Enhancing Concrete Blocks Properties with Superplasticizer Treatment: A Comparative Study of Natural and Recycled Coarse Aggregate

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Introduction

The construction industry generates a significant amount of waste and contributes to environmental degradation. Sustainable building practices are becoming increasingly important, and incorporating recycled materials into construction projects is one way to reduce waste and minimize the environmental impact. Recycled coarse aggregate from demolished concrete structures can substitute natural coarse aggregate in concrete production, but its properties can differ and affect the resulting concrete. Superplasticizers are chemical additives that can improve the properties of recycled coarse aggregate without compromising strength and durability.....

….This project aims to investigate the feasibility of using recycled coarse aggregate and superplasticizers in concrete blocks, comparing properties with those of natural aggregate, analyzing economic and environmental benefits, and exploring potential barriers and opportunities for implementing the use of recycled materials. The project contributes to sustainable building practices and cost-effective, eco-friendly building materials.

Demolished Concrete Waste

Why We Need To Recycle The Concrete

- The usage of natural aggregate is getting more and more intense with the advanced development in infrastructure area.
- In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials.
- Recycling of construction waste is one way to counter risk to construction wastes. So, the invention of proper technology to recycle these materials is of great importance. For instance, concrete waste can be crushed and used as recycled aggregate.

Our Objective

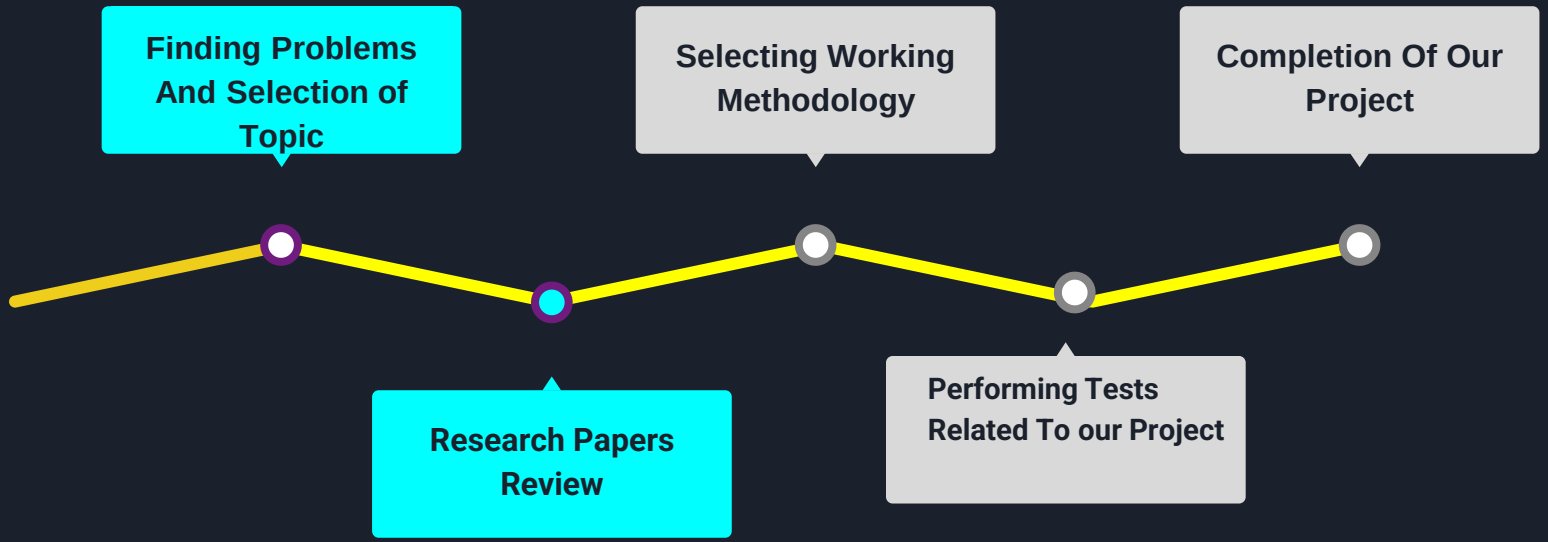
To explore the feasibility of incorporating recycled coarse aggregate into concrete blocks and enhancing their properties through the use of superplasticizers, with the aim of reducing construction waste and promoting sustainable building practices.

- Investigate the properties of the recycled coarse aggregate and evaluate its suitability for use in concrete block production.
- Assess the effects of incorporating recycled coarse aggregate on the compressive strength of the concrete blocks.
- Evaluate the influence of superplasticizers on the workability of the concrete blocks containing recycled coarse aggregate.
- Compare the properties of concrete blocks containing recycled coarse aggregate and superplasticizers with those of conventional concrete blocks.

Working Methodology

- Raw Materials Testing
- Making of Concrete Blocks
- Recycling And Cleaning of Aggregate
- Testing Of Recycled Aggregate
- Comparing The Properties of Natural & Recycled Aggregate
- Making of Concrete Blocks with Superplasticizer
- Conclusion of The Project

Project lifecycle



Materials Used :-

- Natural Coarse Aggregate
- Superplasticizer
- Cement
- Fine Aggregate
- Recycled Coarse Aggregate

Natural Coarse Aggregate :-

Coarse aggregate is a term used to describe materials that are generally larger than 4.75 mm in size and are commonly used in the construction industry. They are typically used in the production of concrete and are a crucial component in providing strength, durability and stiffness to the final product.

In our work we had used 20 mm size aggregate

Recycled Coarse Aggregate :-

They are produced from demolished waste concrete having same or different physical properties

Fine Aggregate :-

Fine aggregate, also known as sand, is a granular material that is used in the production of concrete and mortar. It is generally composed of particles that are smaller than 5mm in size. Fine aggregates are extracted from river beds, beaches, and sand dunes. We had used fine Aggregate locally available fine aggregate.

Cement :-

Cement is a commonly used Binding material that is known for its ability to harden when mixed with water. It is a fine powder that is made by heating a mixture of limestone, clay, and other minerals in a kiln at very high temperatures. We have used OPC 43 grade cement

Superplasticizer

Superplasticizers also known as high range water reducers, are additives used in making high strength concrete. Plasticizers are chemical compounds that enable the production of concrete with approximately 15% less water content.

In Our Project we are going to use sodium lignosulfonate as a Superplasticizer

Literature Reviewed

1. **Properties of recycled concrete aggregate under different curing conditions,** *Abdel-Hay AS [1] (2017)*

This research evaluated the effects of using recycled concrete aggregate (RCA) in new concrete production under different curing conditions.

The study found that a mixing ratio of 50% RCA to natural aggregates and curing with paint material was the most efficient method. The results also showed that increasing the RCA ratio led to a decrease in concrete permeability.

Gap :- Steam Curing can also be used for increasing the properties of RCA

2. The effect of superplasticisers on the workability and compressive strength of concrete made with fine recycled concrete aggregates, *P. Pereira, L. Evangelista, J. de Brito* [5]

The Research explores the use of the superplasticizer to improve the performance of the concrete containing FRCA.

The research identified several conclusions related to the use of superplasticisers, including the decrease in workability with increasing incorporation of recycled aggregates and the greater compressive strength gains with higher water reduction capacity of the superplasticiser.

Gap :- Water Reducers Plasticizers can also be used.

3. Comparisons of natural and recycled aggregate concretes prepared with the addition of different mineral admixtures, *Shi-cong Kou, Chi-sun Poon, Francisco Agrela* [6]

This Paper Reports on lab study performance of natural and recycled aggregate concrete by adding different mineral admixture.

This paper concludes that silica fumes and metakaolin contributed to both short and long term properties while fly ash and ggbs had been beneficial only after a relative log time curing.

Gap:- Use of chemical admixture can be used for both short and long term properties.

4. Nedeljkovic M, Visser J, Savija B, Valcke S, Schlangen E [3] (2021) Use of fne recycled concrete aggregates in concrete

This paper presents a literature review on the use of fine recycled concrete aggregates (fRCA) in new concrete, focusing on their properties and the challenges of using them while reducing cement content.

Gap:- Further Research is needed to understand the relation between FRCA treatment and there characteristic for long term behavior

5. Etxeberria M, Marí AR, Vázquez E [2] (2007) Recycled aggregate concrete as structural material

This paper investigates the use of recycled aggregate concrete (RCA) as a structural material by studying the shear behaviour and strength of beams made with RCA.

The paper concludes that concrete made with up to 25% RCA is suitable for structural use.

Gap :- Percentage can be increased upto 30% while mixing admixture and more research is needed to study the structural behaviour at sever and ultimate condition

List Of Experiments Performed

- Impact Test on Natural Aggregate and Recycled Aggregate
- Crushing Value Test Of Natural Aggregate and Recycled Aggregate
- Specific Gravity of The Natural Aggregate and Recycled Aggregate
- Abrasion Test on Natural Aggregate and Recycled Aggregate
- Water Absorption Test Natural Aggregate and Recycled Aggregate
- Slump Cone Test
- Compressive strength of concrete blocks.

IMPACT TEST ON NATURAL AGGREGATE

To evaluate the toughness of aggregates to break down under application of impact and to determine aggregate impact value of the given sample of aggregate.

Empty Weight of The Cylinder (W1) in (g)	Weight of The Cylinder with Aggregate (W2) in (g)	Weight Of the Aggregate Passing Through 2.36mm sieve (W3) in (g)
623	1030	53.154

Impact Test Value = 13.06%

IMPACT TEST ON RECYCLED AGGREGATE

To evaluate the toughness of aggregates to break down under application of impact and to determine aggregate impact value of the given sample of Recycled aggregate.

Empty Weight of The Cylinder (W1) in (g)	Weight of The Cylinder with Aggregate (W2) in (g)	Weight Of the Aggregate Passing Through 2.36mm sieve (W3) in (g)
623	993	109.96

Impact Test Value = 29.72%

Some glimpses of Impact Test

Crushing Value of Natural Aggregate

To assess the strength of coarse aggregates used in the pavement components under gradually applied load and to determine the aggregates crushing value of the given sample of aggregates.

Empty weight of the cylinder (W1) in (g)	Weight of cylinder with the aggregates (W2) in (9)	Weight of aggregate passing through 2.36mm sieve (W3) in (g)	Aggregate Crushing Value (%) = (W3/(W2-W1))*100
3146.00	6214.00	724	23.59

Crushing Value of Recycled Aggregate

Empty weight of the cylinder (W1) in (g)	Weight of cylinder with the aggregates (W2) in (9)	Weight of aggregate passing through 2.36mm sieve (W3) in (g)	Aggregate Crushing Value (%) = (W3/(W2-W1))*100
3146.00	6405.00	1259	38.63

Specific Gravity of Natural Aggregate

S. No.	Description	Observed Values
1	Weight of saturated aggregate and basket in water (W_1)	2200.8gm
2	Weight of basket in water (W_2)	750gm
3	Weight of saturated aggregates in air (W_3)	2205gm
4	Weight of oven-dry aggregates in air (W_4)	2172gm
6	Specific Gravity (W4 / [W3 - (W1 - W2)])	2.88

Specific Gravity of Natural Aggregate: 2.88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Specific Gravity of Recycled Aggregate

S. No.	Description	Observed Values
1	Weight of saturated aggregate and basket in water (W_1)	2101.6gm
2	Weight of basket in water (W_2)	750gm
3	Weight of saturated aggregates in air (W_3)	2319gm
4	Weight of oven-dry aggregates in air (W_4)	2233gm
6	Specific Gravity (W4 / [W3 - (W1 - W2)])	2.34

Specific Gravity of Recycled Aggregate : 2.34

Water absorption On Natural Aggregate & Recycled Aggregate

The purpose of the water absorption test is to determine the amount of water that an aggregate can absorb and to assess its suitability for use in concrete and other construction materials.

Results :-

The Water absorption percentage of Natural Coarse aggregate is 2.14
The Water absorption percentage of Recycled Coarse aggregate is 6.92

Abrasion Value Test On Natural Aggregate

The abrasion value test is a common test used to determine the durability and hardness of aggregates.

Aggregate Abrasion Value = (B/A) x 100

A = 5000 g, Weight in grams of total material.
B = 814 g, Weight in grams of the fraction passing through 1.70 mm IS sieve.

RESULT :-
The Abrasion Value of Natural Coarse Aggregate is 16.28%

Abrasion Value Test On Recycled Natural Aggregate

The abrasion value test is a common test used to determine the durability and hardness of aggregates.

Aggregate Abrasion Value = (B/A) x 100

A = 5000g, Weight in grams of total material.
B = 1780g, Weight in grams of the fraction passing through 1.70 mm IS sieve .

RESULT :-
The Abrasion Value of Natural Coarse Aggregate is 35.60%

Compressive strength of concrete made of NCA

Days.	Cube 1 (N/mm^2)	Cube 2 (N/mm^2)	Cube 3 (N/mm^2)	Average Strength
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

Compressive strength of concrete made of RCA

Test Age	Cube 1 (MPa)	Cube 2 (MPa)	Cube 3(MPa)	Average
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

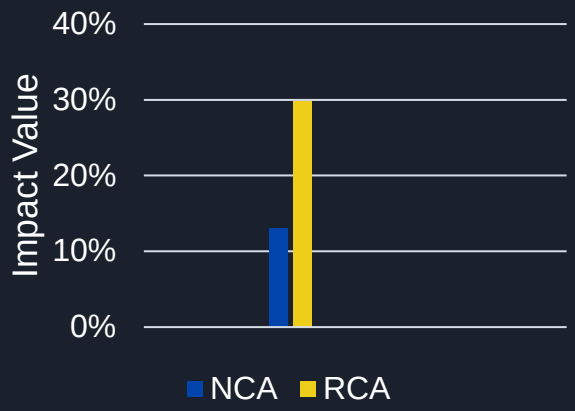
Slump values For different Proportions of RCA

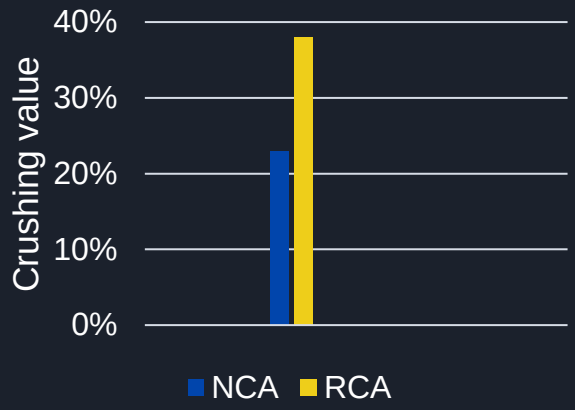
Batch No	% of Replacement of RCA	Slump(mm)
Mix-1	0	106
Mix-2	10	111
Mix-3	20	115
Mix-4	30	120
Mix-5	50	123
Mix-6	100	70

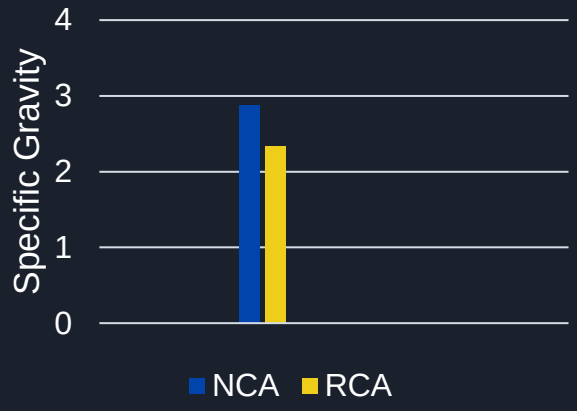
Compressive strength of concrete made of RCA/NCA MIX

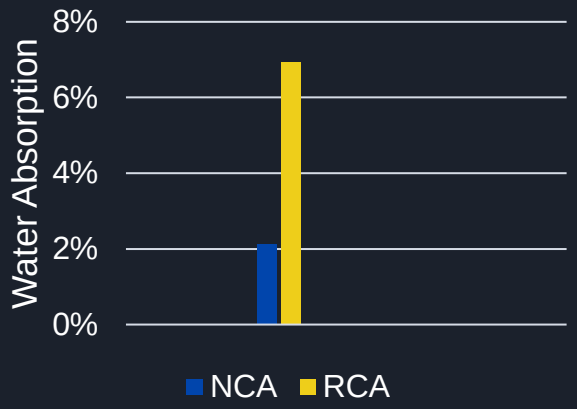
Mix With Percentage of Replacement	7 Days Strength (MPa)	14 Days Strength (MPa)	28 Days Strength (MPa)
1. 0%	22.1	31.2	38.1
2. 10%	22.5	33.5	40.5
3. 20%	24.3	35.8	40.0
4. 30%	26.1	38.0	42.8
5. 50%	28.9	34.1	39.7
6. 100%	18.7	25.2	34.6

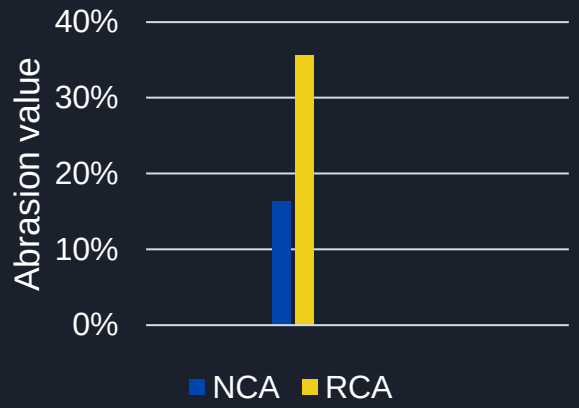
Results & Discussion

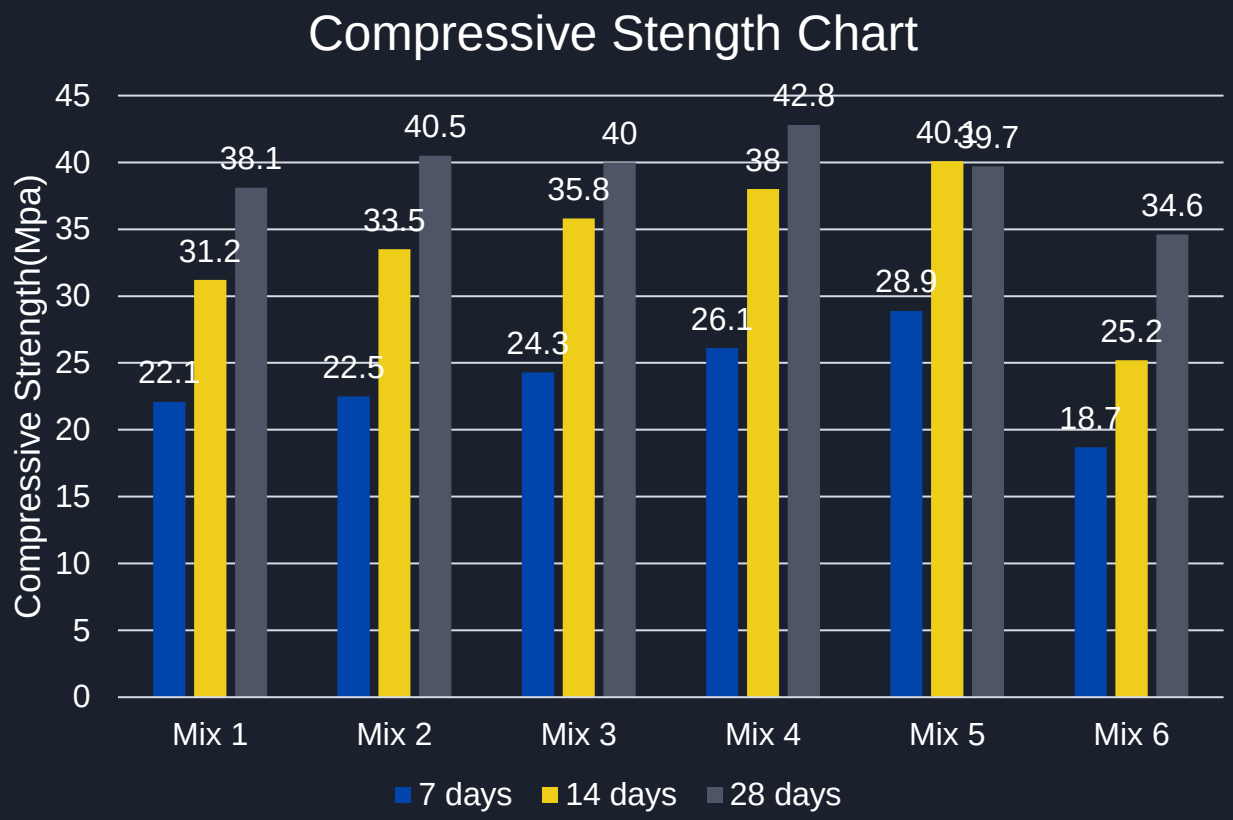







Water Absorption
8%
6%
4%
2%
0%
NCA
RCA


Abrasion value
40%
30%
20%
10%
0%
NCA
RCA


Compressive Stength Chart
Compressive Strength(Mpa)
45
40
35
30
25
20
15
10
5
0
22.1
31.2
38.1
22.5
33.5
40.5
24.3
35.8
40
26.1
38
42.8
28.9
40.1
39.7
18.7
25.2
34.6
Mix 1
Mix 2
Mix 3
Mix 4
Mix 5
Mix 6
7 days
14 days
28 days

CONCLUSION

Based on the results of our research, we have arrived at the conclusion that the use of recycled aggregate can be a viable option in concrete mixes, 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.

The compressive strength of concrete first increases with the substitution of normal aggregate for recycled aggregate, and then after a certain point, its value starts decreasing. We observed that the most favorable range of replacement of aggregate is 30%, at which we obtain the maximum value of compressive strength at 7, 14, and 28 days.

In summary, the use of recycled aggregate in concrete mixes can be a feasible option, but it is important to carefully consider the percentage of substitution and the use of superplasticizers to maintain the desired workability and strength of the concrete.

Some glimpses of our work


REDMI NOTE 7S
AI DUAL CAMERA


SALTER

A change in mindset: Regenerate value out of waste i.e. concrete debris.

THANK YOU