www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

ENHANCING CONCRETE BLOCKS PROPERTIES WITH SUPERPLASTICIZER TREATMENT: A COMPARATIVE STUDY OF NATURAL AND RECYCLED COARSE AGGREGATE

Mr. Ashwini Tiwari[1], Mr. Nitin Kumar Shukla[2], Ambrish Kumar Tiwari[3], Mr. Mulk Raj Anand[4], Vishvesh[5], Kartik Yadav[6], Abhay Kumar[7], Shivanshu Singh[8]

[1]Assistant Professor, Department Of Civil Engineering, Rajkiya Engineering College Mainpuri (UP), India.

[2]Assistant Professor, Department Of Civil Engineering, REC Ambedkar Nagar, India.

[3]Assistant Professor, Department Of Applied Sciences & Humanities, Rajkiya Engineering College Mainpuri (UP), India.

[4,5,6,7,8]Department Of Civil Engineering, REC Mainpuri, India.

Corresponding Author E-Mail: aktiwaria@gmail.com

DOI: https://www.doi.org/10.58257/IJPREMS44102

ABSTRACT

The construction Industries has a significant impact on solid waste and environmental degradation, and consequently, incorporating recycled materials into construction projects is gaining interest to promote sustainable building practices.

This study suggests using superplasticizers—chemical additions that can increase concrete's workability and flowability while preserving its strength and durability—to get around these problems. The purpose of this research is to determine whether it is feasible to add recycled aggregate to concrete blocks and improve their characteristics by adding superplasticizers. This project compares the properties of concrete blocks made with natural and recycled coarse aggregates, and assesses the impact of varying superplasticizer dosages on their characteristics and compressive strength.

The results of the study show that employing recycled coarse aggregate in the manufacturing of concrete can promote sustainable building practices and lessen construction waste. The research provides information about the optimal dosage of superplasticizers for enhancing explores the distinctive features of recycled coarse aggregate and emphasises the benefits of using recycled materials in building projects for an economic and environmental aspect.

Keywords: Sustainable building practices, Recycled materials, recycled coarse aggregate, Construction waste, sustainable practices.

1. INTRODUCTION

The significance of sustainable construction techniques is highlighted by the construction industry's substantial contribution to waste creation and environmental degradation. Utilising recycled materials in building has become more popular as a cost-effective and environmentally beneficial strategy. When making concrete, recycled coarse aggregate from demolished concrete structures can be used in place of natural coarse aggregate. However, there are a number of ways that recycled coarse aggregate varies from natural aggregate, which may have an impact on the final concrete's characteristics. Superplasticizers are chemical admixtures that enhance the workability and flowability of concrete without reducing its strength or durability. This study explores the feasibility of using recycled coarse aggregate in concrete blocks and improving their properties with the addition of superplasticizers. When making concrete, recycled coarse aggregate made from the debris of demolished concrete structures can be used in place of natural coarse aggregate. However, the properties of recycled coarse aggregate can differ from natural coarse aggregate, which might affect the ultimate concrete's characteristics.

Problem Statement and Research Questions

In the manufacturing of concrete, recycled coarse aggregate is becoming more widely acknowledged as an environmentally beneficial substitute for natural coarse aggregate. Nevertheless, recycled coarse aggregate may have different qualities than natural aggregate, which might affect the final concrete blocks' qualities. Superplasticizers have been proposed as a means to enhance both the performance of concrete blocks and the properties of recycled coarse aggregate. This study aims to address the following research questions:

Q1.What qualities distinguish natural coarse aggregate?

Q2. How does the recycled coarse aggregate different from the natural coarse aggregate in terms of their properties?

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

Purpose and Significance of the research

To the purpose of this study is to determine whether it is feasible to use recycled coarse aggregate in concrete blocks and improve their qualities by adding superplasticizers. Through waste reduction and an examination of the financial and ecological advantages of recycled materials, the research aims to advance sustainable building. The results of this study can help guide sustainable building practices and decision-making in the construction sector.

2. RESEARCH METHODOLOGY

A multi-step procedure was used to evaluate the effects of recycled aggregate in concrete mixes. According to IS 2386 Parts I, III, and IV (1963), the physical characteristics of both natural and recycled aggregates, such as specific gravity, water absorption, impact resistance, and abrasion value, were evaluated. First, a concrete mix was made with natural aggregate, and the slump test was used to determine its workability. After making the necessary changes until the desired workability was achieved, compressive strength was measured at 7, 14, and 28 days.. This mixture was then used to make concrete blocks, and at the same intervals, the blocks' compressive strength was assessed. Recycled aggregate was obtained from concrete blocks and tested for physical properties using the same methods applied to natural aggregate. Using an ideal dosage of 2%, several mixtures were made with varying amounts of recycled aggregate and set superplasticizer content. The slump test was used once again to evaluate each mix's workability. The blocks of concrete were 150 x 150 x 150 mm in size. The mechanical performance of each mix was evaluated by measuring its compressive strength at 7, 14, and 28 days. The results were analyzed and compared to determine the impact of recycled aggregates and superplasticizers on the workability and compressive strength of the concrete mixes.

MATERIALS

The following substances were utilized in the concrete mixtures:

- Grade 43 Portland-composite cement
- River sand used as a fine aggregate.
- There are two types of coarse aggregate, both with an average grain size of 20 mm: recycled concrete aggregate and natural coarse aggregate.

Superplastisizer

Sodium lignosulphonate is a commonly used superplasticizer in concrete mixes. In order to increase the workability of concrete manufactured from recycled concrete aggregates, we employed sodium lignosulphonate in this project. Sodium lignosulphonate works by dispersing the cement particles in the mix, allowing for better hydration and creating a more dense and cohesive material. This results in a reduction of water content, leading to an increase in strength and durability of the concrete.

Through our experimentation, we have found that the application of sodium lignosulphonate in our mixes of concrete has resulted in an improvement in workability, allowing for easier placement and compaction of the concrete. Furthermore, the addition of this superplasticizer has also caused the compressive strength to increase, indicating the improved performance of the concrete.

Overall, our use of sodium lignosulphonate superplasticizer with recycled aggregate has proven to be a successful combination, resulting in concrete with enhanced workability and mechanical properties.

PHYSICAL PROPERTIES OF RCA AND NCA

Crushing value test

The crushing value test in accordance to IS 2386 Part IV, is a commonly used method for evaluating the mechanical strength of aggregates, providing important information about their quality and suitability for use in various construction applications such as roadways and concrete structures. Higher crushing values indicate lower strength and durability, which can negatively impact the overall quality of construction material. Fig 1 presents the crushing values of recycled aggregate (RCA) and natural aggregate (NCA).

According to our research, recycled aggregates had a crushing value of 38%, whereas natural aggregates had a crushing value of 23%. This discrepancy shows that recycled aggregates are not as strong or long-lasting as natural aggregates.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

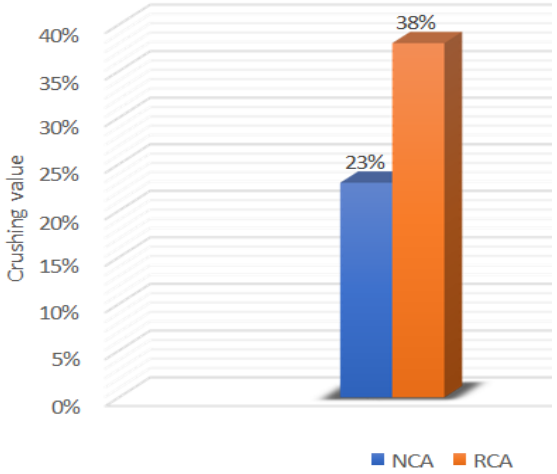

Fig 1: Crushing Value Test

Impact test

The impact test is a common technique for evaluating the durability and toughness of aggregates, and it adheres to Indian Standards (IS:2386 Part IV)-1963. According to our research, the absorption rate of natural aggregates was 13.06%, whereas that of recycled aggregates was 29.72%. Fig 2 illustrates the impact values for Natural Aggregate (NCA) and Recycled Aggregate (RCA).

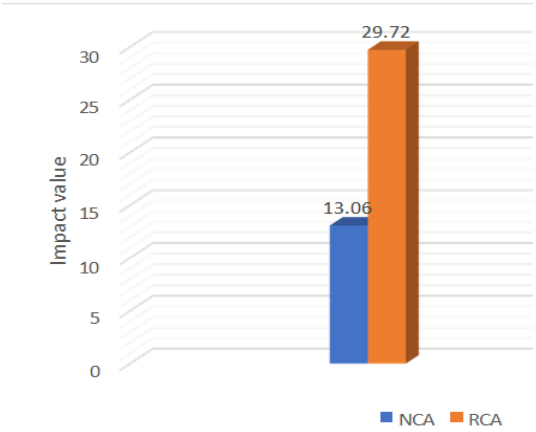

Fig 2: Impact Value Test

Specific gravity test

This test is conducted for determining aggregate's density—which indicates their quality and appropriateness for construction. It was carried out in compliance with IS 2386 Part III, shows that denser and stronger aggregates are often linked to higher specific gravity values. The natural and recycled aggregates in our experiment had specific gravities of 2.88 and 2.34, respectively. Fig 3 displays the specific gravities of recycled aggregate (RCA) and natural aggregate (NCA).

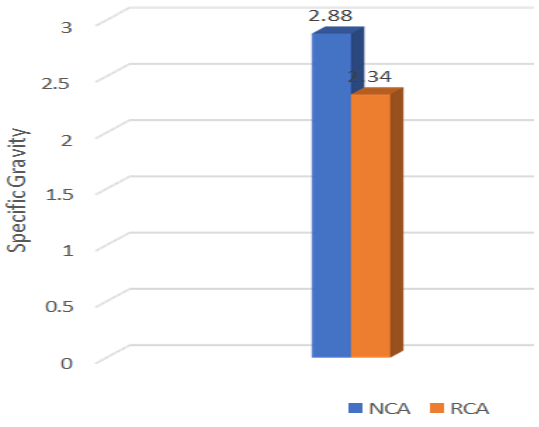

Fig 3: Specific Gravity Test

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

Water absorption test

This test is widely used method for determining the volume of water that aggregates absorb, providing important information about their quality and suitability for construction applications. In India, this test is performed according to IS 2386 Part III and obtained a result of 2.14% for natural aggregate, indicating relatively low absorption and good quality for construction. However, The recycled aggregate's higher water absorption test result of 6.92% suggests that it might not be appropriate for various building applications. The comparison analysis has been shown in Fig 4.

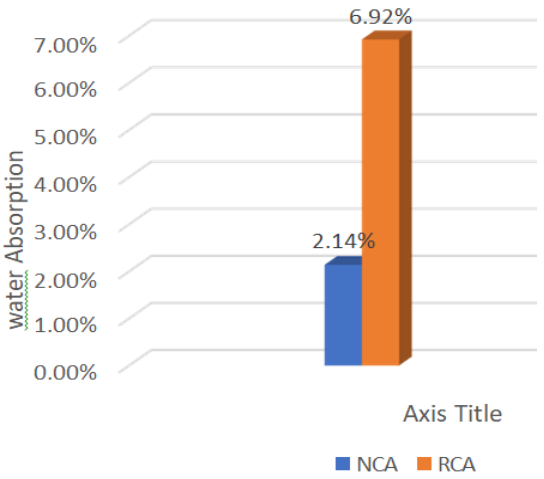

Fig 4: Water Absorption Test

Abrasion value test

The abrasion value test in accordance to IS 2386 Part IV is widely used to assess the resistance of aggregates to wear and tear caused by abrasion

In our test the result obtained was 16.28% on natural aggregate indicating good resistance to wear and tear. However, the test conducted on recycled aggregate produced a result of 35.6%, This indicates that it might not be as appropriate for some construction applications because it is higher than the ideal limit. The difference in Abrasion Values between Natural Coarse Aggregate (NCA) and Recycled Coarse Aggregate (RCA) is depicted in Fig 5.

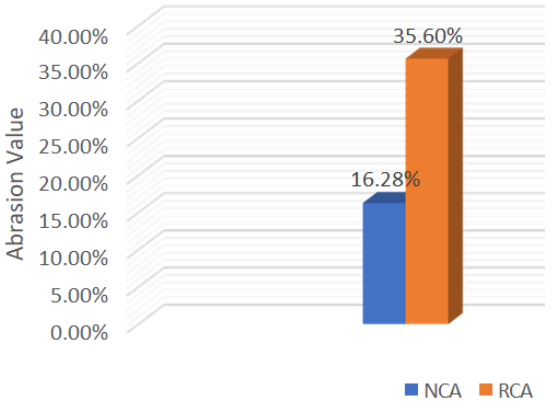

Fig 5: Abrasion Value

3. RESULTS

Composition of M30 grade concrete without superplasticizer

In this study, the composition of M30 grade concrete without the use of a superplasticizer was investigated. The mix design was in accordance with IS code IS 10262:2009.

To calculate the target mean strength of the concrete, the formula $f_t = f_{ck} + 1.65$ x standard deviation is used. Here, f_{ck} represents the characteristic compressive strength of the concrete at 28 days, which was set at 30 N/mm². The standard deviation was taken as 5 N/mm², resulting in a target mean strength of 38.25 N/mm².Overall, The results of this research study provide essential information onthe composition of M30 grade concrete without the use of a superplasticizer, and the target mean strength that can be expected from such a mixture. Data for compressive strength in accordance with IS 516:1959 is given in Table 1.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

Table 1: Compressive strength test on M30 grade concrete without superplasticizer

Days.	B	C	D	E
7	23.80	26.40	25.60	25.26
14	32.70	34.30	33.60	33.53
28	42.90	39.50	43.30	41.90

B - Cube 1 (N/mm²), **C -** Cube 2 (N/mm²), **D** - Cube 3 (N/mm²), **E** - Average Strength

Composition of M30 grade concrete using recycled aggregates

This study focuses on the composition of M30 grade concrete that utilizes recycled aggregates. Additionally, an admixture was added to the mixture in the amount @ 2.0 percentby mass of cementitious material.

The IS 456:2000 formula was used to determine the concrete's intended mean strength.The target mean strength (fck) was determined to be 38.25 MPa using this formula. This was calculated by multiplying the concrete's typical compressive strength at 28 days (fck = 30 MPa) by 1.65 times the estimated standard deviation of 5 MPa. The compressive strength data for RCA concrete, as per IS 516:1959, is presented in Table 2.

Table 2: Compressive strength test on M30 grade concrete using recycled aggregates

Test Age	F	G	H	I
7 days	17.65	15.80	19.50	17.65
14 days	24.80	26.70	27.90	26.46
28 days	31.75	31.45	32.60	31.93

F - Cube 1 (MPa)**, G -** Cube 2 (MPa), **H -** Cube 3(MPa), **I** - Average

Concrete's compressive strength increases and peaks at about 30% replacement before declining when natural material is replaced with recycled aggregate. At this optimal replacement amount, we tested the maximal compressive strength at 7, 14, and 28 days as indicates in table 1 and table 2.

Impact of Recycled Aggregate and Superplasticizer on Concrete's Workability and Compressive Strength with Varying Proportions

In this study, we substituted recycled aggregate for natural aggregate in different percentages: 0%, 10%, 20%, 30%, 50%, and 100%. In order to improve the concrete's workability and compressive strength, a superplasticizer was also added. The study aims to assess the effects of superplasticizer and recycled aggregate on the workability and compressive strength of concrete. While the quantities of cement, sand, water, and superplasticizer were the same in all mixes, the weight of natural aggregate was replaced with an equivalent weight of recycled aggregate to preserve uniform proportions. To guarantee consistent workability, the slump values for every mix were measured and are displayed in Table 3.

Table 3: Slump value for different proportions of RCA

Batch No	% of Replacement of RCA	Slump (mm)
1	0	106
2	10	111
3	20	115
4	30	120
5	50	123
6	100	70

The analysis indicates a direct correlation between the proportion of substituted aggregate in the concrete and its workability. In the absence of a superplasticizer, increasing the substitution percentage results in reduced workability. However, the addition of a certain percentage of superplasticizer can increase workability as indicates in table 3.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 10, October 2025, pp : 237-242

e-ISSN : 2583-1062
Impact Factor : 7.001

Table 4: Compressive Strength Test Results

J	K	L	M	N
1	0	22.1	31.2	38.1
2	10	22.5	33.5	40.5
3	20	24.3	35.8	40.0
4	30	26.1	38.0	42.8
5	50	28.9	34.1	39.7
6	100	18.7	25.2	34.6

J - Mix, **K** - % of Replacement of RCA, **L**- 7 Days Strength (MPa), **M** - 14 Days Strength (MPa), **N** - 28 Days Strength (MPa)

4. CONCLUSION

Based on the findings of our research, we conclude that incorporating recycled aggregate in concrete mixes can be a feasible and effective option, provided that it is used in conjunction with natural aggregate and that the properties of the resulting mixture are enhanced through the use of superplasticizer. However, our findings indicate that it is not advisable to fully replace natural aggregate with recycled aggregate, as this may not produce the desired strength in the resulting concrete mix.

By improving workability with fixed water and cement levels, lowering permeability, permitting a lower cement content while retaining strength and workability, and increasing rupture stress, superplasticizers have a good effect on concrete. A reduced water/cement ratio is the cause of the strength gains associated with superplasticizers.

In conclusion, it is a good idea to incorporate recycled aggregate into concrete mixtures; nevertheless, it is crucial to consider the role of superplasticizers and the appropriate replacement proportion in order to ensure the necessary workability and strength of the concrete. This research can help to guide decision-making in the industry and encourage the adoption of acceptable building practices.

5. REFERENCES

[1] Abdel-Hay AS (2017) Properties of recycled concrete aggregate under diferent curing conditions. HBRC J 13(3):271–276. https:// doi.org/10.1016/j.hbrcj.2015.07.001

[2] Etxeberria M, Marí AR, Vázquez E (2007) Recycled aggregate concrete as structural material. Mater StructConstr 40(5):529– 541. https://doi.org/10.1617/s11527-006-9161-5

[3] Nedeljkovi M, Visser J, Savija B, Valcke S, Schlangen E (2021) Use of fne recycled concrete aggregates in concrete : a critical review. https://doi.org/10.1016/j.jobe.2021.102196

[4] C.S. Vieira, P.M. Pereira, M. de Lurdes Lopes, Recycled Construction and Demolition Wastes as filling material for geosynthetic reinforced structures. Interface properties, J. Clean. Prod. 124 (2016) 299–311, https://doi.org/ 10.1016/j.jclepro.2016.02.115.

[5] The effect of superplasticisers on the workability and compressive strength of concrete made with fine recycled concrete aggregates,P. Pereira, L. Evangelista, J.deBrito, https://doi.org/10.1016/j.conbuildmat.2011.10.050

[6] Comparisons of natural and recycled aggregate concretes prepared with the addition of different mineral admixtures, Shi-cong Kou, Chi-sun Poon, Francisco Agrela, https://doi.org/10.1016/j.cemconcomp.2011.05.009

[7] Comparison of recycled aggregate treatment methods on the performance for recycled concrete, Jiangang Wang, Jinxi Zhang, Dandan Cao, Haixiao Dang, Bo Ding, https://doi.org/10.1016/j.conbuildmat.2019.117366

[8] The effect of superplasticizers on the mechanical performance of concrete made with fine recycled concrete aggregates, P. Pereira , L. Evangelista, J. de Brito, https://doi.org/10.1016/j.cemconcomp.2012.06.009

[9] Influence of quality of recycled aggregates on the mechanical properties of recycled aggregate concretes: An overview,Jeonghyun Kim, https://doi.org/10.1016/j.conbuildmat.2022.127071

[10] Influence of mixed recycled aggregate on the physical – mechanical properties of recycled concrete, César Medina, Wenzhong Zhu, TorstenHowind, María Isabel Sánchez de Rojas, Moisés Frías, https://doi.org/10.1016/j.jclepro.2014.01.002

[11] Improvement of mechanical properties of recycled aggregate concrete basing on a new combination method between recycled aggregate and natural aggregate, Ngoc Kien Bui, Tomoaki Satomi, Hiroshi Takahashi, https://doi.org/10.1016/j.conbuildmat.2017.05.084