THE USE OF SAWDUST ASH AS FINE AGGREGATE REPLACEMENT IN CONCRETE

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ABSTRACT

Sawdust Ash (SDA) generated from rice mills is usually delivered to landfills for disposal. Using of sawdust ash in concrete is an interesting possibility for economy on waste disposal sites and conservation of natural resources. This paper examines the possibility of using sawdust ash as replacement in fine aggregate for a new concrete. Natural sand was partially replaced (5%, 10%, 15%, 20%, 25% and 30%) with SDA. Compressive strength, Tensile strength (cubes and cylinders) and Flexural strength up to 180 days of age were compared with those of concrete made with natural fine aggregates. Fineness modulus, specific gravity, moisture content, water absorption, Bulk density, %voids, % porosity (loose and compact) state for sand (S) and SDA were also studied. The test results indicate that it is possible to manufacture concrete containing sawdust ash with characteristics similar to those of natural sand aggregate concrete provided that the percentage of sawdust ash as fine aggregate is limited to 10-20% respectively.

Key Words: Sawdust Ash, Mechanical properties, Fineness Modulus, Bulk density, Moisture content, Water absorption.

INTRODUCTION

During the last decades it has been recognized with growing sawdust ash waste are of large volume and that this is increasing year by year in the household, mills and factory’s. Now a days even in rice mills they are using sawdust for burning due to shortage of rice husk. In Chidambaram a huge quantity of sawdust ash waste is produced in the near by rice mills and households are dumped. On the other hand, one bucket of sawdust cost Rs 6.00 and we get sawdust ash with no cost. The need for housing are estimated more cost and some construction materials like natural sand are becoming rare1. This waste storage disposals are becoming a serious environmental problem especially for Chidambaran place disposal sites are lacking. Hence there is a need for recycling more and more waste materials.

The most widely used fine aggregate for the making of concrete is the natural sand mined from the riverbeds. However, the availability of river sand for the preparation
of concrete is becoming scarce due to the excessive nonscientific methods of mining from the riverbeds, lowering of water table, sinking of the bridge piers, etc. are becoming common treats. The present scenario demands identification of substitute materials for the river sand for making concrete. The choice of substitute materials for sand in concrete depends on several factors such as their availability, physical properties, chemical ingredients etc. SDA (Sawdust Ash) is one of the byproducts in burning sawdust not being used for any applications other than filling-up.

Sawdust ash as fine aggregate is of particular interest, because their use can considerably reduce the problem of dumping and waste storage simultaneously helps the preservation of natural fine aggregate resources. There is however some obstacles for the use of sawdust ash aggregate in concrete. Codes limitations on water absorption and lack of knowledge about the behavior of concrete made of sawdust ash as fine aggregate. The first use of sawdust and shavings in place of sand and gravel to get a lighter and cheaper concrete should get acquainted a lighter and cheaper concrete should get acquainted with the ting diatom. Friberg used it to cut costs in his new home at Moscow, Idaho after the Second World War.

Recent successful studies on the use of wood sawdust wastes as a new brick material supplement appears to be viable solution not only to the environmental problem but also to the problem of to economic design of buildings. Recent successful studies on the use of sawdust as aggregate in concrete have been reported in BMP Association Ltd. Sawdust concrete. In this study they represents that sawdust concrete has several unique characteristics which make it competitive among other building materials. It is made of green, ecologically pure stuff, controls interior humidity level, frost proof, and favorable thermal mass, sound proofing, and fire proof and light weight.

Some researchers carried out in the past used wood ash wastes as a replacement for cement in concrete mixes. Large quantity of wastes used in this research is currently disposed in sanitary landfills or open dumped into uncontrolled waste pits and open areas. This is a world wide energy loss and environment disposal problem. Disposal of this product waste is a major problem for many small business. Therefore, the acceptable solution of this problem with a commercial value is crucial.

The objective of this paper is to present the results of experimental investigations on Physical and Mechanical properties of concrete made with SDA concrete. Natural fine aggregate is substituted by weight by sawdust ash at rates varying from 5, 10, 15, 20, 25 and 30 percentages. Compressive tension, and flexural strength are evaluated and compared up to 180 days of ages. Specific properties of concrete materials and SDA are also studied.

**MATERIAL AND METHODS**

The raw materials, used for this study are natural coarse aggregate, fine aggregate, SDA aggregate and 53 grades Portland cement. The SDA used for this study was collected from the rice mills points in Chidambaram taluk at Cuddalore District. Sawdust is shown in Fig. 1 Sawdust ash by open burning using a small construction area used to burn the Paddy shown in Fig. 2. SDA shown in Fig. 3 was collected and sieved using sieve size from 4.75mm onwards. Table 1 shows the Fineness Modulus results of S, SDA, (S+10%SDA), (S+20%SDA), and (S+30%SDA). Fig. 3 shows the Fine aggregate material of grading curve and also
The sand used for the study was locally available river sand conforming to grading zone III of IS:383-1970. The coarse aggregate was a normal weight aggregate with a maximum size of 20mm IS: 456-2000. Table 2 shows the physical properties of SDA and Fine aggregate and coarse aggregate. Table 3 shows chemical characteristics of the SDA material. The control mix of the concrete was designed with a mix ratio of cement /water /Sand /Coarse of 1:0.48:1.66:3.61 by weight. This mix design yielded an average 28 days compressive strength 41 Mpa. The sand was replaced with 5%, 10%15%, 20%, 25% and 30% SDA.

<table>
<thead>
<tr>
<th>Material</th>
<th>Fineness Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (S)</td>
<td>2.21</td>
</tr>
<tr>
<td>SDA</td>
<td>1.78</td>
</tr>
<tr>
<td>(S+10%SDA)</td>
<td>2.2</td>
</tr>
<tr>
<td>(S+20%SDA)</td>
<td>2.0</td>
</tr>
<tr>
<td>(S+30%SDA)</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Table 2: Physical properties of Materials

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sand</th>
<th>Coarse</th>
<th>SDA</th>
<th>(S+10%SDA)</th>
<th>(S+20%SDA)</th>
<th>(S+30%SDA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>2.65</td>
<td>2.7</td>
<td>2.5</td>
<td>2.67</td>
<td>2.6</td>
<td>2.61</td>
</tr>
<tr>
<td>Water absorption %</td>
<td>0.45</td>
<td>8.3</td>
<td>0.56</td>
<td>0.50</td>
<td>0.52</td>
<td>0.529</td>
</tr>
<tr>
<td>Moisture content %</td>
<td>3.70</td>
<td>0</td>
<td>0</td>
<td>3.7</td>
<td>3.5</td>
<td>3.1</td>
</tr>
<tr>
<td>Bulk density (dry loose)</td>
<td>1568</td>
<td>1450</td>
<td>1250</td>
<td>1435</td>
<td>1365</td>
<td>1301</td>
</tr>
<tr>
<td>% Voids</td>
<td>40.8</td>
<td>39</td>
<td>64</td>
<td>53.8</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td>% Porosity</td>
<td>28.9</td>
<td>27</td>
<td>41</td>
<td>34.6</td>
<td>35.8</td>
<td>36.7</td>
</tr>
<tr>
<td>Bulk density (dry)</td>
<td>1512</td>
<td>1640</td>
<td>1300</td>
<td>1436</td>
<td>1380</td>
<td>1320</td>
</tr>
</tbody>
</table>
Table 3: Chemical analysis of SDA

<table>
<thead>
<tr>
<th>Oxide</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>MnO</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>P₂O₅</th>
<th>SO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage by mass</td>
<td>65.3</td>
<td>4.0</td>
<td>2.23</td>
<td>9.6</td>
<td>5.8</td>
<td>0.01</td>
<td>0.07</td>
<td>0.11</td>
<td>0.43</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Experimental program

The SDA were collected from rice mills and its properties were tested. Analysis was carried out in Concrete mixtures with 5 levels of SDA replacement ranging from 5% to 25%. The specimens were cast and tested to study the possibility of using SDA as a substitute material for sand in concrete. The control mix, Utilizing SDA replaced as the fine aggregate, was designed for the cube, cylinder and beam. Based on the laboratory trials, the mix proportion of the control mix (M20) was finalized and they were investigated to determine the effect on compressive and tensile strength in cubes and cylinder. The mixture were 0%, 5%, 10%, 15%, 20% and 25% with different sawdust replacement in fine aggregate in analyzed. It is also used to investigate the effect of SDA replacement on Flexural strength.

Tests to determine specific gravity, moisture content, water absorption, Bulk density, Compressive and tensile strength of cubes and cylinders, SDA was used to replace 0 to 30% of the sand by weight. For compressive and tensile strength tests 150 x 150 mm cubes and 150 x 300 mm cylinders specimens were used. A total of 450 specimens were cast and cured in water at room temperature in the laboratory for 28, 45, 60, 90, 180 days. At the end of each curing period, three specimens for each mixture were tested for Compressive, Tensile and Flexural and the average was recorded.

Flexural strength was measured using 100x100x500 mm beam specimen in the centre of the beam load applied. A total of 90 beams were cast and cured in water for 28, 45, 60, 90, 180 days. For each mixture, three beams were loaded to failure, and the average strength was recorded in each case.

RESULTS AND DISCUSSION

Workability of the concrete decreased as the percentages of SDA replacement increased. The density of the concrete 2502 kg/m³ at 0% replacement of SDA but at 30% the density decreased to 2341 kg/m³.

Compressive strength

The compressive strength test results for the concretes containing SDA fine aggregates of cubes and cylinders according to their age are very similar to each other.
Thus, the results are presented in Fig. 4 and Fig. 5. Concretes containing SDA as fine aggregates, with a mixing ratio of 20%, 25% and 30% displayed a reduction in compressive strength than that of plain concrete respectively. This tendency towards a decrease in compressive strength with an increase in mixing ratio was repeated for concretes 180 days of age. At 5%, 10% and 15% mixing ratio there was increase in strength than that of plain concrete. In any case, the SDA as fine aggregate in concrete did not have any notable effect on the compressive strength of the concrete.

**Sawdust ash content Vs Compressive strength of concrete cubes**

![Sawdust ash content Vs Compressive strength of concrete cubes](image1)

**Fig. 4**: Compressive strength of cubes.

**% Sawdust ash content Vs Compressive strength of concrete cylinders**

![% Sawdust ash content Vs Compressive strength of concrete cylinders](image2)

**Fig. 5**: Compressive strength of cylinders

**Tensile strength**

The Tensile strength test results for the concretes containing SDA fine aggregates of cubes and cylinders according to their age are very similar to each other. Thus, the results are presented in Fig. 6 and Fig. 7. Concretes containing SDA as fine aggregates, with a mixing ratio of 20%, 25% and 30% displayed a reduction in compressive strength than that of plain concrete respectively. This tendency towards a decrease in tensile strength with an increase in mixing ratio was repeated for concretes 180 days of age. At 5%, 10% and 15% mixing ratio there was increase in strength.
than that of plain concrete. In any case, the SDA as fine aggregate in concrete did not have any notable effect on the compressive strength of the concrete.

Fig. 8: Flexural strength of the concrete beams.

Fig. 9: Compressive strength of cubes Vs cylinder.

Fig. 10: Tensile strength of cubes Vs cylinder.
CONCLUSION

From the tests conducted on SDA replaced in fine aggregate for concrete as presented in various sections, the following conclusions are made:

The SDA produced from burning of sawdust is suitable for use in concrete making. The fineness modulus, specific gravity, moisture content, uncompacted bulk density and compacted bulk density of 10% Sawdust ash were found to be 2.2, 2.67, 3.7%, 1435kg/m³ and 1436kg/m³ For a given mix, the water requirement increases as the SDA content increases. The compressive strength of cubes and cylinders of the concrete for all mix increases with age of curing and decreases as the SDA content increases. The Tensile strength of cubes and cylinders of the concrete for all mix increases with age of curing and decreases as the SDA content increases. The Flexural strength of the beam of the concrete for all mix increases with age of curing and decreases as the SDA content increases. SDA is available in significant quantities as a waste and can be utilized for making concrete. This will go a long way to reduce the quantity of waste in our environment. The optimum replacement level in fine aggregate with SDA is 10%.

REFERENCES

2. Fitzgerald O.A, He built a home of Sawdust-Concrete, In: Reprinted by the permission from popular mechanics, copyright. (1948)