INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 1)
Available online at: www.ijariit.com

A 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 56days.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 and also find durability aspect of concrete as acid resistance test and alkalinity resistance is the minimum effect of concrete up to 5 % replacement of saw ash dust with cement after increasing percentage of SAD in concrete than increasing loss of concrete mass and compressive strength respectively. Further studies can be carried out as this study only concludes that there is an increase in strength up to 5% replacement of cement by the saw ash powder. The further scope is to find out the optimal %age of saw ash powder to replace than increasing compressive strength as well as tensile strength and also the minimum loss of strength after acid and alkalinity resistance test.

Keywords— *Saw ash dust, Admixture, Workability, Compressive strength, Split tensile strength, Durability*

1. 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. 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 consulted a few years ago, it was found that million tons of waste material are produced & burned every year like sawdust ash. 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.

2. MATERIALS USED

2.1 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 30 conforming to Indian Standard IS: 1489-1991(Part-1) are listed in Table 3.1. 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

2.2 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.

2.3 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.

2.4 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.

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

3.1 Workability of concrete mixes

The workability of concrete mixes was found out by slump test as per procedure & the compaction factor was found out using the procedure as given in chapter 3. Water-binder (w/b) ratio was kept constant 0.4 for all the concrete mixes. Super-plasticizer Gelenium hky 8765 was used to maintain the required slump. The dosage of super-plasticizer was kept 1.0% by weight of the binder.

Table 1: Workability & Compaction factor values for different concrete mixes

Mix no.	Description	Superplasticizer (%) by weight of the binder	Slump (mm)
M1	100%OPC	1.00	60
M2	95%OPC+5%SAD	1.00	58
M3	90%OPC+10%SAD	1.00	56
M4	85%OPC+15%SAD	1.00	50
M5	80%OPC+20%SAD	1.00	43

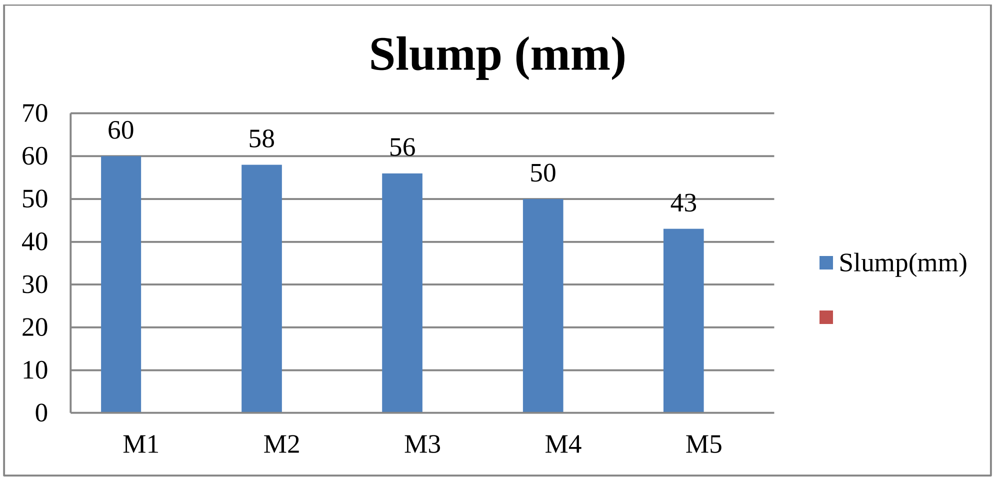

Fig. 1: Slump test results

Table 1 shows that as the addition of saw ash dust to concrete mix increases, the workability and compaction factor of the concrete mix was found to decrease as compared to the control mix. To achieve the required slump superplasticizer was added to the concrete mix. The lowest value of slump was obtained with mix 80% OPC+ 20 % SAD and the highest value was obtained with 95% OPC + 5% SAD. There is a decrease in workability of concrete with an increase in SAD. Due to the high content of saw ash dust, it is very difficult to get required slump values without the addition of superplasticizer.

4.2 Compressive Strength

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, 28 and 56 days. The compressive strength test results of all the mixes at different curing ages are shown in Table 2. Variation of compressive strength of all the mixes cured at 7, 14, 28 and 56 days are also shown in figure 2. Figure 2 shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC) after 7, 14, 28 and 56 days.

Table 2: Compressive stress (MPa) results of all mixes at different curing ages.

Mix no.	Description	7 Days	14 Days	28 Days	56 Days
M1	100%OPC	28.07	28.86	31.05	38.6
M2	95%OPC+5%SAD	29.95	30.3	32.95	39.15
M3	90%OPC+10%SAD	28.93	29.49	30.90	37.60
M4	85%OPC+15%SAD	27.05	28.33	29.95	34.30
M5	80%OPC+20%SAD	24.21	25.45	27.35	31.10

Table 2 shows that there is an increase in compressive strength up to 5% replacement thereafter decrease in compressive strength is observed. It is also observed that the value of compressive stress increases for every sample with an increase in the period of curing.

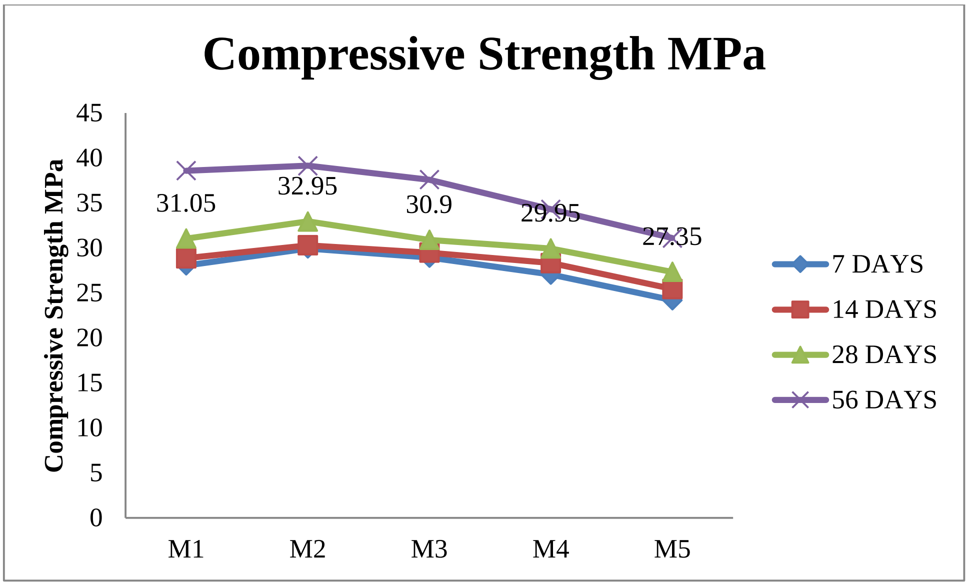

Fig. 2: Compressive Strength MPa

It is clear from the figure 2 that as the percentage replacement of saw ash dust in the concrete mix increases there is an increase of compressive strength of the sample with respect to the control mix up to 5% replacement thereafter there is a decrease in the compressive strength.

4.4 Split tensile strength test results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 7, 14, 28 and 56 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table 3. Variation of splitting tensile strength of all the mixes cured at 7, 14, 28, and 56 days is also shown in figure 3. Figure 3 shows the variation of splitting tensile strength of concrete mixes with respect to control mix (100%OPC) after 7,14, 28, and 56 days respectively.

Table 3: Split tensile stress (MPa) results of all mixes at different curing ages.

Mix Number	Description	7 Days	14 Days	28 Days	56 Days
M1	100%OPC	3.35	3.40	4.46	4.73
M2	95%OPC+5%SAD	3.34	3.39	3.52	4.81
M3	90%OPC+10%SAD	3.14	3.20	3.43	4.34
M4	85%OPC+15%SAD	2.89	3.10	3.33	4.20
M5	80%OPC+20%SAD	2.10	2.75	2.99	3.75

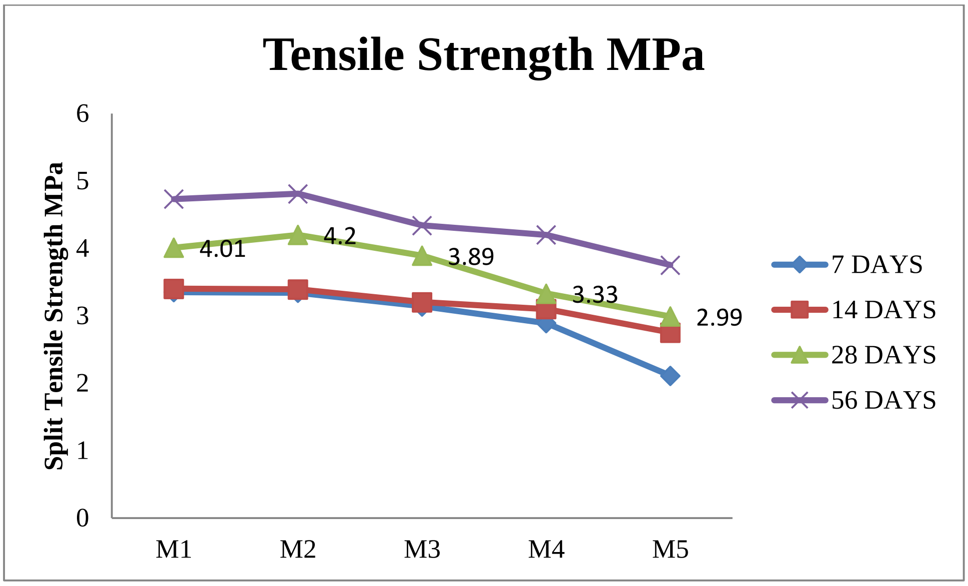

Fig. 3: Variation of the split tensile strength of concrete with age

Table 3 shows that the splitting tensile strength test results of the samples follow an increasing trend till the 5% replacement thereafter there is a decrease in the tensile strength. As the percentage replacement of the saw ash dust increases in the mix there is a rising trend in the graph observed in the tensile strength of the mix up to replacement level of 5% and as the percentage replacement increases to 20% there is decrease in the tensile strength observed probably due to an increase in saw ash dust replacement percentage

5. ACID RESISTANCE TEST RESULTS

From the test results, it is clear that the concrete prepared with recycled aggregate shown relatively lower mass change. Although both control mix and saw ash dust concrete mix suffered slight mass, the overall loss in mass of saw ash dust was much higher. The maximum reduction of mass is obtained at 20% replacement of saw ash dust. All concrete specimens get affected by the acid test. The percentage difference in compressive strength for 0% SAD is less compared to 20% SAD mix and the trend is shown in the table below. So, it can be concluded that the effect of acid increased with the increase in the saw ash dust percentage in the mix.

Table 4: Weight loss and compressive strength loss after 28 days of immersion in the base (H_2SO_4).

Mix.	Compressive Strength At 28 days	Compressive Strength At 28 days	Percentage of Difference in Compressive Strength
100%OPC	31.05	26.00	-16.24
95%OPC+5%SAD	32.95	27.85	-17.41
90%OPC+10%SAD	30.90	24.50	-20.71
85%OPC+15%SAD	29.95	23.01	-23.01
80%OPC+20%SAD	27.35	20.24	-25.99

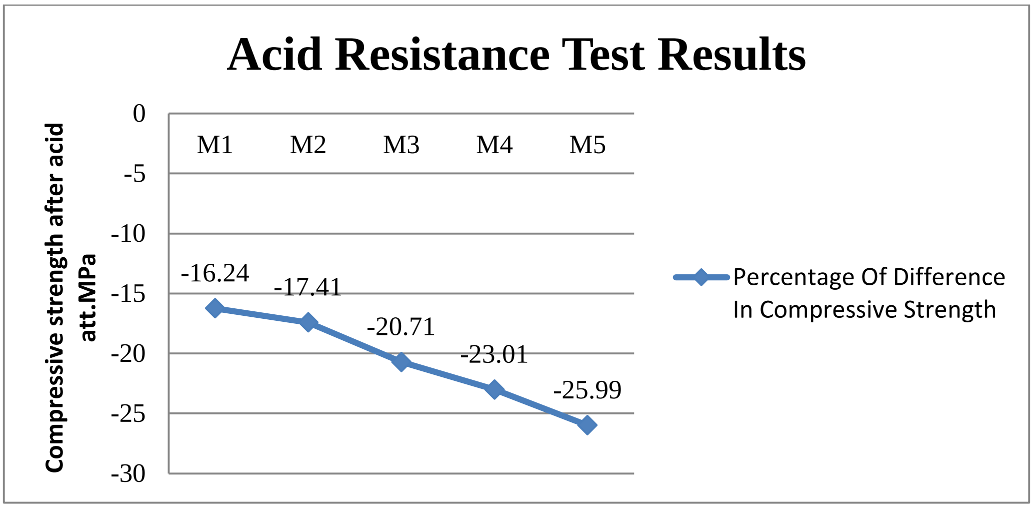

Fig. 4: Variation of compressive strength curing in H_2SO_4 solution

6. ALKALINITY RESISTANCE TEST

For alkalinity test, 5% Sodium Hydroxide (NaOH) by volume of the water with a pH value of 12 was maintained. Cubes were immersed in the above solution for a period of 28 days. It was observed that the weight of specimens increased when kept in solution after 28 days curing. The effect of the alkaline solution on compressive strength and the results are shown in Table 5 and the tested specimens were shown in figure 5.

Table 5: Weight loss and compressive strength loss after 28 days of immersion in the base (NaOH)

Mix.	Compressive Strength At 28 days	Compressive Strength At 28 days	Percentage of Difference In Compressive Strength
100%OPC	31.05	29.25	-5.56
95%OPC+5%SAD	32.95	31.00	-5.91
90%OPC+10%SAD	30.90	28.40	-8.09
85%OPC+15%SAD	29.95	26.61	-11.23
80%OPC+20%SAD	27.35	24.00	12.50

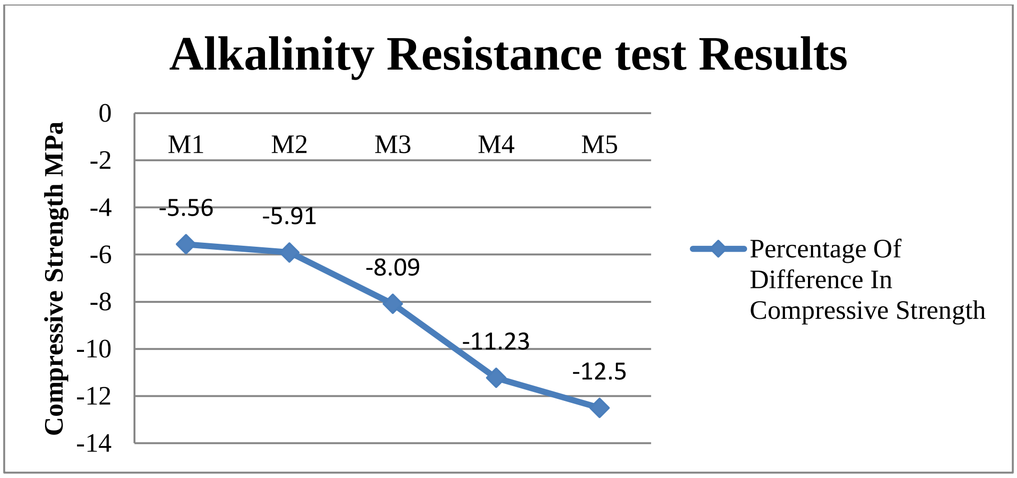

Fig. 5: variation of compressive strength curing in NaOH solution

7. CONCLUSIONS

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.
- It was observed that increasing acid resistance with an increasing percentage of saw ash dust in the concrete and minimum effect of acid in the mix. 95% +5%SAD with compare to the control mix.
- It was observed that 5% replacement of saw ash dust in concrete with decreasing effect of alkalinity resistance thereafter increasing the loss of strength.
- Further studies can be carried out as this study only concludes that there is an increase in strength up to 5% replacement of cement by the saw ash dust. The further scope is to find out the optimal %age of saw ash dust to replace.

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