

An Experimental Study on Performance of Concrete Using Combination of Waste Terracotta and Glass Particles.

Himanshu

M. Tech Student, Department of Civil Engineering

World College of Technology and Management, Gurugram-122506, India

ABSTRACT

The ongoing demands for sustainable construction material have led to increased research on utilization of industrial and construction waste in concrete production. This study investigates the performance of concrete by incorporating waste terracotta and glass particles as partial replacement for conventional coarse and fine aggregates. The primary objective is to evaluate the mechanical and durability properties of such modified concrete while promoting eco-friendly waste management practices.

In this experiment, waste terracotta is used as a substitute for coarse aggregates, whereas crushed glass particles are used for replacing fine aggregates mix varying proportions in combine forms. A series of concrete mixes are prepared with different replacement percentages like 20%, 30% and 40%, and tests are conducted to assess workability, compressive strength, tensile strength and flexural strength. Additionally, durability aspect such as water absorption and resistance to environmental conditions are also examined. Compare replacements with control mix to show the existing values for futuristic scope. Our focus is gaining attention because these materials are easily available from construction debris and ceramic industries.

1. INTRODUCTION

Concrete, A most usable manmade construction material which is formed with the mixture of cement, fine aggregates, coarse aggregates and water with proper proportion. According to the various studies and reports by different organizations, 30 billion tonnes of concrete are used worldwide, which is 2nd after the water consumption which will reach 20 billion cubic meters annually by 2050. The primary ingredient of concrete is cement, which produces approximately 4-5 billion tonnes annually which provides strength and binds the other ingredients. China is the largest cement producer country 52-57% of worldwide production, followed by India, the EU and the U.S. The environmental impact of concrete globally is 10% in carbon emission according to “the global cement and concrete association”.

The research mainly considers M30 grade concrete with a constant water-cement ratio and admixture dosage to maintain uniformity in mix. Combined different replacement levels such as 20%, 30% & 40% are adopted to determine the optimum percentage that provides satisfactory strength and durability without affecting the performance of concrete.

Objectives of the study

The main objectives of this thesis are:

1. To investigate the suitability of terracotta & glass as coarse and fine aggregates in combine replacement of concrete mix.
2. To evaluate the workability of fresh concrete using slump test.
3. To determine the compressive strength of concrete at different curing periods.

4. To study the split tensile strength characteristics of modified concrete mixes.
5. Comparing the performance of conventional concrete and waste material-based concrete.
6. To identify the optimum replacement percentage that provides maximum strength and satisfactory performance.

Scope of the study

The scope of this thesis includes the following aspects:

1. The study is limited to M30 grade concrete prepared with a water-cement ratio of 0.45 and 1% admixture dosage.
2. Combined replacement considered in the study are 20%, 30%, and 40%.
3. Experimental investigations are carried out into fresh and hardened concrete properties.

2. LITERATURE REVIEW

Z. Ismail & E. Al-Hashmi (2009) the waste glass as fine aggregates in the experiments 10-20% partially replaced for sand produced concrete formation of high compressive and flexural strength. With the angular form of glass particles inclined to diminish the slump, hence workability goes to improve in it. The fine particles of glass act as a pozzolan, which consumed calcium hydroxide ($\text{Ca}(\text{OH})_2$) and getting deficiency in the alkalinity of concrete, which help to deduct the expansion problems adjuvant with coarse particles. The study shows the alkali-silica reaction (ASR) issues found out in the experiments.

L. M. Federico & S. E. Chidiac (2009) Outcomes of research show that as waste glass was consumed as an aggregate, The umbilicus switches toward utilizing it as a supplementary cementitious material due to its pozzolan behavior. The serious situation in this concept is ASR issue directly relates to the size of particles, Using very fine glass instead of coarse recycled glass down the tendency of ASR. This study recommends mechanical treatments, such as fine grinding to down the ASR, the review notes are chemical treatment, use of lithium compound considerably to reduce the ASR reactions.

C. Thejaswini Veena et. al. (2023) Waste glass attends as feasible, Affordable partial replacement for fine aggregates in concrete & maintain mechanical properties at specific percentages. Research shows replacing sand with glass powder (up to 30%) gives convenient compressive strength & durability. Waste glass can modify the compressive strength by 3-7% and tensile strength upgrades due to pozzolanic reactions, which provides the bond strength between cement and glass particles. The usage of waste materials diminishes the requirement of natural sand, addressing disposal challenges while increased workability and lower density.

Medina C. et al. (2012) The sanitary ceramic industrial waste can be successfully used as a partial replacement for natural coarse aggregates in concrete. The study shows that up to 20-25% ceramic waste upgrades the mechanical properties, specifically compressive and tensile strength, due to concentrated pore structure. The resulting eco-concrete indicates high strength and expands porosity. This study highlights the reduction of environmental impact by recycling ceramic waste. The concrete with reused ceramic can achieve the strength level at 80-95% of standard concrete, with some mixes.

Senthamarai R. M. & Manoharan P. D. (2005) shows the behaviors of fresh & hard concrete with ceramic waste coarse aggregates and differentiate the properties with standard concrete & depiction of ceramic waste aggregates and similarity with crushed stone coarse aggregates. Ceramic waste can be modified into coarse aggregates used in concrete mix. The compressive, flexural & splitting tensile strength of ceramic waste coarse aggregates concrete are lower by 3.8, 18.2 & 6%.

Mir Fazal Ul Hassan & Ashish Kumar focuses on eco-friendly concrete by using waste glass as fine aggregates and recycled aggregates as coarse for the concrete mix. The workability of mix decreases due to the use of recycled aggregates, which absorb more water as compared to normal & glass provides high workability for its smooth texture. 20-30% use of recycled aggregates gives strength decrease & 10-15% glass replacement shows bonding improvement due to

pozzolan behavior. Excess amount of glass can raise the ASR but if suitable can improve the resistance to permeability

3. METHODOLOGY

Data Collection

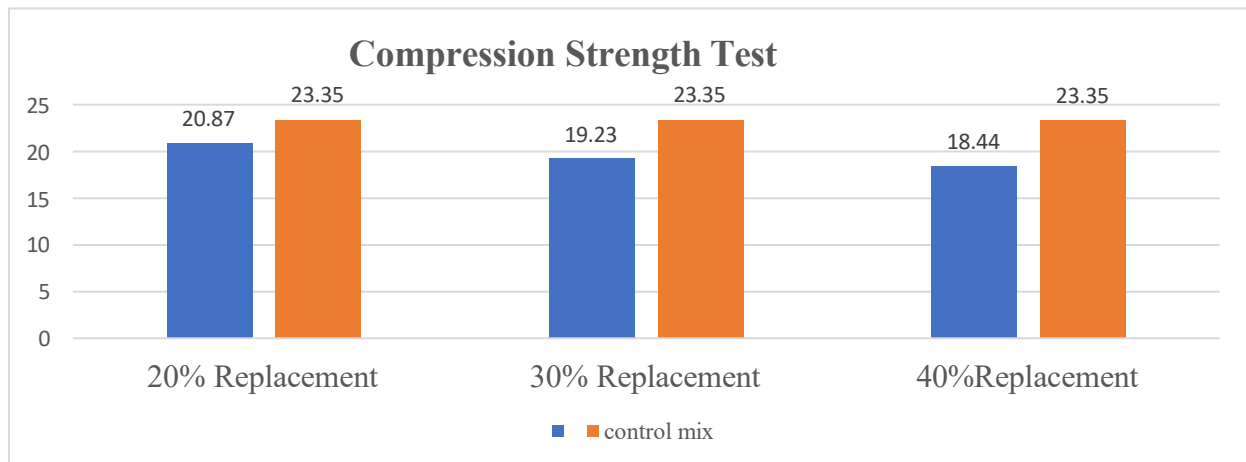
Data collection comes directly through experiment investigation conducted in laboratory, after proper mix design and material selection.

Parameters Analysis

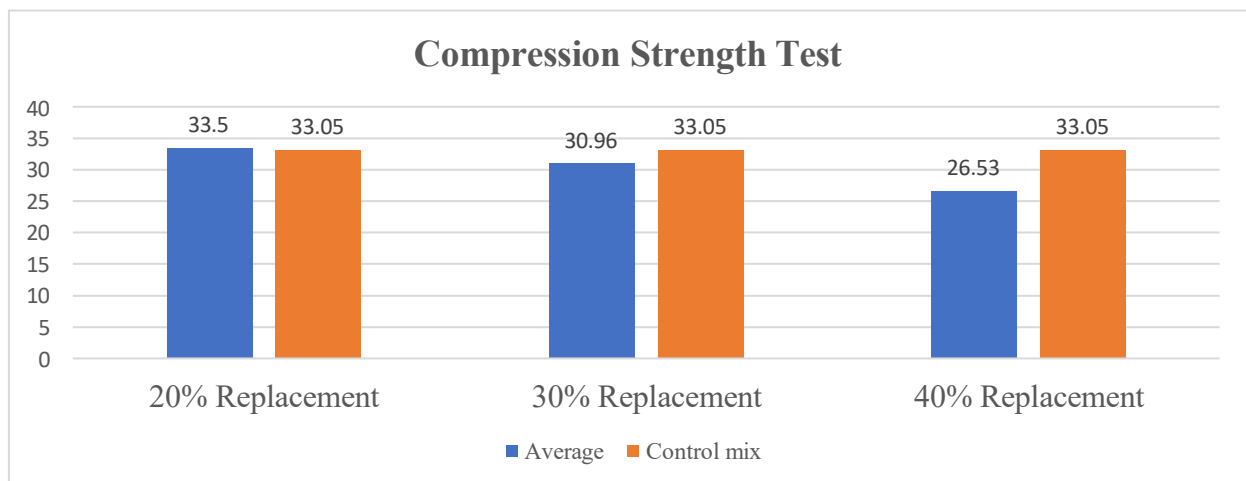
- ❖ Compressive Strength Test (fck)
- ❖ Split Tensile Strength (ft)
- ❖ Workability Test

4. RESULT & DISCUSSION

Compression Strength test (fck): 07 days

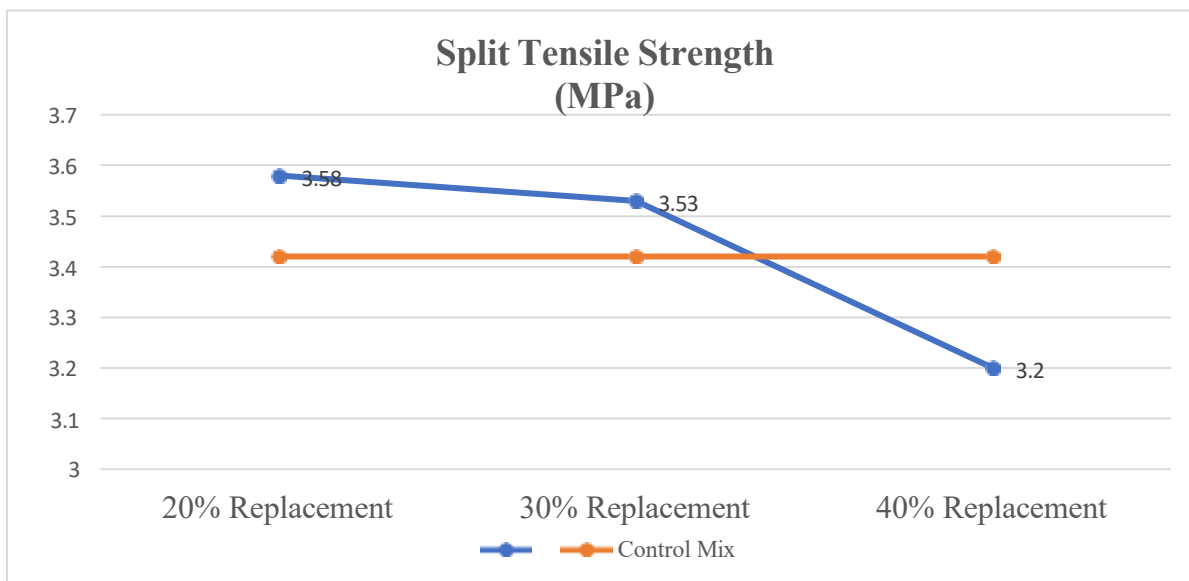
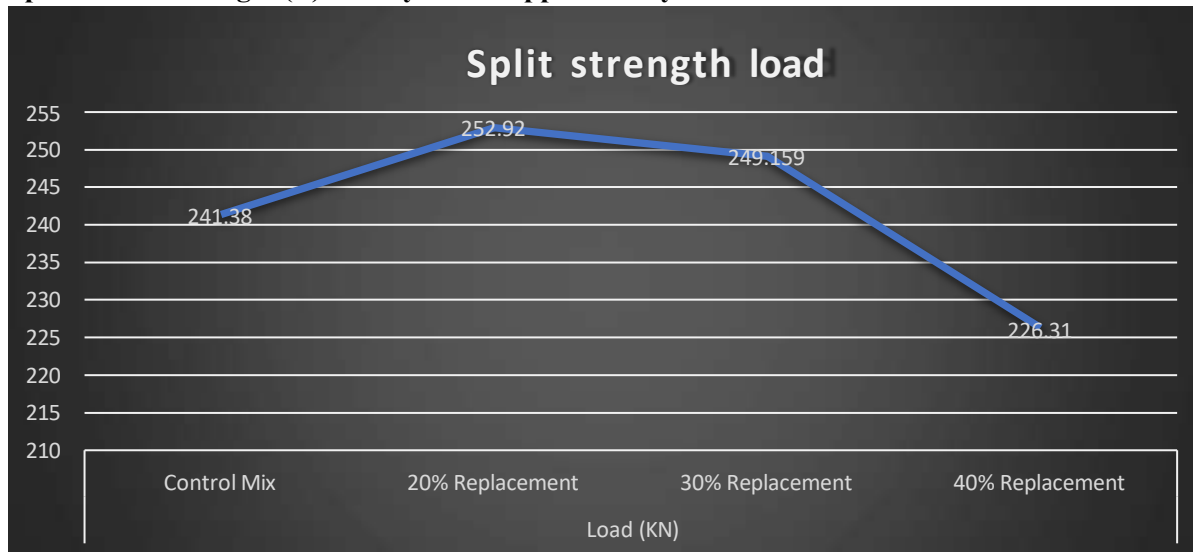


Compression Strength test (fck): 28 days



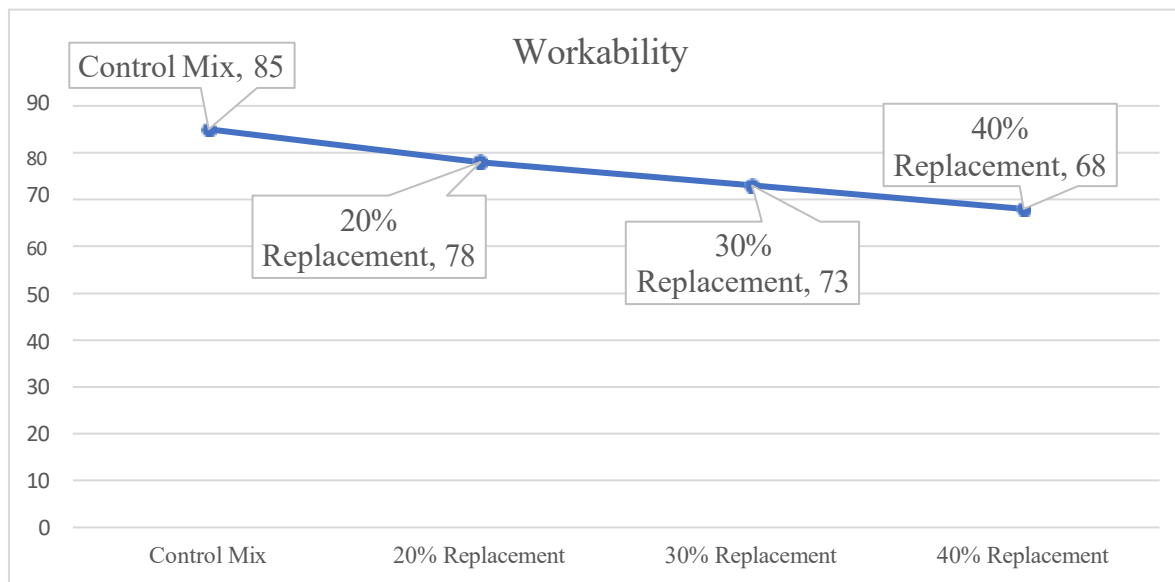
Strength of 20% & 30% partial replacement sample is slightly close and higher than the control mix, but when 40% used it may decrease, having multiple causes like personal errors, handling process, mixing time and more.

Split Tensile Strength (ft): 28 days Load applied on cylinder:



Concrete having waste material replacement showed satisfactory tensile performance up to 20% & 30% combine replacement in concrete. The angular shape and rough texture of terracotta improve interlocking within mixture, helps in resisting tensile stresses. Both samples have average value of 3.58 & 3.53 MPa.

Workability Test:



The workability of specimens decreases when waste glass & terracotta percentage increases. The control mix had the highest workability because natural aggregates absorb less water and provide smooth flow.

5. CONCLUSION

The research successfully demonstrated that waste terracotta aggregates and glass aggregates can be effectively utilized as combined partial replacement materials in concrete production. The experiment results confirmed that the developed concrete achieved satisfactory mechanical properties while contributing to sustainability, waste management and conservation of natural resources. Therefore, the use of these waste materials in concrete can be considered a promising alternative for sustainable construction practices.

6. REFERENCES

1. Indian standard institution (1987).IS 1199: Methods of Sampling and Analysis of Concrete. Bureau Of Indian Standards, New Delhi.
2. Indian standard institution (1959).IS 516: Methods of Tests for Strength of Concrete. Bureau Of Indian Standards, New Delhi.
3. Mehta, P.K., & Monterio, P.J.M. (2014). Concrete: Microstructure, Properties, and Materials (4th ed.). Elsevier.
4. Neville, A.M. (2011). Properties of Concrete (5th ed.). Pearson Education.
5. Gambhir, M.L. (2013). Concrete Technology (5th ed.). McGraw-Hill Education.
6. Turgut, P., & Yahlizade, E.S. (2009). "Research into concrete blocks with waste glass." International Journal of Civil and Environmental Engineering.
7. Topcu, I.B., & Canbaz, M. (2004). "Properties of Concrete Containing Waste Glass." Cement and Concrete Research.
8. Medina, c., Sanchez De Rojas, M.I., & Frias, M. (2012). "Reuse Of Sanitary Ceramic Waste as Coarse Aggregate in Eco-Friendly Concrete." Cement and Concrete Composition.

9. Senthamarai, R.M. & Manoharan, P.D. (2005). "Concrete with Ceramic Waste Aggregates." Cement and Concrete Composition.
10. Shao, Y., Lefort, T., Moras, S., & Rodriguez, D. (2000). "Studies on Concrete Containing Waste Glass." Cement and Concrete Research.
11. Ling, T.C., & Poon, C.S. (2012). "Use of Recycled Glass in Concrete." Construction and Building Materials.
12. IJERT. Research paper related to waste terracotta aggregate and glass powder concrete.
13. ResearchGate. Journal papers on sustainable concrete material and waste aggregates utilization.
14. ScienceDirect. Articles related to recycled glass and ceramic waste in concrete technology.