silicate minerals. They inferred that the compressive quality of lattices containing common (crystalline) calcium silicates enhances with expanding alkalinity, anyway the contrary pattern is seen in networks orchestrated with handled calcium silicate sources.

3. MATERIALS USED

3.1 FLY ASH

As per ASTM C-618, two noteworthy classes of fly ash are perceived. These two classes are identified with the sort of coal consumed and are assigned as F-Class and C-Class in a large portion of the present writing. F-Class fly ash is typically created by consuming anthracite or bituminous coal while C-Class fly cinder is for the most part acquired by consuming sub bituminous or lignite coal.

In this work F-Class fly ash is utilized and its specific gravity is 2.52.

3.2 COARSE AGGREGATES

Those particles that are transcendently held on the 4.75 mm (No. 4) sieve and will go through 3-inch sieve, are called coarse aggregate. The coarser the aggregate, the more sparing the blend. Bigger pieces offer less surface region of the particles than a comparable volume of small pieces. Utilization of the biggest reasonable most extreme size of coarse total allows a decrease in bond and water prerequisites. Pulverized stone blend of 20mm and 10mmsize are utilized in this work.

The specific gravity, fineness modulus and water absorption of 20mm size coarse aggregates are 2.69, 7.22 and 0.25% respectively.

The specific gravity, fineness modulus and water absorption of 10mm size coarse aggregates are 2.57, 6.4 and 0.5% respectively.

3.3 FINE AGGREGATES:

Those particles passing the 9.5 mm (3/8 inches) Sieve, as a rule passing the 4.75 mm (No. 4) sieve, and overwhelmingly held on the 75 µm (No. 200) sieve are called fine aggregate.
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The specific gravity and fineness modulus of fine aggregate utilized in this work are 2.55 and 2.96 respectively.

3.4 QUARRY STONE DUST (QSD)

The concept of substitution of normal fine aggregate by Quarry Stone Dust which is featured in this investigation could help the utilization of quarry dust produced from quarries. By substitution of quarry stone residue, the prerequisite of land fill territory can be decreased and can likewise tackle the issue of regular sand shortage.

The specific gravity and fineness modulus of quarry stone dust utilized in this work are 2.62 and 5.3 respectively.

4. CASTING OF GEO POLYMER CONCRETE

Geo Polymer concrete can be produced by embracing the customary procedures utilized in the fabricate of Portland cement concrete. In the research facility, the fly ash and the aggregates were first combined dry in 80-litre limit container blender for around three minutes. The aggregates were set up in immersed surface-dry (SSD) condition, and were kept in plastic containers with lid. The alkaline liquid was blended with the super plasticizer and the additional water, assuming any. The fluid segment of the blend was then added to the dry materials and the blending proceeded as a rule for another four minutes. The fresh concrete was casted and compacted by the typical strategies utilized on account of Portland cement concrete.

Compaction factor test and Vee bee consistometer test were carried out in fresh state of Geo Polymer Concrete.

Compressive, Tensile and Flexural qualities of created Geo Polymer Concrete blended containing distinctive extents of Quarry Stone Dust have been gotten by testing the examples.

5. RESULTS AND ANALYSIS

The following notations have been used in this study for different mixes

- Mix-1 (M1) – 100% Sand + 0% QSD
- Mix-2 (M2) – 80% Sand + 20% QSD
- Mix-3 (M3) – 60% Sand + 40% QSD
- Mix-4 (M4) – 40% Sand + 60% QSD
- Mix-5 (M5) – 20% Sand + 80% QSD
- Mix-6 (M6) – 0% Sand +100% QSD

The results of workability tests are presented in graphical forms.

The result of compaction factor test is presented in the graphical form in Fig. 1.

![Figure 1](variation of compaction factor values)
It can be observed that the compaction factor value increases with increase in percentage of Quarry Stone Dust and then decreases after reaching optimal value at 60% replacement level.

The results of Vee bee consistometer test are depicted in Fig.2. It can be noticed that the Vee-Bee test results confirm the same trend as per compaction factor test.

![Figure 2 Variation of Vee Bee time (seconds)](image)

**Strength tests**

The results of compressive strength tests are presented in graphical form in Fig3,4&5.

![Figure 3 Compressive strength for different mixes at 7 days](image)
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The comparison of compressive strength of different mixes for 7, 14 and 28 days is shown in the graphical form in Fig.6

The compressive strength value increases with increase in percentage of Quarry Stone Dust and then decreases after reaching optimal value at 60% replacement level.

For all mixes, the compressive strength increases with increase in Age.

The result of Tensile strength test for 7, 14 and 28 days represented in the graphical form in Fig.7,8,&9 respectively.
Figure 7 Tensile strength for different mixes at 7 days

Figure 8 Tensile strength for different mixes at 14 days

Figure 9 Tensile strength for different mixes at 28 days

The comparison of Tensile strength of different mixes for 7, 14 and 28 days is shown in the graphical form in fig.10
Figure 10 variation of 7, 14 and 28 days Tensile strength

The Tensile strength value increases with increase in percentage of Quarry Stone Dust and then decreases after reaching optimal value at 60% replacement level.

For all mixes, the Tensile strength increases with increase in Age.

The results of Flexural strength test for 7 and 28 days are represented in the graphical form in Fig.11 & 12 respectively.

Figure 11 Flexural strength for different mixes at 7 days

Figure 12 Flexural strength for different mixes at 28 days
The comparison of Flexural strength of different mixes for 7 and 28 days is shown in the graphical form in fig.13.

![Graph of 7 and 28 days Flexural strength]

**Figure 13** variation of 7 and 28 days Flexural strength

The Flexural strength value increases with increase in percentage of Quarry Stone Dust and then decreases after reaching optimal value at 60% replacement level.

For all mixes, the Flexural strength increases with increase in Age.

### 6. CONCLUSIONS

From this study the following conclusions were made:

1. The compaction factor workability of Geo Polymer concrete increases with increasing the percentage of QSD upto 60% and then decreases.
2. The Vee Bee test values of Geo Polymer concrete decreases with increase in the percentage of QSD upto 60% and then decreases indicating increasing of workability upto 60%.
3. The maximum value of compressive strength was observed at 40% sand + 60% QSD at all ages. The compressive strength of concrete decreases with increase in Quarry Stone Dust beyond 60%.
4. The maximum value of Tensile strength was observed at 40% sand + 60% QSD at all ages. The tensile strength of Geo Polymer concrete decreases with increase in Quarry Stone Dust beyond 60%.
5. The maximum value of Flexural strength was observed at 40% sand + 60% QSD at all ages. The flexural strength of concrete decreases with increase in Quarry Stone Dust beyond 60%.

### REFERENCES:


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