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Evaluation of Concrete with Glass and Coconut Shell in Place of Coarse Aggregate and Partially Replaced Cement

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ABSTRACT- Supplies for building are getting more expensive every day. The two essential components of the concrete are pozzolanic material and crushed rock. These days, a lot of scientists are investigating building materials that could both raise and lower construction prices. It has been shown that using some industrial leftovers and agricultural residues as construction materials, particularly in underdeveloped countries, provide a number of real advantages. It was discovered that there is a lot of potential for using coconut shells to replace part of the aggregate used in concrete. The current work consists solely of a compilation of data related to GFRGC and earlier studies conducted by other academics. Millions of tonnes of glass waste are created annually.

KEYWORDS- Glass, coconut shell, cement, aggregate.

I. INTRODUCTION

According to Hawkins et al. (2003), the behaviour of regular Portland cement is unaffected by adding of up to 5% limestone. Since it saves money, energy, and reduces carbon dioxide emissions, using limestone powder in place of cement makes sense for concrete. However, because limestone must be mined, there are issues with environmental protection and the usage of a non-renewable resource for a sector as large as the construction industry. Lime production also uses water and entails energy-intensive processes. Determining similar material from trash and employing it in the construction of concrete becomes crucial. A poultry waste with a chemical makeup that is almost identical to limestone is calcium-rich egg shell. Portland cement manufacture is not only expensive and energy-intensive, but it also emits a lot of carbon dioxide. About one tonne of CO2 is released into the atmosphere during the manufacturing of one tonne of Portland cement. Fly ash, a byproduct of the burning of pulverised coal, is extracted from the fuel gases of thermal power plants using mechanical and electrostatic separators. Natural resources like limestone (CaCO3) are used as the main raw material in the making of cement. As of 2004, ASTM International C150 permitted up to 5% mass fraction of limestone to be included into regular port land cement. According to Hawkins et al. (2003), Portland cement's performance is unaffected by the use of up to 5% limestone. Additionally, bigger limestone percentages can be used in concrete at lower w/c ratios, according to Bentz et al. (2009). In concrete, altering the cement with limestone powder makes sense since it saves money, energy, and reduces carbon dioxide emissions. Between 0% and 50% of the total cementitious material's weight is replaced with coconut shell and glassy snowflakes in concrete. The utilisation of big volume fly ash and lime appears to give the best solution to rising cement demands as both materials are widely available and inexpensively priced in large volumes. Through reduced energy consumption (energy used to create cement), these two components produce concrete that is more "green" and helps to preserve natural resources. They also lower greenhouse gas emissions correspondingly. Reduced garbage disposal is among the additional advantages (land filling these industrial byproduct). As a more ecological, durable, and cost-effective alternative to regular Portland cement, the utilization of HVFA in concrete has recently grown in favour.

II. LITERATURE REVIEW

Jayeshkumar Pitroda et al (2012): This article demonstrates the viability of employing thermal industry trash as a substitute in part for cement in the manufacturing of concrete. As a substitute for entire additional concrete, using glass powder as a supplemental cementitious[1] ingredient in concrete compositions was tested. For M-20, Instead of cement, glass powder has been employed. in the following percentages:[2] 0% (without fly glass particles), 10%, 20%, 30%, and 40%. Concrete mixtures were created, tested, and compared to standard concrete in terms of compressive and split strength. These tests were conducted to assess the mechanical characteristics, and the results for compressive strength up to 28 days and strength for 56 days were taken.

Parag s. Kambli & sandhya r.mathapati(2014): Three different mix designs were created for concrete grades M20, M35, and M50. The range of the replacement rate for coconut shell was, in turn, 0% to 10% to 20% to 30% to 40%. Based on the finding of this research, concrete cubes of the M20 grade with 30% CS aggregate replacement had a 28-day strength of 23 MPa. 42 MPa of strength were achieved after 28 days for M35 using concrete cubes with 30% CS aggregate substitution[3]. At 28 days, strength of 51 MPa for

M50 grade concrete cubes with 30% replacement of CS aggregates was attained[4].

Amu And Salami (2010): carried out the experiment and found that egg shell worked well with ordinary salt on lateritic soil as a valuable stabiliser for road construction. Stabilization achieved by mixing ideal egg shell powder with 2–10% common salt. The outcome shown that adding common salt to egg shell stabilised soils enhanced their CBR and compaction properties[4]. The impact of coconut fibre and egg albumen on the mortar's compression and flexural capacity was reported by Ngo Slew Kee (2010) in his investigation on the issue of "Effect of coconut fibre and egg albumen in mortar for greener environment."[6]

Okonkwo et al., (2012): has come to the conclusion that egg shell ash can be utilised as a cement substitute since the mechanical properties was raised of lateritic soil. Constant Cement of 6 and 8 percent combined with egg ash powder of 0-10 percent at intervals of 2 percent indicates an improvement in compressive strength of 35%[7] but fell short of the durability standards for strength. In the end, they discovered that a soil-cement egg shell mixture might be utilised for paving roads. In an experiment on the impact of eggshell powder on the plasticity index in clay[8] and expansive soils, ArashBarazesh et al. (2012) found that adding egg shell waste to clay soil can increase the soil's plasticity index[9].

III. OBJECTIVE & SCOPE OF THE WORK

- In the ongoing project, coconut shell is selected to partially substitute coarser aggregate used in concrete. The prevalence of waste products like coconut shell is rising daily. These can be utilised as aggregates, reducing the quantity of trash they contain.
- Waste glass has some pozzolanic qualities when reduced to a very fine powder. As a result, glass powder can partially replace cement and aid in the development of strength. However, the reaction can be partially or completely avoided by managing the reactive silica, cement alkali level, and moisture.
- Coconut shells are used as a substitute in some cases for coarse aggregates and glass powder is utilized as a substitute replacement for cement to be able to provide more affordable concrete solutions. The replacements will take place in order to lower the cost of producing concrete.
- Building projects expenses are increasing exponentially. The primary source of concrete is concrete, and the equipment needed to make it are becoming more expensive by the day.
- The purpose of replacing material is to reduce and control the cost of construction materials as well as construction expenditures.
- By partly replacing coconut shells and glass powder for cement and aggregates, the amount of waste on the globe will reduce.

IV. MATERIAL PROPERTIES

A. Cement

The substance known as cement is often as a powder it may be turned into a paste by the addition of water and, when shaped or poured, will solidify into a mass. The phrase "cement" refers to a a number of organic materials are employed as adhesives or fasteners, however these are actually categorised as adhesives. Portland cement is the type of construction cement that is most frequently utilised. The clinker, which is a close mixture of calcareous and argillaceous minerals, was intensely heated to produce its bluish grey colour. The main raw material is a blend of clay or shale and high calcium lime stone, sometimes known as cement rock. Some cements may also use blast furnace slag. The most significant type of cement is by far regular Portland cement. It has only single grade of OPC in existence prior to 1987, and it was governed by IS 269-1976. Higher grade cements were introduced in India after 1987. Depending on the cement's strength after 28 days of testing, the OPC was divided into three grades: 33 grade, 43 grade, and 53 grade. This testing was excecuted according to IS 4031-1988. The cement is referred to as 33 grade cement if the 28-day strength is greater than 33 N/mm2. 43-grade cement is defined as having a strength of at least 43 N/mm2. Cement is referred to be 53 grade cement if its strength is greater than 53 N/mm2. However, the factory's measurements of this cement's real strength.

Table 1: Properties of cement

S. No.	Property	Test Result
1	Compressive Strength (MPA)	47.25
2	Fineness (%)	6.2
3	Specific Gravity	2.96

B. Coarse Aggregates

Crushed stone is used to make concrete's coarse aggregates. The quarrying, crushing, and grading of commercial stone. Trap rock, limestone, and granite make up practically all of the crushed stone. The characteristics of fresh concrete are influenced by the form and texture of the aggregate more so than with hardened concrete. A smooth surface can improve workability, whereas a rough surface creates a stronger bond between the paste and the aggregate, boosting strength.

C. Coconut Shells

Because of the smooth surface on one side of the shells, coconut shell concrete is more workable. When compared to regular concrete, coconut shell concrete has a great impact resistance. Coconut shell has a greater potential to hold moisture and absorb water than traditional aggregate (see figure 1).

Figure 1: Coconut shell grinding

D. Glass Powder

All around the world, glass powder is a common Pozzolonic

substance. The benefits of utilizing it in concrete include better workability, increased strength, less permeability, and decreased hydration heat(see figure 2).

Figure 2: Glass Powder

E. Water

Clean water is essential because contaminants can reduce concrete strength and corrode steel reinforcing. Water used to make and cure concrete should be reasonably clean and free of noxious substances including oil, acid, alkali, salt, sugar, silt, and other noxious chemicals that could affect the concrete or steel. If water is fit for drinking, it is also considered fit for making concrete. Therefore, drinkable tap water was used for mixing and curing purposes in this experiment.

V. RESULTS AND DISCUSSION

A. Workability Test

It was found that the workability was rising as the fraction of material being replaced increased. Coconut shell and cement concrete may be easier to deal with due to the smooth surface on one side of the shells and the fact that the shells are smaller than conventional aggregates(see table 2 and figure 3).

Table 2: Slump test values

% Replacement of coarse aggregate &cement	Slump cone value (mm)
0	3.5
10	4.3
20	6.3
30	9.2
40	10

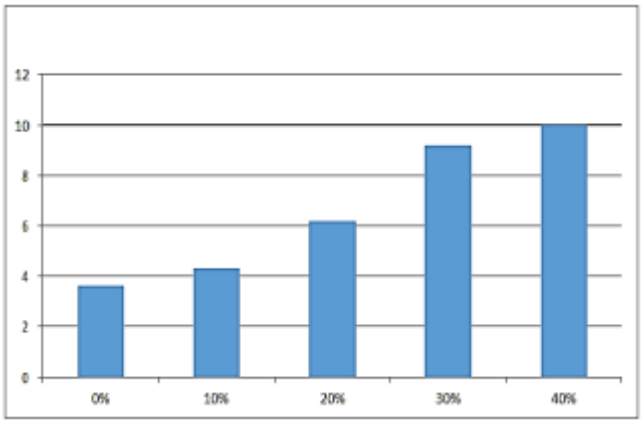

Figure 3: Workability test results

B. Compressive Strength Test

Compressive strength on average of the 20% replacement mix was 22.62 MPa, or around 94.25% of the strength of regular concrete (24MPa). Similarly, with 30% and 40% replacement, we obtained compressive strengths of 14.93 MPa and 5.48 MPa, respectively. The outcome demonstrates that concrete made of coconut shells can even be utilised in applications requiring considerable strength with replacements of 20% or less(see table 3 and figure 4).

Table 3: Compression test results

% Replacement of coarse aggregate &cement	7days	14days	28days
0	29	38	43
10	28	34	40
20	30	37	44
30	27	34	41
40	25	33	39

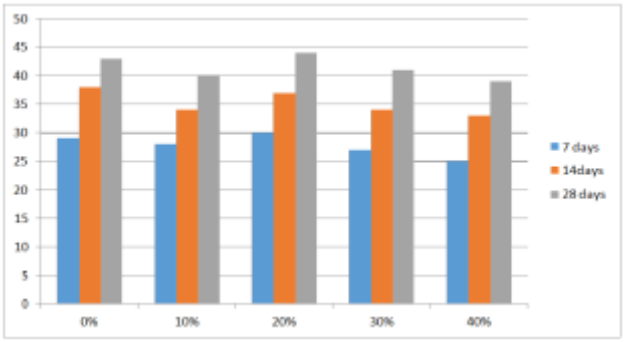

Figure 4: Compression test results

C. Split Tensile Strength Test

The splitting tensile strength of the 20% replacement mix was 2.22 MPa, or around 89.5% of the strength of regular concrete (2.48MPa). For 30% and 40% replacement, respectively, we obtained splitting tensile strengths of 1.27 MPa and 0.495 MPa (see table 4 and figure 5).

Table 4: Split-tensile test results

% Replacement of coarse aggregate &cement	7days	14days	28days
0	2.67	3.70	4.12
10	2.47	3.42	3.80
20	2.73	3.78	4.20
30	2.48	3.44	3.83
40	2.35	3.25	3.62

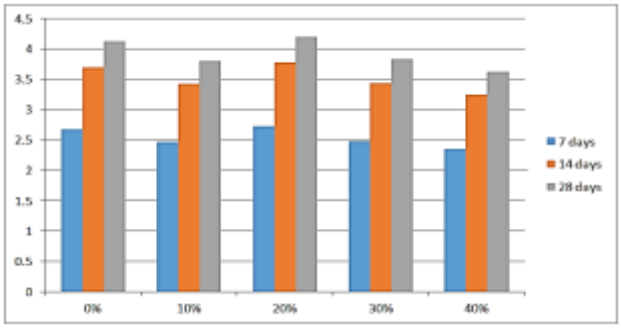

Figure 5: Test results of split tensile strength

VI. CONCLUSIONS

From this study, the following conclusions were made:

- The strength properties of the coconut shell and glass powder mixer are more than 20% higher than those of conventional concrete.
- If we replace the coconut shells and glass powder by more than 15% and 30%, respectively, the concrete's strength is reduced.
- By replacing the current components of concrete with glass powder and coconut shells, we can reduce the cost of manufacturing cement for coarse aggregates.
- According to the investigation, cement and aggregates can be replaced by glass powder and coconut shell in concrete up to 20% to 30% of the time.
- By substituting eggshell powder and fly ash for cement during the manufacture of cement, we can lessen the impact on the environment.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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