ABSTRACT

Concrete is the best material of choice of where strength, compression, tensile and absorption resistance are required. In order to minimize the cost of construction material in daily life and to utilize the natural source materials such as saw dust is used. The use of waste product in concrete not only makes it economical but also solves some of the disposal problems. The present study works on the possibility of using saw dust as a construction material for concrete was experimentally investigated by replacing fine aggregate as a saw dust. Saw dust is available as natural material and also useful for industrial purpose in order to minimize the fine aggregate and also the cost in the construction field.

Keywords: Concrete, Construction, Fine aggregate and saw dust.

1.1 Saw Dust

The development in the construction industry all over the world is progressing. Attempts have also been made by various researchers to reduce the cost of its constituent and hence total construction cost by investigating and ascertaining the usefulness of material which could be classified as local materials. Some of these local materials are agricultural or industrial waste which includes sawdust, concrete debris, fly ash, coconut shells among others which are produced from milling stations, thermal power station, waste treatment plant and so on. As a result of the increase in the cost of construction materials, especially cement, crushed stone (coarse aggregate), fine sand (fine aggregate); there is the need to investigate the use of alternate building materials which are locally available. In this changing time,
sawdust particles might just be one of an infinite number of solutions for low cost housing. The availability of river sand for the preparation of concrete is becoming scarce due to the excessive non-scientific methods of mining from the riverbeds, lowering of water table and sinking of the bridge piers among others, are becoming common treats. Sawdust is an industrial waste in the timber industry constitutes a nuisance to both the health and environment when not properly managed. Sawdust can be defined as loose particles or wood chippings obtained as by-products from sawing of timber into standard useable sizes. Generation of wood wastes in sawmill is an unavoidable environmental pollution and hence a great efforts are made in the utilization of such waste. Thus, this research investigates the potential use of wood sawdust wastes to produce a low-cost and lightweight composite for construction and engineering purpose. Figure 1 shows the saw dust.

![Figure 1 Saw dust](image)

### 2. METHODOLOGY

Figure 2 shows the methodology of the study.

![Figure 2 Methodology](image)

### 3. MATERIAL COLLECTION

#### 3.1 Cement

The cement used was ordinary Portland cement 53 (OPC 53). All properties of cement were determined by referring IS 12269 – 1987. The specific gravity of cement is 3.15. The initial and final setting times were found as 55 minutes and 258 minutes respectively. Standard consistency of cement was 30%.
Table 1 shows the Properties of cement.

Table 1: Properties of Cement

<table>
<thead>
<tr>
<th>Description of test</th>
<th>Test results</th>
<th>Requirements of IS: 8112 1989</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial setting time</td>
<td>65 minutes</td>
<td>Min. 30 minutes</td>
</tr>
<tr>
<td>Final setting time</td>
<td>270 minutes</td>
<td>Max. 600 minutes</td>
</tr>
<tr>
<td>Fineness (specific surface by Blaine’s air permeability test)</td>
<td>412.92 m²/kg</td>
<td>Min. 225 m²/kg</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.11</td>
<td>2.4 – 2.9</td>
</tr>
</tbody>
</table>

3.2 Coarse Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

Table 2 shows the properties of coarse aggregates.

Table 2: Properties of coarse aggregate

<table>
<thead>
<tr>
<th>PROPERTIES</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific weight (g/cm³)</td>
<td>2.70</td>
</tr>
<tr>
<td>Sieve 200</td>
<td>1.29%</td>
</tr>
<tr>
<td>H₂O absorption</td>
<td>1.15</td>
</tr>
<tr>
<td>Fineness modulus</td>
<td>3.24</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>2.66</td>
</tr>
<tr>
<td>Size</td>
<td>Passing through 4.75mm sieve</td>
</tr>
</tbody>
</table>

3.3 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates these can be from Primary, Secondary or Recycled sources. Grading.

- Durability.
- Particle shape and surface texture.
- Abrasion and skid resistance.
- Unit weights and voids.
- Absorption and surface moisture.

Table 3 shows the properties of fine aggregates.
3.4 Water
Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength-giving cement gel, the quantity and quality of water are required to be looked into very carefully.

3.5 Sawdust
Sawdust or wood dust is a byproduct of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with the saw or other tool; it is composed of fine particles of wood. It is also the byproduct of certain animals, birds and insects which live in wood, such as woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of flammability. The properties of saw dust are shown in Table. It shows the density of lightweight aggregate and will reduce the overall density of concrete. When the concrete density is decreased the self weight and dead loads may be reduced in structures, resulting which the design details will be economic and ultimately the construction cost will decrease. The moisture content of the saw dust is to be considered while finding water cement ratio as the moisture content is 9.8%. Also sun drying was carried out for further time period before concreting. As this is not a cementitious material and used only as an inert material the fineness modulus is verified and found as satisfactory. The Saw dust affects the setting and hardening of concrete. Table 3 shows the properties of saw dust.

Table 3: Properties of saw dust

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fineness Modulus</td>
<td>1.90</td>
</tr>
<tr>
<td>2</td>
<td>Moisture Content</td>
<td>9.8%</td>
</tr>
<tr>
<td>3</td>
<td>Bulk Density</td>
<td>615kg/m3</td>
</tr>
</tbody>
</table>

Figure 3 shows the saw dust.
4. MIX DESIGN

4.1 Mix Proportion

Table 4 shows the Mix Proportion.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (kg/m³)</td>
<td>FA (kg/m³)</td>
<td>CA (kg/m³)</td>
<td>Water (kg/m³)</td>
</tr>
<tr>
<td>547.37</td>
<td>656.42</td>
<td>1141.99</td>
<td>191.58</td>
</tr>
</tbody>
</table>

Table 5 shows the 10% replacement of Mix proportion.

|            |            |            |            |            |            |
|------------|------------|------------|------------|------------|
| Cement (kg/m³) | FA (kg/m³) | CA (kg/m³) | Water (kg/m³) | 10% Replacement (kg/m³) |
| 547.37     | 590.7      | 65.64      | 1141.99    | 191.58     |

Table 6 shows the 15% replacement of Mix Proportion.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (kg/m³)</td>
<td>FA (kg/m³)</td>
<td>CA (kg/m³)</td>
<td>Water (kg/m³)</td>
<td>15% Replacement (kg/m³)</td>
</tr>
<tr>
<td>547.37</td>
<td>557.95</td>
<td>98.46</td>
<td>1141.99</td>
<td>191.58</td>
</tr>
</tbody>
</table>

5. TESTING METHODS

The following are the test which was conducted in the project:
- Water absorption test
- Slump cone test
- Compressive Strength test
- Split tensile Strength test

5.1 Water Absorption Test

The average dry weight of cube specimens after removing from moulds was measured and the average weight of cube specimens after submerging in water for curing was measured at 28 days of age. The percentage of water absorption was measured for each concrete specimen and it gave indirect measure of durability.

5.2 Slump Cone Test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. It indicates the characteristic of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence.

5.3 Compressive Strength Test

Compressive strength is the capacity of material or structure to resist or withstand under compression. The Compressive strength of a material is determined by the ability of the material to resist failure in the form cracks and fissure. In this test, the push force applied on the both faces of concrete specimen and the maximum compression that
concrete bears without failure is noted. The compressive strength of concrete is determined in batching plant laboratories for every batch in order to maintain the desired quality of concrete during casting. The strength of concrete is required to calculate the strength of the members. Concrete specimens are cast and tested under the action of compressive loads to determine the strength of concrete.

5.4 Split Tensile Strength Test
A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete. In direct tensile strength test it is impossible to apply true axial load.

6. TEST RESULTS

6.1 Compression & Split Tensile Strength
Table 7 shows the Compression and split tensile strength test.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>NAME OF THE TEST</th>
<th>SPECIMEN</th>
<th>DAYS</th>
<th>LOAD IN (kN)</th>
<th>STRENGTH IN (kN/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>1</td>
<td>COMPRESSION</td>
<td>CUBE</td>
<td>7</td>
<td>634.5</td>
<td>654.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>821.25</td>
<td>830.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td>951.75</td>
<td>972.0</td>
</tr>
<tr>
<td>2</td>
<td>SPLIT TENSILE</td>
<td>CYLINDER</td>
<td>7</td>
<td>176.71</td>
<td>197.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>233.26</td>
<td>247.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td>282.74</td>
<td>303.94</td>
</tr>
</tbody>
</table>

Figure 4 shows the graph of compression strength test.

Figure 5 shows the graph of split tensile test.
6.2 Slump Cone Test

Table 8 shows the slump cone test.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>% OF REPLACEMENT</th>
<th>SLUMP VALUE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0%</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>135</td>
</tr>
<tr>
<td>3</td>
<td>15%</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 8: Slump cone test

6.3 Water Absorption Test

Table 9 shows the water absorption test.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>% OF REPLACEMENT</th>
<th>INITIAL WEIGHT (KG)</th>
<th>OVEN DRY WEIGHT</th>
<th>WEIGHT AFTER IMMERSION</th>
<th>% OF WATER ABSORPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0%</td>
<td>8.41</td>
<td>8.30</td>
<td>8.51</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>8.03</td>
<td>7.81</td>
<td>8.23</td>
<td>5.37</td>
</tr>
<tr>
<td>3</td>
<td>15%</td>
<td>7.94</td>
<td>7.51</td>
<td>8.03</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Table 9: Water absorption test

8. CONCLUSION

From the experimental results and discussion, using the combination of saw dust as fine aggregate in concrete can reduce the material cost in construction because of the low cost and abundant wood waste.

By using different saw dust content of 10%, 15%, the Optimum Stability of the saw dust mix is found out. From the graph, it is found that

- Production of Sustainable Light-weight concrete is attained.
- The compression strength of concrete is increased up to 10% replacement of saw dust.
- Similarly, in split tensile strength test, the strength of concrete is increased, when we partially replace saw dust (10%), instead of fine aggregates.
- It is found that the strength was decreased, when we replace saw dust more than 10%
- Increase in percentage replacement by saw dust increases workability of concrete.

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AUTHOR

Prof. Dr. T. Subramani Working as Professor and Dean of Civil Engineering in Vinayaka Missions Kirupananda Variyar Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. Having more than 28 years of Teaching experience in Various Engineering Colleges. He is serving as reviewer for many International Journals and also published 250 papers in International Journals. He has presented more than 107 papers in conferences, especially 77 in International and 30 National Level. He has authored 07 books. Guided more than 259 students in PG projects. Currently he is guiding 03 Ph.D., Research Scholars. He is serving as examiner and Valuer for B.E & M.E Degree Theory and Practical Examinations for Madras University, Periyar University, Anna University, Annamalai University and Vinayaka Missions Research Foundation [Deemed to be University]. He is Question paper setter and Valuer for UG and PG Courses of Civil Engineering in number of Universities. He is serving as Chairman of Board Of Studies (Civil Engineering), Vinayaka Missions Research Foundation [Deemed to be University], also a member of Board of studies in Periyar University. He is Life Fellow in Institution of Engineers (India) and Institution of Valuers, Life member in number of Technical Societies and Educational bodies like MISTE, MIGS, MIRC,ISRMTT, UWA, Salem District Small and Tiny Association (SADISSTIA), SPC – Salem Productivity Council. He has delivered much technical talk in various field. He is a Chartered Civil Engineer and Approved Valuer for many banks. He is a Licensed Building Surveyor in Salem City Municipal Corporation-Salem, and Licensed Civil Engineer in Salem Local Planning Authority- Salem. He is the recipient of many prestigious awards.

K Athul is perusing B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. Salem. He has well knowledge in AUTOCAD drawing and Staad pro Analysis.

K H Sahid Ahamed is perusing his B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. He has well knowledge in AUTOCAD drawing. His hobbies are playing Basketball, Hockey and Cricket.

Vimal Vijayan is persuing B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. He has well knowledge in AUTOCAD drawing. His hobbies are playing Volleyball, drawing, Reading books.

S.Priyanka is persuing B.E. Degree in the branch of Civil Engineering in Vinayaka Missions Kirupananda Variyar Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. She published 30 papers in International Journals. She has presented more than 13 papers in conferences, especially 8 in International and 5 National Level. She has well knowledge in AUTOCAD drawing and STAAD Pro