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Experimental Study on Mechanical Properties of Geopolymer Concrete by using Fly Ash and RHA

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ABSTRACT

As the cement business is to blame for the worldwide emission of dioxide regarding 5-7% in preparation of concrete, the dose of cement is reduced by the addition of minerals, and this strategy will contribute to the protection of the setting and preservation of energy. This possibility is distinguished to be a geopolymer that frequently contains fly junk, metallic element or hydrated oxide (NaOH or KOH),sodium salt. thanks to concrete's interest in industrial development, the assembly of normal hydraulic cement and therefore the use of typical channel sand are enlarged. throughout the cement production method, theoutflow of dioxide has exaggerated. At constant time, thanks to MISBR mining of quicksand, the availability of waterway sand has become progressively valuable and scarce. This mainly focuses on this analysis paper is to centre the ecological proximity of cement and waterway sand. The experiment was performed to represent the mechanical properties of geopolymer concrete. In this estimate various types of strengths in the geopolymer concrete. The materials used are ash, alkaline liquid, fine mixture, coarse mixture, GGBS, Rice husk ash, and Inter-sand.

KEYWORDS: *GGBS, RHA, M-Sand, Fly ash, Geopolymer, Protect Environment.*

INTRODUCTION

Cement is widely used because of its incredible performance and bonding nature in two materials and easy to use and mix and place and apply to the structure. India is the one of an important leading role in the top three in cement production around the world. Cement production in China was 2.29 billion tons in 2013, followed by India with 270 million tons. Global cement demand is on an upward trend and is expected to increase by 4.5% in the next five years. Cement is a world-wide used material and global demand in 2019 is to be 5.19 billion metric tons of cement.Manufacturing of Cement is various for different processes. In this manufacturing, most of the materials are used the same such as limestone and clay, and so on, etc.in this process involves heating and cooling of materials at different stages. Now a day's lot of researches are going on cement for improving its performance and as well as durability too. This also focuses on the elimination of weakness problems subjected to the cement. One of the main disadvantages is the emission of gases during the manufacturing process. Which may lead to cause pollution to the environment. In this, some of the researchers explain that the production of 1 ton of cement releases 1 ton of around six percent of theemission of CO_2.The main problem of it is

carbon emissions and footprint. After wood, concrete is the regularly utilized material by the network. After developing cement next is focuses on concrete material. Concrete material has a lot of limitations according to environmental conditions and so on etc. lot of researches is going on for developing concrete with suitable material. In this, we got a good solutionin the name of geopolymer concrete. This concrete is very good compared to conventional concrete and gives an excellent result.This concrete is made from wastes.

LITERATURE WORK

Krishnan L et.al(2014)led considers and inferred that geopolymer innovation is appropriate. This author mainly explains the importance of geopolymer concrete and its uses in the industry sectors. Geopolymer fastener is ready by using waste materials and debris and GGBS with basic fluids sodium hydroxide and sodium silicate.

Ali A. Aliabdo et.al(2016)utilized inventive mechanical waste fly debris as a replacement of cement and the impact of little expansion of cement with fly debris is depicted in this work. The target of the investigation is to discover the compressive strength, split elasticity attributes of fly debris based geopolymer and with some expansion of cement. This paper additionally expects to discover the soluble arrangement resting time, restoring period, and relieving temperature on fly debris based geopolymer concrete.

Hardijito et.al(2008)explains that geopolymer concrete and its mechanical properties. The author also explains the compositions of geopolymer concrete and its characteristics as well. We can get good compressive strength of geopolymer concrete withadditionally demonstrated.the fluid proportion of mass is depending on the proportion of sodium silicateto sodium hydroxide. There is an expansion in compressive strength with the increment in restoring temperature. Longer restoring time likewise expanded the compressive strength.

Usha et.al (2015)in this author explains theimportance of geopolymer concrete and its uses in various civil engineering structures. In this investigation, fly debris was supplanted by various mineral admixtures

Shankarsanni et.al (2013)led a test examination on geopolymer concrete and dependent on fly debris. The evaluations picked for the examinations are done for various mix proportions. The antacid arrangement utilized for the examination was the blend of two important solutions in the first one is sodium silicate,another important second solution is hydroxide arrangement, and used proportions are 2, 2.50, 3, and 3.50.

METHODOLOGY

COARSE AGGREGATES

In these Locally available materials are used mostly such as crushed granite and the size of stone aggregates are taken according to Indian code standard such as ten millimeters in size. These two important sieve pans are used for the classification of aggregates such as 10mm and 4.75mm. by using these sieves we can determine the type of aggregates and properties also according to IS.

RHA (RICE HUSK ASH)

Rice husk is a natural material that is obtained from farming in agriculture. There areseveralusages increases nowadays. The main reason for that is locally available material and also very cheap compared to other materials. this is used as anecological material for strengthening cementingmaterial.

Fig.rice husk ash

Sr. No.	Particulars	Properties
1	Colour	Gray
2	Shape Texture	Irregular
3	Mineralogy	Non Crystalline
4	Particle Size	< 45 micron
5	Odour	Odourless
6	Specific gravity	2.3
7	Appearance	Very fine

Table. Properties of RHA

MANUFACTURED SAND

Artificial sand (M-Sand) can replace quicksand for concrete development. The artificial sand is sent out from the hard rock by crushing. The squashed sand particles are in the shape of a cube, and the edges are grounded. After cleaning and inspection, they can be used as developing materials. The size of artificial sand (M sand) is less than 4.75mm. Artificial sand is an alternative to quicksand. Due to the rapid industrial development, people's interest in the sand has greatly increased, which in most cases leads to insufficient sand for proper waterways.

Properties	Type of sand	
	M-sand	River sand
1. Textural composition (% by weight)		
Coarse sand (4.75-2.00 mm)	28.1	6.6
Medium sand (2.00-0.425 mm)	44.8	73.6
Fine sand (0.425-0.075 mm)	27.1	19.8
2. Specific gravity	2.63	2.67
3. Bulk density (kN/m3)	15.1	14.5
4. pH	10.11	8.66
5. Chemical composition of M-sand		

Table. Types of sand and properties

GGBS:GGBS is gottenquickly chilling (extinguishing) liquid debris from the heater with the assistance of water. During this procedure, the slag gets divided and changed into nebulous granules (glass), meeting the prerequisite of IS Code (fabricating particular for granulated slag utilized in Cement). The granulated slag is ground to wanted fineness for delivering GGBS.The substance creation of JSW's GGBS adds to the creation of unrivaled cement.

Fig.GGBS

Properties	Materials	
	Fly ash	GGBS
Color	grey	whitish
pH	8.40	10.03
Specific gravity	2.15	2.84
Liquid limit (%)	32	40
Plastic limit (%)	non-plastic	non-plastic
Plasticity index (%)	non-plastic	non-plastic
Sand (%) (4.75–0.075 mm)	26.11	0.30
Silt (%) (0.075–0.002 mm)	70.89	99.70
Clay (%)(<0.002 mm)	3.00	0.00

Table. Fly ash & GGBS Properties

FLY ASH

It is one of the important materials used in geopolymer concrete. In this Class, F type is Low calciumand fly ash obtained from Enmore thermal power station and it was analyzed as per IS:38121981 having a specific gravity of 2.21 were used. ASTM-Fly ash came from the coal-burning power station.

Fig.Fly ash

Sl. number	Physical properties	Observed values
1	Specific gravity	2.51
2	Initial setting time	45 Min
3	Final setting time	280 Min
4	Consistency	35%

Table. Physical properties of Fly ash

Binder	L O I	Al2o3	Fe2O3	SiO2	MgO	SO_3	Na_2O	Chlorides	Cao
Fly ash	.9	31.2	1.5	61.12	.75	.53	1.34	.06	3.2

Table. composition of Fly ash

EXPERIMENTAL RESULTS

SLUMP CONE TEST

It is one of the important types of tests used in concrete. This type of test gives a good result for the workability and properties of concrete as well. This

is used to evaluate the performance of concrete. This test is accurate and quantifiesthe function of the new concrete. More specifically, it is used tomeasures the consistency between groups. It is a simple and easy test and an easy-to-use method. This test is used to know the workability. In the given below showing a slump test with having various steps.

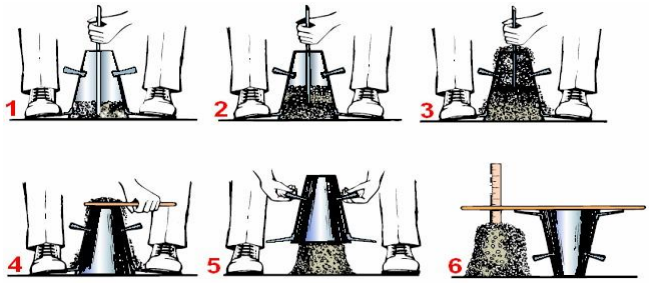

Fig. Showing Steps involved in the slump cone test.

SLUMP CONE TEST

S.No	%GGBS+%RHA+%M-Sand	The slump in mm for M40 Grade concrete
1	0%GGBS+0%RHA+0%M-sand (Mo)	56
2	2.5%GGBS+2.5%RHA+5%M-sand (M1)	42
3	5%GGBS+5%RHA+10%M-sand (M2)	36
4	7.5%GGBS+7.5%RHA+15%M-sand (M3)	26
5	10%GGBS+10%RHA+20%M-sand (M4)	22

Table. The slump in mm for M40 Grade concrete.

COMPACTION FACTOR TEST

It is one of the important tests of concrete.In this test cylinder and trowel are used to level the concrete surface in the mould. This test gives a better result. It is used to know the workability. It consists of two cylindrical hoppers. Which are installedone another above one. Sometimes for better operation, we can use grease onthe inner surface of the hoppers and the cylinder.We can take the weightof the empty cylinder. Place the cylinder below the hoppers and start the procedure.Observe the mix, if the color of the mixture is uniform, we can get good results. If the color of the mix is non-uniform repeat the process to get the uniform and homogeneous mix.

Fig. compaction factor test Apparatus

COMPACTION FACTOR TEST (C.F.)

S. No	%GGBS+%RHA+%M-Sand	C.F. for M40 Concrete
1	0%GGBS+0%RHA+0%M-sand (Mo)	.82
2	2.5%GGBS+2.5%RHA+5%M-sand (M1)	.84
3	5%GGBS+5%RHA+10%M-sand (M2)	.88
4	7.5%GGBS+7.5%RHA+15%M-sand (M3)	.92
5	10%GGBS+10%RHA+20%M-sand (M4)	.96

Table.Compaction factors for M40 Grade concrete

COMPRESSIVE STRENGTH

It is one of a good test.In this one cube is placed between the testing equipment and then apply the load. The dial gauge shows the force reading in KN. By using these readings we can calculate thestrength. The below figure clearly shows that cube and testing machine. The process of testing is very simple and easy to use in the laboratory.

Fig.Cube testing under Compressive strength

COMPRESSIVE STRENGTH

S.NO.	%GGBS+%RHA+%M-Sand	7 days Mpa	14 days Mpa	28 days Mpa
1	0%GGBS+0%RHA+0% M-sand (M0)	26.1	35.5	39.3
2	2.5%GGBS+2.5%RHA+ 5%Msand (M1)	26.95	36.11	39.87
3	5%GGBS+5%RHA+10% Msand (M2)	27.31	36.95	40.21
4	7.5%GGBS+7.5%RHA+ 15%Msand (M3)	26.81	36.43	39.71
5	10%GGBS+10%RHA+2 0%Msand (M4)	26.35	35.81	39.31

Table. Results ofthe strength ofcubes

SPLIT TENSILE STRENGTH

It is one of the important types of tests used in concrete. In this load is applied cylinders between the equipment. The next force is required to break the cylinder is noted in the dial gauge in KN. After the calculation of tensile force, we can determine the tensile strength easily by using numerical formula. The sample is taken out from the curing tank and set for drying for 1 to 2 hours. On either side of the cylinder of specimens draw the diametrical lines to make sure that the lines represent the same axial place. Place the plywood strips on the lower plate of CTM and fix the cylinder over it. As per IS 456-2000 the tensile capacity of concrete is $0.7\sqrt{fck}$. Split tensile strength=PD$/\pi DL$

Fig. cylinder under Split tensile strength

SPLIT TENSILE STRENGTH

S.No	%GGBS+%RHA+%M-Sand	7 daysMpa	14 days Mpa	28 days Mpa
1	0%GGBS+0%RHA+ 0%M-sand (Mo)	2.55	2.97	3.13
2	2.5%GGBS+2.5%RHA+5%Msand (M1)	2.5	3.03	3.19
3	5%GGBS+5%RHA+10%M-sand (M2)	2.67	3.11	3.25
4	7.5%GGBS+7.5%RHA+15%Msand (M3)	2.58	2.95	3.2
5	10%GGBS+10%RHA +20%Msand (M4)	2.57	2.79	3.01

CONCLUSIONS

Under normal operating room temperature, geopolymer concrete often does not show obvious physical changes, but can be observed under normal conditions. The complete Geopolymer concrete specimen placement process takes up to 72 hours without hardening the surface. 5%GGBS+5%RHA+10%M-sand had a maximum compressive strength, split tensile and flexural strength.8m can make good use of power, and the average strength can be increased by 8m. The higher the ratio of GGBS + RHA + M-Sand, the higher the durability of concrete caused by acid attack, alkali attack, and sulphate attack. As the best substitute for cementing materials, GGBS has the characteristics of high compressive strength, low heat of hydration, chemical corrosion resistance, better workability, durability, and high cost-effectiveness. The excess temperature in oven curing causing cracks on cubes Rice husk ask is also the reason for high compressive strength and its reason for avoiding chemical reactions. The acid solution has an obvious corrosiveeffect on cement-based materials. The aggressive solution increases as the acid concentration increases.

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