To Investigate the Compressive Strength Properties of an Iron Slag, Wood Wool and EPS Beads Composition Material

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Abstract - *The production of significant quantities of by-products from industries and rapid urbanization has led to these materials being treated as waste with no specific use in other fields. This project aims to use slag, a commonly ignored material, in combination with EPS beads to reduce its environmental impact. The primary objective of this project is to study the behavior of slag-based materials under compression, including their physical properties and the results of tests conducted on the slag material. The study involved mixing slag, wood wool, and EPS beads with ordinary Portland cement of grade 43 as a binding agent in different ratios of 0.2, 0.4, 0.6, and 0.8. The samples were cured for two periods of 14 and 28 days. The test results suggest that slag and wood wool-based materials can serve as effective fill materials and are comparable to conventional granular fill materials. The study provides valuable insights into the potential use of slag and other waste materials in the construction industry, which could contribute to sustainable development.*

Key Words: Polymers and Plastics, Recycling, Waste Products, Slag, EPS beads, Compressive strength, Environment

1.INTRODUCTION

A considerable part of the investment of a project construction and infrastructure is relying on the mechanical properties of the underlying soil deposits and the foundation type that need to be adapted to support the said super structure. With the increasing need of land for the purpose of new projects, it becomes crucial to to improve and make use of even the less suitable soils with properties that lack the properties to make construction activities viable.

Given this, a newly developed construction material with properties to make the soil more suitable and also economical at the same time by making use of iron slag as a filler material, which is a by product in steel manufacturing plants. Also, in this manner it helps dispose of slag in without causing hazard for environment.

1.1 EPS Beads

EPS beads, made of polystyrene, dissolved pentane, and a fire-retardant additive, are ideal fill materials for geofoam blocks due to their closed cell structure. Research studies have used them as fill materials with soil, slag, bottom ash, and cement. The EPS beads used in this project have a density of 22kg/m3 and an average size of 2-3 mm.

1.2 Wood Wool

The waste from a wood processing saw is chopped into a 0.5-meter-long sliver, fed into an Excelsior cutting machine by a conveyer belt provided to Juggle, and then back to the teeter chamber, providing strength, reinforcement, and additional uses.The wood wool was procured from Singh Wood Works, Tatibandh, Raipur, Chhattisgarh.

1.3 Iron Slag

Iron and steel slag are materials used in infrastructure projects, with production estimated between 330 million and 390 million tons in 2022. These slags are generated during blast furnace slag and steelmaking slag, which are used to modify iron components. However, large infrastructure projects often use lowlying areas with unfavorable soil conditions, making construction difficult due to soil improvement. Disposal of slag is challenging due to the need for large land and environmental impact. Efforts have been made to utilize slag in large quantities, with blast furnace slag production ranging from 300 to 540 kg per tonne of pig or crude iron, and 150 to 200 kg per tonne of slag in steelmaking. The slag used in this project was tested for physical properties, including density, specific volume, and moisture content.

In this experimental study, the slag was procured from in semi dry state from Chandni fly ash bricks and allied products, Heerapur, Raipur, Chhattisgarh

Table -1: PHYSICAL PROPERTY OF IRON SLAG

Properties	Value
Maximum dry unit weigh	19.5 kn/m3
Optimum moisture content	13%
Specific volume	1.9
Coefficient of uniformity (Cu)	2.94
Coefficient of curvature (Cc)	1.05

Fig -1: Slag

Fig -2 : EPS Beads and Wood Wool

2. MIX RATIO AND PREPARATION OF SPECIMEN

In the present study, the mix ratio refers to the proportion between the weight of EPS beads and that of Slag. This ratio has been calculated based on previous research works conducted by Padade and Mandal in 2014, Ram Rathan Lal and Badwaik in 2015, as well as Marjive et al. in 2016. The ratios were selected based on a specimen size of 70 mm x 70 mm x 70 mm (343 cc). It is noteworthy that the Cement percentage was kept constant at 10% with respect to weight of slag. To prepare specimens, water quantity was determined by multiplying optimum moisture content with weight of stone dust. The dry weight of WS required for making specimens was calculated using a formula. These calculations were performed meticulously to ensure accurate results. It is important to note that this study aimed at investigating various aspects related to mix ratios including strength development, density variations among others; hence it was imperative for us to consider these factors while conducting our experiments. Overall, through rigorous testing procedures coupled with accurate calculations we have produced reliable data which can be used by other researchers working within this field or industry professionals seeking solutions for their specific needs . WFA = Ydmax x VS (Here, Ydmax= Maximum dry unit weight of slag VS = Volume of dry Slag). Volume of dry slag was calculated by using the formula- VS= VBeads- V (Here, VB = Volume of beads V = Total volume of specimen). The weight of beads was calculated by using the formulaWB = ρB x VB (Here, ρB = density of beads VB = volume of beads).The wood wool percentage was calculated with respect to weight of slag given as the ratio of 1%. 1.5% and 2%

Fig -3: Mixing of different materials

Fig -4: Specimen with mould

Table -2 : MIX RATIOS AND QUANTITY OF MATERIALS

S no	Mix ratio	eps beads (gm)	Slag (gm)	Cement (gm)	Volume of water(gm)
1	0.2	1.01	490.45	49	63.75
2	0.4	1.58	388.84	38.9	50.54
3	0.6	1.95	322.41	32.2	41.91
4	0.8	2.22	275.51	27.5	35.81

3. TESTING PROCEDURES

Upon completion of the curing period, the specimens underwent a process of air drying. Following this step, each specimen was subjected to measurement using an electronic weighing machine with precision and accuracy. Subsequently, compression tests were conducted on these specimens in order to determine their compressive strength. The universal testing machine was utilized for this purpose, ensuring that reliable and consistent results were obtained.

4. RESULT AND DISCUSSION

Density

The impact of mix ratios on the densities of the specimens was found to be substantial. The density of the unreinforced specimen ranged between 1000-1500 kg/m3. However, by incorporating 0.2% - 0.8% EPS beads into the specimen, the density of the specimens was observed to decrease. Specifically, the addition of EPS beads resulted in a reduction in density ranging from 9-29% compared to the unreinforced specimen.

Compressive Strength

After the completion of 14, and 28-day curing periods, compression tests were conducted on the specimens. The compressive strength of the newly developed geomaterial was found to be significantly influenced eps beads percentages, mix ratio values, and the duration of the curing period. The peak value of the compressive stress was taken as the compressive strength.. For all mix ratios and Pw/S values, the increase in compressive strength from 14 to 28 days of curing was between 670- 1830 kpa.

Mix ratio	**28 Days**			**14 Days**		
	1%.	**1.5%.**	**2%**	**1%.**	**1.5%.**	**2%**
0.2	1750.	1830.	1300	1630.	1500.	1100
0.4	1250.	1610.	1210	1180.	1300.	1180
0.6	1220.	1510.	890	770.	830.	700
0.8	1068.	1260.	810	670.	1100.	810

Fig -5: Effect of mix ratios on density of specimen

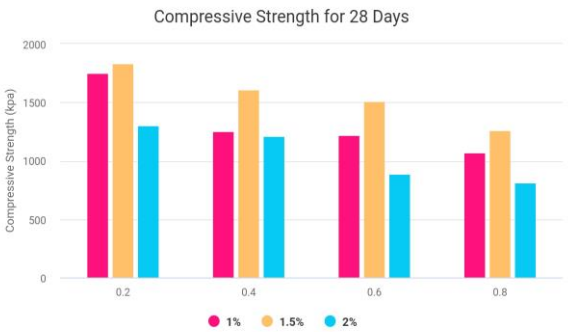

Fig -6: Relationship between compressive strength and mix ratios for 28 days

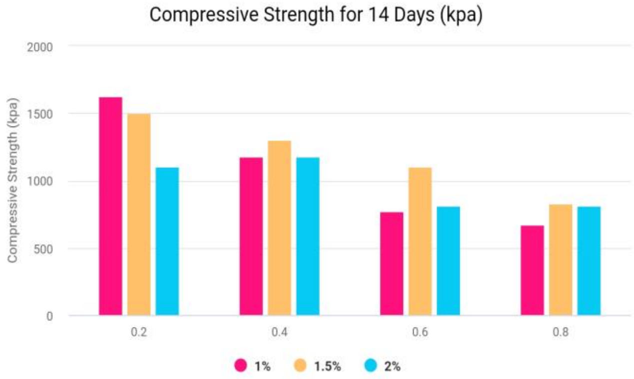

Fig -7: Relationship between compressive strength and mix ratios for 14 days

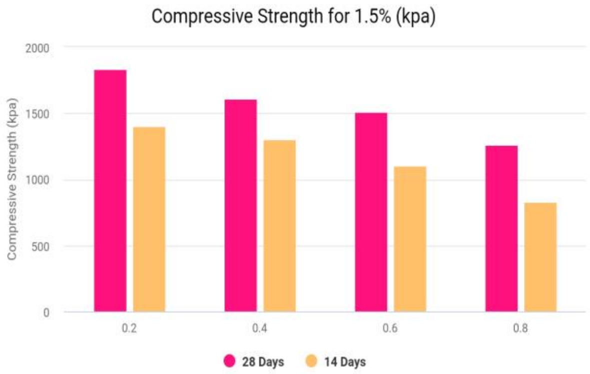

Fig -8: Relationship between compressive strength and Pw/S ratio values for 1.5%

5. FAILURE PATTERN

All of the specimens failed within a range of axial strain between 0.65% and 1.95% when they were subjected to an axial compressive load. As seen in Fig. 4.1, the failure pattern displayed separate planes of failure in both vertical and diagonal orientations. It is important to remember that this finding sheds light on the material's structural behaviour under compression, which might have important ramifications for engineering applications where high stress loads are anticipated. Consequently, more research into these results could be helpful in improving our comprehension of material qualities and how they behave under different loading scenarios.

Fig -9: Failure Pattern of Specimen

6. CONCLUSION

The study investigated the compressive strength of materials made from EPS beads, wood wool, and slag. Results showed that compressive strength values were significantly influenced by mix ratio and curing period. The strength decreased with increasing mix ratios, while the density increased with increasing EPS bead percentages. The compressive strength ranged from 670 kpa to 1830 kpa and the density ranged from 1000 kg/m3 to 1500 kg/m3 . The study concluded that the material's compressive strength and density were influenced by these factors.

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