Partial Replacement of Fine Aggregate with Sawdust for Concrete: A Research

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ABSTRACT

Concrete's significance as a building material is growing daily. Sand is a primary fine aggregate that gives concrete strength and greater component adherence. It has been difficult for civil engineers to turn industrial waste into useful building and construction materials because of the high demand on the building material industry, particularly in the last ten years due to population growth, which has resulted in a chronic shortage of building materials. It was found that sawdust-containing concrete compacted more effectively than regular concrete when the specimen was cast to test the concrete's compressive strength. Dry porous sawdust might absorb enough water to serve as an efficient internal curing method, absorb extra water in the mixture, and supply the water needed for the cement to hydrate. Sawdust will lower construction costs and address environmental problems because it is already waste. Without compromising the strength of the concrete, using sawdust to replace sand to a degree of 0 to 25% will help reduce the amount of sawdust waste produced in society.

***Keywords**: Workability, Compressive Strength, Durability, Wood, Slump Cone Test, Compaction Factor Test.*

1. INTRODUCTION

Everywhere in the world, the construction business is developing. Numerous scholars have also attempted to lower the cost of its components and, consequently, the overall cost of building by examining and determining the value of materials that may be categorized as local materials. Agricultural or industrial waste, such as sawdust, fly ash, concrete debris, and coconut shells, are among these local resources. They are generated by milling stations, thermal power plants, waste treatment plants, and other facilities. It is necessary to look into the usage of alternative building materials that are readily available locally due to the rising cost of construction supplies, particularly cement, crushed stone (coarse aggregate), and fine sand (fine aggregate)Sawdust particles could be one of countless options for affordable housing in this evolving era. Due to excessively non-scientific techniques of mining from riverbeds, lowering the water table, and sinking bridge piers, among other things, river sand is getting harder to find for use in the making of concrete. When improperly managed, sawdust, an industrial waste from the lumber industry, can be harmful to human health and the environment .Sawdust is the term for loose particles or wood chips that are left over after timber is cut into uniformly usable pieces. Since the production of wood waste in sawmills is an inevitable source of damage to the environment, considerable effort is made to make use of this waste. Therefore, this study explores the possibility of using wood sawdust wastes to create an inexpensive, lightweight composite for engineering and construction applications.

2. LITERATUREREVIEW

Dilip kumar et al. (2014):

In order to make the concrete blocks for the study, I combine cement, water, sawdust, coarse and fine aggregates. In concrete, a certain percentage of sawdust is utilized in place of sand. While everything else remains the same, I substitute 10%, 15%, and 20% sawdust for sand. Once the concrete blocks are made, I will weigh the original concrete block and the sawdust concrete block to compare the two. Additionally assessed is the concrete block's unit density. According to a research article, sawdust concrete can be utilized as structural concrete at an appropriate replacement % and has an impact on construction costs. Following the brief investigation into the strength characteristics of sawdust, the subsequent conclusions can be established. At early stages, as the percentage of sawdust replacement rises, both the strength and compressive strength improve. Additionally, incorporating sawdust decreases the weight of concrete, resulting in a lighter material that can serve various functions in lightweight construction within civil engineering.

Albert M Joy, Aayena K Jolly (2016):

The research titled “Study of Partial Replacement of Fine Aggregate with Sawdust for Concrete” investigates the potential of a sawdust-cement-gravel mixture to offer similar benefits as the conventional cement-sand-gravel formulation. To conduct this study, a specified number of cubes, cylinders, and beams were cast, incorporating sawdust to replace fine aggregate at ratios of 15%, 20%, 25%, and 30%, and their properties were compared with those of a standard mix (M25). The results indicated that the 28-day compressive strength and splitting tensile strength of the concrete did not show significant increases, but they were comparable to those of the nominal mix concrete. The results revealed that replacing fine aggregate with 25% sawdust achieved the best performance, aligning with the requirements for M25 grade concrete.

Akshay Sawant, Arun Sharma (2018):

The research focused on the partial substitution of sand with sawdust in concrete. The study examined M25 grade concrete using a nominal mix with a weight ratio of (cement, fine aggregate, coarse aggregate) prepared accordingly. A water-cement ratio of 0.48 was determined for this purpose. The objective was to evaluate the properties of concrete which was cast with the partial replacement of sand.

3 MATERIAL AND METHODLOGY

Coarse Aggregate- Aggregates play a crucial role in the composition of concrete. They help reduce shrinkage and enhance cost-effectiveness. Crushed granite sized at 10mm and 20mm was utilized as a coarse aggregate**.**

Fine Aggregate- Sand is classified by its size, being smaller than gravel yet larger than silt. It is a non-renewable resource, and there is a significant demand for sand that is appropriate for concrete production. Fine aggregate that meets the necessary criteria for experimental purposes and conforms to the specifications outlined in code IS: 383-1970.

Cement-Portland Pozzolana Cement used in this project brand name mycem Cement

Water- Purified water was utilized in this research. The water was free of contaminants. Test results indicate that the pH level of the water should not be lower than 6.

Saw dust- The sawdust utilized in this research was gathered from sawmill facilities located near VIDISHA. To prepare the material, the initial step involved allowing the collected sawdust to dry at room temperature for several days to eliminate excess moisture. This drying process is necessary as the sawdust obtained from the sawmill tends to be damp due to the ambient humidity in the factories and seasonal variations. Next, the sawdust is sieved. Larger pieces of wood and undesirable impurities are discarded, and only the wood dust that passes through a sieve with a size of 2.36 mm is selected for use in this study. Sawdust serves as the primary component of particleboard and is readily available for the furniture industry.

3.1 PROPERTIESOFSAWDUST:

Table1.Physical properties of sawdust

SL.NO	PARTICULARS	TESTRESULTS
1	Specific Gravity	2.62
2	Fineness Modulus	2.11

3	Water Absorption	1.7%

3.2 TEST ON HARDENED CONCRETE

Compression Test

Compression test is the most common test conducted on hardened concrete, partly because most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength. The Compression test is carried out on specimens cubical or cylindrical in shape. Prism also sometimes used, but it is not common in our country. Sometimes the compressive strength of concrete is determined using parts of the beam tested in flexure. The end parts of the beam are left intact after failure in flexural and, because the beam is usually of square cross section thin part of the beam could be used to find out the compressive strength. The cube specimen sizes are 150mm x150mm x 150mm.

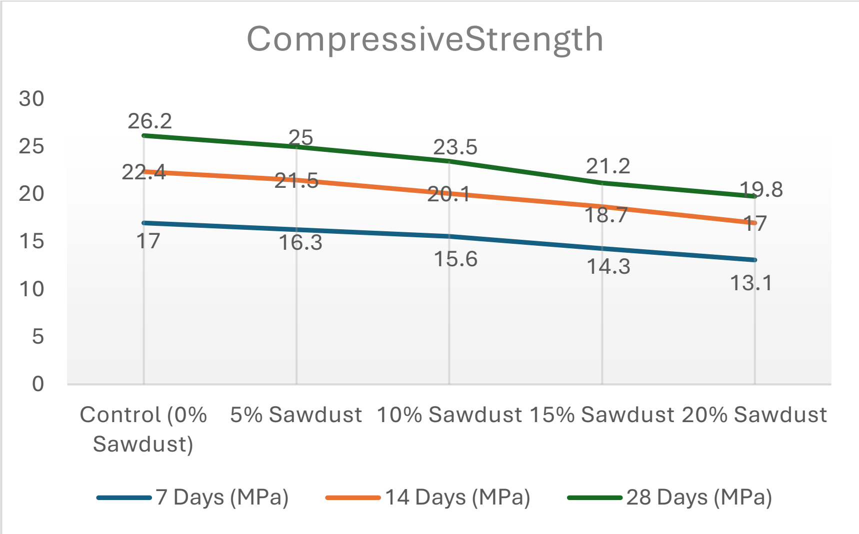
Figure4 Compressive strength of cubes

3.2.1 RESULTSANDDISCUSSIONS

It is evident that the compressive strength of concrete decreases as the percentage of sawdust increases. The control mix, containing no sawdust, exhibited the highest compressive strength at 28 days, with a value of 26.2 MPa. The 5% sawdust replacement led to a slight reduction in strength at all curing stages, but the strength was still quite close to the control mix. At 10%, 15%, and 20% sawdust replacement, the compressive strength decreased progressively. This decrease can be attributed to the porous and lightweight nature of sawdust, which results in a reduction in the density and cohesion of the mix.

Table1: compressive strength of cubes

Mix Proportion	7 Days (MPa)	14 Days (MPa)	28 Days (MPa)
Control (0% Sawdust)	17.0	22.4	26.2
5% Sawdust	16.3	21.5	25.0
10% Sawdust	15.6	20.1	23.5
15% Sawdust	14.3	18.7	21.2
20% Sawdust	13.1	17.0	19.8



3.2.2 Split Tensile Strength Test

This is an indirect test to determine the tensile strength of cylindrical specimens. Splitting tensile strength tests were carried out at the age of 28 days for the concrete cylinder specimens of size 150 mm diameter and 300 mm length, using compression testing machine of 2000 KN capacity. The load was applied gradually till the specimen splits and readings were noted.

Table 2: Split tensile strength for cylinder

Mix	Split Tensile Strength (N/mm^2)
Nominal Mix	4.33
5%	3.5
10%	2.02
15%	1.13
20%	1.07

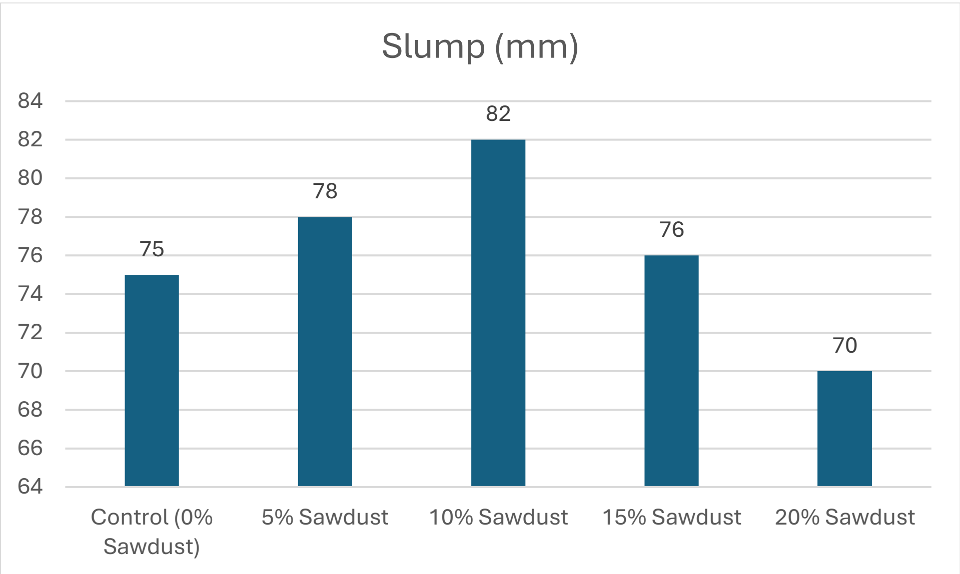
3.2.3 WORKABILITY TEST:

In the research paper, the workability of plain concrete is assessed using the slump test, in accordance with IS 1199: 1959 and IS 456: 2000. Workability refers to how easily concrete can be mixed, placed, and finished without segregation or excessive bleeding. For this study, a standard slump cone is used, with dimensions of 300 mm height, 200 mm diameter at the base, and 100 mm diameter at the top. The concrete mix is prepared with a specified water-cement ratio, typically ranging between 0.4 and 0.6, depending on the required workability. The slump test involves filling the cone with concrete in three layers, each compacted with 25 strokes. After removing the cone, the slump is measured from the top of the cone to the highest point of the concrete. The numerical value obtained, usually ranging from 25 mm to 150 mm, indicates the mix's workability. A slump of 25-50 mm represents low workability suitable for heavy-duty applications like pavements, 75-100 mm is medium workability for general construction, and 100-150 mm is high workability, typically required for complex formworks or areas with dense reinforcement. These values are critical in ensuring the concrete mix is practical for placement while also achieving the desired strength and durability.

Figure 5 Slump Test

Table3: Slump Test Result for Different Mixes

Mix Proportion	**Slump (mm)**
Control (0% Sawdust)	75
5% Sawdust	78
10% Sawdust	82
15% Sawdust	76
20% Sawdust	70

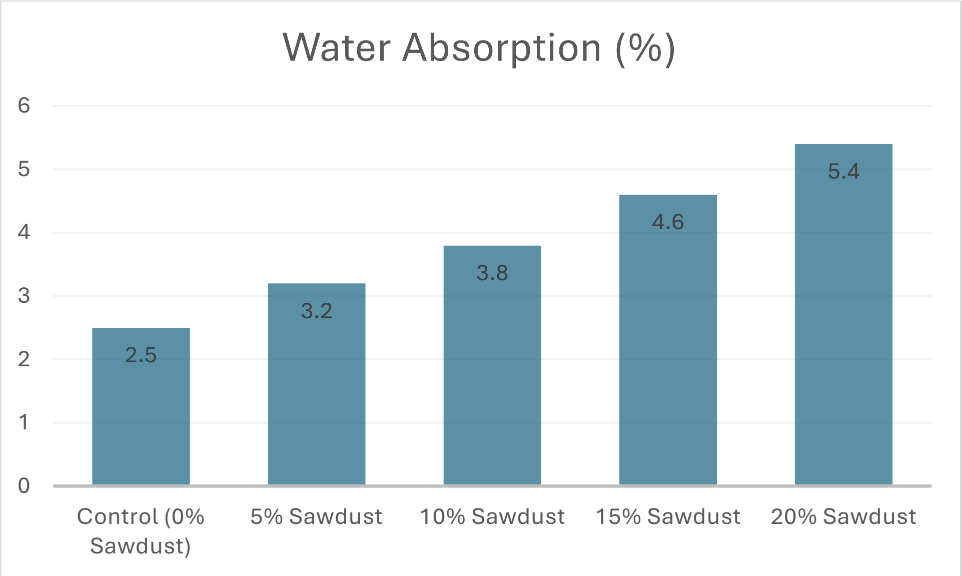


3.2.4 WATER ABSORPTION TEST:

The water absorption test is a standardized procedure used to evaluate the porosity and permeability characteristics of hardened concrete, which are directly related to its durability and resistance to environmental deterioration. As per IS 1199 (Part 2): 2018, cube specimens of standard size (either 100 mm or 150 mm cubes) are oven-dried at 105 ± 5°c for a minimum of 24 hours until a constant mass is achieved. The dried specimens are then cooled in a desiccator and subsequently immersed in clean water at 27 ± 2°c for 24 hours. After immersion, the saturated mass is recorded. The percentage of water absorption is calculated using the formula:

Table4: Water absorption

Mix Proportion	Water Absorption (%)
Control (0% Sawdust)	2.5
5% Sawdust	3.2
10% Sawdust	3.8
15% Sawdust	4.6
20% Sawdust	5.4



4 CONCLUSION

Based on the investigation on sawdust, the following conclusions were made.

- 28-day compressive strength and splitting tensile strength of the concrete is not increased to large extent but it almost matches with the compressive and splitting tensile strength of nominal mix concrete.
- The compressive strength obtained for the replacement of fine aggregate with 20% sawdust was proved to be the optimum mix to get M20 grade of concrete.
- The flexural strength of sawdust cement-concrete are gradually increasing as the percentage of partial

replacement of fine aggregate with sawdust increases as the fiber content in sawdust is very high and is responsible for the increase of strength.

- Weight of the sawdust concrete was reduced as compared with normal concrete and also become more economical.
- The utilization of Sawdust in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of sand with Sawdust reduces the cost of making concrete.
- Saw dust concrete is light weight in nature and it proves to be environment friendly, thus paving way for green concrete.
- The result of compressive test indicated that the strength of concrete decreases with respect to the percentage of Saw dust added (15% and 20%). As the percentage sawdust content increased in the mix the compressive strength decreased.

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