# Experimentation On Utilisation of Recycled Coarse Aggregate with Plastic (Polypropylene) Fibre in Concrete

Shruti Bhoyar[1], Nehal Belwale[2], Pruthvesh Giradkar[3], Vanjul Ganvir[4], Dr. Balbir Singh Ruprai[5], Dr. Manish Lende[6]
*B.tech Students of K.D.K College of Engineering Nagpur*
*Guide, Dr. Balbir Singh Ruprai*
*Assistant Professor of K.D.K College of Engineering Nagpur*
*Co-Guide, Dr. Manish Lende*

***Abstract*—The rapid growth of construction activities has increased the consumption of natural aggregates, leading to environmental degradation and resource scarcity. At the same time, the disposal of construction and demolition waste, as well as plastic waste, has become a pressing concern. To overcome these challenges, this study investigates the utilisation of recycled coarse aggregate (RCA) and Polypropylene plastic fibre in concrete as a sustainable alternative to conventional materials. RCA was used as a partial replacement for natural coarse aggregates in M30 grade concrete, while plastic Polypropylene fibres, obtained by shredding waste, were added to improve ductility and crack resistance.**

**The experimental programme focused on the fresh and hardened properties of concrete, with tests conducted on compressive strength, water absorption test and flexural strength. The results suggest that although the use of RCA slightly reduces workability, it significantly contributes to waste reduction and promotes circular economy practices. The inclusion of Polypropylene fibre showed a positive influence on tensile strength and enhanced resistance to micro-cracking, which are critical for improving the durability of concrete.**

## I. INTRODUCTION

Concrete is everywhere – from small houses to massive highways. But producing it comes at a cost huge amounts of natural stone are quarried for coarse aggregates, and meanwhile, Polypropylene fibre keep piling up as waste, since they don't easily decompose. This project tries to solve both issues at once. By replacing natural aggregate with recycled coarse aggregate (RCA), we reduce the burden on the environment. By adding Polypropylene plastic fibres , we give waste plastic a new life and also make the concrete tougher against cracks. In this study, we used M30 concrete and added Polypropylene plastic fibres at 30%, 40%, and 50% RCA with 0.2% to 0.3% of fibre. We then tested the mixes for compressive strength, flexural strength, and water absorption.

To address these issues, recycled coarse aggregate (RCA) obtained from demolished concrete structures has emerged as a promising alternative to natural aggregates. Using RCA not only reduces the environmental burden associated with waste disposal but also conserves natural resources, making it a more sustainable option for modern construction. However, one of the challenges of using RCA in concrete is its slightly lower strength and higher water absorption compared to natural aggregates. This limitation can be addressed by incorporating fibres into the mix to enhance the overall performance of concrete.

In this study, polypropylene fibres (PPF) are used as an additional reinforcement. Polypropylene, a widely available thermoplastic polymer, is known for its lightweight nature, resistance to chemical attack, and ability to improve crack resistance and ductility when used in fibre form. When combined with RCA, polypropylene fibres can significantly improve the tensile and flexural properties of concrete, making it more durable and resistant to shrinkage cracks.

## II. RESEARCH PAPER REVIEW

Many researchers have looked at ways to make concrete greener.

Studies show that:

1. The Utilization of Recycled Aggregate in High Performance Concrete

Author's Name: Bassam A. Tayeh, Doha M. Al Saffar, Rayed Alyousef
Summary: This review examined the use of recycled aggregates (RA) in high-performance concrete. The authors found that RA generally increases water demand and reduces workability due to its porous texture. However, they emphasized that these issues can be overcome by incorporating supplementary materials such as fly ash or silica fume, enabling RA to serve as a practical substitute for natural aggregates without compromising strength.

2. Use of Recycled Aggregate Concrete
Author's Name: Tushar R. Sonaware, Sunil S. Pimplikar
Summary: This study reported that recycled aggregate concrete shows a 10–16% decrease in compressive strength when compared to conventional mixes. Despite this drawback, the authors highlighted its importance in sustainable construction, as it reduces reliance on natural resources and encourages recycling of construction waste.

3. Recycled Aggregate – A Viable Solution for Sustainable Concrete Production
Author's Name: Markssuel Marvila, Paulo de Matos, Erich Rodriguez, Sergio Neves Monteiro, Afonso R.G. de Azevedo
Summary: The authors argued that RA is an environmentally friendly and practical material for concrete production. They noted that up to 30% replacement of natural aggregates is acceptable in structural applications, while 100% replacement is suitable for non-structural purposes. The study emphasized the need for international standards, improved processing methods, and greater awareness to enhance its application in the construction industry.

4. Strength and Durability Evaluation of Recycled Aggregate Concrete
Author's Name: Sherif Yehia, Kareem Helal, Amani Zaher, Anaam Abusharkh, Hiba Istiayeh
Summary: This research concluded that concrete containing 100% recycled aggregates could still meet durability and strength requirements if proper mix design, aggregate gradation, and moisture adjustments are adopted. The findings demonstrate that RA has potential for use even in demanding applications, provided the mix is carefully optimized.

5. Experimental Study on Recycled Concrete Aggregates
Author's Name: Zidan Ahmed, Shed Khaja, Yaser Ali, Mohammed Ahmed Uddin, Abdul Aha
Summary: The authors tested recycled concrete aggregates in low-load structural applications. Their study revealed that RA can be effectively used for constructing boundary walls, low-cost housing, and similar structures. They also stressed that using RA not only conserves natural resources but also reduces waste, aligning with the principles of sustainable and green construction.

6. Suitability Investigation of Recycled Concrete Aggregate for Concrete Production
Author's Name: Woubishet Zewdu Taffese
Summary: In this experimental work, RA was shown to have slightly inferior mechanical and physical properties compared to natural aggregates. However, the study demonstrated that in many cases, the performance of RA remained within the acceptable range for normal-weight concrete, supporting its feasibility for practical use.

7. Methods for Improving the Durability of Recycled Aggregate Concrete
Author's name: Yuanxun Zheng, Yahui Zhang, Peng Zhang
Summary: The study by Zheng, Zhang, and Zhang (2021) focuses on ways to improve the performance of recycled aggregate concrete (RAC). The authors highlight that carbon dioxide treatment of recycled coarse aggregate helps form calcium carbonate, which strengthens the microstructure and enhances compactness. They also note that the removal of old mortar significantly reduces water absorption, thereby improving durability. Additionally, the inclusion of cementing agents helps fill micro-cracks, while fibers contribute to better toughness and resistance against shrinkage. When RAC is reinforced with fiber-reinforced polymers (FRP), its overall mechanical strength increases considerably, making it a more reliable and sustainable alternative to conventional concrete.

8. A Comprehensive Review on Recycled Aggregate and Recycled Aggregate concrete
Author's name: Bo Wang, Libo Yan, Qiuni Fu, Bohumil Kasal
Summary: This review paper brings together past and current knowledge about the use of recycled aggregates in concrete. The authors highlight that while RA is a sustainable material, its porosity and the presence of old mortar often reduce the strength and

durability of concrete. To overcome this, removing the adhered mortar and improving treatment methods is essential. The study also points out that RA works better in non-structural applications due to its relatively lower strength compared to natural aggregates. Overall, the paper emphasizes the potential of RA for reducing construction waste and supporting circular economy goals, but it calls for more research on ways to enhance its performance.

9.Incorporating Coarse and Fine Recycled Aggregates into Concrete Mixes: Mechanical Characterization and Environmental Impact

Author's name: Ammar Younes, Emad Elbeltagi, Aboelkassim Diab, Giulia, Fam Saeed, Casare Sangiorgi.

Summary: This study evaluates the behavior of concrete when natural aggregates are replaced with coarse and fine recycled ones. It was observed that the particle size distribution between conventional aggregates and recycled ones was quite similar, which makes blending easier. The concrete mixes with up to 50% recycled coarse aggregate showed slump values within the acceptable range of international standards, meaning that workability was not compromised. Interestingly, the indirect tensile strength of recycled aggregate mixes was higher than that of natural aggregate mixes when the replacement level reached up to 75%. This suggests that, with proper proportioning, RA can deliver satisfactory strength without major drawbacks, while also reducing environmental impact.

10. Studies on Recycled Concrete Aggregate

Author's name: Shivam Kumar, Shrunga S, Supreeth Hallur, Yashas R, Reshma E K

Summary: This paper provides a broad perspective on the challenges and opportunities associated with recycled concrete aggregate (RCA). The authors stress that inaccurate measurement of water absorption in aggregates can lead to poor mix quality, so understanding this property is vital. They recommend the use of plasticizers to counterbalance the high absorption and to ensure better workability and strength. Another important point they make is the lack of uniformity in recycled aggregates, which makes it difficult to have a universal standard. Their conclusion underlines the need for proper quality control and standardized procedures if RCA is to be widely adopted in the construction industry.

11. Mechanical Properties of Recycled Aggregate Concrete with Industrial Waste Ash

Author's name: Uruya Weesakul, Thant Paing Htun, Ali Ejaz, Phromphat Thansirichaisree, Quedeer Hussain

Summary: This research highlights that increasing the proportion of recycled brick and concrete in mixes generally reduces the strength of recycled aggregate concrete (RAC). However, the addition of fly ash (FA) and sugarcane bagasse ash (SCBA) can enhance strength. The study also reveals that while tensile and flexural strength decrease with higher recycled aggregate content, water absorption increases, although the presence of FA and SCBA helps control it.

12. Impact of Plastic Waste Fiber and Treated Construction Demolition Waste on the Durability and Sustainability of Concrete

Author's name: Selvakumar Duraiswamy, Prakash Neelamegam, M. VishuPriyan, George Uwadiogbu Alaneme.

Summary: This study examined the use of plastic waste fibers and processed demolition waste in concrete. Results show that at an optimal level of fiber inclusion, concrete demonstrated similar compressive strength to conventional mixes while significantly improving flexural and tensile strength by 11.41% and 17.72%, respectively. The findings emphasize how recycled materials can make concrete more sustainable without compromising performance.

13. Effects of Recycled Aggregate on the Characteristics of Concrete

Author's name: Prabhakar Kumar Singh, Md Daniyal

Summary: The review indicates that using recycled coarse aggregate (RCA) generally lowers strength compared to natural coarse aggregate (NCA). However, these drawbacks can be minimized through mix adjustments, aggregate treatment, and better beneficiation methods. The authors stress the importance of thoroughly understanding RCA's properties for reliable durability testing and conclude that RCA remains a more sustainable alternative to NCA.

14. Investigating the Use of Recycled Concrete as Aggregates in the Construction of Structural Beams

Author's: Leighton A. Ellis, Lee P. Leon, Amy V. Charran

Summary: The research demonstrated that compressive strength of RCA concrete can be

maintained even under shear force, showing promise for structural applications. In compression tests, concrete cylinders made with silica fume (SF) exhibited fewer failure modes compared to those without SF, confirming RCA's potential for use in structural members when combined with supplementary materials.

15. A Case Study on Utilization of 50-year-old Concrete in Recycled Aggregate

Authors: Zongping Chen, Jinjun Xu, Yuliang Chen, Chenggui Jing

This case study investigated the reuse of decades-old concrete as recycled aggregate. The authors found that even aged concrete could be effectively utilized, demonstrating long-term sustainability in concrete recycling. Their study reinforces the practical benefits of reusing older construction materials in new mixes.

16. Environmental Impact of Concrete Slab Made of Recycled Aggregate Concrete Based on Limit States of Load-Bearing Capacity and Serviceability

Author's name: Tereza Pavlu, Jan Pešta, Tomáš Vlach, Kristina Fortová

Summary: This study highlights the environmental advantages of using recycled aggregate concrete (RAC). It reduces overall wastage and carbon emissions.Steel reinforcement is better suited for certain structural limit states, while glass fibers improve load-bearing conditions due to slab thickness optimization.Climate change assessment revealed that RAC mixes often perform on par with natural aggregate mixes in terms of environmental impact.

17. Use of Recycled Aggregate Concrete in Structural Members

Author's name: Ram Prasad Neupane, Thanongsak Imjai, Natt Makul, Reyes Garcia, Boksun Kim, Sandeep Chaudhary

Summary: This review shows that RAC generally absorbs more water, has lower density, and weaker compressive, tensile, and flexural strength compared to natural aggregate concrete (NAC). The strength loss ranges between 10%–26%, depending on replacement levels. Despite weaknesses, RAC can still be used if construction and demolition waste (C&DW) is properly processed and regulated.

18. Studying the Usability of Recycled Aggregate to Produce New Concrete

Author's name: Ola Adel Qasim, Nahla Hilal, Mohammad I. Al Bijawii, Nadhim Hamah Sor, Taher A. Tawfik

Summary: The study points out that lack of proper waste collection leaves much construction debris unused. Increasing RCA replacement reduces workability due to its rough texture. RCA has lower density but much higher water absorption compared to NAC. Compressive strength reduces as RCA content increases, regardless of concrete age.

19. Suitability Investigation of Recycled Concrete Aggregates for Concrete Production

Author's name: Woubishet Zewdu Taffesse

Summary: The research reveals that RCA has slightly weaker mechanical properties compared to NAC but still falls within acceptable ranges for construction. Fresh concrete made with RCA is somewhat less workable. The study concludes that manually processed RCA can effectively be used in the construction industry, reducing waste.

20. Strength and Durability Evaluation of Recycled Aggregate Concrete

Author's name: Sherif Yehia, Kareem Helal, Anacam Abusharkh, Amani Zaher, Hiba Istaiyeh

Summary: This paper evaluates RAC from both strength and durability perspectives. While RAC generally shows reduced durability and strength compared to conventional concrete, it can still be a sustainable alternative if mix designs are optimized. It emphasizes that durability challenges (like water penetration) can be addressed with supplementary cementitious materials.

## III. CONCLUSION

The study concludes that using recycled coarse aggregate with polypropylene plastic fibers in M30 grade concrete is both sustainable and practical. RCA helps reduce dependency on natural aggregates and promotes effective waste management, while polypropylene plastic fibers enhance strength, control cracks, and improve durability. Though slight strength reduction may occur with higher RCA replacement, the fibers balance this effect, making the concrete reliable for structural applications. Overall, this approach offers an eco-friendly and economical solution for modern construction.

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