VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

GREEN CONCRETE USING PLASTIC WASTE AS PARTIAL REPLACEMENT OF COARSE AGGREGATE

MAHADEVAN PARAPPURATH[1], GAVANDGAVE SHIVAJI[2], PROF.PRATIBHA PATIL[3] *[1] (Civil Engineering, Viva Institute of Technology/ Mumbai University, India)*

Abstract : *The construction industry is one of the largest consumers of natural resources and a major contributor to environmental pollution. Conventional concrete production involves high cement consumption, leading to significant carbon dioxide (CO_2) emissions. To overcome this issue, green concrete has emerged as a sustainable alternative. This project focuses on the development of green concrete using polymers as partial replacement or additives to improve strength, durability, and sustainability. Polymers such as plastic waste, polymer resins, or polymer fibers are incorporated into concrete mixes to reduce environmental impact and enhance performance characteristics like crack resistance, workability, and durability. Experimental investigations are carried out to study compressive strength, workability, and environmental benefits of polymer-based green concrete. The study concludes that polymer-modified green concrete is a promising solution for eco-friendly and sustainable construction practices.*

Keywords *- Green concrete ,polymers ,sustainable construction ,plastic waste eco friendly concrete, polymer modified concrete*

I. INTRODUCTION

Concrete is the most widely used construction material across the world due to its strength, durability, and versatility. However, the production of cement used in concrete is responsible for approximately 7–8% of global CO_2 emissions. With increasing environmental concerns and depletion of natural resources, the construction industry is moving towards sustainable and eco-friendly materials.

Green concrete refers to concrete that reduces environmental impact by using industrial waste, recycled materials, or alternative binders. Polymers, especially waste plastics and polymer-based additives, have gained attention for their potential use in concrete. These polymers improve durability, reduce permeability, and enhance resistance to chemical attack.

This project aims to study the feasibility and performance of green concrete using polymers, contributing to sustainable development and waste management..

Objective- The main objective of this project is to study the feasibility of using waste PET (Polyethylene Terephthalate) plastic flakes as a partial replacement of coarse aggregate in concrete. The project aims to evaluate the effect of PET replacement on the compressive strength of M25 grade concrete at different replacement levels (0%, 5%, 7.5%, and 10%). Another objective is to reduce environmental pollution caused by plastic waste and to promote sustainable construction practices by utilizing plastic waste in concrete.

Scope - The scope of this project is limited to laboratory-level experimental investigation. The study focuses only on compressive strength characteristics of concrete cubes prepared with PET flakes as partial replacement of coarse aggregate. The project does not cover durability tests such as permeability, shrinkage, or flexural strength. The results obtained can be useful for non-structural and lightweight concrete applications and provide a base for future research**.**

II. LITERATURE REVIEW

2.1 Saikia & de Brito (2012):

studied the use of PET plastic waste as partial replacement of natural aggregates in concrete. Their experimental results showed that replacing coarse aggregate with PET reduced the density of concrete, making it lightweight. However, higher PET content led to a reduction in compressive strength due to weak bonding between plastic particles and cement paste. The study concluded that limited replacement (up to 5–10%) is feasible for non-structural applications.

2.2 Ismail & Al-Hashmi (2008) :

investigated the effect of plastic waste as a construction material in concrete. They observed that plastic aggregate improves workability but decreases compressive strength when used in large proportions. The research highlighted the environmental benefits of using plastic waste, especially in reducing landfill disposal and conserving natural aggregates.

2.3 Choi et al. (2005):

examined concrete containing recycled PET bottles as lightweight aggregate. The study reported that PET aggregate concrete had lower compressive strength compared to conventional concrete but showed better thermal insulation properties. This makes PET concrete suitable for non-load-bearing structural elements.

2.4 Frigione (2010):

focused on recycling PET bottles as fine aggregate in concrete. The study found that small percentages of PET improved crack resistance and reduced brittleness. However, excessive PET replacement resulted in segregation and strength loss, emphasizing the importance of proper mix design.

2.5 Albano et al. (2009)

evaluated the mechanical behavior of concrete containing plastic aggregates. The results showed a decrease in compressive and tensile strength with increasing plastic content. Despite strength reduction, the concrete exhibited improved ductility, making it less prone to sudden failure**.**

2.6 Batayneh et al. (2007)

studied the feasibility of using plastic waste in concrete mixtures. The research concluded that plastic aggregates reduce unit weight and compressive strength but can still be used for pavement blocks, kerbs, and partition walls where high strength is not critical.

2.7 Siddique et al. (2008)

investigated waste plastic as a replacement for fine aggregate in concrete. The study showed that concrete with up to 5% plastic replacement achieved acceptable compressive strength while improving sustainability. It emphasized that plastic waste can be successfully used when proper grading and mixing techniques are adopted.

2.8 Ganesh Prabhu et al. (2014)

studied the durability properties of concrete with plastic aggregate. The results indicated reduced water absorption and better resistance to chemical attack. This suggests that plastic-modified concrete may perform well in aggressive environments.

2.9 Kou et al. (2009)

analyzed recycled materials including plastics in concrete production. Their findings showed that recycled plastic reduces stiffness and strength but significantly enhances energy absorption capacity. This property can be beneficial in seismic-resistant structures when used carefully**.**

2.10 Azhdarpour et al. (2016)

investigated the effect of surface-treated PET aggregates on concrete strength. The study revealed that surface treatment improves bonding and partially recovers strength loss. This highlights the importance of material treatment before use.

III. METHODOLOGY

3.1 Materials Used:

This chapter deals with the materials used in this research and the various test that were carried out.

3.1.1 Cement

Cement is one of the binding materials in this research. Cement is the important binding material in today's construction world. Portland cement is mentioned; no grade (e.g., 43/53) is specified in the paper.

Fig no: 3.1.1 Cement

3.1.2 Coarse aggregate

Fig no:3.1.2 coarse aggregate

3.1.3 fine aggregate (sand)

Fig no:3.1.3 fine aggregate

3.1.4 plastic flakes PET [cold drinks bottles]

Volume 1, Issue 9 (2026)
PP 01-07

The pet of cold drinks bottles like pepsi thumbs up are high grade plastic which give us enough strength to withstand the some amount of load.

Fig.no.3.1.4

IV.Procedure

Step 1: Collection of Materials:

OPC 53 grade cement was collected.

Natural river sand was used as fine aggregate.

Crushed angular coarse aggregate of 20 mm size was used.

Waste PET plastic bottles were collected, washed properly, dried, and cut into small flakes manually.

Potable water was used for mixing and curing.

Step 2: Preparation of PET Plastic Flakes:

Plastic bottles were cleaned to remove dirt and labels.

Bottles were cut into small flakes using manual cutting tools.

PET flakes were air-dried before mixing.

Plastic flakes were used as partial replacement of coarse aggregate by weight.

Step 3: Mix Design Selection:

M25 grade concrete mix design was adopted as per IS 10262.

Four mixes were prepared:

0% PET (Control mix)

5% PET replacement

7.5% PET replacement

10% PET replacement

Step 4: Batching of Materials:

Manual batching was carried out at the RMC plant.

Cement, fine aggregate, coarse aggregate, PET flakes, and water were measured by weight.

For PET mixes, required percentage of coarse aggregate was removed and replaced with PET flakes.

Example:

For 5% PET replacement

95% Coarse Aggregate + 5% PET flakes (by weight)

Step 5: Mixing of Concrete:

Cement and sand were dry mixed thoroughly.

Coarse aggregate was added and dry mixed.

PET plastic flakes were added and mixed uniformly.

Water was added gradually and mixed until a uniform concrete mix was obtained.
Care was taken to avoid segregation and balling of plastic flakes.

Step 6: Casting of Concrete Cubes:
Standard cube moulds of size 150 mm × 150 mm × 150 mm were used.
Moulds were cleaned and oiled properly.
Concrete was placed in three layers.
Each layer was compacted using tamping rod (35 blows per layer).
Top surface was finished smoothly.

Step 7: Curing of Concrete Cubes:
Cubes were demoulded after 24 hours.
Specimens were cured in clean water at room temperature.
Curing was done for 7 days and 28 days.

Step 8: Compressive Strength Test:
After curing, cubes were removed and wiped dry.
Cube dimensions were checked.
Cubes were placed centrally in the Compression Testing Machine (CTM).
Load was applied gradually at a uniform rate until failure.
Maximum load at failure was recorded.

Fig.no.4.1.1

MIXING OF PLASTIC FLAKES DRY STATE

Fig.no.4.1.2

3 cubes of green concrete 5% of pet flakes M25

COMPRESSIVE STRENGTH TEST RESULT:

CUBE SIZE:150X150X150MM
CROSS SECTIONAL AREA= 22500MMSQRE

1. 0% PET :
the average compressive strength obtained was about 19 MPa at 7 days, approximately 22.7 MPa at 14 days, and around 27.1 MPa at 28 days. The results confirm that the control concrete satisfied the target strength requirement of M25 grade concrete at 28 days.

2. 5% PET:
concrete with 5% PET plastic as partial replacement of coarse aggregate, the average compressive strength recorded was around 17.3 MPa at 7 days, about 20.9 MPa at 14 days, and approximately 24.4 MPa at 28 days. Although a slight reduction in strength was observed compared to the control mix, the 28-day strength remained close to the required strength, indicating that 5% PET replacement is acceptable.

3. 7.5% PET:

7.5% PET replacement, the average compressive strength was observed to be about 15.6 MPa at 7 days, around 18.7 MPa at 14 days, and approximately 21.8 MPa at 28 days. The reduction in strength was more significant due to weaker bonding between PET flakes and cement matrix.

4. **10% PET:**

For 10% PET replacement, the compressive strength values further decreased. The average strength obtained was around 13.8 MPa at 7 days, about 16.4 MPa at 14 days, and approximately 19.6 MPa at 28 days. The higher percentage of PET resulted in increased voids and reduced load-carrying capacity**.**

V. CONCLUSION

ADVANTAGES:

1.The study confirms that PET plastic waste can be effectively used as partial replacement of coarse aggregate in concrete.
2.Compressive strength of concrete increases with curing age for all mixes, irrespective of PET content.
3.Increase in PET percentage leads to a gradual reduction in compressive strength.
4.Control mix (0% PET) achieved the target strength of M25 concrete at 28 days.
5.Concrete with 5% PET replacement showed strength close to M25 grade and performed satisfactorily.
6.Beyond 5% PET replacement, strength reduction became significant.
7.Concrete with 7.5% and 10% PET showed lower compressive strength due to poor bonding between PET flakes and cement matrix.
8.PET-based concrete exhibited relatively ductile failure compared to conventional concrete.
9.Use of PET plastic helps in reducing environmental pollution and landfill waste.
10.An optimum PET replacement level of about 5% is recommended for structural concrete applications.

LIMITATIONS:

1.Only compressive strength was studied; other properties such as tensile strength and durability were not investigated.
2.The study was limited to M25 grade concrete only**.**
PET flakes were manually cut, resulting in non-uniform size and shape.
3.Long-term durability aspects such as creep, shrinkage, and chemical resistance were not considered.
4.The study was conducted under laboratory conditions and may vary in field applications.

Acknowledgements

"I extend my deepest gratitude to our project advisor, Prof.Pratibha patil, for her invaluable guidance and support throughout this group project. Her expertise and feedback were crucial in directing our research and refining our final outputs.
Special thanks are due to each of my team members: gavandgave shivaji .Their dedication, insight, and hard work were integral to the success of our project. Collaborating with them was not only educational but also immensely enjoyable.
I would also like to acknowledge our department's administrative staff, who facilitated our project logistics and provided essential support with scheduling and resources.
Our appreciation also goes to the peers who participated in our surveys and interviews, providing the critical data needed for our analysis.
Lastly, I am grateful for the constant encouragement and support from our families and friends, who helped us stay motivated and focused throughout the duration of the project.
This project was a collective effort, and its success is a reflection of the hard work and commitment of everyone involved."

REFERENCES

Journal Papers:

[1].IS 456:2000, Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi.

[2].IS 10262:2019, Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards, New Delhi.

[3].IS 516:2018, Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi.
Saikia, N., & de Brito, J., "Use of plastic waste as aggregate in cement mortar and concrete," Construction and Building Materials, Vol. 34, pp.385–401, 2012.

[4].Frigione, M., "Recycling of PET bottles as fine aggregate in concrete," Waste Management, Vol. 30, No. 6, pp. 1101–1106, 2010.

[5].Albano, C., et al., "Influence of PET waste on the mechanical properties of concrete," Journal of Materials Science, Vol. 44, pp. 493–499, 2009.

[6].Choi, Y.W., et al., "Effects of waste PET bottles aggregate on the properties of concrete," Cement and Concrete Research, Vol. 35, pp. 776–781, 2005.

[7].Siddique, R., et al., "Use of recycled plastic in concrete," Resources, Conservation and Recycling, Vol. 55, pp. 885–892, 2011.

[8].Awoyera, P.O., & Adesina, A., "Plastic wastes to construction products: Status, limitations and future perspective," Case Studies in Construction Materials, Vol. 12, 2020.

[9].Rahmani, E., et al., "Mechanical properties of concrete containing recycled PET particles," Construction and Building Materials, Vol. 44, pp. 362–368, 2013.