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STRENGTH STUDIES ON CONCRETE BY PARTIAL REPLACEMENT OFCEMENT WITH GGBS AND ROBOSAND

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ABSTRACT :

Concrete is a composite material made from cement, water, fine aggregate and coarse aggregate. But present researchers are in interest of finding new concrete by using different alternative materials or products produced from industries which are harmful to environment. An attempt has been made in the present investigation to evaluate the compressive strength and split tensile strength properties by replacing cement partially with GGBS and the perfect substitute for river sand is Robo-sand. River sand is one of the basic ingredients in manufacture of concrete. River sand has become expensive and scarce. Therefore, finding substitutes for the river sand is the objective. The crusher dust is known as Robo-sand can be used as alternative material to the river sand. Robo-sand possess similar properties as that of river sand, hence accepted as a building material. Some percentage of cement is replaced by GGBS and some percentage of fine aggregate is replaced by Robo-sand. In this project, experimental study was carried out on M-40 grade of concrete. In this concrete mix sand was replaced by Robo sand by a constant percentage and cement was replaced by GGBS in various percentages such as 10%, 20%, 30% and 40%. By changing the percentage replacement of material, strength equal to the conventional concrete, optimum percentage of Cement or fine aggregate can be found. Due to the scarcity of fine aggregate and high cost of cement partial replacement of material has been take place. In this study compressive strength, tensile strength are evaluated. In this project we replace the GGBS to the cement for obtaining the optimum value. Optimum value of GGBS is considered as the 15%. Now keeping the GGBS percentage constant and partial replacement of fine aggregate by Robo sand with increasing percentage has been experimented. The compressive test on concrete cubes, tensile test on cylinders is taken into account. The curing at 7days, 28days of cubes, cylinders and beams is considered.

Keywords: Robo Sand, GGBS, Compressive strength, Split tensile strength.

I.INTRODUCTION :

The demand for Portland cement is increasing dramatically in developing countries. Portland cement production is one of the major reasons for CO2 emissions into atmosphere. GGBS when used as a partial replacement substance for cement in concrete, it reacts with Ca(OH)2 one of the by-products of hydration reaction of cement and results in additional C-S-H gel which results in increased strength. Ground Granulated Blast-furnace Slag (GGBS) is obtained by rapidly cooling molten iron slag, a byproduct of iron and steel manufacturing, using water or air. This cooling process transforms the slag into a glassy, granular form, which is then dried and finely ground to produce GGBS. To obtain an adequate thermal activation, the temperature range should be established between 600 to 750ºC. The principle reasons for the use of clay-based pozzolans in mortar and concrete have been due to availability of materials and durability enhancement. In addition, it depends on the calcining temperature and clay type. It is also possible to obtain enhancement in strength, particularly during the strength of curing. The very early strength enhancement is due to a combination of the filler effect and acceleration of cement hydration. This project comprises of replacing of cement (OPC,53grades) for different percentage of robo sand and GGBS and then testing them for their compressive strength.

II.CHEMICAL COMPOSITION OF GGBS

Chemicals	Percentage (%)
SiO**2**	30.62
Al**2**O**3**	18.63
Fe**2**O_3	3.82
MgO	13.29
CaO	32.07
SO_3	1.57

TABLE-1- CHEMICAL COMPOSITION OF THE GGBS

III. APPROXIMATE CHEMICAL COMPOSITION OF OPC

Chemicals	Percentage (%)
SiO_2	20-25
Al_2O_3	4-8
CaO	60-67
Fe_2O_3	2-4
MgO	0.1-4
SO_3	1-3
Na_2O	0.1-1
K_2O	0.1-1

TABLE-1- APPROXIMATE CHEMICAL COMPOSITION OF THE OPC

IV.MIX PROPORTION RATIO

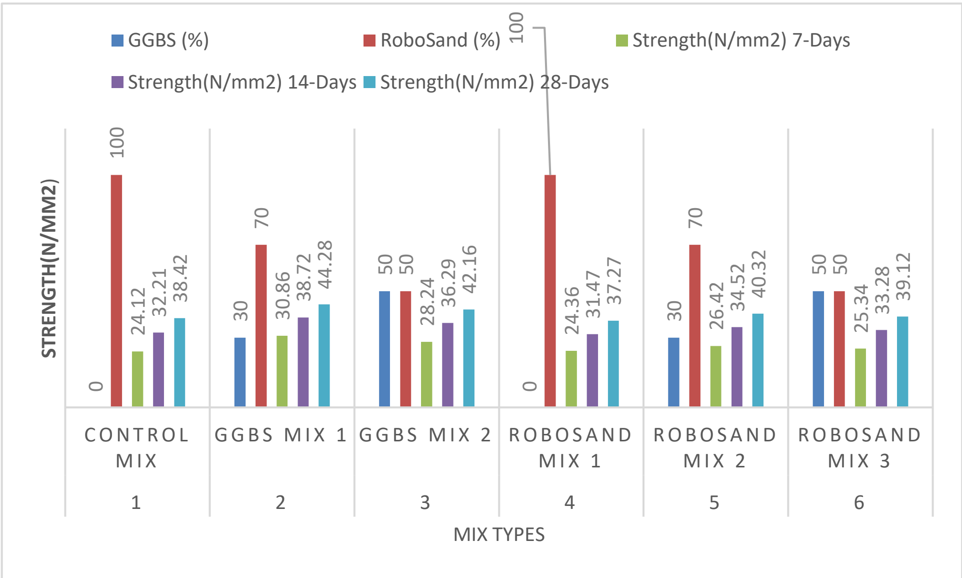
Cement	Fine aggregate	Coarse aggregate	Water
432.50	648.20	1144.57	186
1	1.49	2.64	0.43

TABLE-3- MIX PROPORTION RATIO

V. COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAYS

S.NO	Mix Type	GGBS (%)	Robo Sand (%)	Strength(N/mm^2)		
				7-Days	14-Days	28-Days
1	Control Mix	0	100	24.12	32.21	38.42
2	GGBS Mix 1	30	70	30.86	38.72	44.28
3	GGBS Mix 2	50	50	28.24	36.29	42.16
4	Robo Sand Mix 1	0	100	24.36	31.47	37.27
5	Robo Sand Mix 2	30	70	26.42	34.52	40.32
6	Robo Sand Mix 3	50	50	25.34	33.28	39.12

TABLE-5- COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAYS

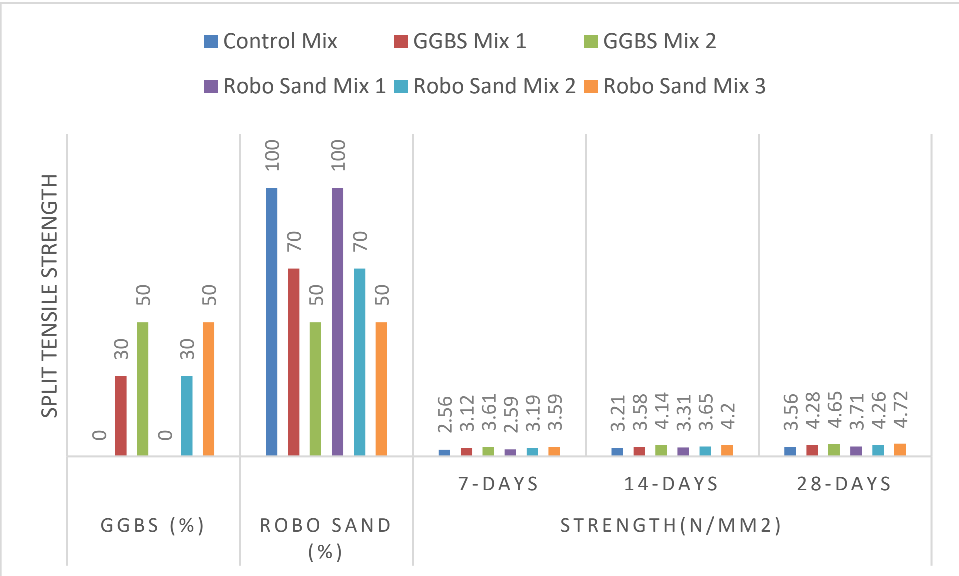


GRAPH-1-COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAYS

VI.SPLIT TENSILE STRENGTH FOR 7,14, AND 28 DAYS

S.NO	Mix Type	GGBS (%)	Robo Sand (%)	Strength(N/mm^2)		
				7-Days	14-Days	28-Days
1	Control Mix	0	100	2.56	3.21	3.56
2	GGBS Mix 1	30	70	3.12	3.58	4.28
3	GGBS Mix 2	50	50	3.61	4.14	4.65
4	Robo Sand Mix 1	0	100	2.59	3.31	3.71
5	Robo Sand Mix 2	30	70	3.19	3.65	4.26
6	Robo Sand Mix 3	50	50	3.59	4.2	4.72

TABLE-6-SPLIT TENSILE STRENGTH FOR 7,14, AND 28 DAYS



GRAPH-2- Split tensile Strength For 7,14, And 28 Days

VII.CONCLUSIONS :

- The addition of GGBS significantly improves the compressive strength of the concrete. For example, GGBS Mix 1 (30% GGBS) shows higher strength at all ages compared to the Control Mix.
- GGBS Mix 1 (30% GGBS) achieved the highest strength values at 7, 14, and 28 days, indicating that a moderate replacement level effectively enhances performance without compromising workability.
- The use of Robo Sand as a fine aggregate shows variable effects. Robo Sand Mix 2 (30% GGBS, 70% Natural Sand) exhibited better strength compared to Robo Sand Mix 3 (50% GGBS, 50% Natural Sand), suggesting that too high a proportion of Robo Sand might affect the overall concrete quality.
- The Control Mix (0% GGBS, 100% Robo Sand) displayed lower strength than GGBS mixes, confirming the benefits of GGBS in enhancing concrete properties.
- All mixes showed a continuous increase in strength from 7 to 28 days, indicating effective hydration and pozzolanic reactions, particularly in mixes containing GGBS.
- GGBS Mix 1 outperformed other mixes, with 44.28 N/mm² at 28 days, while GGBS Mix 2 and Robo Sand Mix 2 also provided satisfactory performance, showcasing the potential of GGBS and Robo Sand combinations for sustainable concrete solutions.
- The addition of GGBS significantly enhances the compressive strength of concrete. For instance, mixes with 30% and 50% GGBS consistently demonstrated higher strength at all curing ages compared to the control mix (0% GGBS).
- The 50% GGBS mix yielded the highest strength values at 7, 14, and 28 days, indicating that a higher proportion of GGBS positively influences concrete performance due to improved bonding and pozzolanic activity.

- The use of Robo Sand as a fine aggregate resulted in comparable strength outcomes to traditional sand. Both Robo Sand mixes (30% and 50% GGBS) showed a slight increase in strength relative to control mixes, confirming its potential as a sustainable alternative.

- All mixes displayed a continuous increase in strength from 7 to 28 days, emphasizing the importance of hydration and the pozzolanic reaction of GGBS over time.

VIII.REFERENCES :

Bureau of Indian standards, IS 10262:2009, Concrete Mix Proportioning Guidelines. Bureau of Indian standards, IS 12269:1987, OPC-53 Grade Cement.

1. *Bakharev, T.* (2005). "Geopolymeric materials: A new era in construction." *Journal of Materials in Civil Engineering*, 17(4), 367-376.
2. *Kumar, P., & Gupta, R.* (2017). "Experimental study on concrete using GGBS and Robo Sand." *International Journal of Engineering Research and Applications*, 7(4), 55-60.
3. *Sahu, S. K., & Yadav, R.* (2014). "Performance of concrete using GGBS and Robo sand." *International Journal of Advanced Research in Engineering and Technology*, 5(1), 41-46.
4. *Hossain, K. M. A., & Lachemi, M.* (2011). "Strength and durability properties of concrete using GGBS and fly ash." *Construction and Building Materials*, 25(10), 4134-4142.
5. *Bui, Q. B., et al.* (2018). "The effect of GGBS on concrete properties." *Advances in Materials Science and Engineering*, 2018.
6. *Mehta, P. K., & Monteiro, P. J. M.* (2014). "Concrete: Microstructure, Properties, and Materials." *McGraw-Hill Education*.
7. *Loh, S. K., & Mohamad, I.* (2016). "Utilization of GGBS as partial cement replacement in concrete." *Journal of Applied Sciences*, 16(8), 380-387.
8. *Shukla, S., & Singh, M.* (2018). "A study on properties of concrete using GGBS and Robo sand." *International Journal of Civil Engineering and Technology*, 9(2), 1277-1284.