International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Development of Sustainable Concrete Using Construction and Demolition Waste

Mr. Rajesh sarkar[1], Mr. Yogendra parate[2], Ms. Karishma Gabhane[3],

Ms. Priya Bansod[4]

[1234]UG Students, Department of Civil Engineering. Priyadarshini College of Engineering
Nagpur, Maharashtra, India

ABSTRACT

Waste from construction and demolition accounts for a significant portion of global solid waste, with the majority of it ending up in landfills. Processing this debris and using it to make fresh concrete is a useful and profitable approach to manage it. Effective methods for utilising construction and demolition debris in concrete have been investigated by researchers. The study aimed to test the quality of recycled materials by evaluating their strength, water absorption, density, and the type of concrete they can produce. Compared to natural coarse aggregates, recycled aggregates from leftover concrete are heavier, more angular, and absorb more water. Strength and load-bearing capacity are enhanced as a result. To improve workability and examine their endurance, more research is necessary.

This study explores the properties of recycled aggregates and focuses on developing concrete mixes incorporating them to minimize the environmental impact of the construction industry. It also compares concrete made with recycled and natural aggregates to evaluate their strength, Durability and Workability. We replaced natural aggregate concrete with 100% recycled aggregate concrete. Natural aggregate concrete has a higher compressive strength than recycled aggregate concrete.

Keywords : C & D waste , Natural Aggregate Concrete, Recycle Aggregate , Strength , Durability , Workability.

1. INTRODUCTION

The most popular building material for all kinds of civil engineering projects is concrete. Aggregates such as gravel, crushed stone, or sand are used to make it. However, the decreasing quality of natural aggregates and their environmental impact are concerns. Recycled aggregates from construction debris are currently utilised to remedy this. Concrete with recycled aggregate might become necessary in the future [4]. Old concrete is crushed into recycled aggregates, which can be fine or coarse, to make building more environmentally friendly. If beneficial, they can contribute to environmental preservation and the preservation of natural resources. However, their properties are not fully understood and can vary. Since they come from different types of concrete, researchers need to test them. Factors like the original concrete's water-to-cement ratio affect their strength, durability, and water absorption [5].

This paper aims to developed the high-performance concrete (HPC) of M60 grade made with natural aggregate and recycled aggregates (RA). Is also aim to compare the natural aggregate concrete with recycled aggregate concrete. It examines RA workability, weight, and water absorption. Additionally, it evaluates the strength, structure, and durability of concrete when RA replaces natural aggregates. The paper also Presents the durability of HPC with RA as a natural aggregate substitute [6].

2. OBJECTIVES

- To determine the Properties of recycled aggregate.
- To develop concrete mixtures using recycled aggregates to reduce the environmental impact of the Construction Industry.
- To compare the Properties of concrete.

3. LITERATURE REVIEW

3.1. Dr. Ing John K. Makunza, Sustainable Concrete Made from Recycled Aggregates (IJCIET), Volume 7, Issue 3, May-June 2016. The study was conducted by testing recycled aggregates, preparing concrete samples, and evaluating their properties in both fresh and hardened states. Most test results showed that recycled aggregates did not fully meet the minimum standards set by codes. However, the required concrete grade was successfully achieved.

3.2 Pierre Matar, Rouba El Dalati, Strength of Masonry Blocks Made with Recycled Concrete Aggregates, (ELSEVIER), Issue In 2011. The findings of an experiment on masonry blocks constructed with recycled concrete aggregates are presented in this study. The study aimed to examine how recycled aggregates affect the strength of concrete blocks. Tests were conducted on different sets of blocks: five sets with varying amounts of recycled aggregates and one set made entirely with natural aggregates. The results showed that adding cement to recycled aggregates can produce concrete blocks with strength similar to those made with natural aggregates.

3.3. Mr. Dupargude Naveenkumar R, Sustainable Use of Recycled Aggregate In Concrete, (IJERT), ISSUE 6, June-2023. This research focuses on using recycled aggregates in concrete to promote sustainability. It examines factors such as slump, RCA percentage, compressive strength, and split tensile strength. Theoretical results were first validated by testing concrete cubes after casting and curing. For M25 grade concrete, replacing 75% of natural aggregates with RCA reduced costs by 11.89% per cubic meter. For M30 grade concrete, the same replacement reduced costs by 7.12% per cubic meter**.**

3.4. Dr. K. Ramadevi, Concrete Using Recycled Aggregates, (LJCIET), Volume 8, Issue 9, September 2017. In order to efficiently manage concrete debris, this study focusses on an attempt to create recycled aggregates from construction and demolition (C&D) waste. The college campus garbage yard was used to gather concrete refuse. It was utilised in M25-grade concrete after being sorted, crushed with a jaw crusher, sieved, and cleaned. Recycled aggregates replaced natural coarse aggregates in varying proportions: 0%, 30%, 60%, and 100%.

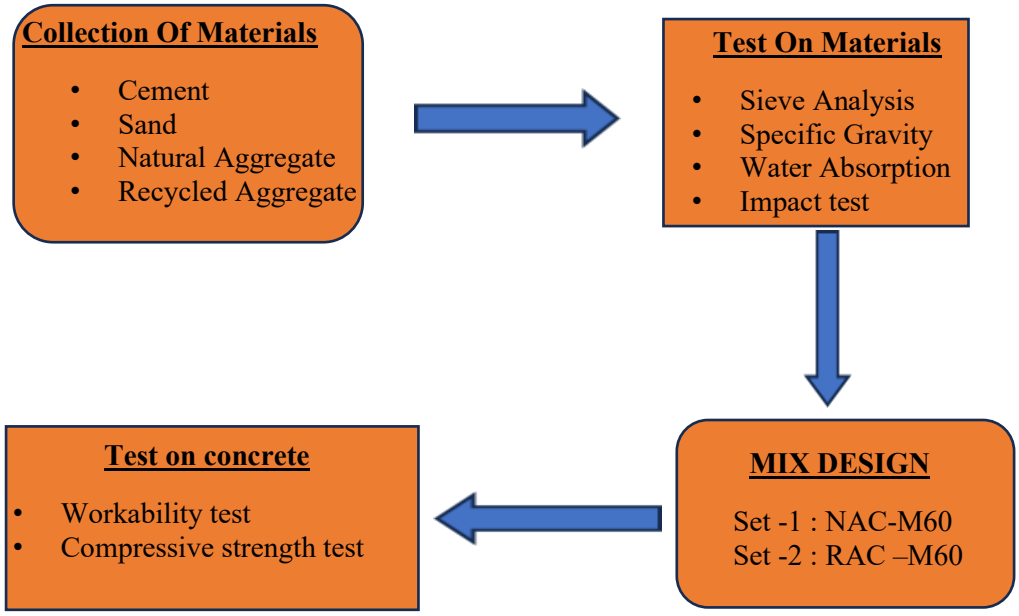
3.5. Shamsher Singh[1], Experimental Investigation of Green Concrete in Construction Industry by Using Recycled Aggregate Demolished Waste, (IJSHRE), Volume 6 Issue 10 October, 2018. This paper explains how to select materials for recycled aggregate concrete. Using recycled aggregates can help reduce CO_2 emissions, prevent pollution, and reuse waste materials. According to laboratory testing, the strength of concrete reduces when recycled aggregates are used in place of natural aggregates. But even with a 60% replacement, the necessary strength is maintained. Consequently, up to 60% of the natural aggregates in structural concrete can be substituted with recycled aggregates.

3.6. B. Suguna Rao, Vishwas B.Laxmeshwar, Mechanical Strength Behavior of Recycled Aggregate Concrete, (IJCNIS), 31 Aug 2024. This experiment was conducted to determine the Young's modulus of recycled aggregate concrete and compare it with different standards. The results show that concrete with a 45% recycled aggregate replacement performs well. This suggests that construction and demolition (C&D) waste can be partially used to produce concrete strong enough for structural applications.

3.7. Shivam Kumar, Shrunga, Studies on Recycled Concrete Aggregate- An Overview, (IJERT), Volume 9, Issue 1 2021. The utilisation, recycling status in various nations, pertinent standards, and important characteristics of recycled concrete aggregates are all covered in detail in this study. After analyzing various studies, the paper presents general conclusions and suggests directions for future research.

3.8. Dhyaa Mohammed, Sameh Tobeia, Compressive strength improvement for recycled concrete aggregate, EDP Sciences, 2018 This study explores how old demolished concrete can be recycled into coarse aggregates and how it affects concrete properties, especially compressive strength. It also examines whether adding materials like silica fumes can improve the strength of recycled concrete. Concrete cubes were made using both natural and recycled coarse aggregates, then cured and tested to study their strength.

4. METHODOLOGY



4.1. Material

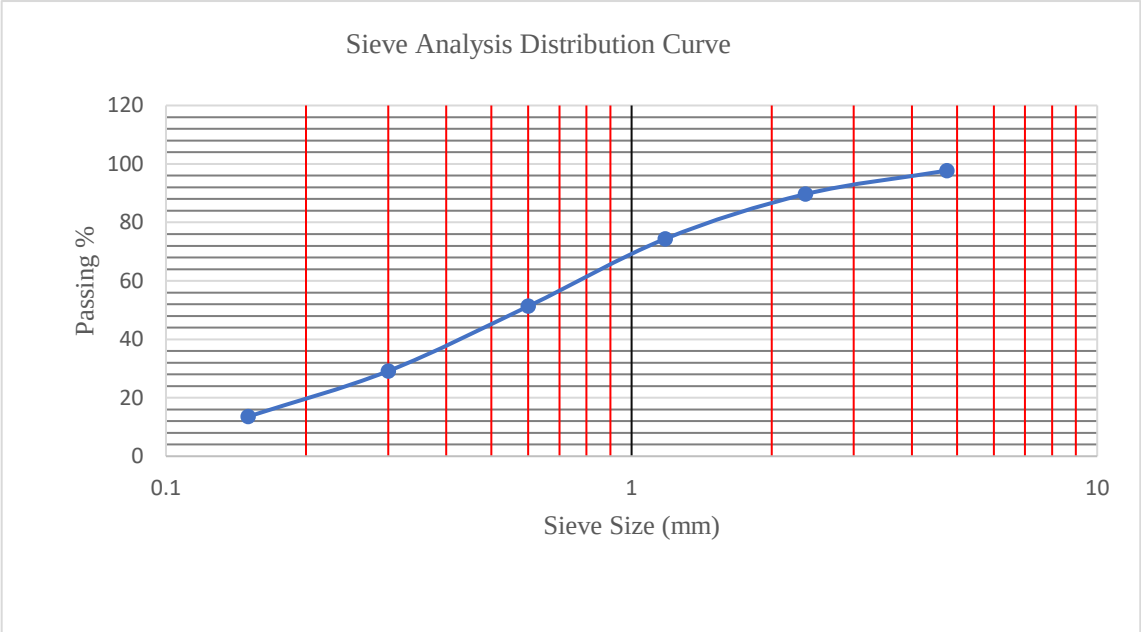
4.1.1. Cement

Ultratech's Ordinary Portland Cement (OPC) was used in this project. It is manufactured in India and is available in 50 kg bags. UltraTech OPC 53 grade cement is a high-strength and durable cement used for projects requiring rapid strength development, such as reinforced concrete, pre-stressed concrete, and fast-paced construction. It achieves a minimum compressive strength of 53 MPa (53 N/mm²) after 28 days

4.1.2 Fine Aggregates (sand)

In this project, fine aggregate (sand) from Kanholibara Stone Quarry was utilised. By filling in the spaces between larger coarse aggregates, fine aggregate—typically made up of sand particles smaller than 4.75 mm—improves the workability, strength, and overall performance of concrete. Sieve analysis distribution curve of fine aggregate are given below:

Fig: Sieve Analysis Distribution Curve Of Fine Aggregate



4.1.3. Natural Coarse Aggregate:

This project made use of natural coarse aggregate from the Kanholibara Stone Quarry. Twenty millimetres is the greatest size of natural coarse aggregate that can be utilised in concrete. Below is a gradation curve for natural coarse aggregate.

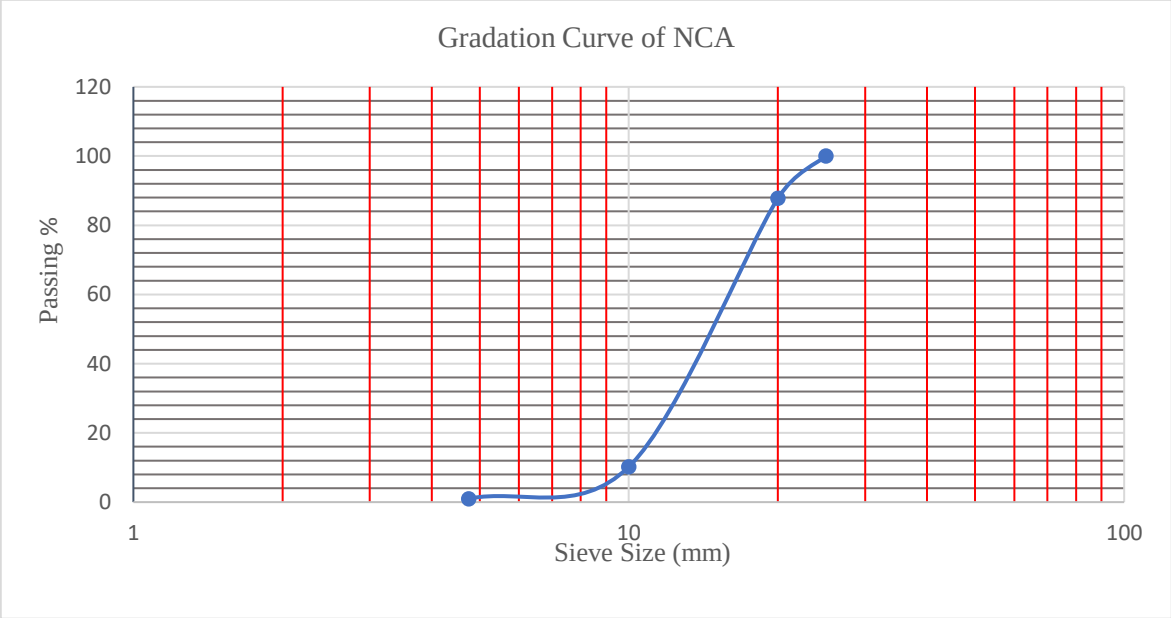


Fig. Gradation curve of natural coarse aggregate

4.1.4. Recycled Coarse Aggregate:

Recycled Coarse Aggregate from Sumangal Vihar Isasani ,Nagpur was used in this work. The recycled coarse aggregate used in the concrete can only be 20 mm in size.The gradation curve of Recycled coarse aggregate are given below;

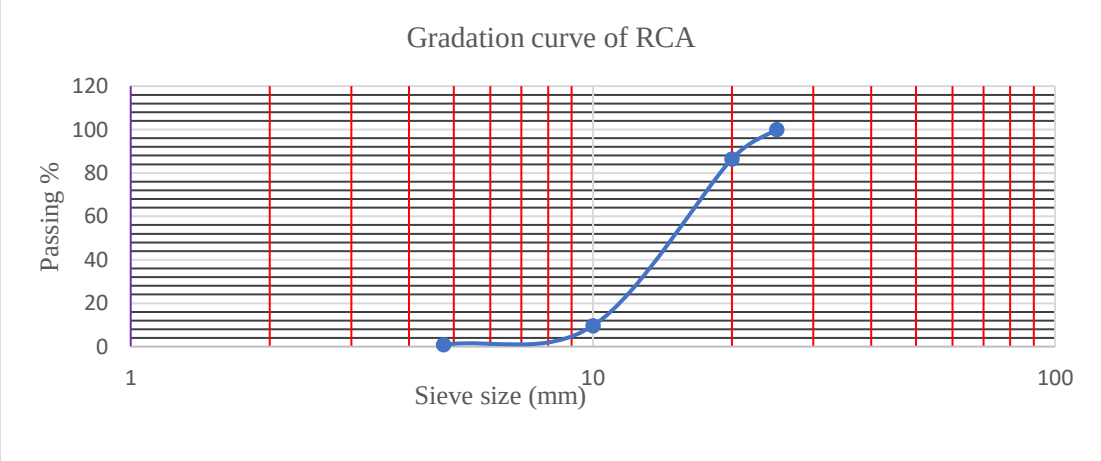


Fig. Gradation Curve of Recycled Coarse Aggregate

4.1.5. Chemical Admixture

Visco-Flux 5500 Chemical Admixture from Apple Chemie Construction Chemical Company was Used In this work. VISCOFLUX - 5500 is a fourth-generation advanced polycarboxylate polymer admixture for high strength concrete and slump retention properties. The polymer significantly reduces water with improved slump life of the mix. The Advantages Of this Chemical Admixture are : Higher water reduction in a range of 30-35% making it highly suitable for the intended use, Increased early and ultimate compressive strengths, Increased flexural strength, Better resistance to carbonation, Lower permeability, Better resistance to aggressive atmospheric conditions, Increased durability.

4.2 Test on Materials

The Following table shows that material , test with their respected IS-Code.

Sr. No.	MATERIALS	TEST	IS CODE
01	Cement	• Specific Gravity	• IS: 2720 (PART 3)
02	Fine Aggregates	• Specific Gravity • Sieve Analysis	• IS: 2386 (PART 3) • IS: 383 (TABLE 4)
03	Course Aggregates-Natural	• Specific Gravity • Sieve Analysis • Water Absoption • Impact test	• IS: 2386 (PART 3) • IS: 383 (TABLE 2) • IS: 2386 (PART 3) • IS : 2386 (PART 4)
04	Course Aggregates-Recycled	• Specific Gravity • Sieve Analysis • Water Absoption • Impact test	• IS: 2386 (PART 3) • IS: 383 (TABLE 2) • IS: 2386 (PART 3) • IS 2386 (PART 4)

4.3 Mix Design

REQUIRED DATA: - GRADE M60

1. Type Of Cement & Grade of Cement: OPC, 53 Grade.
2. Maximum Nominal Size of Aggregate: 20mm.
3. Explosive condition: Moderate (IS 456 -Table 3)
4. Minimum cement content: 300 Kg /m^3 (IS 456 - Table 5)
5. Workability in terms slump: 100mm -150mm (IS 456 - Cl. 7.1)
6. Standard Deviation: 5.0 N/mm^2 (IS 10262- Table 2)
7. Type of Coarse Aggregate: Crushed Angular Aggregate.
8. Maximum Cement Content: 450 Kg /m^3 (IS 456- Cl. 0.8.2.4.2)
9. Maximum W/C Ratio: 0.5 (Is 456- Cl- 8.2.4.2)
10. Fine Aggregate: Zone Ц.
11. Type of Admixture Used: Viscoflux- 5500 (Superplasticizer)

Mix Proportion for 1m^3 M60 Concrete

W/C ratio	Water	Cement	Sand	Aggregate	Admixture
0.31	138.012 kg	445.2 kg	644.95 kg	1301.28 kg	4.452 kg

4.4 Test On Concrete

4.4.1 Slump Test

The consistency and workability of freshly mixed concrete were assessed using the slump test, following IS: 1199-1959 standards.

Procedure:

The slump test was performed on concrete mixes using normal and magnetized water. The mould was wetted, filled in three layers, and each layer was compacted with 25 tamping strokes. After levelling, the mould was lifted vertically, and the slump was measured as the height difference between the mould and the concrete.

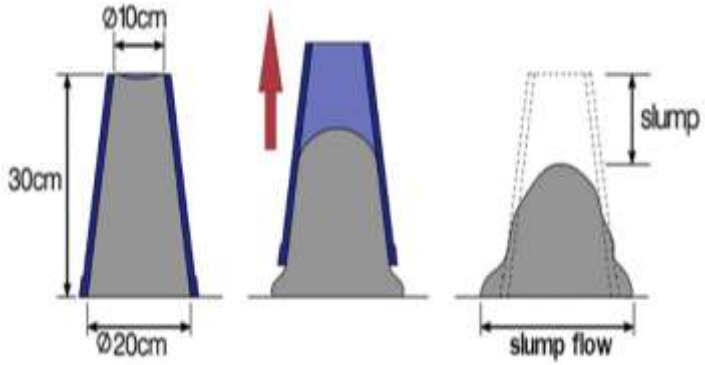


Fig. Slump Test

4.4.2. Compressive Strength test

A compression test on a 2000 kN capacity testing equipment was used to ascertain the concrete cube specimens' compressive strength. A 150 mm cube mould is used in the compression test to determine the concrete's strength. The mould is cleaned before testing to remove any, hardened concrete or extra water. Three specimens were evaluated at 7, 14, and 28 days, and the average strength of each cube was noted.The compressive test are performed in our department concrete Laboratory.

SR. NO.	MATERIALS	SPECIFIC GRAVITY	SPECIFIC GRAVITY RANGE AS PER IS	WATER ABSORPTION	WATER ABSOPTION RANGE AS PER IS	IMPACT TEST
1	Cement OPC 53 Grade	**3.14**	3.1 – 3.16	-	-	-
2	Natural Coarse Aggregate	**2.81**	2.5 – 3.0	**1.10 %**	0.1 – 2.0 %	**11.12%** (10% - 30%)
3	Recycled Coarse Aggregate	**2.74**	2.35 – 2.74	**2.38 %**	2.8 – 5.9 %	**34.22%** (30% - 45%)
4	Fine Aggregate	**2.67**	2.5 – 3.0	**2.95 %**	Less than 3%	-
5	Water	**1.0**	-	-	-	-
6	Admixture	**1.12**	-	-	-	-

Fig:

Compressive Strength Test

Sr.no.	**Weight (gm)**	**Density (gm/cm^3)**	**Load (KN)**	**Strength (N/mm^2)**	**Average strength**
1	8500	2.51	1080	48.00	
2	8420	2.49	1100	48.88	**47.40 N/mm^2**
3	8310	2.46	1020	45.33	

5. RESULTS AND DISCUSSION

Sr.no.	**Weight (gm)**	**Density (gm/cm^3)**	**Load (KN)**	**Strength (N/mm^2)**	**Average strength**
1	8260	2.41	930	41.33	
2	8300	2.46	950	42.22	**41.33 N/mm^2**
3	8100	2.43	910	40.44	

5.1 Test on Materials

5.2 Compressive Strength Test

M60 Natural aggregate concrete (7 Days)

M60 Recycled aggregate concrete (7 Days)

M60 Natural aggregate concrete (14 Days)

Sr.no.	Weight (gm)	Density (gm/cm^3)	Load (KN)	Strength (N/mm^2)	Average strength
1	8360	2.47	1120	49.77	
2	8340	2.47	1220	54.22	**52.29N/mm^2**
3	8420	2.49	1190	52.88	

M60 Recycled aggregate concrete (14 Days)

M60 Natural aggregate concrete (28 Days)

Sr.no.	Weight (gm)	Density (gm/cm^3)	Load (KN)	Strength (N/mm^2)	Average strength
1	8550	2.53	1430	63.55	
2	8450	2.50	1390	61.77	**62.66 N/mm^2**
3	8300	2.45	1410	62.66	

M60 Recycled aggregate concrete (28 Days)

Sr.no.	Weight (gm)	Density (gm/cm^3)	Load (KN)	Strength (N/mm^2)	Average strength
1	8560	2.54	1210	53.77	
2	8440	2.50	1270	56.44	**55.84 N/mm^2**
3	8470	2.51	1290	57.33	

5.3 Comparison Between NAC &RAC

Sr.no.	Weight (gm)	Density (gm/cm^3)	Load (KN)	Strength (N/mm^2)	Average strength
1	8450	2.50	1340	59.55	
2	8100	2.40	1260	56.00	**58.07 N/mm^2**
3	8540	2.53	1320	58.66	

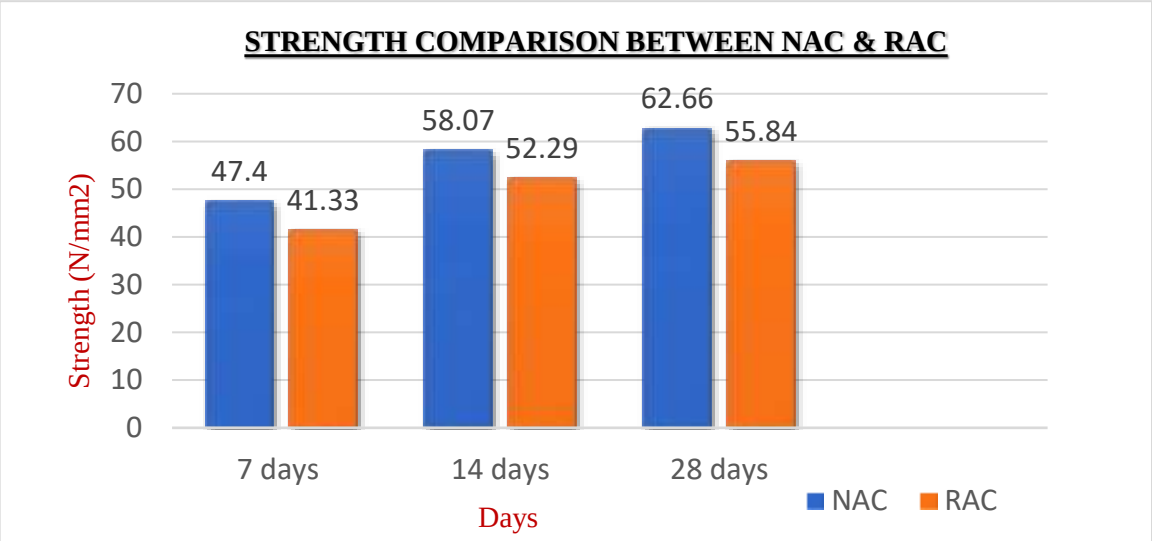


Fig. strength comparison between NAC % RAC

In the above data shows, a compression test is an efficient way to compare the strengths of recycled aggregate concrete and natural aggregate concrete. The strength of natural aggregate concrete is somewhat greater than that of recycled aggregate concrete.

6. CONCLUSION

- In this study, natural aggregate concrete attained 91.80% of the target compressive strength for M60 grade concrete.
- The study also revealed that concrete made with recycled aggregates reached 81.81% of the target compressive strength for M60 grade concrete.
- The use of recycled aggregates in construction significantly contributes to waste reduction and environmental preservation, while also minimizing the demand for extracting and transporting natural aggregates from natural sources.

REFERENCE

1) Dr. Ing John K. Makunza, Sustainable Concrete Made From Recycled Aggregates International Journal of Civil Engineering and Technology, Volume 7, Issue 3, May-June 2016.

2) Pierre Matar, Rouba El Dalati, Strength Of Masonry Blocks Made With Recycled Concrete Aggregates, (ELSEVIER), Issue in 2011

3) Mr. Dupargude Naveenkumar R, Sustainable Use Of Recycled Aggregate In Concrete International Journal Of Innovations In Engineering Research And Technology, ISSUE 6, June-2023.

4) Dr. K. Ramadevi, Concrete Using Recycled Aggregates, International Journal of Civil Engineering and Technology, Volume 8, Issue 9, September 2017

5) Shamsher Singh[1], Experimental Investigation of Green Concrete in Construction Industry by Using Recycled Aggregate Demolished Waste, International Journal of Software & Hardware Research in Engineering, Volume 6 Issue 10 October, 2018

6) Bassam A. Tayeh, Doha M. Al Saffar, The utilization of recycled aggregate in high performance concrete: a review, ELSEVIER, 3 June 2020

7) Manik Goyal, Hinoni Goyal, A Review Paper on use of Recycled Aggregates in Concrete, International Journal of Engineering Research & Technology , Volume 6.

8) B. Suguna Rao, Vishwas B.Laxmeshwar, Mechanical Strength Behavior of Recycled Aggregate Concrete, International Journal of Communication Networks and Information Security , 31 Aug 2024.

9) Shivam Kumar, Shrunga, Studies on Recycled Concrete Aggregate- An Overview, International Journal of Engineering Research & Technology, Volume 9, Issue 1 2021.

10) Dhyaa Mohammed, Sameh Tobeia, Compressive strength improvement for recycled concrete aggregate, EDP Sciences, 2018

11) Rajat S. Tembhurne Prof. M. M. Makwana, Strength & Durability Parameter of Recycled Concrete Aggregate, International Journal of Science Technology & Engineering, September 2018.