Educational Administration: Theory and Practice
2024, 30(6), 559-564
ISSN: 2148-2403
https://kuey.net/

Research Article

Investigation Of Coal Bottom Ash And Glass Powder In Concrete As Partial Replacement For Sand And Cement

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Citation: Shabir Ali et al. (2024), Investigation Of Coal Bottom Ash And Glass Powder In Concrete As Partial Replacement For Sand And Cement, *Educational Administration: Theory and Practice*, *30*(6), 559-564
Doi: 10.53555/kuey.v30i6.5262

ARTICLE INFO

ABSTRACT

The study involves varying replacement levels to understand their impact on concrete properties. To make concrete better for the environment and more efficient, we can mix in waste materials. This saves natural resources like river sand and keeps important land from getting polluted. Two examples of leftovers we can add to concrete are desolate glass powder and coal bottom ash. These accoutrements might else be thrown down, but using them in concrete is a smart way to cut down on waste and make construction more sustainable. Through quantitative analysis. the study attempts to ascertain the impacts on the concrete fusions' continuity, flexural strength, and compressive strength. Additionally, this study's main goal was to look at using them in concrete to substitute cement and sand with glass powder and coal bottom ash. In place of sand, concrete samples were made using 0%, 10%, 15%, 20%, 30%, and 40% coal bottom ash and 20% mass glass powder in place of regular Portland cement. They go through several laboratory testing, including as compressive, flexural, and workability tests. The results provide the optimal replacement fraction at which the likelihood of failure increases. Each test takes 28 days to complete and is carried out in compliance with the IS code.

Keywords- Concrete, Cement, Fine Aggregate, Coarse Aggregate, Waste materials, Glass Powder, Coal Bottom-Ash, Workability.

1. INTRODUCTION

In India Coal is one of the most burning issues due to its large quantity of product in thermal power plants. Every time a million tons(MTs) of CBA are generated of pollution the 35 million metric tons of coal produced in India. Also 3 million tons of glass waste material produce every time in India. By probing their parcels and felicity, this study contributes to a greener and more effective constructionindustry. Coal-fired thermal factories use furnaces to make coal bottom ash, or CBA. It is a non-flammable substance made from burned coal that is mostly made up of fused patches of coarse ash. The produced ash has left to be pumped into polluted water bodies or dumped in an open area close to the facility. It takes the usage of nethermost ash to solve this kind of issue. Up to 25% of the total ash is made up of the nethermost ash, while the remaining 75% is made up of the cover ash. More than 70 percent of India's electricity is produced by the burning of fossil fuels, with coal-fired power plants producing around 61 percent of that total (Aggarwal et al 2007). Approximately 407 million metric tons of coal are consumed in coal-fired thermal power plants each year for 131 million tons of coal ash are produced yearly from the creation of power (Singh and Siddique 2014). Furthermore, observations have shown the fact that CBA is nicely canted, with mature grain sizes that are comparable to those of swash beach. It is mostly composed of silica, iron, and aluminum oxide, with trace amounts of calcium, magnesium, and sulfate. Because of the way that CBA is assembled, it's a suitable choice for concrete. When CBA is utilized, either wholly or partially, in place of beach in concrete, other experimenters have had positive outcomes. This is as a result of CBA's appropriate rates, which function effectively as a fine total in concrete. The attractiveness of using CBA as fine summations in concrete

products stems from these physical elements.
Glass is manufactured by melting a admixture of silica, soda pop ash and CaCO3 at veritably high temperature followed by cooling. It's typically used in common life of mortal with colorful forms like distance glass, vessel glass, bottles, bulb glass, tube glass etc. Grounded on the different chemical composition of glass, it may be divided into categories such as aluminum silicate glass, soda pop lime glass, borosilicate glass, and lead glass. Soda- lime glasses are widely utilized to make wastes, floats, and holders; in waste glasses, soda pop lime glasses account for more than 80 percent of the weight (Shi and Zheng, 2007). the waste glass is crushed into specified size to make it suitable for use in concrete as cement. the use of WG as cement could have excellent future in concrete assiduity. The application of WG in concrete manufacturing is obviously new technology which needs expansive observation and disquisition to promote the waste for construction assiduity as a cover for cement.
The goal of the current study was to examine the effects of replacing cement and fine aggregate separately with glass powder and coal bottom ash on the compressive, and flexural strength parameters of concrete. further contrasted with those of regular concrete. The selected accessories were carefully examined in relation to their packets, including their chemical composition, flyspeck size distribution, particular graveness, and fineness modulus. This study also examined the effects of utilizing coal bottom ash and glass powder on the microstructure, drying loss, and palpitation of glass powder-bottom ash concrete fusion samples.

2. MATERIAL 2.1-Cement:

According to IS 8112:1989, 43-grade Ordinary Portland Cement (OPC) was utilized in the study. Because of its specific strength, which denotes the maximum pressure it can bear before breaking, this kind of cement is unique. The categorization "43- grade" denotes that it has a minimum compressive strength of 43 megapascals (MPa) following 28 days of curing. Because of its adaptability, compatibility with a wide range of admixtures, and dependable performance in a variety of climatic situations, OPC is a cement that is frequently used in construction. Cement that complies with IS 8112:1989 is guaranteed to meet the exact quality criteria established by the Indian criteria Institution.

2.2- Fine aggregate:

The sand that was used was obtained locally and was classified as Zone II by IS: 383-1970, meaning that it could be used to make concrete. Its specific gravity of 2.62 indicates that the particle density is suitable and of acceptable quality. Sand tested in accordance with IS: 383-1970 guarantees optimal performance in construction applications by guaranteeing conformity with specified specifications.

2.3- Coarse aggregate :

To the IS: 383-1970 specifications, the coarse aggregate utilized had a specific gravity of 2.93 and a down size of 20 mm. Because it offers structural strength, this size is perfect for concrete mixtures. Its high specific gravity suggests that it is durable and compact. Testing conducted in accordance with IS: 383-1970 guarantees that the aggregate satisfies the necessary quality standards for use in construction.

2.4- Coal bottom ash:

This study employed coal bottom ash from a coal- fired thermal power plant in Bathinda, Punjab, India. The IS - BIS: 2389-1963 (Part III), which is comparable to ASTM C 128-93, was used to determine its qualities. The ash had a specific gravity of 1.39, a fineness modulus of 1.37, and a water absorption percentage of 31.58%.The primary constituents of the material were the oxides of silicon (56.44%), the oxide of aluminum (29.24%), and the oxide of iron (8.44%), with minor quantities of other substances, according to a chemical analysis performed using an energy dispersive spectrophotometer. The loss on ignition was 0.89%, which is less than the 6% required by ASTM C618-

3. It is classified as ASTM C 618-03 Type F ash because of its low calcium oxide level (0.75%) and 94.21% composition of SiO2, Al2O3, and Fe2O3. The ash's eligibility for use in concrete is indicated by these qualities, especially when it comes to meeting ASTM requirements for fly ash in Portland cement concrete.

2.5- Glass powder:

Glass debris that was readily available locally was gathered and turned into glass powder for use in concrete. Because glass trash is naturally hard, it must be ground or crushed to the right particle size for combining with concrete. By taking this step, the concrete mix's characteristics are improved as the glass powder is effectively incorporated into it.

Table 1: Chemical properties of cement and G.P.

Contents	Cement	Glass powder
SiO_2	21,0	71.4
Al_2O_3	5.9	1.4
Fe_2O_3	3.4	0.2

CaO	64.7	10.6
MgO	0.9	2.5
Na_2O	_	12.7
K_2O	_	0.5
TiO_2	_	_
SO_3	2.6	O.1

Table 2: Physical properties of Glass Powder

Colour	Light grey
Fineness Modulus	2.98
Specific gravity	2.48
Water absorption (%)	0.40
Density (kg/m^3)	1680

3. METHOD 3.1- Mix proportions:

First, concrete was made using various ratios of glass powder for cement and CBA for fine aggregate. The compresive strength, flexural strength, and workability of the initial samples led to the selection of concrete for additional analysis that included varying percentages of CBA as fine aggregate and 20% glass powder as a substitute for cement. River sand, completely saturated surface dry (also known as SSD) CBA, and a set amount of water into the cement ratio (w/c) were added to each concrete mixture. The CBA was mostly used in concrete to replace river sand. In every example, the effective w/c was 0.4. All created concretes had the same slump range (6–18 cm) and cement content (375 kg/m3). IS code method was used to calculate the mixture proportions.

3.2- Mix design:

- Grade Design - M40
- Cement - OPC 43 grade (conf. IS 8112)
- Maximum Nominal size of aggregate - 20 mm
- Minimum cement content-340 kg/m^3(IS:456)
- Maximum water-cement ratio - 0.45
- Workability - 100 mm (slump)
- Exposure condition – very Severe (for reinforcement concrete)
- Type of Aggregate - angular aggregate
- Maximum cement content – 450kg/m^3
- Chemical Admixture type – Superplasticizer

3.3- Target strength:

f'ck=fck+1.65 s 40+1.65*5
f'ck = 48.25 N/mm^2

3.4- Selection of water-cement ratio :

From table 5 of IS:456:2000,maximum water cement ratio = 0.45 adopt water-cement ratio = 0.40 0.40<0.45 okay.

3.5-Casting and curing of specimens:

In order to measure the compressive strength and retention of water, concrete cubes with size of 150 mm x 150 mm x 150 mm were formed in contrast, beams with dimensions of 100 mm x 100 mm x 500 mm were made to measure flexural strength. The specimens were demolded and allowed to cure in water at a comfortable temperature until they reached the designated test age, after which they were left in for an extra hour after the water was added. The testing results were consistent and reliable since the casting and curing procedures followed guidelines. Concrete testing commonly involves selecting sample sizes and curing conditions, which offer valuable information on the mechanical characteristics and environmental and load-bearing durability of the concrete.

4. RESULT AND DISCUSSION 4.1- Workability:

Mix designation	Percentage replacement of sand and cement by CBA and glass powder	Slump value (mm)
M	CEMENT 0% SAND 0%	75
M1	CEMENT 20% SAND 10%	61
M2	CEMENT 20% SAND 15%	54
M3	CEMENT 20% SAND 20%	36
M4	CEMENT 20% SAND 30%	20
M5	CEMENT 20% SAND 40%	13

Adaptability Workability declines when the amount of glass powder and coal bottom ash increases (i.e., the amount of cement and sand falls). As a result, the movement is restricted.

4.2- COMPRESIVE STRENGTH:

Mix designation	Percentage replacement of sand and cement by CBA and glass powder	Compressive strength after 7 days (N/mm^2)	Compressive strength after 28 days (N/mm^2)
M	CEMENT 0% SAND 0%	32.24	50.62
M1	CEMENT 20% SAND 10%	33.60	54.78
M2	CEMENT 20% SAND 15%	32.86	52.40
M3	CEMENT 20% SAND 20%	30.05	47.27

M4	CEMENT 20% SAND 30%	27.15	44.56
M5	CEMENT 20% SAND 40%	25.93	42.96

The workability of fresh concrete is a multifaceted issue including satisfying many requirements for compatibility, stability, and flexibility. If CBA and CFA employ industry waste products in concrete as a partial substitute for the sand paste and cement, respectively, maintaining the mix's properties as new concrete may later.. Slump is a metric used to determine how workable or consistent concrete is. the effects of using CBA in place of sand and glass powder in concrete mixes with similar weight-to- cement ratios. For control mixes M, M1, M2, M3, M4, and M5, the corresponding slump values were 75mm, 61 mm, 54 mm, 36 mm, 20 mm, and 13 mm. Since the porous CBA particles are known to have a far greater ability to absorb water ratio than the river sand particles, some water is internalized by them. The workability of concrete using different percentages (0%, 10%, 15%, 20%, 30%, and 40%) of CBA in place of sand and 20% glass powder in place The results of a test on hardened concrete that was done for seven and twenty-eight days using 0–40% coal bottom ash and 20% glass powder are shown in the table. Table data indicate that as curing time rises, so does compressive strength. After a seven-day curing period, the compressive strength of control concrete mix M 32.24 N/mm2 was achieved by M2 (15% CBA – 20% GP) at 32.86 N/mm2, M3 (20% CBA – 20% GP) at 30.05 N/mm2, M4 (30% CBA – 20% GP) at 27.15 N/mm2, and M5 (40% CBA –20% GP) at 25.93. The glass powder (GP) – coal bottom ash (CBA) mixture M1 (10% PBA – 20% GP) achieved 33.60 N/mm2.
Compared to the experimental combinations, the control concrete's compressive strength rose more slowly as the curing age increased. Glass powder- coal bottom ash concrete mixes M1, M2, M3, M4, and M5 had respective compressive strengths of 54.78 N/mm2, 52.40 N/mm2, 47.27 N/mm2, 44.56 N/mm2, and 42.96 N/mm2 at 28 days of curing age, compared to 50.62 N/mm2 of control concrete mixture M.

4.3- Flexural strength:

Mix designation	Percentage replacement of sand and cement by CBA and glass powder	flexural strength after 7 days (N/mm^2)	flexural strength after 28 days (N/mm^2)
M1	CEMENT 0% SAND 0%	3.32	5.03
M2	CEMENT 20% SAND 10%	3.82	5.76
M3	CEMENT 20% SAND 15%	3.46	5.21
M4	CEMENT 20% SAND 20%	2.89	4.67
M5	CEMENT 20% SAND 30%	2.41	4.01
M6	CEMENT 20% SAND 40%	2.01	3.68

The outcome of varying the concrete's flexural strength for seven and twenty-eight days while substituting glass powder for cement and coal bottom ash for sand. After seven days of curing, the flexural strength of the glass powder-coal bottom ash concrete mixtures M1 (10% PBA – 20% GP), M2 (15% CBA– 20% GP), M3 (20% CBA – 20% GP), M4 (30% CBA – 20% GP), and M5 (40% CBA – 20% GP) increased to 3.82 N/mm^2, 3.46 N/mm^2, 2.89 N/mm^2, N/mm^2, and 2.01 N/mm^2 of compare control mix M value 3.32 N/mm^2.
respectively. The control mix M exhibited a 28-day flexural strength whereas mixes M1, M2, M3, M4, AND M5 attained 5.76 N/mm^2, 5.21 N/mm^2, 4.67 N/mm^2, 4.01 N/mm^2, and 3.68 N/mm^2, of compare control mix M value 5.03 N/mm^2 in that order.

5. CONCLUSION

Drawings from experimental observations lead to the following conclusions:

- The workability declines as the amount of CBA and glass powder increases.
- Compressive strength rises as glass powder percentage rises to 20% and CBA replacement percentage rises to 15%; strength falls beyond these ratios.
- Flexural strength likewise rises with increasing glass powder percentages up to 20% and CBA replacement percentages of 15%; strength decreases beyond such levels.
- It is possible to replace cement with glass powder and sand with CBA when taking the strength parameters into account. Consequently, we may say that it is feasible to substitute cement in concrete with waste glass powder.
- It has been demonstrated that very finely ground glass is a great filler and may have enough pozzolonic qualities to replace some of the cement; at replacement level, the impact of ASR seems to be lessened with finer glass particles.

REFERENCES

1. Muthusamy, K., Rasid, M. H., Jokhio, G. A., Budiea, M. A., Hussin, M. W., & Mirza, J. (2020). Coal bottom ash as sand replacement in concrete: A review. Construction and Building Materials, 236, 117507.
2. Rafieizonooz, M., Mirza, J., Salim, M. R., Hussin, M. W., & Khankhaje, E. (2016). Investigation of coal bottom ash and fly ash in concrete as replacement for sand and cement. Construction and Building Materials, 116, 15-24.
3. Singh, M., & Siddique, R. (2013). Effect of coal bottom ash as partial replacement of sand on properties of concrete. Resources, conservation and recycling, 72, 20-32.
4. Kadam, M. P., & Patil, Y. D. (2013). Effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio. International journal of advanced technology in civil engineering, 2(1), 45-50.
5. Bheel, N., Keerio, M. A., Kumar, A., Shahzaib, J., Ali, Z., Ali, M., & Sohu, S. (2021). An investigation on fresh and hardened properties of concrete blended with rice husk ash as cementitious ingredient and coal bottom ash as sand replacement material. Silicon, 1-12.
6. Bheel, N., Khoso, S., Baloch, M. H., Benjeddou, O., & Alwetaishi, M. (2022). Use of waste recycling coal bottom ash and sugarcane bagasse ash as cement and sand replacement material to produce sustainable concrete. Environmental Science and Pollution Research, 29(35), 52399-52411.
7. Du, H., & Tan, K. H. (2014). Waste glass powder as cement replacement in concrete. Journal of Advanced Concrete Technology, 12(11), 468-477.
8. Aliabdo, A. A., Abd Elmoaty, M., & Aboshama, A. Y. (2016). Utilization of waste glass powder in the production of cement and concrete. Construction and Building Materials, 124, 866-877.
9. Islam, G. S., Rahman, M., & Kazi, N. (2017). Waste glass powder as partial replacement of cement for sustainable concrete practice. International Journal of Sustainable Built Environment, 6(1), 37-44.
10. Babajide Olabimtan, S., & Mosaberpanah, M. A. (2023). The Implementation of a Binary Blend of Waste Glass Powder and Coal Bottom Ash as a Partial Cement Replacement toward More SustainableMortar
11. Production. Sustainability, 15(11), 8776.
12. Archana, B., & Porchejian, C. (2014). Replacement of Fine Aggregate by Bottom Ash in concrete. Int. J. Struct. & Civil Engg, 3(2), 181-186.
13. Babajide Olabimtan, S., & Mosaberpanah, M. A. (2023). The Implementation of a Binary Blend of Waste Glass Powder and Coal Bottom Ash as a Partial Cement Replacement toward More SustainableMortar Production. Sustainability, 15(11), 8776.
14. Singh, Devinder, and Sukhdeep Singh. "utilization of coal bottom ash and waste glass in concrte construction: a comparative study."
15. Aggarwal P, Aggarwal Y and Gupta S M (2007) Effect of bottom ash as replacement of fine aggregates in concrete. Asian J Civil Eng 8(1):49-62.