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# An Experimental Study on Concrete using Debris from Demolished Buildings to Partially Replace the Coarse Aggregate

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*Abstract*— **A lot of waste is being created from construction and demolition activities, and it is currently being thrown away in landfills. Finding enough land to accommodate all this waste is becoming difficult. The best solution would be to recycle and reuse the waste instead of throwing it away. This will not only help protect the environment but also manage the construction waste better. This project focuses on reusing crushed concrete waste by using it as a replacement for a portion of the coarse aggregate in concrete. Different percentages of crushed concrete waste are being tested (20%, 30%, and 40% of the coarse aggregate). The concrete made with this waste material will be analyzed for its durability, including compressive strength, split tensile strength, and flexural strength. By using this waste material, we can replace some of the traditional coarse aggregate and still achieve the required strength in the concrete of a standard M20 grade.**

**Key words: - Crushed Concrete Waste (CCW), Fine Aggregate, Coarse Aggregate, Demolished Crushed Concrete Aggregate (DCCA), OPC (53 Grade) Cement, Lathe garbage.**

## I. INTRODUCTION

As cities grow over time, there is a higher demand for new buildings and infrastructure.

As cities grow over time, there is a higher demand for new buildings and infrastructure. This leads to an increased need for materials like natural aggregates. However, using natural aggregates too much can be harmful to the environment. To address this, we can use recycled aggregates as alternative materials. Many old buildings and structures have become outdated and need to be replaced. Instead of throwing away the debris from these structures, we can process it and use it as coarse aggregates in concrete production. This helps reduce the amount of waste generated and promotes sustainable practices.

In India and South Asia, around 5000 tons of building waste discarded every day. This waste poses a threat to the environment and takes up a lot of space. In the field of concrete engineering, globally, we use 8 to 12 billion tons of natural aggregate each year. Continuously relying on natural sources like stone and sand has negative effects on the climate and the Earth. Therefore, reusing demolished concrete waste as recycled aggregate concrete is seen as an effort to preserve natural resources, protect the environment, and maintain a sustainable balance.

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## II. MATERIALS AND METHODS

### Materials

**Cement:**

The cement that is currently available is called Ordinary Portland Cement (OPC) of grade 53. This grade of cement needs to meet the specifications set by the Bureau of Indian Standards (BIS) as outlined in the IS: 12269-1987 document. According to these specifications, the cement should have a minimum strength of 53 Mega Rascal (MPa) or 530 kilograms per square centimeter (kg/sqcm) after 28 days of curing.

**Table 1: The Physical Properties of Cement**

| S. No | Physical Properties of OPC 53 Grade Cement | Value |
|---|---|---|
| 1 | Specific gravity | 3.15 |
| 2 | Standard consistency | 33.65 |
| 3 | Fineness test | 1.7 |
| 4 | Initial setting time | 30 Minutes |
| 5 | Final setting time | 8 Hrs 30 Minutes |

**Fine aggregate:**

Artificial sand was used as fine aggregate. The specific gravity 2.55 and a fineness modulus 2.93 have artificial sand respectively.

**Coarse aggregate:** Use locally accessible crushed stone as a coarse aggregate. Which include the 20mm size dimensions that were used for the project.

**Table 2: Physical Properties of Demolished Crushed Concrete and Normal Aggregate**

| S. No | Physical Properties | DCCA | Normal Coarse Aggregate |
|---|---|---|---|
| 2 | Impact Value | 28.3 | 13.45 |
| 3 | Water Absorption | 5.62 | 0.95 |
| 4 | Bulk Density | 2.59 | 0.72 |
| 5 | Crushing Value Test | 29 | 17.5 |
| 6 | Abrasion Test | 16.5 | 14 |
| 7 | Size | 20 mm | 20 mm |

**Water:**

The processes of mixing and hydrating are employed to produce potable water. Concrete preparation uses a water-to-cement ratio of 0.35 to accomplish this.

**Test specimens:**

We made test samples for several types of strength in concrete. We used cubes that were 150x150x150 mm in size to test compressive strength. We also used cylinders that were 150 mm in diameter and 300 mm in length to test split tensile strength. Lastly, we used beams that were 150x150x700 mm in size to test flexural strength.

We used crushed coarse aggregates that were 20 mm in size and had varying percentages of demolition debris. These samples were made using M25 grade concrete mix. The samples were then tested according to the guidelines provided by the Indian Standards IS: 516 and 1199.

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**Curing of concrete:**

After 24 hours of making the concrete structure, the mold will be removed and the concrete will be soaked in clean water. The concrete blocks, cylinders, and beams will be completely submerged in clean water for 7, 14, and 28 days. Once the curing process is complete, the concrete will be taken out and left at room temperature for 24 hours before testing it.

**Testing of hardened concrete:**

1. Compressive strength.
2. Flexural strength.
3. Split tensile strength

## III. RESULT AND DISCUSSION

**The Compressive Strength:**

The concrete is poured into a mold and carefully handled to ensure there are no empty spaces. The outer surface of these samples should be completely even and smooth. This is achieved by applying a layer of cement paste evenly across the entire surface. These samples are then tested using a machine that applies pressure to measure their strength after 7 days of curing, 14 days of curing, and 28 days of curing.

**Table 3: Compressive Strength of concrete cubes**

| S.NO | Demolished Crushed Concrete (%) | Compressive Strength in N/mm$^2$ | | |
|---|---|---|---|---|
| | | **7 days** | **14 days** | **28 days** |
| 1 | 0 | 16.3 | 22.6 | 25 |
| 2 | 10 | 19.4 | 27.3 | 31.7 |
| 3 | 20 | 23.6 | 30.2 | 36.5 |
| 4 | 30 | 22 | 28.4 | 34 |
| 5 | 40 | 20.2 | 25.9 | 31.3 |

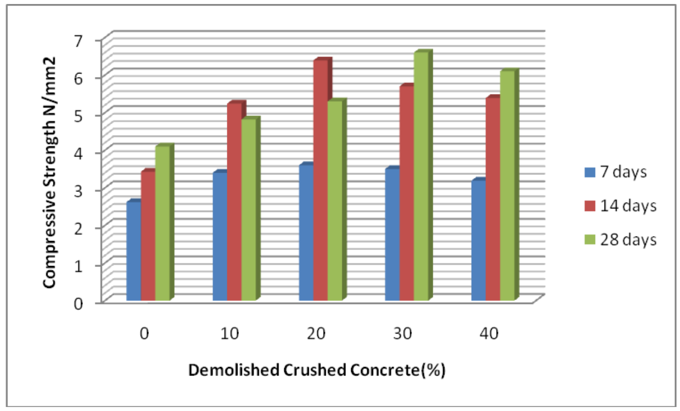


**Figure 1: Compressive Strength of concrete cubes**

A 3-D representation of the graph can be found in Figure 1. It compares the compressive strength of concrete cubes to 20%, 30%, and 40% DCC hardened cubes in terms of the number of curing (hydrations) days status. The analytical data are analysed to determine its maximum range of strength.

**Flexural Strength on Beam:**

Flexural strength, also known as bends strength, modulus of break, or slanting fracture, is a fabric attribute that is defined as the stress in a material just before it passes a flexure test. By performing standard tests on specimens with dimensions of 100 x 100 x 500 mm in testing equipment, the crack modulus is determined.

**Table 4: Flexural Strength of concrete beams**

| S.NO | Demolished Crushed Concrete (%) | Flexural Strength in N/mm$^2$ | | |
|---|---|---|---|---|
| | | **7 days** | **14 days** | **28 days** |

| | | | | |
|---|---|---|---|---|
| 1 | 0 | 2.62 | 3.43 | 4.1 |
| 2 | 10 | 3.4 | 5.24 | 4.82 |
| 3 | 20 | 3.6 | 6.39 | 5.3 |
| 4 | 30 | 3.5 | 5.7 | 6.6 |
| 5 | 40 | 3.19 | 5.39 | 6.1 |

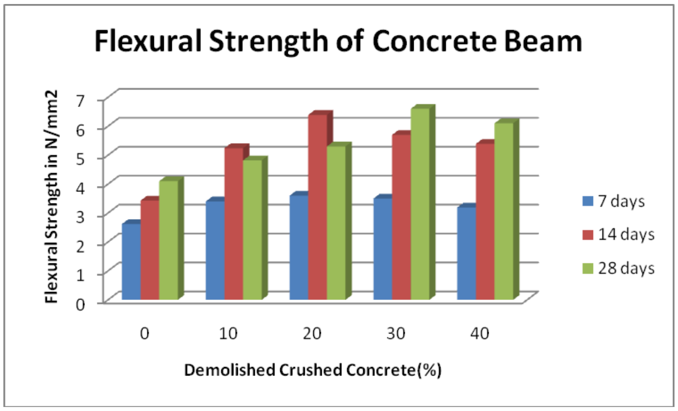


**Figure 2: Flexural Strength of concrete beams**

A 3-D representation of the graph can be found in Figure 2. It shows the flexural strength of concrete beams in comparison to partially replacing 20, 30, 40% DCC hardened beams in numbers of curing (hydrations), 7, 14, and 28-day state. The analytical results are analysed for its greatest range of strength.

### Split Tensile Strength:

Because of each IS 5816:1998, a split tensile test was performed. The cylinder has a 150mm diameter and a 300mm length. The specimen was kept in water for hydration for 7, 14, and 28 days before being evaluated in a wet state using wipes of water and pebbles that were spread out on the ground. By positioning a cylindrical specimen horizontally between the loading surfaces of a compression testing machine (CTM) and applying a load that is practicable to cause the cylinder to break along the vertical diameter, the experiment is accepted in absence.

**Table 5: Split Strength of concrete cylinders**

| S.NO | Demolished Crushed Concrete (%) | Split Tensile Strength in N/mm$^2$ | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | 0 | 2.35 | 2.8 | 3.4 |
| 2 | 10 | 2.52 | 2.96 | 3.65 |
| 3 | 20 | 2.64 | 3.2 | 3.45 |
| 4 | 30 | 2.4 | 2.68 | 3.23 |
| 5 | 40 | 2.5 | 2.8 | 3.1 |

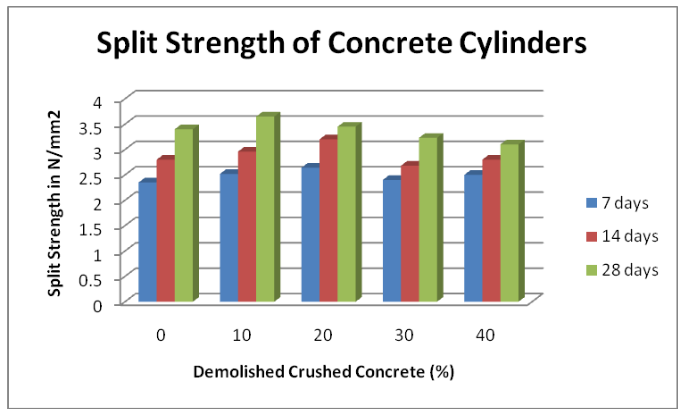


**Figure 3: Split tensile strength of concrete cylinders**

A 3-D representation of the graph appears in Figure 3. It provides a comparison of the split tensile strength of concrete cylinders for partial replacement of 20, 30, 40% DCC hardened cylinders in numbers of curing (hydrations), 7, 14, 28-day status. The analytical results are analysed for its greatest range of strength.

### Recommendation:

According to the test's findings, 20% DCC is advised.

## IV. CONCLUSION

Construction projects may soon substitute recycled aggregates made from construction and demolition debris for primary (natural) aggregates. In comparison to natural aggregate, recycled aggregates are found to have a considerably lower bulk density, higher crushing and impact values, and higher water absorption. Concrete made using recycled material has a lower compressive strength than concrete made with natural aggregate. These changes, meanwhile, depend on the initial concrete that the aggregates were extracted from.

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