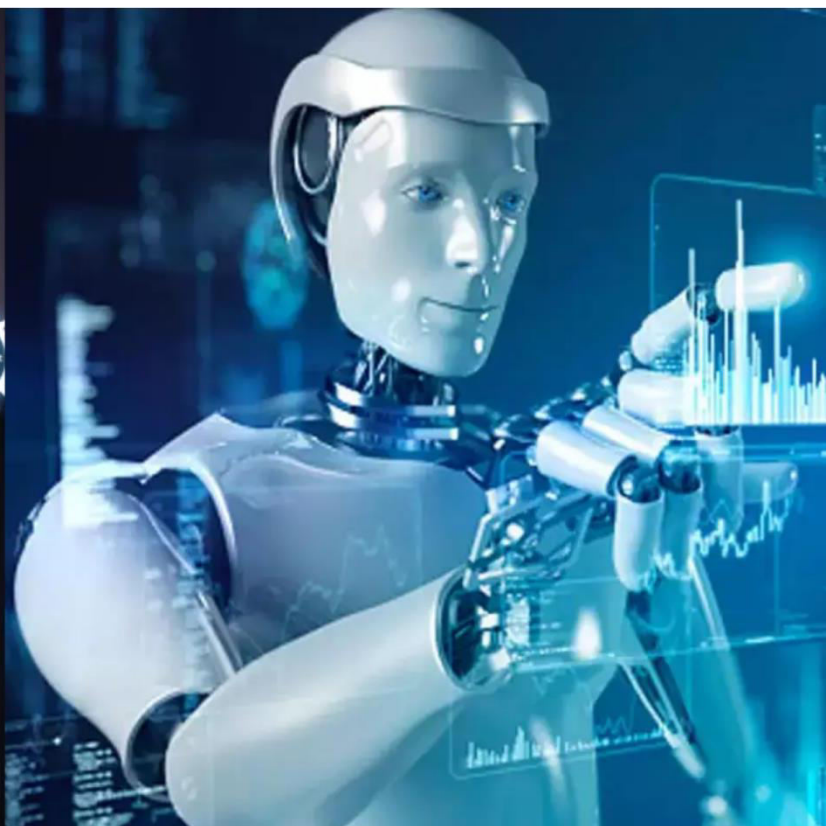




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Partial Replacement of Fine Aggregate with Crushed Concrete

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ABSTRACT: The construction industry creates a lot of demolition waste, and a big part of it is concrete. At the same time, taking too much natural river sand has caused environmental problems and used up natural resources. Using crushed concrete as a substitute for natural fine aggregate in concrete is a good way to be more environmentally friendly. It helps reduce construction waste and saves natural sand. This study looks at how replacing natural fine aggregate with crushed concrete fines at different levels (0%, 5% 10%, 15 % 20% 25%, affects the fresh and hardened properties of concrete. These properties include workability, compressive strength, split tensile strength, flexural strength, and water absorption. Research from other studies shows that replacing up to about 20–30% of fine aggregate with crushed concrete can keep or even improve compressive strength while lowering environmental effects. However, higher replacement levels usually lower workability and mechanical strength because crushed concrete fines absorb more water and have some leftover mortar. The study finds that crushed concrete can be a good replacement for natural fine aggregate if used at the best replacement levels and with proper mix adjustments. This supports sustainable construction practices and helps the circular economy by encouraging the reuse of construction and demolition waste. This study looks at using crushed concrete instead of natural fine sand in M20 grade concrete, with replacement levels of 0%, 10%, 15%, 20%, and 25%. The results show that replacing up to 15–20% of the natural sand with crushed concrete gives good strength and workability. This approach supports sustainable construction by reusing demolition waste and helping to protect natural resources

KEYWORDS: Crushed Concrete, Fine Aggregate, Recycled Concrete Aggregate, Sustainable Concrete, Construction and Demolition Waste

I. INTRODUCTION

Concrete is the most common building material used around the world because it is strong, lasts a long time, and can be used in many different ways. Natural river sand is a key part of concrete. It is the small particles that fill the spaces between the bigger particles and help the mix work well and stay strong. However, because cities and buildings are growing so fast, the need for natural sand has gone up a lot. This has caused too much mining, which harms the environment, erodes riverbanks, and messes up the balance of nature. At the same time, building and breaking down old structures creates a lot of concrete waste. In the past, this waste was mostly thrown away in landfills, which takes up land and pollutes the environment. Recycling broken concrete into crushed concrete aggregate is a good way to manage this waste and save natural resources. Crushed concrete has some cement paste left on the particles, making it more porous and able to soak up water than natural sand. Even though these traits might affect how well concrete works, studies show that using crushed concrete instead of natural sand in certain amounts can still make strong, usable concrete. Most research suggests using about 20 to 30 percent crushed concrete fines as a good balance between being eco-friendly and keeping the concrete strong.

II. OBJECTIVES

1. To check if crushed concrete can be used partly instead of fine sand in concrete.
2. To see how easy it is to mix and handle fresh concrete.
3. To find out how strong the concrete becomes at different times during curing.

4. To test how well the concrete can handle splitting and bending.
5. To check how long the concrete can last under different conditions.
6. To help reduce waste from construction by reusing crushed concrete.
7. To encourage the use of eco-friendly methods in building projects.

III. MATERIALS USED

Cement

- Ordinary Portland Cement (OPC) Grade 43 or 53
- Specific Gravity: 3.01

Fine Aggregate

- Natural river sand
- Zone II grading according to IS 383

Coarse Aggregate

- Crushed granite
- Specific gravity **2.88**

Crushed Concrete Fine Aggregate

- Obtained from demolished concrete
- Crushed and sieved through 4.75 mm IS sieve
- Free from contaminants
- Specific gravity **2.45**

Water

- Potable water suitable for concrete production

IV. METHODOLOGY

1. Collection of demolished concrete waste.
2. Crushing and screening.
3. Preparation of crushed concrete fine aggregate.
4. Mix design according to IS 10262.
5. Replacement levels:
 - 0%
 - 10%
 - 15%
 - 20%
 - 25%
6. Casting of concrete specimens.
7. Water curing.
8. Testing after 7, 14 and 28 days.
9. Analysis of results.

V. EXPERIMENTAL PROGRAM

Fresh Concrete Tests

1. Slump Test

Hardened Concrete Tests

1. Compressive Strength Test
2. Water Absorption Test

VI. EXPECTED RESULTS

Workability

Summary of Average Compressive Strength

Replacement (%)	7 Days (MPa)	14 Days (MPa)	28 Days (MPa)
0	22.44	25.09	27.67
10	24.76	26.44	28.56
15	25.33	27.39	29.44
20	24.52	26.29	28.49
25	22.50	24.84	27.49

Observation: The **15% replacement** of fine aggregate with crushed concrete achieved the highest compressive strength at all curing ages, with a maximum **28-day compressive strength of 29.44 MPa**.

VII. COMPRESSIVE STRENGTH

Compressive strength usually goes up a little when you replace up to 20 to 30% of the material, because the particles fit together better and there's still some cement-like material left. But if you replace more than that, the strength starts to go down. This is because the recycled fines have some old mortar stuck to them and they absorb more water, which weakens the mix.

Split Tensile Strength

- Slight increase up to 20%
- Small reduction beyond 30%

Flexural Strength

- Nearly equal to control mix up to 20%
- Slight reduction after 30%

Water Absorption

- Increases with replacement percentage
- Maximum at 50%

VIII. ADVANTAGES

1. Reduces demolition waste.
2. Conserves natural river sand.
3. Lowers landfill requirements.
4. Supports sustainable construction.
5. Reduces environmental pollution.
6. Promotes circular economy.
7. Potential reduction in construction cost.

IX. TESTS

Cement test

Fineness Test of Cement

To determine the fineness of cement using the 90 µm IS sieve. The fineness of cement affects the rate of hydration, strength development, and heat generation. Finer cement hydrates more rapidly, resulting in higher early strength.

Specific Gravity Test of Cement

To determine the specific gravity of cement using Le Chatelier Flask. The specific gravity is required for accurate concrete mix design and quality control.

Initial and Final Setting Time Test of Cement

To determine the **initial** and **final setting time** of cement using the **Vicat Apparatus**.

Apparatus

1. Vicat apparatus
2. Vicat mould
3. Glass plate
4. Stopwatch
5. Measuring cylinder

Procedure

1. Prepare a cement paste using water equal to the standard consistency (P%).
2. Fill the Vicat mould with the paste and level the surface.
3. Place the mould under the Vicat apparatus.
4. Determine the **initial setting time** using the initial setting needle by recording the time from water addition until the needle penetrates only up to 5 ± 0.5 mm from the bottom.
5. Replace the needle with the final setting attachment.
6. Determine the **final setting time** when the needle makes an impression on the surface but the annular ring fails to do so

Specific gravity test for Crushed Concrete

To determine the **specific gravity** of crushed concrete fine aggregate using a **Pycnometer**, as specified in **IS 2386 (Part 3):1963**. The specific gravity is an important property used in concrete mix design, quality control, and evaluation of aggregate characteristics.

Procedure

1. Wash the crushed concrete fine aggregate thoroughly to remove dust and impurities.
2. Oven-dry the sample at $100-110^{\circ}\text{C}$ for 24 hours and allow it to cool to room temperature.
3. Weigh approximately **500 g** of oven-dried aggregate (W_1).
4. Fill the pycnometer with the aggregate and add water until the sample is completely submerged.
5. Remove entrapped air by gently shaking the pycnometer.
6. Fill the pycnometer completely with water and record the combined weight (W_2).
7. Empty the pycnometer, clean it thoroughly, fill it only with water, and record its weight (W_3).
8. Calculate the specific gravity using the formula.

Formula

Specific Gravity = $\frac{W_1}{W_1 + W_3 - W_2}$ Specific Gravity = $\frac{W_1}{W_1 + W_3 - W_2}$

Where:

- W_1 = Weight of oven-dried aggregate (g)
- W_2 = Weight of pycnometer + aggregate + water (g)
- W_3 = Weight of pycnometer filled with water (g)

X. RESULT

The specific gravity of the crushed concrete fine aggregate was found to be 2.45

Limitations

1. Higher water absorption.
2. Lower workability at high replacement.
3. Greater drying shrinkage.
4. Quality depends on source concrete.
5. Additional processing required.

Applications

1. Residential buildings
2. Pavements
3. Sidewalks
4. Low-rise buildings
5. Non-structural concrete
6. Precast concrete products
7. Sustainable infrastructure

XI. CONCLUSION

Using some crushed concrete in place of natural sand is a good and eco-friendly way to make concrete more sustainable. This helps save natural sand and cuts down on waste that goes to landfills. Studies show that replacing about 0% 10% 15 % 20 to 25% of the sand with crushed concrete works well, keeping the mix easy to work with, strong, and long-lasting. But if you use more than that, the crushed concrete might make the mix less dense and more absorbent, which can hurt its performance. To fix this, you might need to adjust the mix or add special ingredients. Overall, crushed concrete is a useful option for many types of construction projects and helps make the building industry more efficient and eco-friendly. This study shows that crushed concrete can be used as a partial substitute for natural fine sand in making concrete. This offers a sustainable way to deal with the increasing problem of construction and demolition waste, as well as the shortage of natural river sand. The experiments show that when crushed concrete is mixed in the right amounts, the resulting concrete has good workability and strength, and it also helps reduce the environmental effects of making concrete in the usual way. The results show that replacing up to 20 to 30% of the sand with crushed concrete usually keeps or even improves the strength of the concrete, because the crushed particles fit together better and the leftover cement-like materials help. However, if more than this amount is used, the concrete becomes harder to work with and its strength may decrease, as the crushed concrete absorbs more water, has more holes, and holds on to some of the old mortar. The study also says that to make good quality concrete, it's important to process the broken concrete properly, sort it well, and adjust the mix design. Using special additives that reduce the amount of water needed, or changing the water-to-cement ratio, can help make the concrete better. Besides the technical advantages, using crushed concrete helps the environment by saving natural resources, reducing waste in landfills, cutting down on carbon emissions from digging for sand, and supporting a cycle of reuse. Overall, using crushed concrete as part of the mix is a practical, cost-effective, and eco-friendly way to make strong concrete that works well for many kinds of buildings and structures. More research into how long this concrete lasts, how to use it on a bigger scale, and how it performs in different weather conditions will help this sustainable method become more widely used.

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