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SYNTHESIS OF KUDREMUKH IRON ORE TAILING BASED GEOPOLYMER COARSE AGGREGATES USING FLY ASH AS A PRECURSOR IN THE CONSTRUCTION INDUSTRY

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ABSTRACT: *concrete is the basic material in all the construction works and coarse aggregate constitutes nearly 60 to 70% of the mix but the procurement and the generation of the natural coarse aggregate is being deficit day by day and that lead to the use of other alternative materials which are naturally available in India. Fly ash and IOT are the best suitable materials for replacement of natural aggregates because of the availability of these huge sources in all over India. Even though the iron ore tailing utilized in foreign country in the various construction industries, the Indian construction sector if lagging beyond to use in a concrete mixes because the lack of knowledge and the lack of literature. The more research is required in this regard, by this iot can be sufficiently utilized in the various constructions in India. The Iron ore tailing is procured for the KIOCL, kudremukh wherein the large amount of IOT is available as a waste. And it is checked for the effective use of IOT in concrete as a replacement as a fine aggregate with the replacement of 20%,40%,60%, 80% and 100%.This study is taken up to determine the variation of different properties of strength and mainly durability of concrete made by the geopolymer coarse aggregate for M30 grade of concrete. Geopolymer coarse aggregates are prepared by using IOT, flyash and alkaline activator of variable molarity.XRD and SEM analysis is preferred for determination of physical and chemical properties. The cubes are casted with different morality of alkaline activator solution as 8M,10M,12M,14M. and the compressive strength should be determined to find out the optimum molarity of Alkaline activator solution and then the cubes are crushed to produce the coarse aggregates.*

1. INTRODUCTION

The Environmental impact of solid wastes produced from the mining activity or mineral processing has been increased now a days. Iron ore accounting up to 32% of ore extracted end up as tailings. Tailings creates one of the biggest waste handling problems, large scale dumping will causes various adverse effects leading to the environmental degradation. The disposal of the tailing in an echo-friendly manner is the biggest problem for the planner, designer and mines owner. On the other hand the tailing contains the heavy metals will changes the water quality and creates the various health problems to the human society. Huge water quantity required for the iron ore beneficiation. In developing country like India, there is a lot of difficulties arrived in the protection of environment from these pollutants. Flyash is also the another largest waste producing in the country. Power plants produces the large amount of waste and disposed in to the sea which in turn pollute the sea. Due to the lack of land available for the proper disposal of these wastes. There is necessity to use the flyash in industries and in education sectors to turn these waste in to the useful materials. Since the flyash contains dangerous elements in its composition there is necessary to handle carefully to prevent the various health problems. So an effort has been made to use flyash in a construction industry for increasing strength of concrete in which it is being used. Since the large scale dumping of flyash and iron ore tailing causes hazardous environmental problems it made researchers to focus on the utilization of high volume of these wastes in the construction industry. The effective measure has been taken in the use of flyash and iron ore tailings in various forms such as producing bricks and block manufacture using pozzolanic cement or by adding or replacing some quantity in concrete but still large amount of these wastes unutilized. The attention towards the use of the fly ash as a aggregate offering the large volume utilization of flyash in a construction industry. That reduces depleting natural aggregates.

2. OBJECTIVES

1. To Characterize iron ore tailings and flyash for physical and chemical properties.

2. To identify the optimum molarity of alkaline activator and optimum mix for manufacture of geopolymer coarse aggregates as per test for coarse and fine aggregates specified in BIS code IS:383-1970.

3. To compare the various basic properties of Geopolymer coarse aggregate with that of naturally available coarse aggregate

4. To Examine the various strength properties (for 28days) of geopolymer aggregates such as compressive strength, split tensile strength, and flexural strength.

5. Arrive at design specification for manufacture of geopolymer coarse aggregates.

3. LITERATURE REVIEWS

Peem nuaklong et.al (2018) investigated and carried out study to "understand the properties of Metakaoline- high

calcium fly ash geopolymer concrete containing recycled aggregate from the crushed concrete specimen". the result showed that GPC with meta kaoline has the better strength, porosity, water absorption and acid resistance increase the use of metakaoline leads the higher strength both in natural and recycled aggregate geopolymer concrete.

B.P.sharath et al(2018) investigated and carried out the study on "sustainable utilization of iron ore tailing as the fine aggregates in fly ash based geopolymer mortar" and concluded that setting time has been reduced due to the use of iron ore tailing in the production of geopolymer mortar and the compressive strength of geopolymer mortar with the natural sand and the iron ore tailing is ranges from 2.9 to 4.9 MPa and 3.47 to 8.27 Mpa respectively.

Jumah musdif their et.al (2018)investigated and carried out study on "Developing the geopolymer concrete using cold bonded fly-ash aggregate, nano silica and steel fiber". The results indicated that the geopolymer concrete incorporated with the cold-bonded fly ash can be produced with the high compressive strength as high as 28.23 and 36.62 at 28 and 90 days respectively and 2% of nano silica and 1% of steel fiber were improve the investigated properties significantly.

Augusto Cesar da Silva Bezerra et.al (2019) investigated and carried out the study on "Alkaline activation of high calcium ash and iron ore tailing and their recycling potential in building materials". The results are shown that high-calcium ashes and IOT are potential materials to develop the echo friendly building materials. Through alkaline activation, stabilization of wastes without the use of cement contributes to reducing the greenhouse effect. The FTIR spectra showed that calcium alumino silicate is the most expressive phase, which ensure the compressive resistance of the material.

4. MATERIALS AND METHODOLOGY

Fly ash

Fly ash is a byproduct obtained in the combustion process of the coal in the electronic precipitator of the power plant. in coal the combustible elements such as carbon and hydrogen and oxygen and Hydrocarbons and non-combustible minerals impurities of coal chemically recombines and fuse to give crystalline molten ash in various stages in power plants of coal.

Iron ore tailing

It has estimated that there are 370 billion tones of unrefined iron in the world. India is one of the major country to produce iron, even now, about 25.24 billion tons of iron ore is being delivered. The metallic iron is extracted economically from iron ore mineral and rocks. Generally Iron ore found in the form of Goethite (Fe(OH)), Magnetite (Fe_3O_4), Limonite (FeO(OH)n) Hematite (Fe_2O_3), Siderite($FeCO_3$).For making pig Iron, Iron ore is the raw material used, and1also in making of steel which is main raw material. In making the Steel 98% of the ore material is used.

Sodium Hydroxide (NaOH)

Sodium hydroxide is an inorganic compound. A metallic base Alkali salts of Highly caustic white solid materials available in flake or granules pellets or and which are prepared as different concentration of solution. Approximately 50% of saturated solution with water forms Sodium hydroxide (by weight).

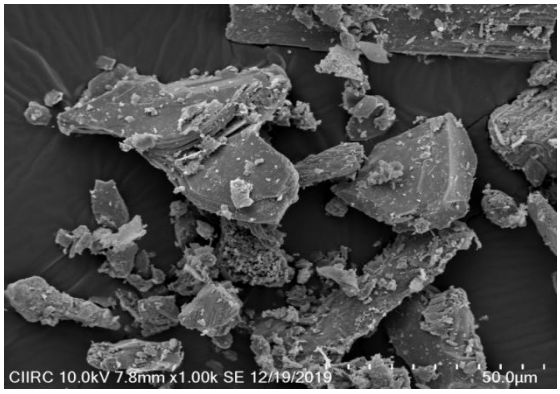
Figure 3.3: Sodium hydroxide

Sodium Silicate (Na_2SiO_3)

Sodium silicate is called liquid glass or water glass. It is available in solid form and also in aqueous solution. It is white or colourless.

Physical properties of Iron ore tailings

Sl no	Properties	Values
1	Water content	1.2 %
2	Specific gravity	2.7
3	Maximum dry density	2.08 gm/cm^3
4	Optimum moisture content	14.34 %
5	Coefficient of Permeability	0.011 cm/sec
6	Bulk density	2.38 gm/cm^3
7	Fineness modulus	3.06



SEM analysis image of IOT 100µm

Methodology adopted in preparing geopolymer aggregates:

Preparing of aggregates is done in 2 phases:

phase-I is to fix the optimum molarity of alkaline activator solution,

phase-II prepare geopolymer aggregate to the fixed molarity of the alkaline activator solution.

Table 4.1: Average compressive strength of the concrete with different ratios of NCA and GCA

Sl.No	GCA:NCA	Age of M40 concrete in Days	Average Compressive Strength (N/mm²)
1	100:0	7 21 28	**13.26** **18.67** **22.42**
2	70:30	7 21 28	**19.51** **26.70** **29.48**
3	60:40	7 21 28	**27.64** **35.68** **38.42**
4	50:50	7 21 28	**22.14** **29.32** **31.60**

at

Table 4.2: Flexural strength values for geopolymer aggregate concrete mix for 7 and 28 days

Beams With 60% replacement of NCA with GCA	7th day test result (N/mm²)	28th day test result (N/mm²)
1	**2.667**	**4.000**
2	**3.200**	**4.845**
3	**3.466**	**5.221**
Average	**3.111**	**4.688**

Table 4.3: Split tensile strength values for geopolymer aggregate concrete mix for 7 and 28 days

Cylinder With 60% replacement of Natural Aggregates with Geopolymer coarse aggregates	7th day test result (N/mm²)	28th day test result (N/mm²)
1	**1.670**	**2.650**
2	**1.780**	**2.540**
3	**1.543**	**2.890**
Average	**1.664**	**2.690**

CONCLUSIONS

1. Specific gravity of flyash is found to be less as compared to specific gravity of iron ore tailings. Flyash has maximum content of silt(74%) and iron ore tailing has maximum content of sand(70%).pH of both flyash and iron ore tailing are basic in nature. Electrical conductivity of iron ore tailing is less as compared to flyash. Total dissolved solids of iron ore tailing is less as compared to flyash. Flyash has maximum content of Mullite and Quartz and iron ore tailing has maximum content of Silicon dioxide in the form of Quartz.

2.Geopolymer coarse aggregates with flyash to iron ore tailing as 70:30 is used for finding the ratio for which maximum strength is obtained.70% flyash and 30% iron ore tailing gives maximum strength. Thus optimum mix used for the preparation of geopolymer coarse aggregates is 70% of flyash and 30% of iron ore tailings. Sodium hydroxide and Sodium silicate are used as binding materials for preparing artificial geopolymer coarse aggregates.

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4. When compared to Natural Coarse Aggregates, Artificial Geopolymer coarse Aggregates have around 30 to 40% less compressive strength for 100% replacement but 60% replacement has good results. Flexural strength of beam and split tensile strength of cylinder made using 60% of geopolymer coarse aggregates and 40% of natural coarse aggregates gives the best result which is within the permissible limits.

5. By making use of 70% flyash and 30% iron ore tailings with Sodium hydroxide and Sodium silicate as binding materials, geopolymer coarse aggregate can be prepared. These are design specifications used for manufacture of geopolymer coarse aggregates. Aggregates prepared using flyash and iron ore tailing are low in cost as flyash and iron ore tailing are free of cost. Thus only labour cost will be applicable for preparation of aggregates.

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IS Codes

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2. IS:456-2000, "*Indian Standard Code of Practice for Plain and Reinforced Concrete*", Bureau of Indian Standards, New Delhi

3. IS:10262-2009, "*Indian Standard Code for Guidelines of Concrete Mix Proportioning*", Bureau of Indian Standards, New Delhi