



Study on use of Saw Dust Ash as Replacement of Cement in Concrete

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ABSTRACT

Scientists, Engineers and Technologists are continuously on the lookout for materials which can be used as substitutes for conventional materials or which possess such properties that would enable their use for new designs and innovations. Applications of Concrete alternative materials fall under the first category. The raw materials for making cement and aggregates are essentially limitless, since practically all of earth's crust can be utilized, if associated costs and energy requirements can be complied with. This course of action cannot be taken as there are other constraints that merit closer examination. The successful utilization of a waste material depends on its use being economically competitive with the alternate natural material. These costs are primarily made up of handling, processing and transportation. The waste materials that can be used in concrete are countless in number. The form in which they are used is wide and varied- they may be used as binder, as a partial replacement of conventional Portland cement or directly as aggregates in their natural or processed states. The stability and durability of products made of concrete using waste material over the expected life span is of utmost importance, particularly in relation to building and structural applications. Keeping all these considerations in mind and taking note of all required standard specifications, wherever possible. our Project aims at creating the confidence of using Waste saw dust ash as high value product in concrete. The project will explore several relevant issues that will be vital when using saw dust ash in concrete. The project will also examine ways to optimize the use of material so that they will offer maximum benefits to the concrete. The project will work out in making concrete industry sustainable. The basic necessity of man after food and water is shelt.

Keywords: saw dust, saw dust ash, workability, mix design, compressive strength

INTRODUCTION

Concrete is defined as any solid mass made with the use of a cementing medium; the ingredients generally comprise sand, gravel, cement and water. That the mixture together of such disparate and discrete materials can result in a solid mass (of any desired shape), with well-defined properties, is a wonder in itself. The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the past participle of "con Cresco", from "com-" (together) and "Cresco" (to grow).

Concrete has been in use as a building material for more than a hundred and fifty years. Its success and popularity may be largely attributed to

- Durability under hostile environments (including resistance to water),
- Ease with which it can be cast into a variety of shapes and sizes, and
- Its relative economy and easy availability

Concrete is remarkably strong in compression, but it is equally remarkably weak in tension. Its tensile 'strength' is approximately one-tenth of its compressive 'strength'. Hence the use of plain concrete as a

Structural material is limited to situations where significant tensile stresses and strains do not develop, as in hollow (or solid) block wall constructions, small pedestals and 'mass concrete' applications (in dams,) etc. Modern concretes preserve these ancient virtues while greatly extending the range of technically achievable goals.

Concrete is used in many different structures such as dam, pavement, building frame or bridge. Also, it is the most widely used material in the world, far exceeding other materials. Its worldwide production exceeds that of steel by a factor of 10 in tonnage and by more than a factor 30 in volume. The present consumption of concrete is over 10 billion tons a year, that is, each person on earth consumes more than 1.7 ton of concrete per year. It is more than 10 times of the consumption by weight of steel.

Scope of current study: -

As discussed earlier cement concrete consumes very high amount of virgin materials and it also suffers from some serious problems when exposed to the environment, like sulphate attack. Partial replacement of cement by waste saw dust ash can overcome these problems and yield high performance concrete. The saw dust ash cement on hydration produces practically no Ca (OH)₂ & hence is superior to Portland cement. Since most of the research work has not been carried out on Saw dust ash, hence there is a scope of studying the behavior of concrete involving the use of varied percentages of waste saw dust ash.

Objectives of current study: -

- To explore and assess the possibility of using waste saw dust ash in concrete in terms of its strength.
- Recover a wood by product through beneficial use when incorporated into concrete.
- To assess the durability of concrete mix.
- To Assess the Compressive strength of concrete mix

DATA COLLECTION

4.1. Tests on fine aggregates: -

4.1.1 Sieve analysis of fine aggregate: -

Source: - River sand.

Weight of sample: - 1000gm.

Table-4.1 Sieve analysis of fine aggregates

S. No.	IS Sieve size	Weight retained (gm)	Cumulative weight retained(gm)	Cumulative% age Wt Retained.
1.	4.75 mm	0	0	0
2.	2.36 mm	10	10	1
3.	1.18 mm	25	35	3.5
4.	600 μ	115	150	15.0
5.	300 μ	667	817	81.7
6.	150 μ	164	981	98.1
7.	Pan	14	995	99.5

Result: -

$$\text{Fineness Modulus} = \sum \text{Cumulative \%age Wt retained} / 100 = 298.8/100 = 2.98$$

Sand is coarse.

As per IS 383-1970, the sand falls in Zone III.

- To have comparative study of workability and change in weight density.
- To assess the role of waste saw dust ash as a partial replacement to cement.
- To compare the design parameters of waste saw dust ash concrete with plain cement concrete.
- To have a comparative study of waste Saw dust ash concrete.

Methodology or Material and Methods

Methodology: -

Step1

Initially materials were procured for casting

Step2

Cubes of design mix M25 were casted and tested for 7 & 28 days.

Step3

The numbers of cubes for design mix M25 were 6.

Step4

Design mix M25 with 8% partial replacement of cement via saw dust ash were casted and tested for 7 and 28 days.

Step5

Design mix M25 with 16% partial replacement of cement via saw dust ash were casted and tested for 7 and 28 days.

Step6

Design mix M25 with 24% partial replacement of cement via saw dust ash were casted and tested for 7 and 28 days.

Table-4.2 Specific gravity test of fine aggregates

S No.	Wt of density bottle W1 (gm)	Wt of bottle & aggregate W2 (gm)	Wt of bottle + aggregate+ water W3 (gm)	Wt of bottle + water W4(gm)	Sp. gravity = $(W2-W1) / [(W2 - W1) (W3-W4)]$
1.	681.1	820.6	1635.5	1549	2.63
2.	681.1	825.5	1644.2	1549	2.50
3.	681.1	840.5	1650	1549	2.68

Average value of specific gravity =2.6.

4.1.3 Tests on cement: -

Table-4.3 Standard consistency test

S No.	Wt. of cement(g)	Wt of water added	%age of water added by wt. of cement	Penetration (mm)	Standard Consistency	Permissible value as per IS 4031 (%)
1.	400	116	29	20	At 31% by weight of cement	Should be about 30% by wt of cement
2.	400	119.58	30	30		
3.	400	124	31	33		

4.1.4 Setting time test: -

Table-4.4 Setting time test of cement

Wt of water added(0.85P) gm	Penetration (mm)	Initial Setting time	Permissible value	Final Setting time	Permissible value as per IS4031 (%)	Remarks
118	35	1 hrs , 10 min	Not less than 30 min	5 hrs and 50 min.	Not more than 10 hrs.	Satisfying the criteria

Size: - Max 20 mm

Weight of sample=3000gms

Table-4.5 Sieve analysis of coarse aggregates

S. No	IS Sieve Size(mm)	Wt. retained (gm)	%age wt retained	Cumulative %age wt retained	%age wt passing	Grading limits single sized 20mm aggregate
1.	40	0	0	0	100	Not conforming to grading limits as per IS 383-1970
2.	20	150	5	5	95	
3.	10	2832	94.1	99.1	0.9	
4.	4.75	27	0.9	100	0	
5.	2.36	-	-	-	-	
6.	Pan	-	-	-	-	

FINENESS MODULUS= \sum Cumulative %age wt retained/100 = 2.04

Table-4.6 Specific gravity test of coarse aggregate

S No.	Wt of density bottle W1 (gm)	Wt of bottle & aggregate W2 (gm)	Wt of bottle + aggregate +water W3(gm)	Wt of bottle + water W4(gm)	Sp. gravity = $(W2 - W1) / [(W2 - W1) - (W3 - W4)]$
1.	680.5	1000.5	1784	1583.5	2.67
2.	680.5	1030.5	1804.5	1583.5	2.71
3.	680.5	1040.5	1810	1583.5	2.7

Average value of specific gravity =2.7.

Result and Analysis

As per our objectives we were able to develop Design mix with Saw Dust Ash as partial replacement of cement on the percentage of 8%,16% and 24%.A number of parameters like compressive strength,water absorption,overall weight of concrete,workability were determined and presented as follows: -
Concrete mix design (grade M-25)

The mix used in the trials is the design mix M 25. This is a reference mix used. The normal concrete cubes have been casted utilizing the design parameters obtained for this mix. The design method used is the IS 10262-1982. Thus, the design parameters are same for every concrete and only the respective replacements are made accordingly from the already obtained design parameters.

(A) Design stipulations

1. Characteristic strength at 28 days 25 MPa.
2. Maximum size of aggregate 20 mm.
3. Degree of workability 0.75 C.F.
4. Type of exposure Moderate.

(B) Test data of materials

1. Specific gravity of cement 3.16.
 2. Specific gravity of coarse aggregate 2.7.
 3. Specific gravity of fine aggregate 2.62.
 4. Zone factor for sand III
- Target mean strength = $f_{ck} + 1.65 \cdot 4 = 31.6 \text{ N/mm}^2$

5.1 Normal concrete M25

The various design parameters are:

Water cement ratio = 0.45

Compaction factor = 0.80

Cement content = 425.73 kg/m^3

Fine aggregate = 619.64 kg/m^3

Coarse aggregate = 1163.64 kg/m^3

Water content = 191.58 kg/m^3

Ratio = C: W: CA: FA

= 1:0.45:2.73:1.45

5.1.2 Casting

The concrete was mixed by the Electric Mixer, hand mixing and cubes were filled and vibrated on the vibrating table. The cubes used as molds are of dimensions $150\text{mm} \times 150\text{mm} \times 150\text{mm}$. The materials were thoroughly mixed with the spades on a clean

CGI sheet. Then water was mixed to the materials. The cubes were filled and vibrated on the mechanical vibrating table. Then they were allowed to set for 24 hours before the molds could be removed. The cubical molds were cleaned and oiled before pouring concrete mix in them.

Slump Test

Slump test was conducted, and slump values have been obtained in observation table-

5.1.3 Curing: -

The cubes have been cured after removing the moulds after 24 hours. Curing has been done by keeping the specimens immersed in water for a period of 6 days for the 7 day test and 26 days for the 28 day test from the date of casting.

The cubes have been tested for the compressive strength at 7 and 28 days respectively under a compressive testing machine. The specimens after proper curing for the required period were tested. The observations seen in the fresh as well as in post hardening test are given in the table below. Three cubes were tested, and then average value was taken.

Date of casting – 18/07/18.

Date on 7th day testing – 25/07/18.

Date on 28th day testing – 16/08/18.

Table-5.1 Compressive strength test for normal M 25 mix.

C	Slu	Load	Load	Compressi	Compres
u	mp	taken	taken	ve	sive
b	(m	@	@ 28	strength	strength
e	m)	7days	days	@ 7 day	@ 28 day
		(KN)	(KN)	(N/mm ²)	(N/mm ²)
1	100	465	630	20.66	28
2	100	448	650	19.9	28.8
3	100	452	642	20	28.5

Average compressive strength @ 7 days
= $60.56/3 = 20.18 \text{ N/mm}^2$.

Average compressive strength @ 28 days
= $85.3/3 = 28.43 \text{ N/mm}^2$.

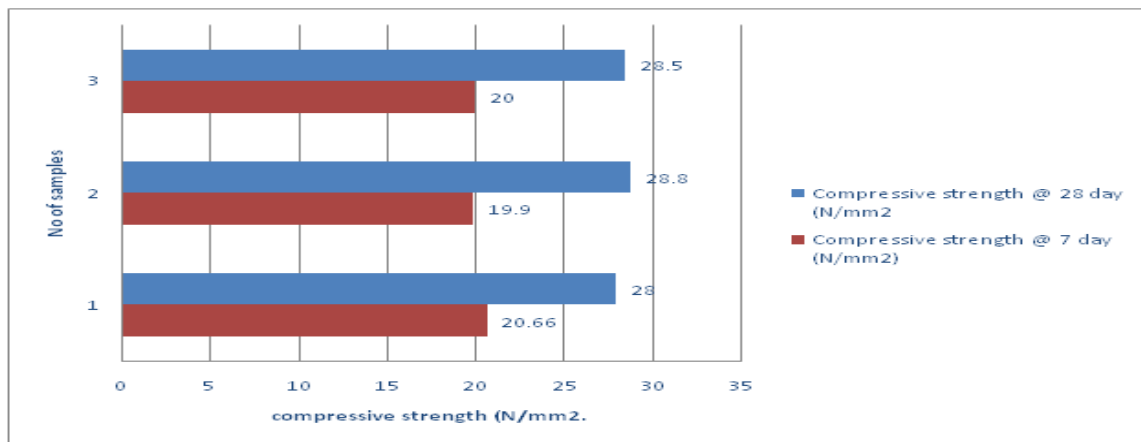


Fig 14 Compressive Strength of M25 for 7 Days and 28 day

5.1.5 Water absorption test: -

Average weight of cubes in wet condition = 2166 gm.
 Average weight of cubes in dry condition = 2073gm.
 Water absorbed = 2166-2073 = 93 gm.

➤ **Saw Dust Ash** It is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool. It is composed of fine particles of wood. The saw dust used for this project was collected from nearby sawmill. Samples were carefully collected to avoid mixing with sand by collecting the newly produced ones with shovel and packing into bags. The saw dust collected was sundried for 10 days to aid the burning process. The saw dust samples collected were burnt into ashes by open burning at temperature of 200 degree Celsius in a drum. The

Ash was then ground after cooling. Sawdust ash obtained is sieved through IS sieve of 90 micron and the retained material obtained is used for experimentation purposes. Chemical composition of saw dust is presented in TABLE 1. Fig.1 shows saw dust ash added to cement for blending and Fig.2 shows sieving of saw dust ash.

A waste material from timber industry having following characteristics

Oxide	% (by wt.)
SiO ₂	68.30
Al ₂ O ₃	3.5
Fe ₂ O ₃	2.23
MgO	5.4
CaO	5.0

Table-5.2 Mixture proportions for saw dust ash

Waste saw dust ash %	w/c ratio	Water (Kg/m ³)	Cement (Kg/m ³)	Fine Aggregate (Kg/m ³)	Waste saw dust ash (Kg/m ³)	Coarse Aggregate (Kg/m ³)	Slump (mm)
0	0.45	191.58	425.73	619.64	0.00	1163.24	75
8	0.45	191.58	391.73	619.64	34	1163.24	66
16	0.45	191.58	357.73	619.64	68	1163.24	70
24	0.45	191.58	325.71	619.64	100	1163.24	72

Table-5.3 Mix design M25 with partial replacement of saw dust ash

% of Saw Dust	Wt Of Cement	Wt Of C.A	Wt Of F.A	Wt Of Water	Wt Of Saw Dust Ash
0%	8.62kg	23.55 kg	12.54 kg	3.87kg	0kg
8%	8.55kg	23.55 kg	12.54 kg	3.87kg	0.7kg
16%	7.25 kg	23.55 kg	12.54 kg	3.87kg	1.4kg
24%	5.82kg	23.55 kg	12.54 kg	3.87kg	2.8kg

Testing of saw dust ash: -

Cubes were removed from the curing tank. Surface water was wiped off. Cubes were dried for 24 hours. Test cube was placed centrally on the lower plate of CTM. Load was applied without shock and continuously increased at a constant rate. Compressive strength was obtained from the ratio of load applied to that of area under impact (P/A).

Compressive strength = load/ Area

Compressive strength (150 mm cube): -

Table-5.4 Compressive strength test

s. no	Saw dust ash%	Date of casting	Date of 7 day testing	Date of 28 day testing	Avg. load @ 7 day (KN)	Avg. load @ 28 day (KN)	Avg. compressive strength @ 7 days(N/mm ²)	Avg. compressive strength @ 28 days(N/mm ²)
1	0	18-07-18	25-07-18	16-08-18	455	640.6	20.22	28.43
2	8%	18-07-18	25-07-18	16-08-18	470.33	649	20.89	28.97
3	16%	19-07-18	26-07-18	16-08-18	414.6	589.3	18.36	26.17
4	24%	19-07-18	26-07-18	16-08-18	324.3	451	14.3	20.8

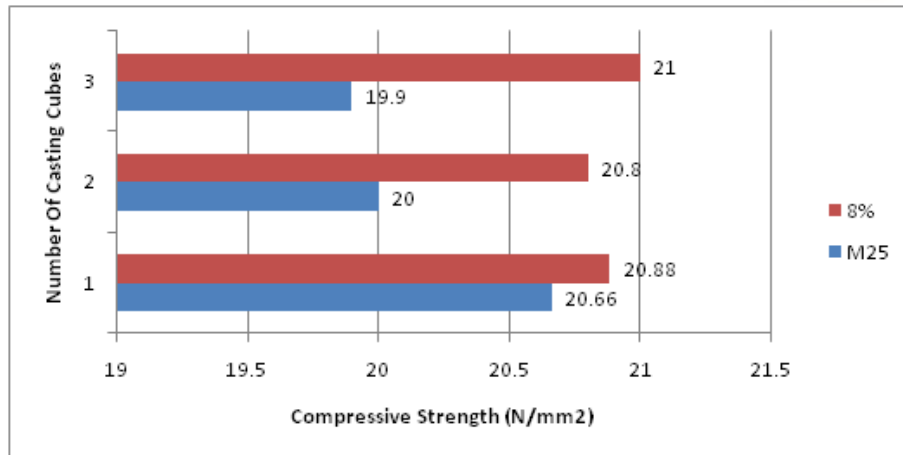


Fig 16: 8% 7days Compressive Strength (N/mm²)

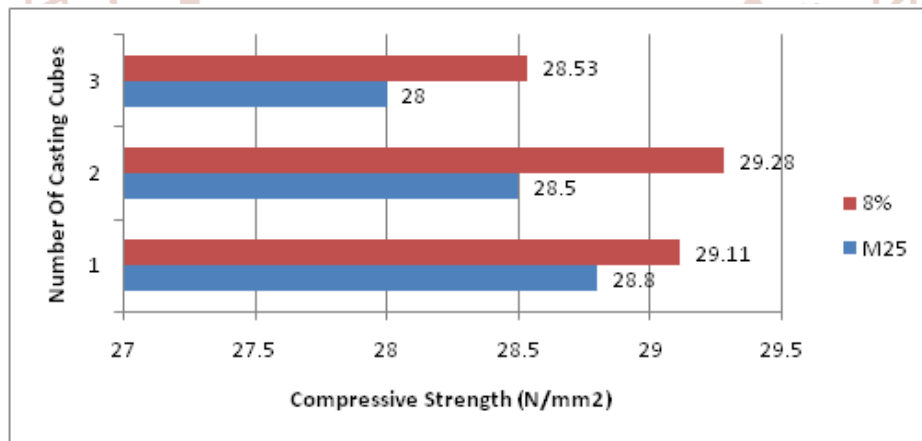


Fig 17: 8% 28days Compressive Strength (N/mm²)

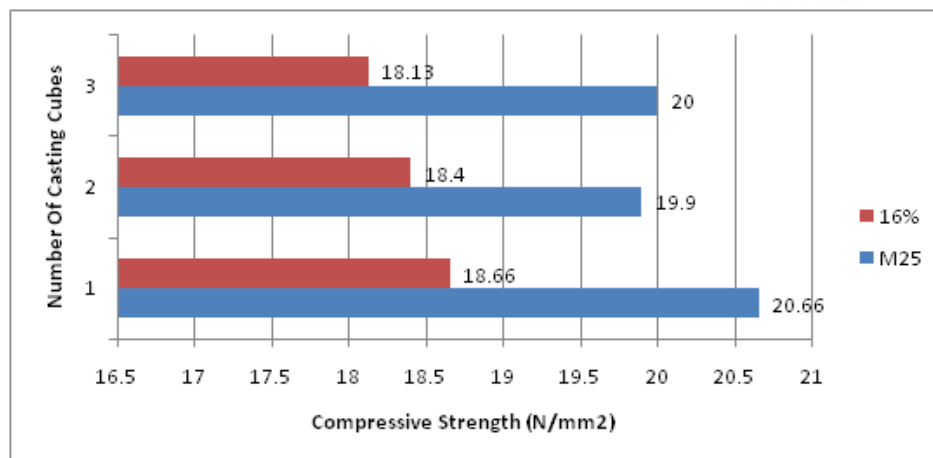


Fig 18: 16% 7days Compressive Strength (N/mm²)

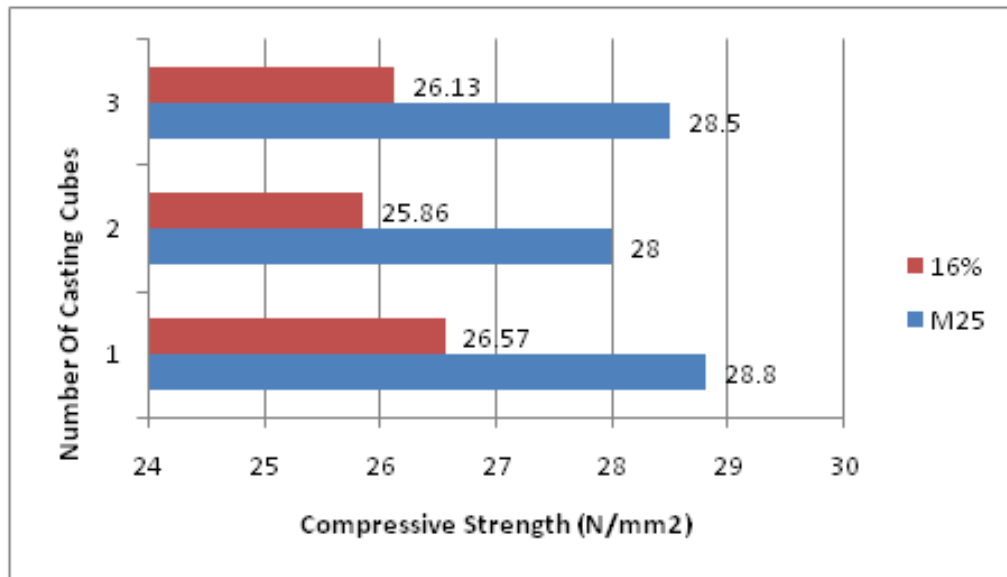


Fig 19: 16% 28 days Compressive Strength (N/mm²)

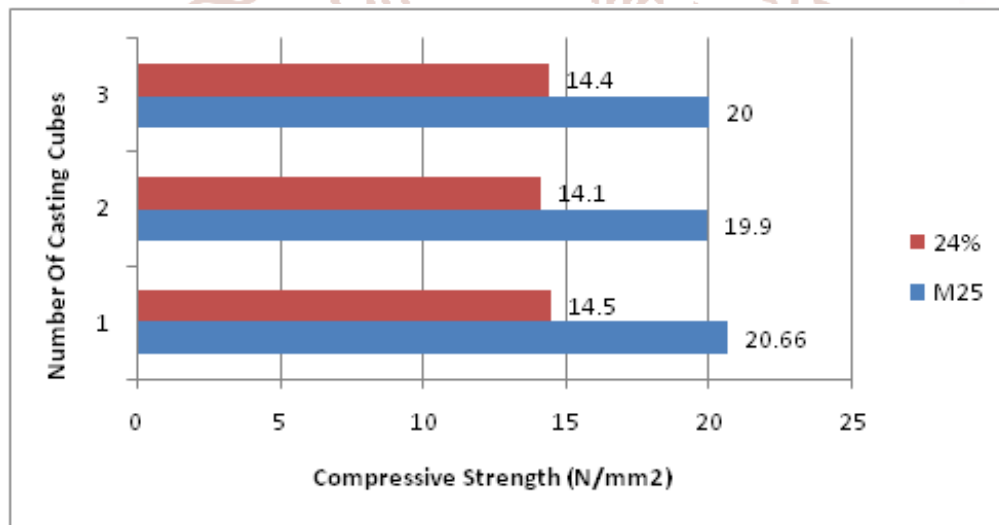


Fig 20: 24 % 7days Compressive Strength (N/mm²)

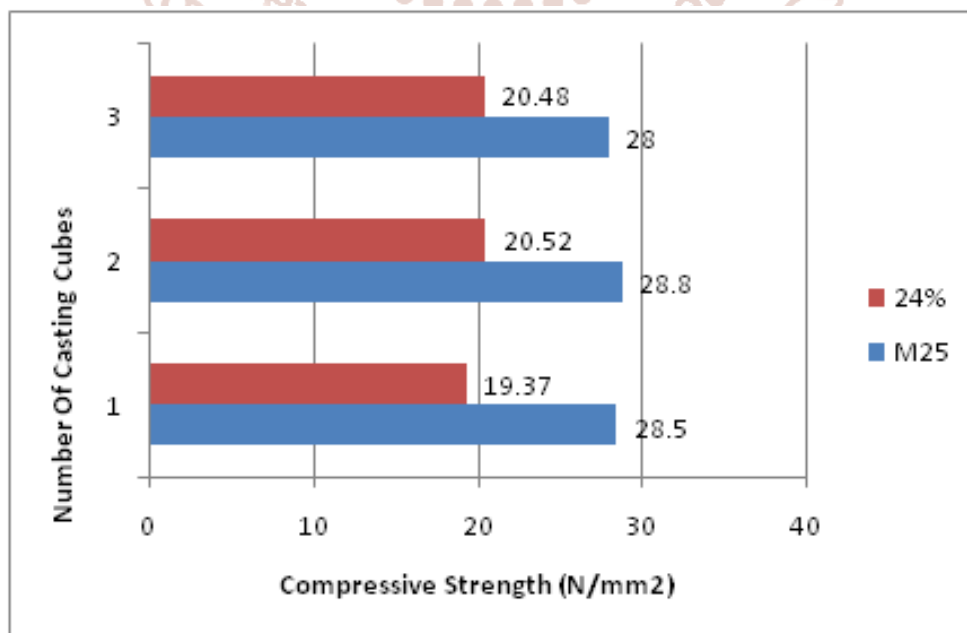
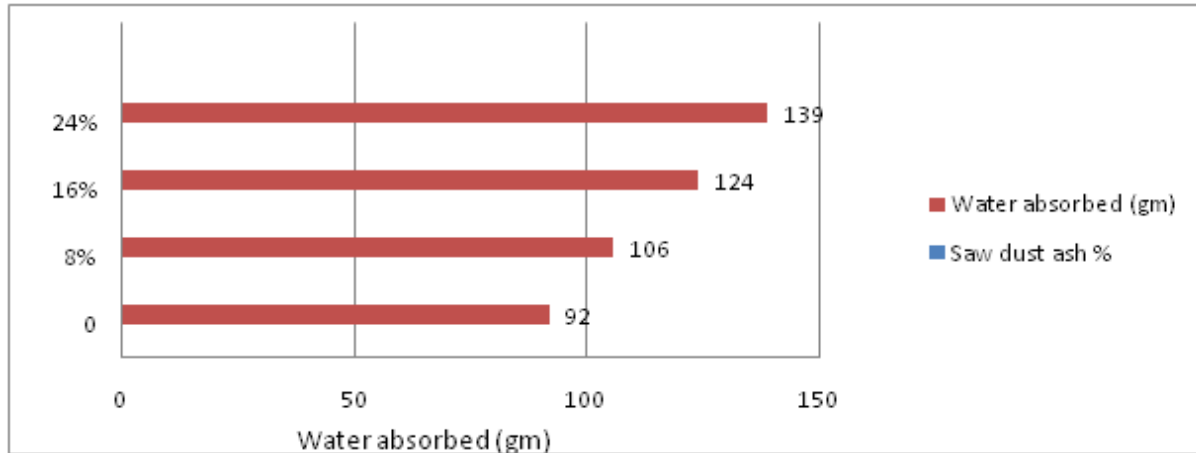


Fig 21: 24% 28 days Compressive Strength (N/mm²)

Table-5.5 Water absorption test

S. No.	Saw dust ash %	Date of casting	Date of 28 day testing	Avg. Dry weight of cube (gm)	Avg. Wet weight of cube (gm)	Water absorbed (gm)	Percentage water absorption
1	0	18/07/18	16/08/18	7318	7410	92	1.09
2	8%	18/07/18	16/08/18	7426	7532	106	1.25
3	16%	19/07/18	16/08/18	7300	7424	124	1.55
4	24%	19/07/18	16/08/18	7113	7252	139	1.71

**Fig 22:- Water absorption test**

Conclusion And Recommendations

Conclusion: -

As per the results, we observe that the optimum value for attaining maximum strength is around 8% as a replacement of saw dust ash and it was also observed that a 16% partial replacement of saw dust ash attains sufficient strength that falls within the parameter of strength governed by the code (is) and 24% partial replacement of saw dust does not any sufficient strength improvements.

On the basis of results obtained, following recommendations can be made: -

- SDA is a suitable material for use as a pozzolan.
- 2.SDA concrete have lower water requirement which implies the more percentage of SDA makes SDA concrete more workable.
- Saw Dust can prove economical as its available in large quantities.
- 4Use of saw dust ash in concrete will eradicate the disposal problem of saw dust
- 5.The compressive strength increases with the curing time and the most recommended percentage to be used is 8%.
- 6.The increase of saw dust ash also shows decrease of strength.
- SDA concrete is light in weight so it can also be used in light concreting.

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