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# Comparative Study on Strength and Durability of Concrete Made with Saw Ash Dust

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**ABSTRACT:-**Sawdust is also known as wooden dust. It is the remains of cutting & drilling wood. It is composed of fine particles of wood, certain insects which live in wood such as carpenter out. It is produced as small irregular chips or small garbage of wood during sowing the logs of wood into different sizes. In this study, sawdust ash prepared from uncontrolled burning of sawdust is evaluated for its suitability as a partial cement replacement in concrete. The strength parameters i.e. compressive strength of concrete with blended sawdust ash cement are evaluated & studied by replacing cement by 5%, 10%, 15%, and 20% by wt. to OPC. Utilizing sawdust waste this research will focus on sawdust wastes obtained from the wooden industry in India. Presently, much of ceramic industries production goes to waste, which is not undergoing the recycle process yet. Replacement of saw ash dust different percentage as 5%, 10%, 15% and 20% of sawdust as partial replacement of cement with M-25 grade of concrete. The age of concrete at 7, 14, 28 and 56 days. From the results of the study, samples of concrete with 0 to 5% saw ash dust replacement have reached optimum strength. Findings showed that concrete containing saw ash dust 0 to 5% showed the highest amount of compressive strength, and split tensile strength of concrete.

**KEYWORDS:-**Saw Ash Dust, Cement, Compressive Strength, Split Tensile Strength

## I. INTRODUCTION

It is generally known that the fundamental requirement for making concrete structures is to produce good quality concrete. Good quality concrete is produced by carefully mixing cement, water, and fine and coarse aggregate and combining admixtures as needed to obtain the optimum product in quality and economy for any use. Saw ash dust is generated as a by-product during cutting of wood [1]. The use of concrete is increased & the rate of construction is increased. Concrete is used in the construction of different structures with long life. In a survey conducted a few years ago, it was found that million tons of waste material are produced & burned every year like sawdust ash [2, 3]. Appropriate utilization of such waste materials brings ecological and economic benefits. Sawdust ash is a waste material produced by the timber industry. It is produced as timber is sown into planks at sawmills. This causes heaps of sawdust to be generated each day. So to use this waste material as replacement of cement is the focus of study. This study examined the use of sawdust ash as a partial replacement for Ordinary Portland Cement (OPC) in concrete [4].

## II. MATERIALS USED

**Cement:-** Ordinary Portland cement (OPC) from a single lot was used throughout the course of the investigation. The physical properties of the cement as determined from various tests conforming to Indian Standard. All the tests were carried out as per recommendations of IS: 4031-1988. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture

**Course aggregate:-**The coarse aggregate with a maximum size 12.5mm having a specific gravity 2.71 and fineness modulus of 6.61%. Angular recycled aggregates from a local source were used as coarse aggregate.

**Fine aggregate:-**Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate. The specific gravity of sand is 2.57.



**Saw Ash Dust:** Sawdust is also known as wood dust. It is the by-product of cutting, drilling wood with a saw or any other tool; it is composed of fine particles of wood. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the sawdust. Sawdust's are produced as small discontinuous chips or small fragments of wood during sawing of logs of timber into different sizes. The chips flow from the cutting edges of the saw blade to the floor during sawing operation and saw ash dust using passing from 90-micron sieve.

### III. LITERATURE REVIEW

**Joy et al. [1]**, checked the 28 days compressive strength, flexural strength and splitting tensile strength at various mix proportions. They cast specified number of cubes, cylinder and beams by replacing fine aggregate with sawdust by 15%, 20%, 25% & 30% and to compare their property with standard mix (M25). Based on the investigation on sawdust, following conclusions were made i.e. in 28 days 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 25% sawdust was proved to be the optimum mix to get M25 grade of concrete. But the flexural strength gradually increases as sawdust content increases. The fibre 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. As a result of this experiment it was observed that the concrete containing sawdust get compacted more efficiently than the normal concrete. Dry porous sawdust could absorb sufficient amount of water that could be an effective mean of internal curing and absorb the excess water in the mix and provide the water required for the hydration of the cement.

**Abdullahi et al. [2]**, checked the compressive strength of concrete and analyse its effect on the construction cost. They casted (150x150x150)mm cube & evaluated the compressive strength of concrete at 7,14,21 and 28 days by replacing fine aggregate from 0% to 50% (in percentage gap of 10). Based on the investigation following conclusions were made i.e. Sawdust as an air-entraining agent has no appreciable positive effect on the compressive strength of concrete. Variation in the compressive strength results is traceable to the fact that it is difficult to obtain sawdust which is not a mixture of several species. A possibility exists for the partial replacement of sand with sawdust in the production of Lightweight concrete. Optimum replacement of sand with sawdust has been found to be 10%. Beyond this limit, the concrete produced did not meet code requirements. As a result of this experiment it was observed that as the percentage sawdust content increased in the mix the compressive strength decreased. The low values of the compressive strength of the concrete used in this investigation could be attributed to the fact that sawdust contains some substances which are injurious to the cement. These substances actually inhibit the hydration of cement and hence the development of strength.

**Suji.D et al. [3]**, determined the optimum quantity of river sand to be replaced by Quarry dust and saw dust and to obtain maximum results and compared the characteristic strength of normal concrete and concrete with Quarry dust and Saw dust. In this experimental study, the test was conducted for M30 mix containing Quarry dust ranging from 0, 10%, 20%, 30%, 40% combined with Saw dust ranging from 0.5%, 10%, 15% & 20% remaining percentage river sand is used. Based on the experimental study following conclusions were made i.e. The compressive strength of quarry dust and saw dust up to 30% and 15% respectively is almost similar to that of control mix. Split tensile strength of quarry dust and saw dust up to 30% and 15% respectively is almost similar to that of control mix. Two-point loading test result shows that the first crack load is almost same for both control mix and quarry dust and saw dust concrete. As a result of this experiment Quarry dust and saw dust content of 30% and 15% by weight has shown the best results. Thus indicates the possibility of using quarry dust and saw dust as a partial replacement of fine aggregate up to this level. The weight can be reduced up to 20%.

**Kumar et al. [4]**, carried out an experimental study to compare the cost of sand used concrete block and saw dust used concrete block and also compared the reduction in weight of two blocks. In this experiment, they prepared 6 test specimens of control concrete & 10%, 15%, & 20% fine aggregate replaced by saw dust by volume each. Based on the study carried out on the strength behaviour of saw dust the following conclusions are drawn i.e. at the initial ages, with the increase in the percentage replacement of saw dust, the strength as well as compressive strength increases. Moreover with the use of saw dust, the weight of concrete reduces, thus making the concrete lighter which can be used as a light weight construction material in many civil engineering purposes.



**Tomas et al. [5]**, carried out the experiment study to analyse the effect of sawdust concrete mixture in terms of adhesion of aggregates, thermal insulation, workability and surface quality. This study also aims to determine the factors affecting the performance of sawdust in concrete mixture in terms of humidity and temperature and design a sawdust concrete mixture as an alternative fine aggregate. In order to contribute to the industry and saving the environment, to provide new knowledge to the contractors and developers on how to improve the construction industry methods and services by using sawdust concrete mixture, and sustain good product performance this study was done. This experimental research tries to implicate that sawdust-cement-gravel mix has an equal advantage than the standard mix of cement-sand-gravel. Both mixed in proportions of 1:2:4 of cement, a fine aggregate, and a coarse aggregate respectively. Two sets of sample with three sample of each were made for a total of 6 specimens to be tested. The first set of three samples consists of the sawdust-cement-gravel mix, the second set of the ordinary concrete mix. Each set were mixed and moulded in the same way and with the same volume proportions. After placement in moulds, both sets were left to cure for a number of days. The curing samples will then be tested at a given period of days specified under the National Structural Code of the Philippines or NSCP (7, 14, and 28 days). The seven day specimen was not cured, the fourteen day specimen was soaked, and the twenty-eight day specimen was washed with a little bit of water every morning. Analysis showed a difference in each specimen tested. Since the curing of specimens were altered in a way to be able to explore other aspects of the research. Experimentation and data analysis shows that the higher the saturation of water deposits in the sawdust particles during curing tend to weaken the sample, making it softer than it was designed for, thus explaining why the soaked and splashed sample appeared weak.

**Jeson.P et al. [6]**, carried out the test experimental study on properties of concrete by partial replacement of cement with silica powder and fine aggregate with saw dust ash. In this experiment natural sand was partially replaced (5%, 10%, and 15%) with SDA. Compressive strength and Tensile strength (cubes and cylinders) on 7, 14 and 28 days of age were compared with those of concrete made with natural fine aggregate. Based on the study carried out on the strength behaviour of saw dust the following conclusions are drawn i.e. in the project it is observed by 5%, 10% and 15% partial replacement of Fine Aggregate with SawDust Ash and 25% partial replacement of Cement with Silica Powder, the 5% of Compressive Strength is more than the Conventional Concrete Target Strength. The other percentage mix has a low Compressive and Tensile Strength this may be due to low bulk density of Saw Dust Ash. But literature says that Saw Dust Ash give good strength if replacement with fine aggregate on concrete.

**Oyedepo et al. [7]**, carried out the test for investigation of properties of concrete using sawdust as partial replacement for sand. The concrete mix ratio of 1:2:4. was prepared using water/cement of 0.65 with 0%, 25%, 50%, 75% and 100% sawdust as partial replacement for fine sand. The coefficient of uniformity and coefficient of curvature of the sand are used in this study. Concrete produced using sawdust as partial replacement of sand has influence on the properties of the concrete. The result of the analysis carried out shows that the workability of concrete with partial replacement of sand with sawdust reduces at constant water-cement ratio; while the use of sawdust in concrete at high percentage of sawdust replacement of sand affected the strength of the concrete as there was a decrease in the strength value, and the density requirement of 1480 to 1840 kg/m<sup>3</sup> was not met. However, use of sawdust as partial replacement of sand at 25 percent by weight gives the same strength requirement when sawdust was not used. Thus, the use of sawdust as partial replacement of sand between 0 to 25% will contribute to reduction in sawdust waste generated in the society without adversely affecting concrete strength.

**Osei et al. [8]**, has carried the experiment on the topic of the effect of replacing sand with sawdust on the properties of concrete. A concrete mix of 1:2:4 was used as control while sawdust was used to replace 25%, 50%, 75% and 100% of sand by volume. In this study the effects of the replacement of sand with sawdust on the strength and density were investigated. Based on the results obtained, the following conclusions are drawn i.e. the compressive strength and density of concrete reduced as the percentage replacement of sand by sawdust increased. The effect of sawdust on the strength of concrete was more pronounced than the effect on the density of concrete. Sawdust concrete can potentially be used in situations where compressive strength is not a major requirement. A percentage replacement of at least 14% can potentially be used in producing structural concrete. Sawdust can potentially replace 16% of sand in the production of structural lightweight concrete. Since sawdust may be obtained at virtually no cost, the cost of concrete can potentially be reduced by replacing sand with sawdust in concrete. Further studies should be conducted on the potential of sawdust as replacement of sand in the production of structural concrete.

**Mageswari et al. [9]**, has carried the experiment by replacing natural sand with SDA (5%, 10%, 15%, 20%, 25% and 30%). This paper consists of fineness modulus, specific gravity, moisture content, water absorption, Bulk density,





%voids, % porosity (loose and compact) state for sand and SDA. In this paper he had found compressive strength test, tensile strength test, flexural strength test of concrete sample for 28,45, 60, 90, 180 days. The fineness modulus, specific gravity, moisture content, uncompacted bulk density and compacted bulk density of Sawdust ash were found. Along with that it was concluded that 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 re- placement level in fine aggregate with SDA is 10%. Workability of the concrete decreased as the percentages of SDA replacement increased. So there is a possibility that 10% of SDA can be used in the field purpose.

IV. RESULT AND DISCUSSION

**Compressive Strength:**-The compressive strength development of concrete (at W/B = 50%, cured in water at 20°C). The compressive strength of concrete reduces with the increase of sawdust ash replacement ratio. This result is not related to water-binder ratio and the presence or absence of durability improving admixture and air content. However, compressive strength growth of concrete is found to be increased with the increase of sawdust ash replacement ratio after 28 days. The relationship of cement-water ratio and compressive strength and the relationship of binder-water ratio and compressive strength are shown in 1. Since the compressive strength development has no difference between PL and D concrete (nonair-entraining type), both are expressed as an approximate straight line in this figure. Until the age of 28 days, a high correlation is shown between cement-water ratio and compressive strength, regardless of sawdust ash replacement ratio. After 28 days, however, because the assistance of pozzolanic reaction of sawdust ash to strength increasing, the correlation between cement-water ratio and compressive strength is poor.

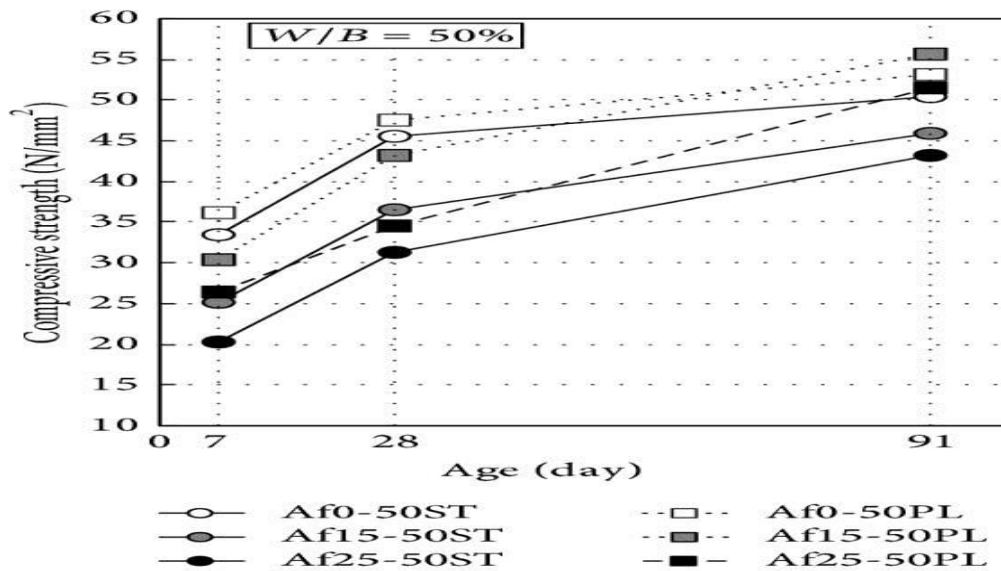


Figure 1: Compressive Strength (N/mm<sup>2</sup>)

Even though there is high correlation between binder-water ratio and compressive strength over a longer period more than 1 year, it is unrealistic to evaluate its strength development in short term of 91 days. Also, the effects of air content are as follows: (1) compressive strength of nonair-entraining concrete (D, PL) is 10% higher than air-entraining concrete (ST); (2) to achieve the same strength, the water-cement ratio of nonair-entraining concrete can be increased by around 5%. The correlation between binder-water ratio and compressive strength is higher in the same sawdust ash replacement ratio. The compressive strength of nonair-entraining concrete (D, PL) is 10%–20% stronger than air-entraining concrete (ST) in the same binder-water ratio depending on the presence or absence of air content (at W/B = 50% or W/B = 43%).

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive



strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently.

Table 1: Compressive strength of Normal and saw-dust mixed fine aggregate concrete

Compressive Strength Values (in MPa)	Grade of Concrete	No. of Days	Strength of Saw- dust(0%) +Sand (100%)	Strength of Sawdust (10%) +Sand (90%)	Strength of Saw- dust (20%) +Sand (80%)	Strength of Sawdust (30%) +Sand (70%)	Strength of Sawdust (40%) +Sand (60%)
	M-25	28	31.56	35.23	32.07	30.28	29.68

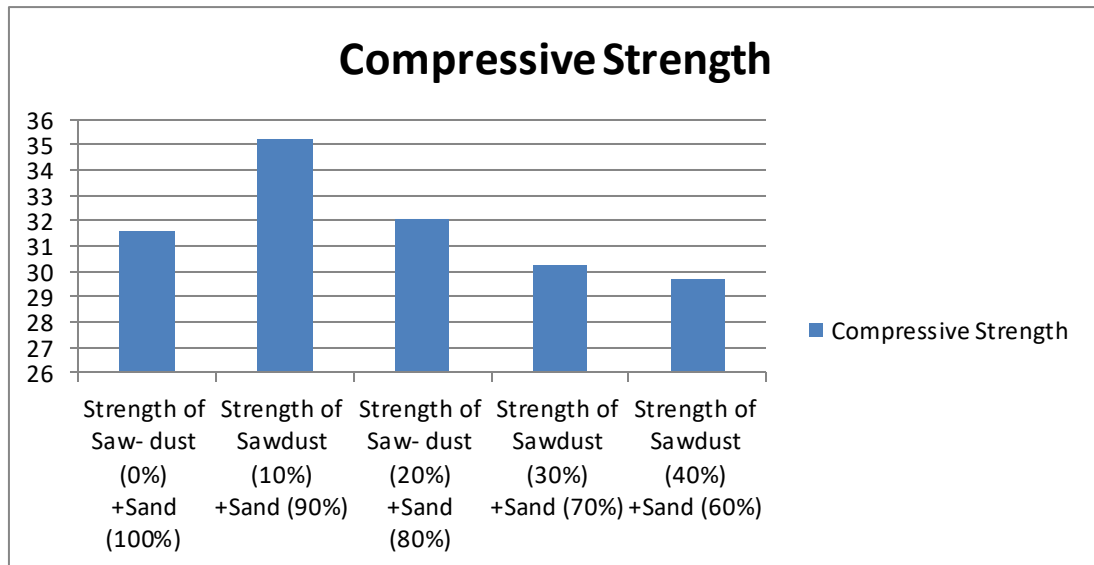


Figure 2: Bar chart showing variation of compressive strength values for different % replacement at the end of 28 days



Figure 3: cubes used for compressive strength test

**SPLIT TENSILE STRENGTH:** The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Table II: Split Tensile strength of Normal and saw-dust mixed fine aggregate concrete

Tensile Strength Test (MPa)	Grade of Concrete	No. of Days	Strength of Saw-dust(0%) +Sand (100%)	Strength of Sawdust (10%) +Sand (90%)	Strength of Sawdust (20%) +Sand (80%)	Strength of Sawdust (30%) +Sand (70%)	Strength of Sawdust (40%) +Sand (60%)
	M-25	28	3.29	3.7	3.52	3.13	2.98

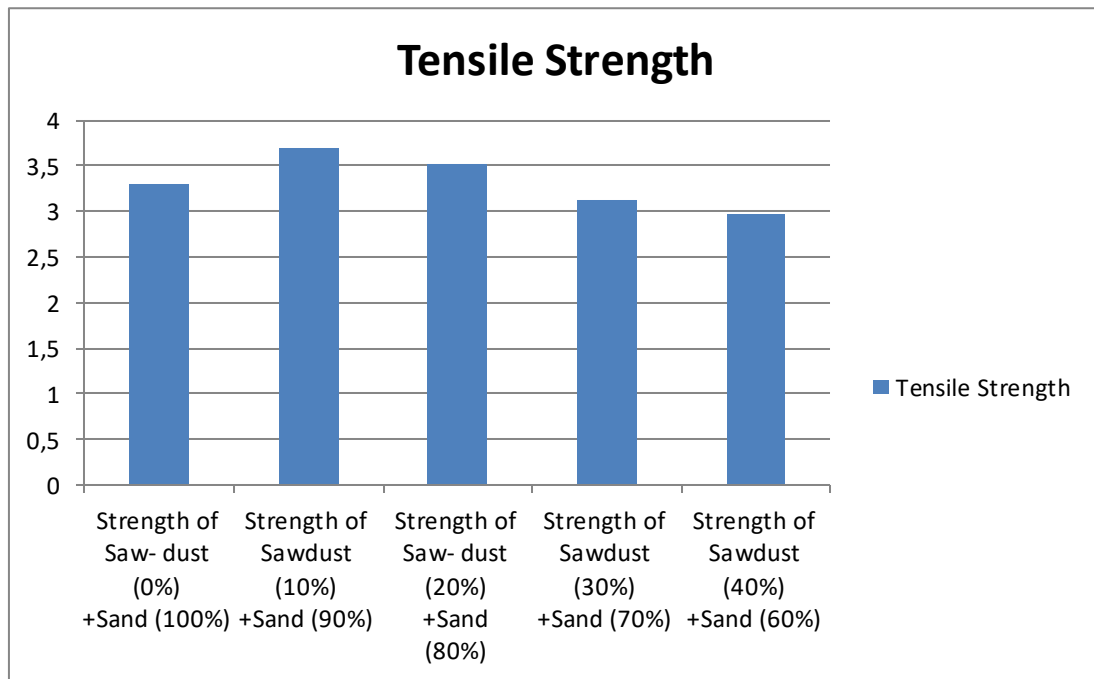


Figure 4: Bar chart showing variation of split tensile strength values for different % replacement at the end of 28 days

### V. CONCLUSION

Based on the scope of work carried out in this investigation, the following conclusions are drawn:

- Reduction in bleeding is observed by addition of saw ash dust in the saw ash dust concrete mixes.
- It was observed that as the addition of saw ash dust to concrete mix increases, the workability of the concrete mix was found to decrease as compared to the control mix.
- At a dosage of about 5% saw ash dust the increase in compressive strength of saw ash dust concrete mixes compared with control mix of concrete at 28 days thereafter decreasing compressive strength.
- It was observed that increasing tensile strength up to 5% replacement of saw ash dust with cement thereafter increasing the percentage of saw ash dust in concrete decreasing tensile strength.

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