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EFFECT OF SEA WATER ON BETHAMCHERLA STONE POWDER WASTE GEOPOLYMER CONCRETE

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ABSTRACT:

Four Geopolymer Concrete mixes are prepared by replacing the Ground Granulated Blast-Furnace Slag (GGBFS) with Bethamcherla stone powder waste in the ratio of 0, 25, 50 and 75% and with 16 Molarity. The cube specimens are immersed in sea water for 60, 90 and 180 days and tested for weight and strength variations. The test results revealed that, there is no significant loss in weight and strength for 60 days immersion but for other immersion duration of 90 and 180 days significant variations are noticed. From the study it is also observed that 25% replacement of Behtamcherla stone powder for GGBS is effective.

Key Words: *Geopolymer Concrete, Sea Water, Bethamcherla Stone Powder waste.*

1.INTRODUCTION:

The cement industry is a non-eco-friendly environmental industry due to the continuous emission of CO_2 during the production of raw materials (limestone and clay) depending on the cement production process. The development of alkali activated materials or geopolymer concrete is an up to date study among scientific community. Industrial by-products such as fly ash (FA) and ground granulated blast-furnace slag (GGBFS) are combined with strong alkaline activating solutions such as potassium hydroxide, sodium silicate, sodium hydroxide, and combination of sodium silicate and sodium hydroxide to form a geopolymer concrete with strength similar or higher than ordinary Portland cement (OPC) concrete (Part et al.2015). The geopolymerization mechanism can be identified with three phases, in the first phase dissolution of oxide materials from fly ash or slag is realized by alkaline solution, in the second phase, gel formation is occurred with transportation and condensation of the dissolved oxide ions into monomers, and in the last stage a three-dimensional alumino silicate network is composed as a result of polycondensation and polymerization into amorphous to alumino silicate polymers. The resulting geopolymer material performs superior chemical and mechanical performance (He et al.2013).

Geopolymer concretes has great potential use in concrete industry due to lack of cement, which requires high amount of energy and CO_2 amounts, lower production costs, energy efficient and environmentally favorable when compared to OPC concrete (Hasanein et al.2011). Compressive strengths over 70 MPa within 24 h and high resistances to chemical attacks allow geopolymer concrete to use in commercial and industrial applications (Petermannet al.2010). Concrete durability has become a critical issue for the future (Mehta and Burrows (2001)) as many structures in urban and coastal environments start to deteriorate after 20-30 years exposed to acid, sulfate and chloride attacks, though their design life was at least 50 years (Visitanupong 2009). Although there are some studies which investigated durability of geopolymer concretes under chemical attacks, few of them is based on the together use of cementitious materials (fly ash, slag or metakaolin) with OPC concrete or the remaining very few ones were only focused on durability properties without considering mechanical performance of geopolymer concrete. Therefore, the use of the geopolymer concrete in structural designs is still limited due to both lack of standards in design codes and the lack of knowledge especially in durability aspects. In this paper, OPC, SGPC (100% slag) and FAGPC (100% fly ash) specimens were produced with same w/c or alkaline solution/fly ash or slag and aimed to investigate both mechanical and durability properties of geopolymer concretes and the results were compared with OPC concrete to understand the applicability of geopolymer concretes in structural design codes. Limited studies have been carried out regarding the durability of geopolymer concretes and the results indicated that geopolymer concretes have shown superior durability performance when exposed to different acid environments compared to OPC concrete (Thokchom et al.2010). But no works has been noticed in the review of literature in association with Bethamcherla stone powder for geopolymer concrete. Hence herein an experimental work has planned to study the effect of sear water on Bethamcherla stone waste powder based geopolymer concrete.

2. Need of present study:

Bethamcherla stone is famous for flooring purpose and this stone mines are located in Kurnool (dist), Andhra Pradesh (state). This layered stone is extracted from mines and transported to polishing stone industries for the purpose of polishing. During polishing stage slurry is generated and when it dries in sunlight, yields a smooth amorphous powder as waste product which requires huge areas for disposal, creates dust nuisance, affects the fertility of soil, water pollution etc. The present Investigation aims to utilise this powder waste to the maximum extent in manufacturing geopolymer concrete by replacing the ground granulated blast furnace slag.

3. Materials:

The materials used in the present investigation are as follows

- Ground granulated blast furnace slag with silicon dioxide, aluminium tri oxide and calcium oxide in percentage of 31, 19.05 and 36% respectively and with Blain fineness of 4550cm^2/g.
- Bethamcherla stone powder waste with silicon dioxide, aluminium tri oxide and calcium oxide in percentage of 23.83, 3.56 and 38.55% respectively and with Blain fineness of 5600cm^2/g.
- Natural river sand with a specific gravity of 2.43 and fineness modulus of 2.3 confirming to zone II is used as fine aggregate.
- Crushed granite with nominal size of 20mm with a specific gravity 2.6 is used as coarse aggregate.

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- Sodium hydroxide 97-100% purity and sodium silicate with 14.7% Na_2O, 29.4% siO_2 with 2.5 alkaline ratios of sodium silicate to sodium hydroxide and alkaline solution to binder ratio of 0.45are fixed and sodium hydroxide concentration is fixed as 16M.
- Potable drinking water
- 2% Super Plasticiser is used as water reducing agent.

4. Methodology:

The weight of GGBFS, Coarse aggregate, Fine aggregate, Sodium hydroxide, Sodium silicate and Placticizer in kg/$m^3$are 408.89, 1201.20, 554.40, 40.88, 102.22, 6.00 respectively. The ground granulated blast furnace slag is replaced with Bethamcherla stone powder waste in the ratio of 0, 25, 50 and 75%. The material required for mixes were weighed and mixed in dry condition for 3 minutes the alkaline liquid of sodium hydroxide and sodium silicate along with super plasticiser were added to dry mix, these are thoroughly mixed for 6 minutes and the mix is placed in the cube moulds and compacted properly. After 24 hours the cubes are removed from the mould and then specimens are further allowed for curing in room temperature for 28 days and after that the cubes are immersed in sea water for 30, 60, 90 and 180 days and their weights and compression strengths are tested at respective days and are presented in table 1.0. The sea water was brought from the Arabian sea (near Surathkal,Karnataka (state), the images can be viewed in figure 1 and specimens immersed in the sea water also seen in the same figure.

Fig 1: Sea water sample collection and immersion of cubes in the sea water

4.1. Effect on weight: The weight loss due to immersion in sea waster on geopolymer concrete for various days are presented in column 3,4 and 5 of Table 1.0. From the results it is observed that, for 25% replacement, the weight loss is minimum or less when compared with for 0% replacement. But for other replacements of 50 and 75%, the weight loss is more than the 0% replacement. From the results it is concluded that, the optimum replacement of ground granulated blast furnace slag with Bethamcherla stone powder waste is about 25% with respect to weight.

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The performance of geopolymer concrete is in the order of 25%>0%>50%>75%. The behavior of weight loss is can be noticed in figure 2

4.2. Effect on Compressive strength: The strength loss due to immersion in sea water on geopolymer concrete for various days are presented in column 6,7 and 8 of Table 1.0. For all replacement the strength loss is more or less gradually varying. Among all the replacements, 25% replacement shown good performance in the view strength loss in the tested range and it is varied from 5.85 to 19.25%. But for 0,50 and 75% replacements the strength loss is varied from 6.26 to 20.30, 6.50 to 21.15 and 6.83 to 24.03 respectively.

From the study it came to know that, the 25% replacement of GGBS with Bethemcherla stone powder is effective and also can be noticed as optimum.

Table 1.0: Compressive strength and weight loss of cubes

Sl.No	(%) Replacement	Weight Loss (%)			Strength Loss (%)		
		60 days	90 days	180 days	60 days	90 days	180 days
1	0	2.25	2.34	8.06	6.26	12.10	20.30
2	25	2.00	2.16	7.98	5.85	10.25	19.25
3	50	2.34	3.65	8.65	6.50	12.65	21.15
4	75	2.88	4.86	9.26	6.83	14.16	24.03

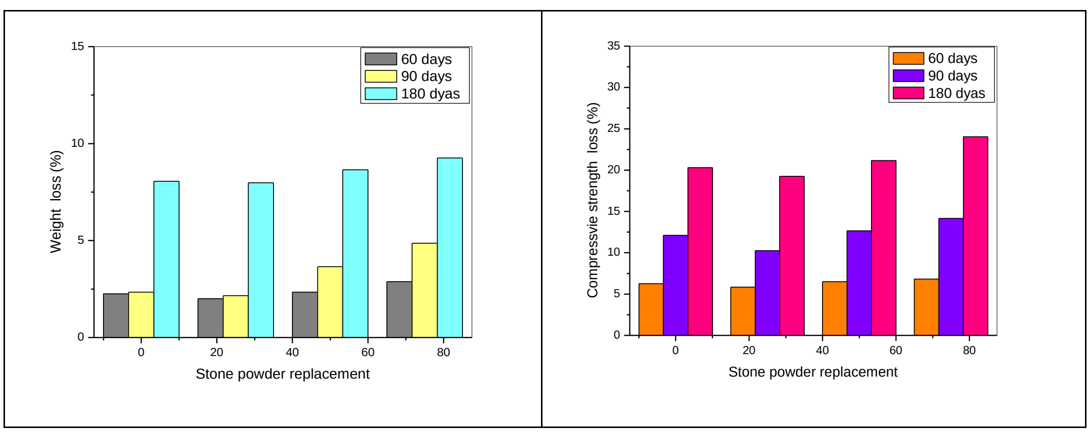

Fig 2: Weight and compressive strength loss vs stone powder replacement

5. Conclusions:

- The usage of Bethamcherla stone powder as replacement to GGBFS is viable.
- The optimum Bethamcherla stone powder waste for geopolymer concrete is 25%.

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- The strength losses are gradually varying from 60 to 180 days.
- The weight and strength loss is less for 25% replacement compared to other replacements
- The performance of geopolymer concrete in association with Bethamcherla stone powder is in the order of 25%>0%>50%>75%.

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