Effect of Partial Replacement of RCA with and without SKY Glenium B8777

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KEYWORDS

Recycled Concrete Aggregate

SKY Glenium B8777

Compressive Strength

Flexural Strength

Split Tensile Strength

Partial Replacement

ABSTRACT

The uses of Recycled Concrete Aggregate (RCA) as a substitute for natural aggregates in concrete has gained attention in recent years due to its economic and environmental benefits. However, the quality of RCA may vary, affecting its performance in concrete. This study investigates the effect of different replacement of RCA with and without SKY Glenium B8777, a viscosity-modifying admixture, on the properties of concrete. The research objectives were to evaluate the compressive strength, split tensile strength and flexural strength of concrete mixtures with different proportions of RCA and SKY Glenium B8777. The experimental program prepared the concrete specimens with different RCA replacement levels (0%, 10%, 20%, 30%, 40%, and 50%) and with and without SKY Glenium B8777. The results showed that the compressive, split tensile strength and flexural strength of the concrete decreased with increasing the RCA content, but the addition of SKY Glenium B8777 helped to improve the strength properties. These findings suggest that partial replacement of RCA with SKY Glenium B8777 can be a viable option to enhance the fresh properties as well as hardened properties of concrete.

1. Introduction

Concrete is a widely used construction material, but its production significantly impacts the environment. To mitigate this impact, researchers have explored the use of recycled concrete aggregate (RCA) as a substitute of natural aggregates. However, using RCA can lead to a reduction in mechanical properties and workability, which can limit its utility in concrete.

In response to this issue, the present study aims to investigate the impact of partially replacing the RCA with SKY Glenium B8777, a high-performance admixture, on concrete properties. SKY Glenium B8777 enhances the workability, consistency, and performance of concrete, and is known to improve concrete flow, reduce water content, and increase strength development. The use of SKY Glenium B8777 in combination with RCA could lead to the development of a more sustainable and durable concrete mix, contributing to a reduction in the environmental impact of the construction industry.

The experimental program of this research will involve casting and testing concrete samples with varying RCA replacement levels (0%, 10%, 20%, 30%, 40% and 50%) with and without SKY Glenium B8777 in a controlled laboratory environment. The compressive, split tensile and flexural strength of the samples will be assessed using standard testing procedures. The study seeks to provide a comprehensive understanding of the impact of RCA replacement and SKY Glenium B8777 on the properties of concrete and inform the development of sustainable and durable concrete structures that can meet the needs of the construction industry while minimizing its environmental impact.

2. Material and Methods

2.1 Material Used

The materials used in this study were carefully selected to ensure that they were of high quality and met the required standards for concrete production. OPC 43 grade cement was chosen due to its high compressive strength and low heat of hydration, which reduces the risk of thermal cracking. The cement was sourced from a reputable supplier and tested to ensure it met the specification of IS code 456:2000.

The natural coarse aggregate used in the study had a nominal size of 20mm and was sourced from a local quarry. The aggregate was tested to ensure that it met the required standards for use in concrete production. The fine aggregate used in the study was sand with a size of less than 4.75mm, which was also sourced locally. The sand was tested to ensure that it met the required standards for use in concrete production.

Recycled Coarse Aggregate (RCA) was also used in this study. The RCA of size 20mm was procured from a concrete recycling plant and was carefully inspected to ensure that it was free of contaminants and met the required standards for use in concrete production. The RCA was obtained through the process of crushing and screening concrete waste, which reduces the amount of waste that ends up in landfills and conserves natural resources.

To study the effect of the SKY Glenium B8777 additive on the RCA mix, the additive was added to the mix. The additive is a high-range water-reducing admixture that can improve the workability of the mix, reduce the water-cement ratio, and improve the strength of the resulting concrete. The proportions of the materials used in the mixes were determined based on the American Concrete Institute (ACI) guidelines to ensure that the mixes met the required standards for concrete production.

2.2 Aggregate Test

A test was carried out on two types of coarse aggregate: natural (sourced from rivers or quarries) and recycled (obtained from construction waste) to assess their properties and suitability for use in construction projects.

2.2.1 Crushing Value Test

The crushing value test is a common test used to assess the mechanical strength and durability of coarse aggregates used in construction. The test is performed on aggregates larger than 10mm in size and involves subjecting a sample of aggregate to a standard compressive test in a compression testing machine. The procedure for the crushing value test for coarse aggregates is described in detail in IS: 2386 (Part-IV) :1963. The standard is divided into several sections, and the procedure for the impact value test is covered in Section [2.3].

Crushing Value (Strength) :

1. Natural Aggregate is 19.16%
2. Recycled Aggregate is 27.87%

Recycled aggregates have lower strength than natural aggregates based on their crushing value.

2.2.2 Impact Value

Impact value is the measure of the toughness of an aggregate, determined by a standard test. It is expressed as a percentage of weight passing through a specified sieve after impact. The procedure for the impact value test for coarse aggregates is described in detail in IS: 2386 (Part-IV) :1963. The standard is divided into several sections, and the procedure for the impact value test is covered in Section [4.3].

Impact Value (Toughness)

1. Natural Aggregate is 25.47%
2. Recycled Aggregate is 33.23%

Recycled aggregates have lower strength than natural aggregates based on their impact value.

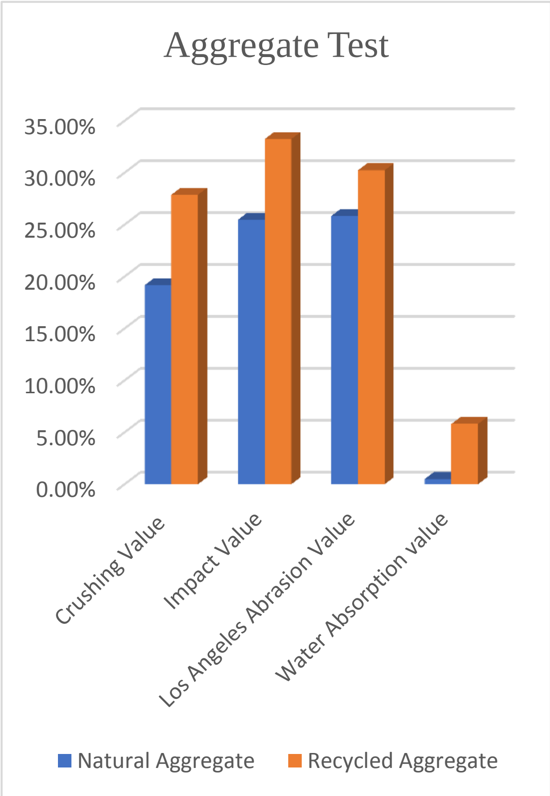
2.2.3 Los Angeles Abrasion Test

The Los angles abrasion test is a standard method used to measure aggregate resistance to abrasion. It involves rotating a steel drum with steel balls, and the result is expressed as a percentage of weight passing a sieve size. The procedure for the impact value test for coarse aggregates is described in detail in IS: 2386 (Part-IV) :1963. The standard is divided into several sections, and the procedure for the impact value test is covered in Section [5.3.4].

Los Abrasion Value (Hardness)

1. Natural Aggregate is 25.83%
2. Recycled Aggregate is 30.23%

Recycled aggregates have lower strength than natural aggregates based on their los abrasion value.



2.2.4 Specific Gravity Test

The specific gravity test is a standard test method used to determine the density of an aggregate relative to the density of water. It necessary to weigh both in air and under water and then calculate the difference in weigh between the two measurements. The test helps to determine the strength and durability of the aggregate and its suitability for use in various construction applications.

a) The specific gravity value of natural aggregate is 2.68.

b) The specific gravity value of recycled aggregate is 2.01.

3. Experimental Studies

3.1Mix Proportion

Table - 1

Mix proportion without admixture	
Cement	437.65 kg/m^3
Water	186.00 kg/m^3
Fine aggregate	661.26 kg/m^3
Coarse aggregate	1163.29 kg/m^3
Mix proportion with admixture	
Cement	329.10 kg/m^3
water	139.87 kg/m^3
Fine aggregate	734.92 kg/m^3
Coarse aggregate	1292.87 kg/m^3
Chemical admixture	6.58 kg/m^3

3.2. Experimental Procedure

1. The materials required for the cube casting, such as cement, fine aggregate, coarse aggregate, RCA, water, and admixture (SKY Glenium B8777), were gathered and kept ready as per the IS codes.

2. The mix design for the concrete was prepared as per IS 10262:2009, using the partial replacement of RCA, with and without admixture (SKY Glenium B8777).

3. The mix proportions were determined based on the required properties of the concrete, such as strength, workability, and durability, as per the guidelines given in IS 456:2000.

4. The mixing was carried out in a pan mixer as per the requirements of IS 456:2000. The coarse aggregate, fine aggregate, and RCA were mixed first, followed by the addition of the cement and water.

5. In the case of the concrete mix with admixture, the dosage of the SKY Glenium B8777 admixture was determined as per the manufacturer's recommendations and as per the requirements of IS 10262:2009. The admixture was added during the mixing process and thoroughly mixed with the other ingredients to achieve a homogeneous mix.

6. The fresh concrete mix was then poured into the cube moulds as per the requirements of IS 516:1959.

7. Compact the concrete using a mechanical vibrator for 1-2 min to achieve maximum compaction density, as specified in IS 456:2000.

8. Cure the cubes in a curing tank at a temperature of 27±2°C for 7 and 28 days.

9. After the completion of the curing period, the cube specimens were tested for compressive strength as per the requirements of IS 516:1959.

10. The compressive strength results were then compared between the concrete mix with and without the admixture (SKY Glenium B8777) and the partial replacement of RCA, and the performance of concrete based on the IS Codes.

4. Result and Discussion

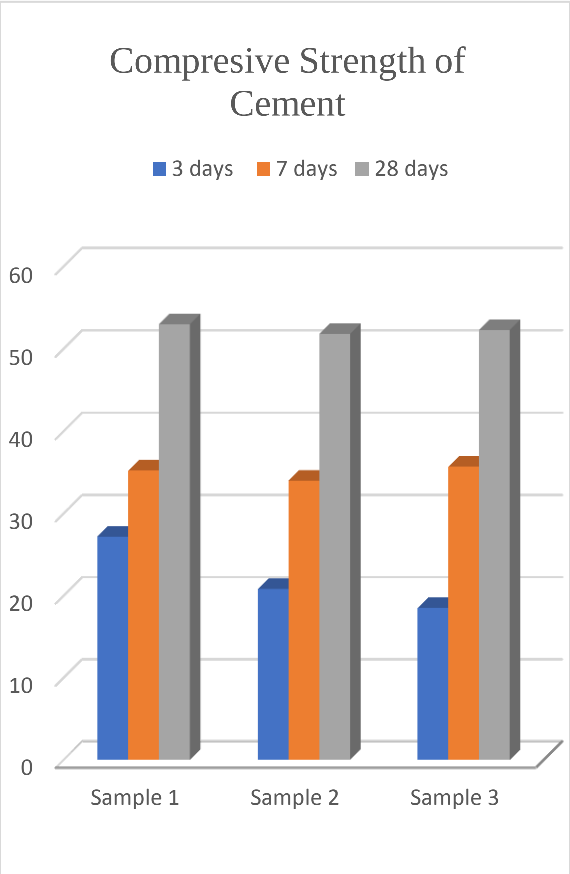
4.1 Physical Properties of Cement

Table 2

Compressive Strength of Cement Mortar

Table 3

Sample no.	*3 days (Mpa)*	*7 days (Mpa)*	*28 days (Mpa)*
Sample 1	*27.2*	*35.2*	*53.1*
Sample 2	*20.8*	*34*	*51.8*
Sample 3	*18.5*	*35.7*	*52.3*



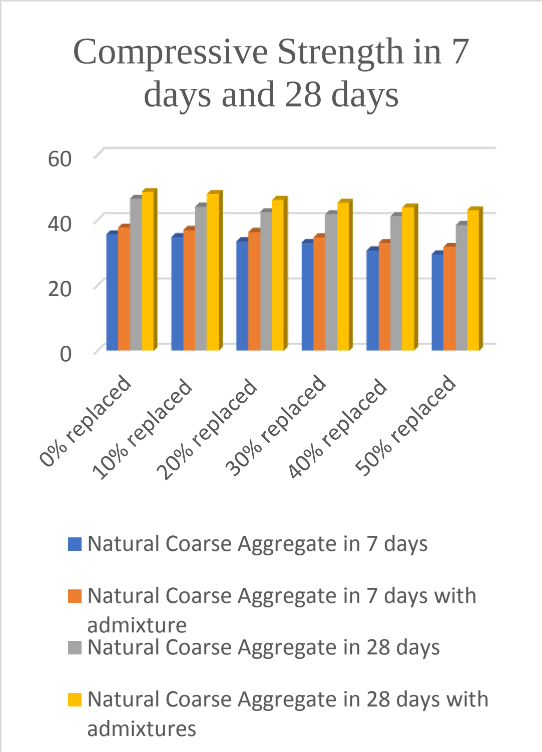
4.2 Compressive Strength

The compressive strength of a concrete cube is an important measure of its quality and ability to withstand the load. The strength of concrete is typically determined using a cube test as per IS code 516:1959. The code outlines the standard procedure for preparing, casting, curing, and testing concrete cubes to determine their compressive strength. The result of this test is used to evaluate the quality and strength of the concrete and also ensure that it meets the required standard for various construction applications.

Properties	*Experimental observation*	*Values by IS: 8112-1998*
Normal consistency test	*33%*	*-*
Specific gravity	*3.16*	*-*
Soundness test	*0.5 mm*	*<10mm*
Initial setting time	*62 min*	*>30 min*
Final setting time	*220 min*	*<600 min*

The load is gradually applied to the cube until it fails, and the maximum load is sustained by the cube is recorded. The compressive strength of cube is calculated

% replaced	*0%*	*10%*	*20%*	*30%*	*40%*	*50%*
Natural Coarse Aggregate (7 days)	*35.7*	*34.9*	*33.5*	*33.1*	*30.8*	*29.6*
Natural Coarse Aggregate with Admixtures (7 days)	*37.8*	*37*	*36.4*	*34.7*	*33*	*31.9*
Natural Coarse Aggregate (28 days)	*46.6*	*44.1*	*42.5*	*41.9*	*41.2*	*38.5*
Natural Coarse Aggregate with Admixtures (28 days)	*48.7*	*48.1*	*46.2*	*45.3*	*43.9*	*43.1*



Split Tensile Strength

Table 5

% replaced –>	0%	10%	20%	30%	40%	50%
Natural coarse aggregate (7 days)	5.1	4.5	4.2	4.2	3.6	3.3
Natural coarse aggregate (7 days) with admixture	5.7	5.3	5.1	4.8	4.2	3.7
Natural coarse aggregate (28 days)	7.2	6.9	6.3	5.9	5.2	4.9
Natural coarse aggregate with admixture (28 days)	7.8	7.5	7.2	6.7	6.1	5.4

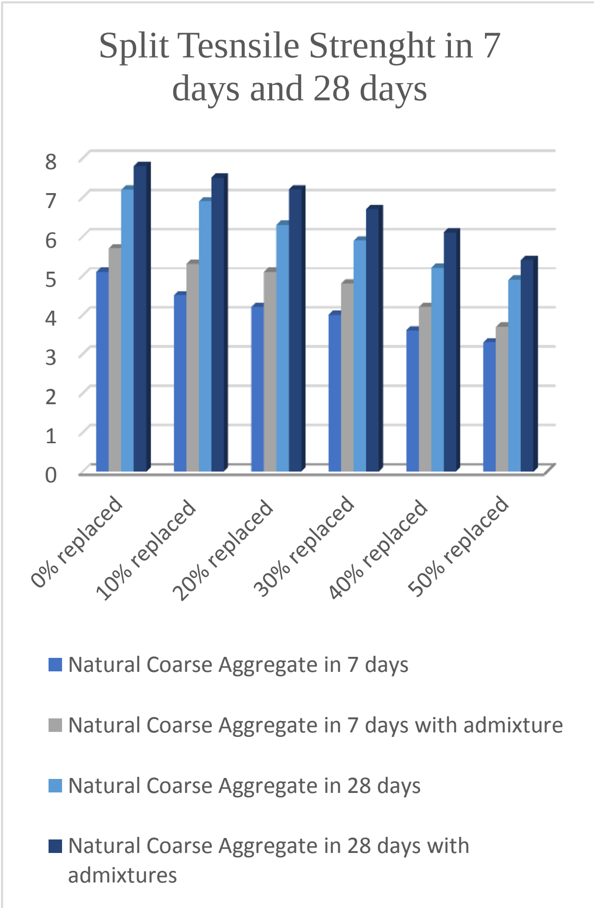
4.3 Split Tensile Test

The split tensile test is a widely used method for indirectly measuring the tensile strength of concrete. It involves applying a load to a beam-shaped sample to produce tensile stress perpendicular to its longitudinal axis. The cube specimen is placed between two compression plates and loaded in compression until failure. The load required to cause failure is recorded, and the tensile strength of cube was calculated by using split tensile method.

The split tensile result is shown on table no. 4

It concluded that the use of admixture in partial replacement of RCA at different proportions 0%, 10%, 20%, 30%, 40% and 50% has shown better split tensile strength as compared to not using admixtures.

We observed that the split tensile strength of cube is increased by 0.68% and 0.71% in 7 days and 28 days respectively by using admixture as compared to without admixtures.



4.4 Flexural Test

A flexural test is performed on a beam by applying a load at mid-span to determine its strength and deformation characteristics. The test involves placing the beam horizontally on two supports and applying a load at the canter until failure. The load and deflection measurements are then used to calculate the flexural strength and modulus of elasticity of the beam.

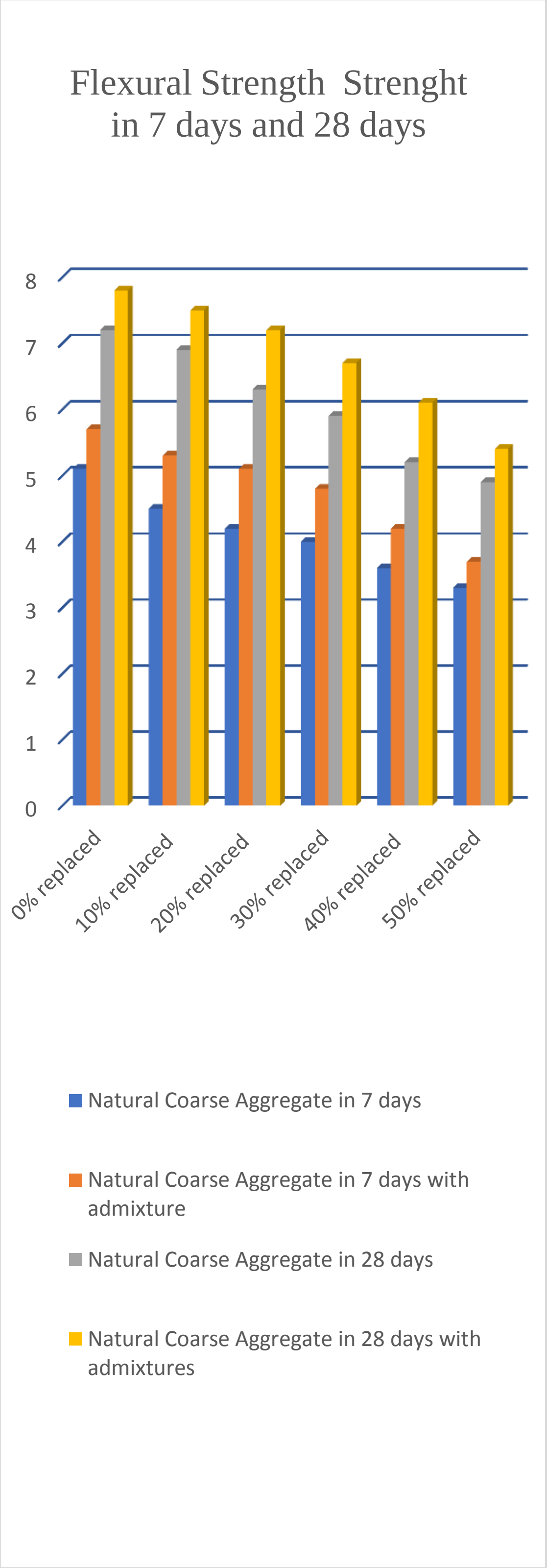
The flexural strength result is shown on table no. 5

It concluded that the use of admixture in partial replacement of RCA at different proportions 0%, 10%, 20%, 30%, 40% and 50% has shown better flexural strength as compared to not using admixtures.

We observed that the flexural strength of beam is increased by 0.33% and 1.05% in 7 days and 28 days respectively by using admixture as compared to without admixtures.

Table 6

% replaced –>	*0%*	*10%*	*20%*	*30%*	*40%*	*50%*
Natural coarse aggregate (7 days)	*4.1*	*3.8*	*3.5*	*3.2*	*2.8*	*2.1*
Natural coarse aggregate (7 days) with admixture	*4.6*	*4.1*	*3.7*	*3.4*	*3.1*	*2.6*
Natural coarse aggregate (28 days)	*7.3*	*6.5*	*6.0*	*5.4*	*5.2*	*4.8*
Natural coarse aggregate with admixture (28 days)	*8.1*	*7.6*	*7.1*	*6.7*	*6.3*	*5.7*



5. Conclusion

In conclusion, this study aims to investigate the impact of partially replacing recycled concrete aggregate (RCA) with SKY Glenium B8777, a high-performance admixture, on the properties of concrete. The study used carefully selected materials that meet the required standards for concrete production, including OPC 43-grade cement, natural coarse aggregates and recycled coarse aggregates, and sand. The properties of the aggregates were assessed through various tests, including crushing value, impact value, Los Angeles abrasion test, and specific gravity test. The results showed that the recycled aggregate had lower strength than natural aggregate based on the crushing value test. The experimental program involved casting and testing concrete samples with varying RCA replacement levels with and without SKY Glenium B8777. The compressive and flexural strength of the samples were assessed using standard testing procedures. The study seeks to provide a comprehensive understanding of the impact of RCA replacement and SKY Glenium B8777 on the properties of concrete and inform the development of sustainable and durable concrete structures that can meet the needs of the construction industry while minimizing its environmental impact.

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