

An Experimental Study on Performance of HDPE Plastic in Concrete Boundary Wall

Shubham Sharma , Ankit Sethi

World College of Technology & Management, Farukhknagar Gurgaon(Haryana)

Abstract - This study examined HDPE (high-density polyethylene) plastic waste as an added material for concrete Boundary wall. The selection of HDPE was based on its increased strength, hardness, and resistance to high temperatures compared with other plastics. It focused on how HDPE plastic can be used as an additive in concrete to increase its tensile strength and compressive strength. 156 specimens were used to identify the effect of adding different percentages and sizes of HDPE lamellar particles to lower, medium, and higher strength concrete for non-structural applications. HDPE 0.5 mm thick lamellar particles were added at 2.5%, 5%, 10%, and 20% by weight of cement. The results showed that the medium concrete class (with compressive strength equal to 10 MPa) had the best response to the addition of HDPE. The 5% HDPE addition represented the optimal mix for all concrete types. In the pursuit of sustainable construction practices, the integration of recycled materials into concrete production emerges as a pivotal strategy. This research delves into the integration of recycled High-Density Polyethylene (HDPE) plastic aggregates into concrete mixes, with the aim of bolstering both the mechanical properties and ecological sustainability of concrete structures. The study meticulously examines the compressive, tensile, and flexural strengths, along with Young's Modulus of Elasticity, of concrete specimens incorporating recycled HDPE plastic aggregates. Notably, a water-to-cement (w/c) ratio of 0.25 was employed in the concrete mix formulation, optimizing the material's performance. The plastic aggregates utilized in this study were meticulously prepared, comprising 50% recycled HDPE plastic and 50% sand, resulting in a balanced 1:1 ratio for the first type, while the second type featured a 1:2 ratio. Through rigorous experimentation and analysis, the findings elucidate the transformative potential of recycled HDPE plastic aggregates in reshaping conventional concrete production paradigms. This research underscores the viability of recycled HDPE plastic aggregates as a sustainable.

1. INTRODUCTION

Concrete's strength, durability, and accessibility make it one of the most popular building materials in the world. It is frequently utilized in boundary walls, pavements, roadways, and structures. Because it offers safety, security, and property separation, a boundary wall is an essential component of any building. Cement, fine aggregate, coarse aggregate, and water are the traditional ingredients used to make concrete. Aggregates make up between 60 and 80 percent of the overall volume of concrete. Natural resources like sand and stone aggregates are being used up quickly due to the growing demand for building materials. At the same time, plastic trash disposal has grown to be a major global environmental issue.

Using HDPE waste in concrete is one practical solution. In addition to lowering environmental pollution, using HDPE plastic waste in place of conventional aggregates also reduces the need for natural aggregates. Concrete made from recycled plastic can help control trash and promote sustainable building methods. Researchers' interest in replacing some of the fine or coarse particles in concrete with plastic trash has grown in recent years.

Objectives of the Study-

- To determine the effect of HDPE on the workability of concrete mixes. To evaluate the compressive strength of concrete containing different percentages of HDPE.
- To study the density and lightweight characteristics of HDPE mixed concrete. To identify the optimum percentage of HDPE that can be used in concrete without significantly affecting its performance.

2. LITRATURE REVIEW

Lopez et al. (2018) Recycled HDPE plastic in place of some of the coarse material in pervious concrete. HDPE was added to percentages of 10%, 20%, and 30%. The best compressive strength was obtained at the 10% replacement level, according to the experimental results. The study also found that concrete became lighter and less dense when additional HDPE was added. The experts suggest that HDPE concrete could be suitable for non-structural applications such as pavements and lightweight construction projects.

Jain et al. (2019) The effects of incorporating plastic waste at weight percentages of 0.5%, 1%, 2%, 3%, and 5% into concrete mixtures. The study found that concrete with higher plastic percentages was less workable and compressive due to insufficient

bonding between plastic particles and cement paste. Conversely, lower percentages reduced the overall weight of the concrete and worked satisfactorily. The study demonstrated how important it is to employ the appropriate amount of plastic waste to get better results.

Merli et al. (2020) I looked through several studies about the use of HDPE in concrete and discovered that, compared to other polymers like PET, HDPE has gotten less attention.

According to the study, HDPE's strength, durability, and ability to tolerate high temperatures make it an excellent option for sustainable building materials. The researchers recommended further research on HDPE concrete for real-world building applications, especially for lightweight and non-structural components.

Saikia & de Brito (2014) Investigated the use of leftover plastic aggregates in concrete production. The study found that adding plastic particles to concrete reduced its density and enhanced its thermal insulating properties. However, excessive use of plastic particles decreased compressive strength due to weak interfacial bonding. The researchers concluded that plastic waste concrete might be effectively used in lightweight, non-load-bearing structures.

Al-Manaseer & Dalal (1997) Research on concrete constructed using plastic particles showed that adding plastic components significantly reduced the unit weight of the concrete. The study found that although lightweight concrete with plastic particles had a lower compressive strength than ordinary concrete, it was suitable for non-structural applications. The results of the study indicate that incorporating waste plastic in concrete helps to reduce environmental contamination and conserve resources.

3. METHODOLOGY

Data Collection

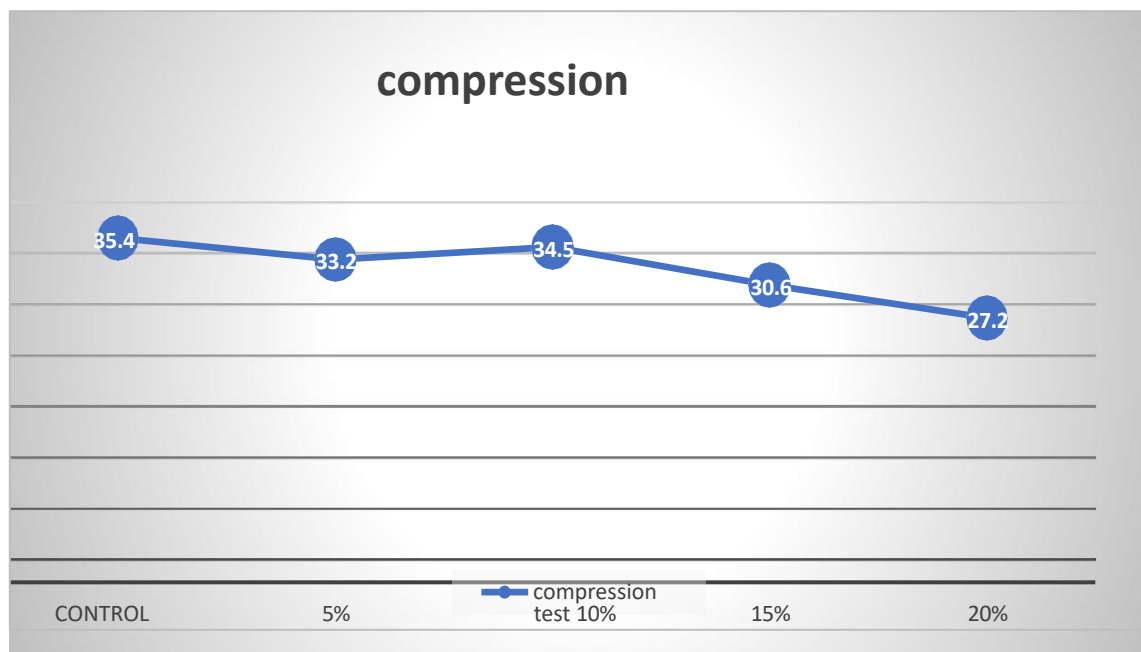
Data collection comes directly through experiment investigation conducted in laboratory, after proper mix design and material selection.

Test Analysis

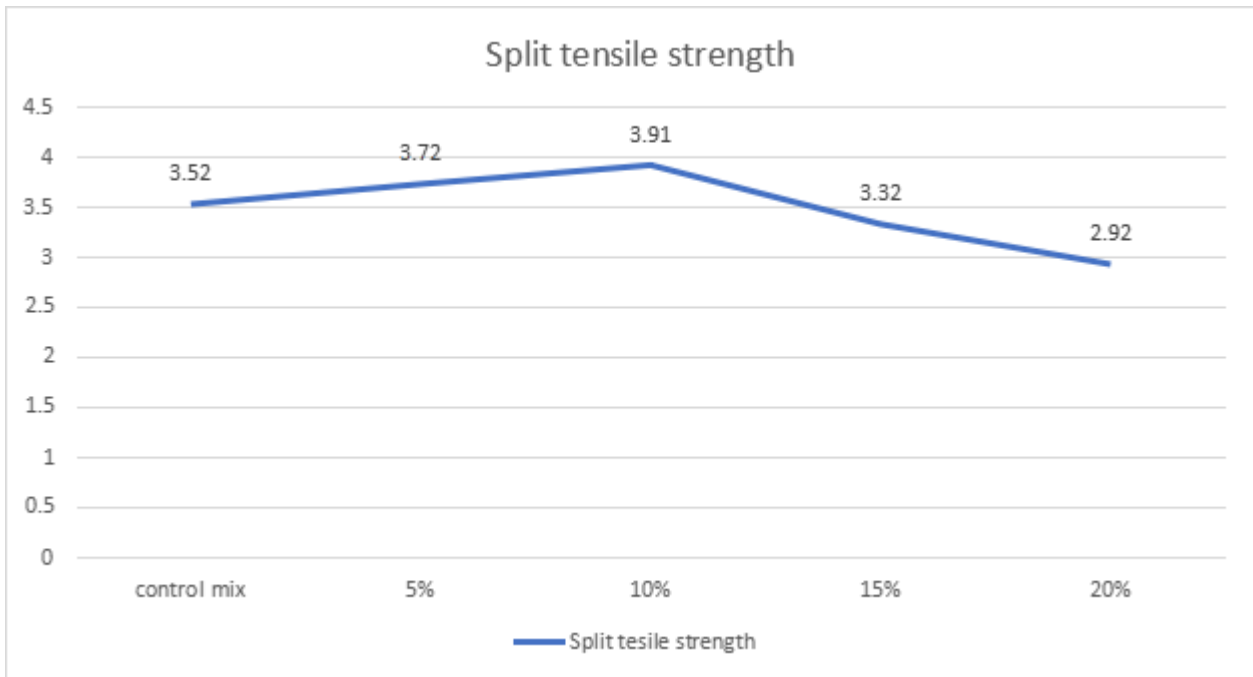
- Compressive Strength Test
- Split Tensile Strength
- Workability Test
- Water Absorption Test

4. RESULT

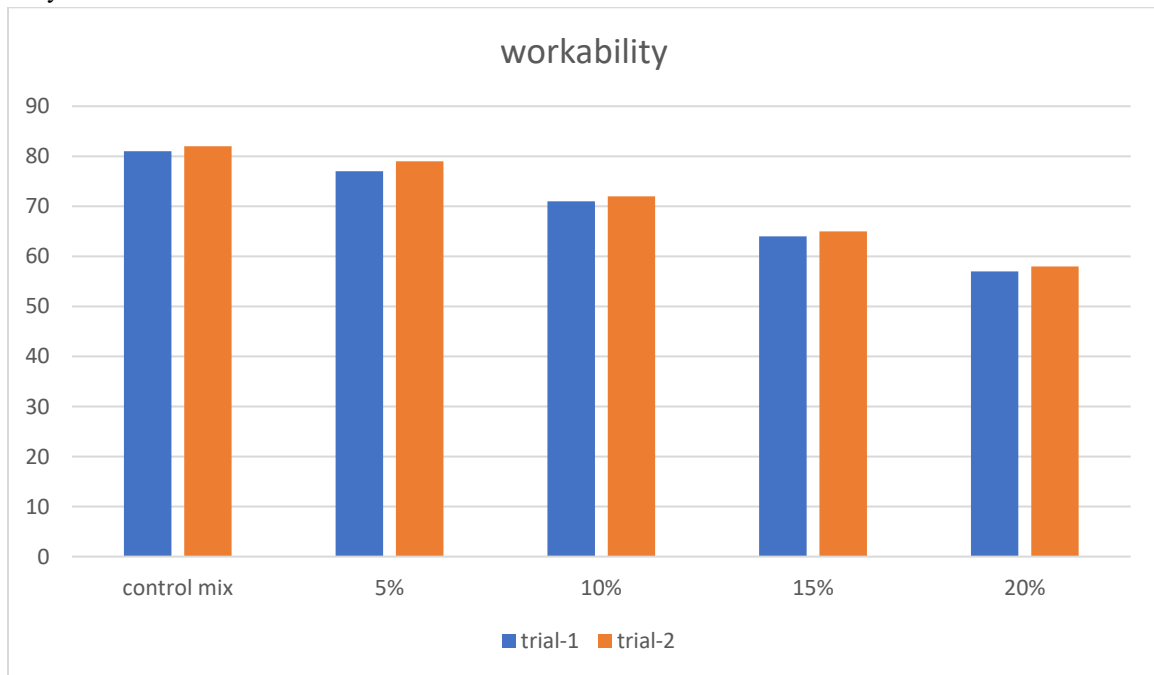
➤ Compressive Strength Test- 28 days



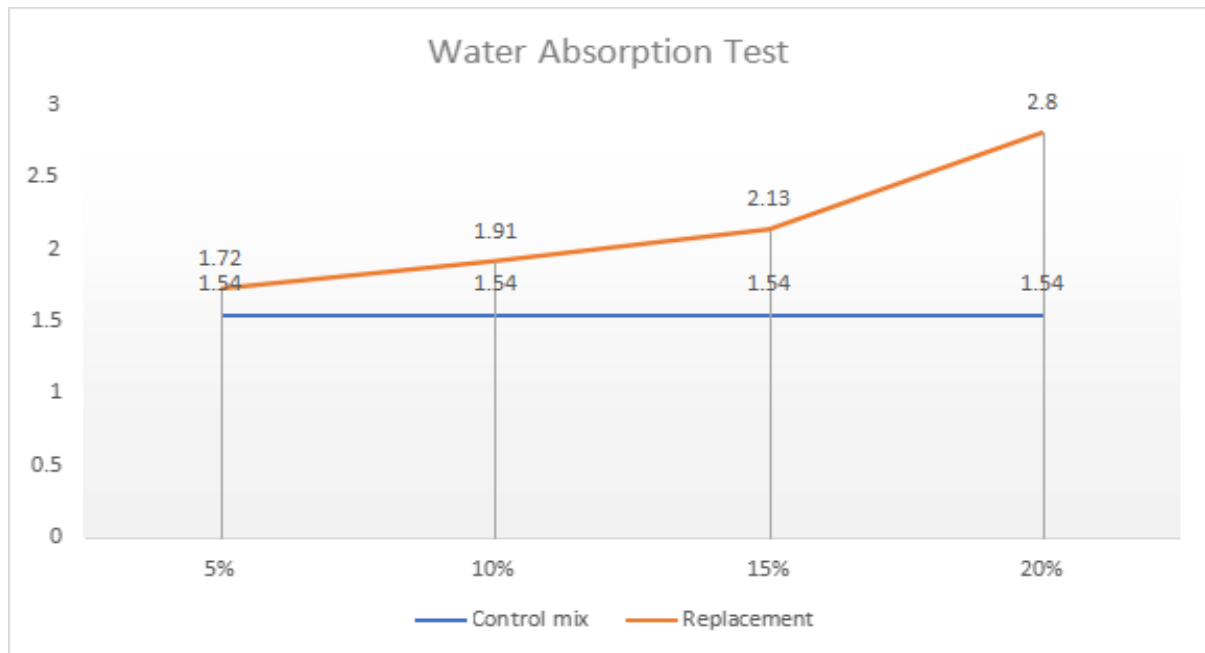
➤ Split Tensile Strength Test- 28 days



➤ Workability Test



➤ Water Absorption Test- 28 days



5. CONCLUSION

This study investigates the use of HDPE (High-Density Polyethylene) plastic waste as a partial replacement of fine aggregate in concrete for boundary wall applications. Concrete of M30 grade was prepared with a water-cement ratio of 0.45 and a 1% admixture dosage to maintain adequate workability.

- This study investigates the use of HDPE (High-Density Polyethylene) plastic waste as a partial replacement of fine aggregate in concrete for boundary wall applications. Concrete of M30 grade was prepared with a water-cement ratio of 0.45 and a 1% admixture dosage to maintain adequate workability.
- The split tensile strength results followed a trend like that of compressive strength. Lower and moderate replacement levels demonstrated satisfactory tensile performance, while higher HDPE contents resulted in reduced tensile strength due to weaker bonding between HDPE particles and the cement matrix.
- The workability of fresh concrete decreased with increasing HDPE content. This reduction was mainly due to the lightweight nature, irregular particle shape, and poor adhesion characteristics of HDPE particles.
- The use of a suitable chemical admixture helped maintain acceptable workability and ensured proper mixing, placement, and compaction of the concrete.
- The study confirmed that HDPE waste can be effectively utilized as a partial replacement material in concrete, thereby reducing the amount of plastic waste sent to landfills and contributing to sustainable waste management practices.
- Based on the overall performance of the concrete mixes, moderate HDPE replacement levels are recommended as the most suitable option for boundary wall construction due to their balance between strength, workability, sustainability, and cost-effectiveness.

6. REFERENCES

- Barnes, D.K., Galgani, F., Thompson, R.C., & Barlaz, M. (2009).** Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364, 1985–1998.
- Gottlieb, H.M. (2021).** Filling the Gaps in the Global Governance of Marine Plastic Pollution. *Natural Resources & Environment*, 35, 1–5.
- Kibria, M.G., Masuk, N.I., Safayet, R., et al. (2023).** Plastic waste: Challenges and opportunities to mitigate pollution and effective management. *International Journal of Environmental Research*, 17, 20.
- Lamba, P., Kaur, D., Raj, S., & Sorout, J. (2021).** Recycling/reuse of plastic waste as construction material for sustainable development: a review. *Environmental Science and Pollution Research*, 29.
- United Nations Environment Programme (2021).** *From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution*. Nairobi, Kenya.
- United States Environmental Protection Agency (2023).** *National Overview: Facts and Figures on Materials: Wastes and Recycling*. [Online]. Available: [epa.gov/facts-and-figures](https://www.epa.gov/facts-and-figures).
- Almeshal, I., Tayeh, B.A., & Alyousef, R. (2020).** Eco-friendly concrete containing recycled plastic as partial replacement for sand. *Journal of Materials Research and Technology*, 9(3), 4631–4643.
- Belmokaddem, M., Mahi, A., Senhadji, Y., & Pekmezci, B.Y. (2020).** Mechanical and physical properties and morphology of concrete containing plastic waste as aggregate. *Construction and Building Materials*, 257, 119559.