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PARTIAL REPLACEMENT OF FINE AGGREGATE BY SEA SAND IN GEOPOLYMER CEMENT CONCRETE

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ABSTRACT- Objectives: To find the optimum replacement level of fineaggregate by sea sand in GPC and to study the properties of GPC with various replacement level of sea sand. **Methods/Statistical Analysis**: An experimental setup withSea Sand has been made suitable for construction purpose by reducing the salt content to equalize its properties similar to the River Sand. **Findings:** By removing the salt from sand by washing with ample water the purified sea sand exhibited better strength than the unpurified sea sand. Hence, it is proved that the corrosion is controllable. Applications/Improvement: The removal of salt content from water is mandatory and hence improves the workability and durability of any construction works.

Keywords: River Sand,Salt Content,GPC,Sea Sand.

1. INTRODUCTION

In construction industry, concrete is the most important material for construction. Concrete is composed of cement, coarse aggregate, fine aggregate and water. Geopolymer is a new promising binder, manufactured by activation of a solid alumino-silicate source material with a highly alkaline activating solution. Fly ash, as considered to be a waste material, rich in silica and alumina and hence can be used as a source material for manufacture of geopolymer. These binders have been reported to achieve high early strength and better durability as compared to ordinary Portland cement based counterparts.

Demand for concrete as construction material is increasing day to day which increases the production of cement. The production of the cement is increasing by 3% annually. Among the greenhouse gases, CO2 contributes about 65% of global warming. The production of one ton of cement directly liberates about 1 ton of CO2 .In terms of reducing global warming, geopolymer technology could reduce approximately 80% of CO2 emission to the atmosphere caused by cement and aggregate industry.

However, the excessive mining of river bed to meet the increasing demand for sand in construction industry has lead to the ecological imbalance in the state. Now the sand available in the river bed is very coarse and contains very high percentage of silt and clay. The silt and the clay presence in the sand reduce the strength of the concrete and holds dampness. Acute shortage and high price of RS has lead to adulteration of sand with salty sea sand which has raised serious concern among builders. In order to reduce the above problems, the useful RS is replaced with the sea sand in GPC. Here we are going to replace sea sand partially with the river sand.

1.1 ADVANTAGES OF GEOPOLYMER CONCRETE

Following are some of the advantages of geopolymer concrete. They are,

1. Less emission of CO2 during manufacture of geopolymer cement (upto 80% reduction when compared to OPC).
2. Geopolymer concrete shows superior to fire resistance and acid attack.
3. GPC shows less shrinkage than OPC concrete.
4. Uses environmental pollutants such as flyash as its components.
5. Water scarcity problem is reduced since no water is used for curing and mixing.
6. Reduces the construction cost.
7. We can put the structure in to use earlier since it achieves 90% of its strength during 3 days itself.

2. LITERATURE REVIEW

AbdulAleem M.I and Arumairaj (2012) made an attemptto find out an optimum mix for the Geo-polymer concrete and they have casted concrete cubes of size 150 x 150 x 150mmand cured under Steam curing for 24 hours based on the compressive strength. The optimum mix is Fly ash: Fine aggregate: Coarse aggregate (1:1.5:3.3) with a solution (NaOH& Na2SiO3 combined together) to fly ash ratio of 0.35. High and early strength was obtained in the Geo-polymer concrete mix.

Balaguru. P (1997) conducted a study on the usage ofGeopolymer concrete for Repair and rehabilitation of reinforced concrete Beams. The primary objective of the

investigation was to determine whether Geopolymer can be used that not for repair of concrete. They concluded that Geopolymer concrete can be successfully used to bond carbon fabrics to reinforced concrete beams.

Bhikshma et al. (2010), investigated the flexural behaviorof high strength manufactured sand concrete. The researchers observed that Workability of the M50 grade manufactured sand concrete observed to be 30% less compared to the conventional concrete, the compressive strength of M50 grade concrete with varying percentages of (0%, 25%, 50%, 75%,and 100%) manufactured concrete improved the strengths by 6.89%, 10.76%, 17.24%, 20.68%,respectively and the load carrying capacity and Moment carrying capacity of the RC beams of manufactured sand concrete obtained 3 to 12% higher when compared to conventional concrete.

Ganapathinaidu.pet al (2012) presented out a Study onstrength properties of Geopolymer concrete with addition of GGBS. In this paper an attempt was made to study the strength properties of Geopolymer concrete using Low calcium fly ash replacing with slag in 5 different percentages. They obtained Compressive strength of geopolymer concrete increases with increase in percentage of replacement of fly ash with GGBS was up to 28.57% of replacement of fly ash by GGBS, the setting was normal and fast setting was observed. They concluded maximum of 25% loss in compressive strength was observed when geopolymer exposed to a temperature of 500 C for two hours.

Joseph Davidovits (1994) carried out a Properties ofGeopolymer cements. This paper focused on Geopolymer concrete has excellent properties and is well-suited to manufacture precast concrete products that are needed in rehabilitation and retrofitting of structures after a disaster. The concluded by introduced low – CO2 geopolymeric cements, not only for environmental uses, but also in construction, civil engineering would reduce CO2 emission caused by the cement and concrete industries by 80%.

3. MATERIALS USED

GEOPOLYMERCEMENT:

Geopolymer is a new promising binder, manufactured by activation of a solid alumino-silicate source material with a highly alkaline activating solution. It is also manufactured by the combination of flyash and GGBS.GPC have been reported to achieve high early strength and better durability as compared to ordinary Portland cement based counterparts.

Table 1 Chemical composition of geopolymercement

COMPONENTS	PROPORTION (%)
SiO_2	40.86
Al_2O_3	15.34
Fe_2O_3	2.02
CaO	2.765
MgO	3.4
SO_3	1.35
Na_2O_3	0.17
K_2O	0.61
TiO_2	1.13
MnO	0.02
Others	4.63

3.1 COARSE AGGREGATE:

Coarse aggregates to be used in reinforced cement concrete shall be of blue granite stone, machine crushed and well graded with a normal size of 60% of12.5 and 40% of 10mm. The compressive strength, crushing value, etc. of the aggregate shall be in accordance with the requirements of IS: 383-1970.

The physical characteristics such as shape, texture and roughness of aggregate significantly influence the workability of fresh concrete, the bond between the aggregate and mortar phase. In general there are four categories, namely rounded, irregular, angular and flaky.

3.2 FINE AGGREGATE:

Two types of fine aggregate has been used in our geopolymer concrete. They are,fine aggregates generally consist of natural sand or crushed stone. Medium and fine sand are to be used in mortar. The properties of fine aggregate shall be in accordance with the requirements of IS: 383-1970.

River sand:

Locally available river sand conforming to grading zone II of IS 383:1970.

Sea sand:

Locally available sea sand from the sea shore and the sand is washed to remove the chloride content in the sand. After washing only the sand is allowed to mix in the GPC

3.3. GEOPOLYMER ACTIVATOR:

It is the type of chemical added in the geopolymer concrete instead of water. If any solution other than activator is added, then the reaction will not happen. The fresh concrete will change into hardened state, but it is of no use. The expected strength will not be achieved

4. TESTS CONDUCTED ON MATERIALS TESTS ON CEMENT

- Specific gravity = 2.5
- Fineness = 7.5%
- Consistency = 30%
- Initial setting time = 15 mins.
- Final setting time = 4 hours.

4.1.TESTS ON FINE AGGREGATE

- Spec. gravity of RS = 2.7
- Spec. gravity of SS = 2.45
- Chloride in washed sand = 0.023g/lit.
- Chloride in unwashed sand= 0.092g/lit.
- Sieve analysis = ZoneII
- Bulk density = 1582 kg/m^3
- Water absorption = 1.5 for RS

= 2 for RS

4.2. TESTS ON COARSE AGGREGATE

- Crushing value = 27.03%
- Abrasion value = 25.8%
- Impact value = 18.6%
- Water absorption = 2%
- Bulk density = 1450 kg/m^3

5. MIX DESIGN

There are many methods available for mix design. Here Indian standard method, based on IS 10262-2009 and IS 456-2000 is adopted for deriving the mix proportion of M25 grade

Table 2 Mix design ratio

CEMENT	FA	CA
370Kg/m^3	646.26Kg/m^3	1253.21Kg/m^3
1	1.75	3.39

4.3 MIX RATIOS:

- M1=Mix ratio 1 (0% sea sand) ie., (100% river sand)
- M2=Mix ratio 2 (25% sea sand)
- M3=Mix ratio 3 (50% sea sand)
- M4=Mix ratio 4 (75% sea sand)
- M5=Mix ratio 5 (100% sea sand)

6 .TESTS ON CONCRETE

6.1. TEST ON FRESH CONCRETE

1. Slump cone test

Mix ratio	M1	M2	M3	M4	M5
Slump(mm)	103	105	108	110	112

ii. Compaction factor test

Mix ratio	M1	M2	M3	M4	M5
Compaction factor	0.95	0.94	0.94	0.93	0.93

iii. Vee bee consistometer

Mix ratio	M1	M2	M3	M4	M5
Time taken	12 sec	12sec	10sec	10sec	9sec

iv. Flow table test

Mix ratio	M1	M2	M3	M4	M5
Value in %	41.2	44.8	48	49.2	50.8

6.2 TESTS ON HARDENED CONCRETE

1. Compressive strength test

MIX RATIO	3day (N/mm^2)	7day (N/mm^2)	14day (N/mm^2)	28day (N/mm^2)
M1	23.11	25.11	29.33	32.89
M2	22.00	24.00	28.22	32.00
M3	20.89	22.89	27.56	30.89
M4	20.22	22.22	26.67	30.22
M5	19.56	21.78	25.78	29.56

ii. Split tensile strength

MIX RATIO	3day (N/mm^2)	7day (N/mm^2)	14day (N/mm^2)	28day (N/mm^2)
M1	1.11	1.43	1.91	3.18
M2	0.95	1.11	1.59	2.71
M3	0.85	1.11	1.43	2.71
M4	0.80	0.95	1.43	2.39
M5	0.64	0.85	1.27	2.23

iii. Flexural strength test

MIX RATIO	3day (N/mm^2)	7day (N/mm^2)	14day (N/mm^2)	28day (N/mm^2)
M1	1.4	1.7	2.2	4.2
M2	1.2	1.65	2.1	4.05
M3	1.15	1.5	1.9	3.85
M4	1.05	1.45	1.75	3.7
M5	0.9	1.2	1.6	3.6

7. CONCLUSION

The geo-polymer concrete is a eco-friendly type of concrete. The details of geo-polymer materials properties, mix design and the compression of the harden concrete properties such as compressive strength , split tensile strength, flexural strength of concrete of concrete with conventional concrete are studied

- The test result shows that the useof geo-polymer concrete shows increase in compressive strength by 24.56%,42.80%,50.40%,53.44%,56.5% for the following mix ratios as compared with conventional concrete.
- The test result shows that the use of geo-polymer concrete shows increase in split tensile strength by 35.50%,26.93%,31.73%,31.8%,27.35% as compared with conventional concrete.
- The test result shows the use of geo-polymer concrete shows increase in flexural strength by 35.46%,26.17%,26.23%,24.32%,22.78% as compared with conventional concrete.
- We have decreased the chloride content upto 75% in the sea sand.
- Since we can achieve 90% of expected strength in 3 days, we can put the structure into early usage.
- Water usage is minimized since we are not using water in mixing as well as curing.

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