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A Study on Evaluation of Concrete with Partial Replacement of Cement and Aggregate with Sustainable Materials

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Abstract: ***The rising concern over environmental sustainability has led to widespread research on sustainable replacements in the field of construction materials. This study evaluates the possibility of partially replacing conventional ordinary portland cement and aggregates in concrete with sustainable materials while preserving structural integrity and performance. Various alternative materials, as well as industrial by-products and replacements were assessed for their effects on mechanical properties such as compressive strength, tensile strength, and durability etc. various test are to be conducted by the author in this paper . The study employed a comparative investigation of different mix designs including sustainable materials to determine their suitability. Results indicated that certain replacements, such as fly ash, silica fume, and recycled aggregates exhibites admirable strength characteristics and environmental benefits. Additionally, we focusses on highlighting the role of IS codes in regulating material properties and construction practices. The author finds the potential for sustainable materials in concrete production along with reducing carbon emissions and resource depletion while maintaining structural performance and lifespan.***
Keywords: ***concrete, opc, IS Codes, suistainable concrete structure, Sustainable Materials etc.***

I. INTRODUCTION

Concrete is the backbone of modern structure, widely used in the construction of buildings, roads, bridges, and various other structures in the field of civil engineering. concrete versatility, durability, and strength make it essential in civil engineering domain . we finds The cement industry alone contributes approximately 7–8% of carbon dioxide (CO_2) emissions, mostly due to the energy-intensive process of clinker production. moreover the extensive mining of natural aggregates further reduces natural resources and upsets ecosystems creating imbances .author wants to say that, there is a growing interest in accepting sustainable substitutes to reduce the ecological footprint of concrete while upholding its structural integrity.

A. Need for Sustainable Materials in Concrete

The rapid stride of urbanization and infrastructure development has heightened the demand for concrete, placing massive pressure on natural resources. The traditional style to concrete production depend on heavily on Portland cement as a binder and natural aggregates (such as sand and gravel) .after studying litreture we find that However, sustainability gains eminence in the construction industry, authors , researchers and engineers are vigorously discovering partial replacements for cement and aggregates using ecological materials. These alternative materials not only help in reducing carbon emissions but also improve waste management.

B. Sustainable Materials for Cement and Aggregate Replacement

Abundant materials have been identified as viable replacements for cement and aggregates in concrete. Some of the most promising substitutes of cement and aggregate include:

C. Cementitious Replacements

Fly Ash: author finds fly ash as a by-product of coal combustion in thermal power plants, fly ash enhances workability and long-term strength in concrete. Where Ground Granulated Blast Furnace Slag (GGBS) is used as a by-product of the steel industry, as it improves durability and reduces permeability. Another type of material is Silica Fume . It is An ultrafine material made from silicon and ferrosilicon production, author discovers silica fume enhances the compressive strength of concrete. Rice Husk Ash (RHA) is also versatile and Rich in silica content, after test performed we find RHA Very important as it contributes to pozzolanic reactions results in improving strength and durability.

D. Aggregate Replacements

Aggregate reolacements are as follows the first material is Recycled Concrete Aggregate (RCA) . It is Crushed concrete from demolition waste decreases the need for new aggregates and promotes a circular economy. Crushed Glass is also Used as a partial fine aggregate replacement, it improves durability and aesthetics. Author finds Plastic Waste particularly Shredded plastic materials can partially replace fine and coarse aggregates, reducing plastic pollution. Adnan rashid found Coconut Shells and Palm Kernel Shells are beneficial in agricultural by-products used as lightweight aggregate alternatives

E. Authors concluded

This research is vital as it aims to evaluate the feasibility of replacing conventional cement and aggregates with sustainable materials while maintaining the properties of concrete. By analysing the performance of these alternative materials, the study will contribute to the development of eco-friendly construction practices that line up with global sustainability goals. Additionally, executing sustainable concrete solutions can lead to profitable low cost construction, reduced environmental degradation which enhances waste utilization ultimately providing development and resource-efficient construction industry.

F. Objectives of the Study

The primary objectives of this study are as follow:

1) To evaluate the mechanical properties (compressive strength, tensile strength, and flexural strength) of concrete with partial replacement of cement and aggregates using sustainable materials.
2) To estimate the durability characteristics of the modified concrete under various environmental conditions.
3) To compare the economic viability of sustainable concrete mixtures with conventional concrete.
4) To promote the use of industrial and agricultural waste in construction, thereby reducing landfill waste and conserving natural resources.

II. LITRETURE REVIEW

Various Several studies have discovered the possibility of incorporating waste materials in concrete. From litreture studied Murugesh and Balasundaram (2017) observed water hyacinth ash as a cement substitute and found that 10% replacement provided finest strength. where as Okwadha and Makomele (2018) analysed bio-admixtures in self-compacting concrete and discovered improved flowability. From litreture we can conclude that Paris et al. (2016) evaluated alternative cementitious materials and highlighted the potential of agricultural wastes. Author finds Singh and Siddique (2015) demonstrated that coal bottom ash can replace fine aggregates, reducing environmental impact. These studies support the incorporation of agro-industrial waste materials in concrete to enhance sustainability.

III. MATERIAL AND METHODOLGY

A. Materials Used

We use the following material for the test.

1) Cement: OPC 53-grade cement (ambuja cement) with a specific gravity of 3.15.
2) Fine Aggregates: particularly accquire from the local River, fineness modulus of 2.75.
3) Coarse Aggregates: we use Hard stones (20mm & 12.5mm sieves) sizes.
4) Waste Materials: mainly we use WHA, Fly Ash, RHA, and E-Waste etc.

After reviewing the litreture review in detail, the first step is to conduct a preliminary survey. Preliminary survey was conducted to detect the suitable place from where samples has to be collected. sample is collected from local site of j&k. Attempts were made to cover up the maximum possible wards of area located near site and household of author, to get optimum samples and their feedback from the survey was recorded.

Following Test are conducted to check the different parameters of concrete
Compressive Strength Test. As per specifications of (IS 516-1959)
Flexural Strength Test As per (ASTM C78)
Tensile Strength Test following (IS 5816-1999)
And Water Absorption Test (ASTM C642)
Standard procedures are followed during the conduct of various test as per different IS Codes . As per Requirement Suitable data is assumed accordingly.

IV. RESULTS AND DISCUSSION

Compressive Strength : After Test we Find Concrete samples combining 10% WHA Showing an increase of 8% in compressive strength over conventional concrete. Compressive Strength Development Over Time is shown in Figure 1:

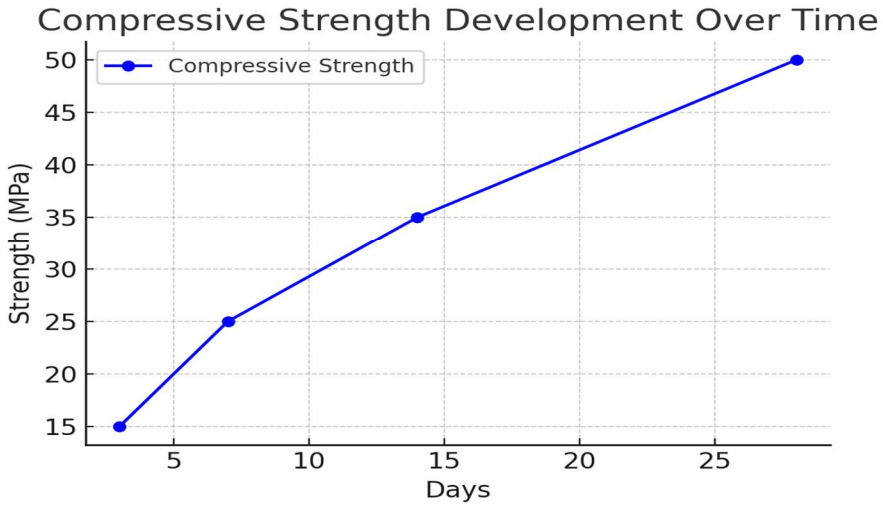

Figure 1: Compressive Strength Development Over Time

While Performing the test we finds The addition of fly ash improved flexural strength by 12%.
Flexural Strength Development Over Time is shown in Figure 3

Figure 2: Compressive Strength Machine [UTM]

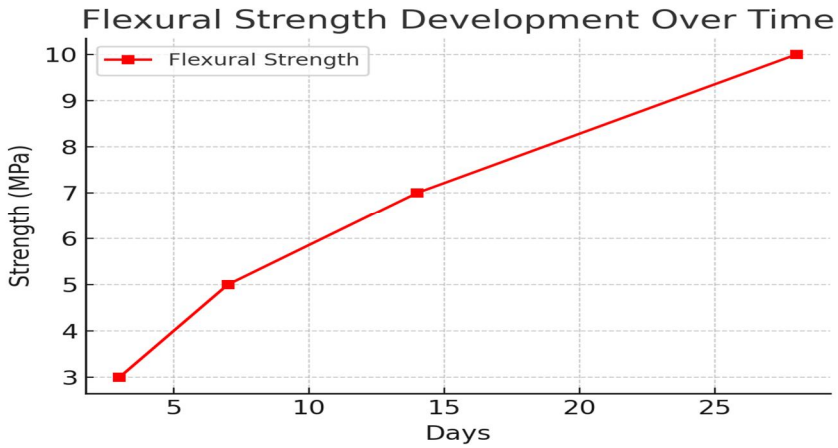

Figure 3: Flexural Strength Development Over Time

Figure 4: Flexural Strength Development Over Time

For Tensile Strength : During test we find Rice husk ash slightly improved tensile strength, with the highest recorded at 7 MPa at 28 days for a 10% replacement. Shown in figure no 5.

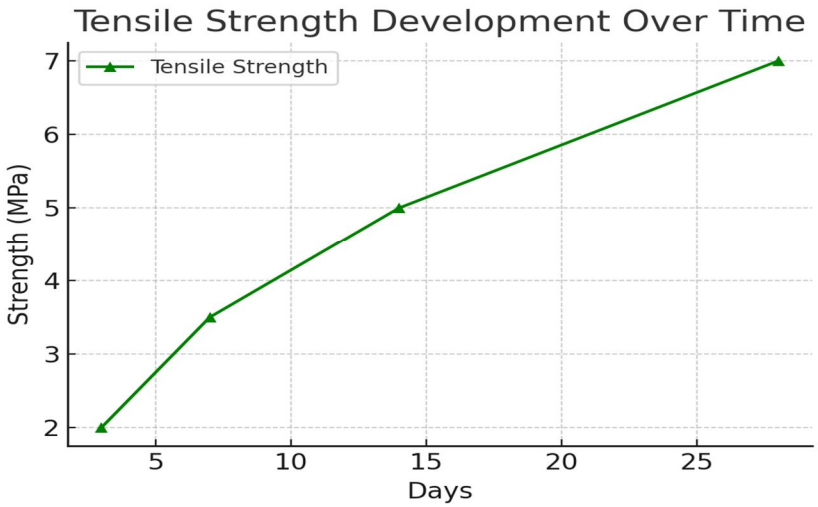

Figure 5: Tensile Strength Development Over Time

We concluded In Case Of Water Absorption Concrete containing e-waste had reduced water absorption we find result as lowering permeability by 15% compared to control samples.

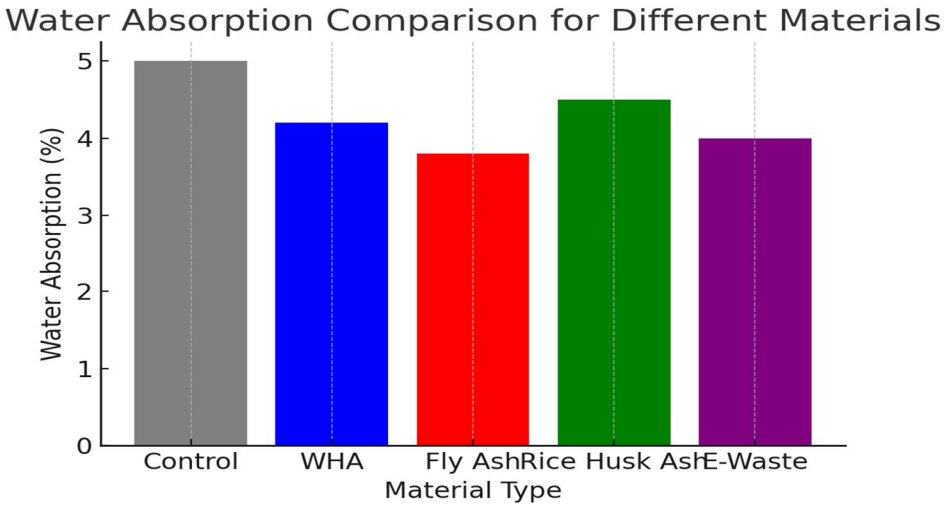

Figure 6: Water Absorption Comparison for Different Materials

TABLE No 1 Final Results and Observations

Property	Control Concrete	WHA Concrete (10%)	Fly Ash Concrete (10%)	RHA Concrete (10%)	E-Waste Concrete
Compressive Strength (MPa)	50	54	52	51	49
Flexural Strength (MPa)	8.5	9.2	9.5	9.0	8.8
Tensile Strength (MPa)	6.5	7.0	6.8	7.2	6.4
Water Absorption (%)	5.0	4.2	3.8	4.5	4.0

V. CONCLUSION

The study successfully validates the possibility of using sustainable materials as partial replacements for cement and aggregates in concrete. After performing test and observing test results we concluded that combining alternative materials such as fly ash, silica fume, and recycled aggregates can achieve great results .The authors concluded that improved mix designs can enhance strength characteristics without compromising durability and other parameters. Moreover, refrence and performing test to IS codes ensures that these sustainable modifications line up with established construction standards very well . The research and writers focuses on the importance of sustainable practices in modern construction focusing contributing to reduced carbon footprints. Writers suggests that Future research should be done focus on long-term performance evaluations and large-scale implementation strategies for sustainable concrete and their applications.

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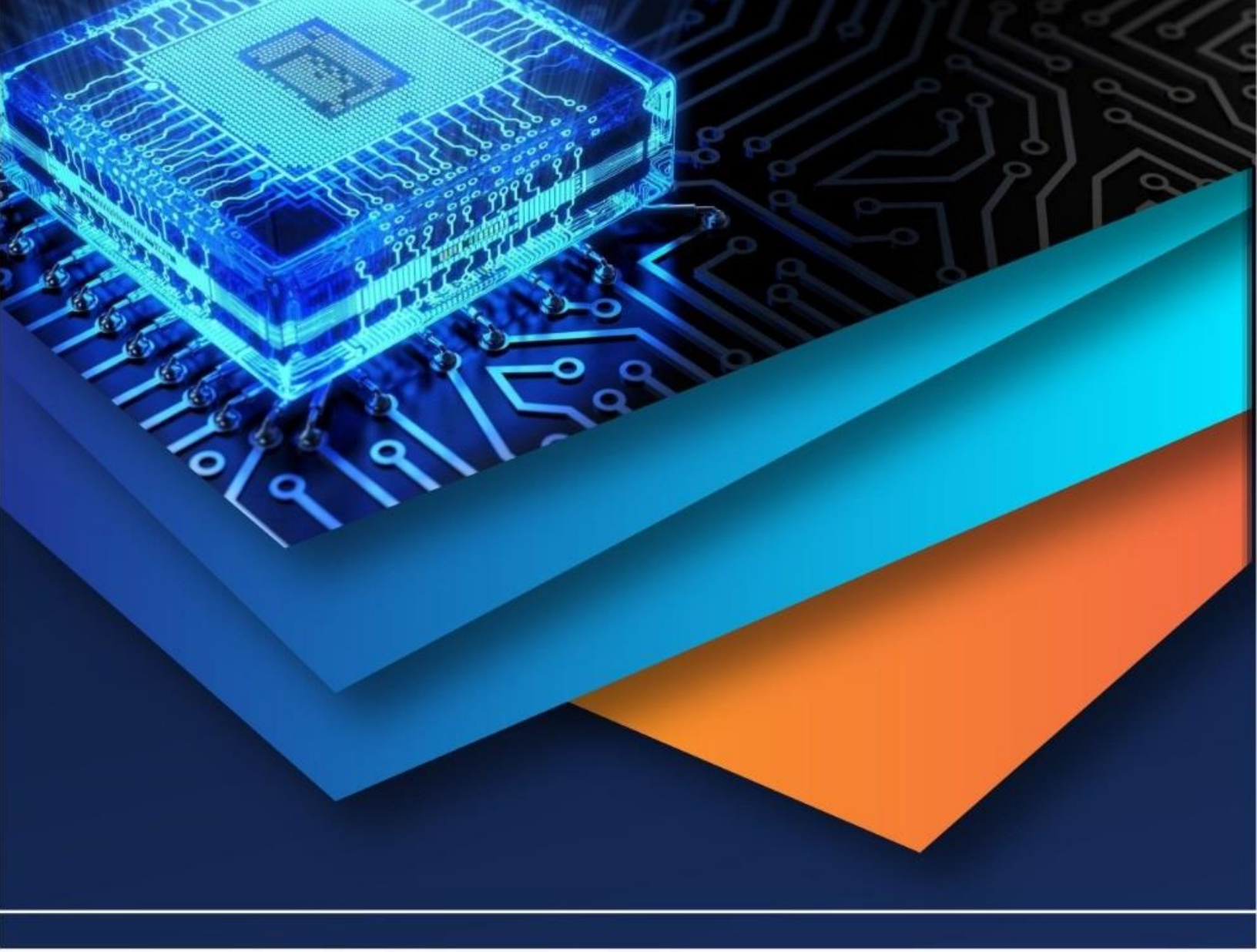

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