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Research Article

Experimental Study on Replacements of Sawdust Concrete in Structures and its Acoustic Conditions

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Abstract

Sawdust 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. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the saw dust. Sawdust has a variety of other practical uses, including serving as mulch, as an alternative to clay cat litter, or as a fuel. Mixed with water and frozen, it forms pyrite, a slow-melting, much stronger form of ice. Sawdust can be used as alternative substitute for fine aggregate in concrete production. In this project contains of partial replacement of sawdust & m-sand used with rivers sand for manufacturing a concrete. It gives optimum results about strength and different tests to be conducted on this project to find the different behavior of concrete by using a sawdust and m-sand. This project contains tests of impact load strength and by using sawdust so the special test consists of acoustic tests. Now way days in tunnel is lining with concrete so possibility of sudden impact load to be applied so we know the impact strength of the concrete. Wood as an acoustic material so its waste used in concrete so has to absorb some quantity of sound so as this factor the acoustic test to be condtion discussed under this project.

Keywords: Sawdust; Compressive Strength; Impact Strength.

Introduction

Increase in the developmental activities world over, the demand for construction materials is increasing exponentially. An ever-evolving world requires innovative construction methods. Sawdust 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. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the saw dust. Sawdust has a variety of other practical uses, including serving as mulch, as an alternative to clay cat litter, or as a fuel. Until the advent of refrigeration, it was often used in icehouses to keep ice frozen during the summer. It has been used in artistic displays, and as scatter.

One of the most widely used materials for construction is concrete. This is due not only to the wide range of applications that concrete offers, but also its great strength, affordability, durability, and versatility. Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it is able to be moulded to virtually any form or shape. Before using the saw dust it should be washed and cleaned. because of large amount of barks are present which can affect setting time and heat of hydration of cement. Concrete obtained from sawdust is a mixture of sawdust, gravel with certain percentage of water to entrance the workability and full hydration of the cement which provide great in bonding of the concrete. Sawdust concrete is light in weight and it has satisfactory heat insulation and fire resisting values. Nails can be driven and firmly hold in sawdust concrete compare to other lightweight concrete which nail can also easily drive in but fail to hold construction community might well be aware of, incorporating organic materials into solid concrete is not such a good idea to begin with. First of all, its loose molecular structure would cause the structure to fail at a certain stage and second, it would compete and retard the hydration process of cement. Also, presumptions indicate that if each sawdust particle took up enough water during hydration, they could aid the hydration process especially in the center parts of concrete that is impossible to cure with water thus eliminating the need of curing because water deposited in sawdust particles are being harvested by cement particles. The most important aspect and main target of the experiment are proving that sawdust-cement-gravel mixtures can prove to be more lightweight and cost efficient. Since sawdust is already waste then the cost would go down as well as

weight cause of its extremely light unit weight.

Objective of the Study

The objectives of the present experimental study are as follows:

- To utilize the waste wood product as an effective replacement material for concrete.
- To determine the optimum quantity of fine aggregate (River sand) to be replaced by m-sand and sawdust.
- To achieve the economy in construction.
- By partial replacement of sawdust to determine the impact load resisting property of concrete.
- By using sawdust to implement the construction of structure in higher traffic intensity areas.

Experimental Study

Materials Characterization

The present investigation is carried out to study the behavior of concrete using alternative saw dust and M-sand. The tests were carried out in our college (GEC,CHAMARAJANAGARA).

Materials used

It is well known that strength of concrete is dependent on the properties of its ingredients. The materials used in present investigation are as follows:

- 43 grade OPC
- Natural river sand
- Manufacturing sand (M-Sand)
- Coarse aggregates
- Saw Dust
- Water

Properties of Cement

Chemical and Physical Properties of OPC (Table 1 & 2)

Properties of Natural River Sand

Table 3

Properties of Manufacturing Sand

The manufactured sand has required gradation of fines, physical properties such as shape, smooth surface textures and consistency which make it the best sand suitable for construction. This physical property of sand provides greater strength to the concrete by reducing segregation, bleeding, honeycombing, voids and capillary. Thus required grade of sand for the given purpose helps the concrete fill voids between coarse aggregates and makes concrete more compact and dense, thus increasing the strength of concrete.The specific gravity of m-sand is 2.58.

Properties of coarse aggregates

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness Index and Elongation Index were maintained well below 15%. (Table 4)

Table 1. Chemical Properties.

CONTENTS	%
Cao	63
Sio_2	20
Al_2O_3	6
Fe_2O_3	3

Table 2. Physical Properties.

Test	Result	As per	Code Provision
Specific Gravity	3.15	IS 4031 (Part III)-1988	3.15
Normal consistency (%)	31	IS 4031 (Part IV)-1988	<= 30
Initial setting time(min)	45	IS 4031 (Part V)-1988	> 30
Final setting time(min)	455		< 600
Specific surface area (cm2/gm)	3135	IS 4031 (Part II)-1988	3100 - 3500

Table 3. Test results on fine aggregate.

Test	Result	As Per	Code Provision
Specific Gravity	2.6	IS 2386 (PART III)	-
Bulk Density (kg/m^3)	1497	IS 2720 (PART XXVIII)	-
Fineness modulus	3.06	IS 383 - 1970	3 - 3.5

Table 4. Properties of Coarse Aggregate.

Sl.NO	Property	Value
1	Specific Gravity	2.67
2	Water Absorption	0.50%
3	Particle shape	Angular

Properties of Sawdust

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with a 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 the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. (Table 5)

Properties of Water

Potable water has been used in the concrete mix design. PH value as per IS 456-2000 less than 6 to 7.5.

Mix Propotions

Mix design procedure: In present study M20 grades concrete were designed as per IS:10262-2009. The weight ratios of mix proportions are tabulated. (Table 6)

Test Procedure

- The mix design is carried out as per TRIAL batching.
- Materials required for casting 6 cubes is calculated.
- The ingredients are mixed as per standard procedure in the order of fine aggregate,coarse aggregate and cementitious material using mechanical mixer after buttering the same.
- After mixing, slump test is carried out.
- Concrete is poured in to moulds in three layers and each layer is tamped for about 25 times after the cube moulds are thoroughly oiled.
- Fresh concrete densities of slab are measured.
- The concrete is allowed to harden for 24 hours before demoulding it.
- The slabs are then immersed in water for the process of curing.
- The slabs are then removed from water bath and allowed to dry in air for 2 hours and then air densities are calculated.

The slabs are then tested for 28 days for the impact strength.

Impact Test

The impact loading consisted of a 600kg steel mass,dropped from different height, Figure 1. The mass was stabilized with vertical guide rails, shown in Figure 4.1. The same steel slab as from the static load tests was used in distributing the load from the mass onto the slab. The slab was suspended in the hangers that were connected to a frame by a one-way hinge. A complete view of the frame is shown in Figure 1.

Acoustic Test

Testing of Slab Specimens for Acoustic Strength

This section describes how to use physically the instrument in order to correctly measure the noise level existing at the point where the microphone is placed. The following steps must be taken successively:

1. Batteries must be checked before use and during long measur-

Table 5. Chemical composition of Saw Dust.

SL.No.	Composition	Constituents Percentage (by weight)
1	SiO_2	87
2	Al_2O_3	2.5
3	Fe_2O_3	2
4	MgO	0.24
5	CaO	3.5

Table 6. Mix proportion.

Grade of concrete	M20
Weight-Ratio(C:FA:CA)	1:1.5:3
Water-Cement ratio	0.45

Figure 1. View of the setup, before impact loading.

ing sessions.
2. A wind shield must be used if the air velocity is noticeable. It should anyway be used all the time as a dust shield.
3. The microphone should be oriented as described previously.
4. All intruding objects such as the body of the sound level meter (SLM) or the operator itself will degrade the frequency response of the microphone at high frequencies and directivity effects will appear at much smaller frequencies. Therefore, the SLM should be, whenever possible, installed on a stable and sturdy tripod equipped with resilient blocks to isolate the sound level meter from vibration and consequent spurious readings. The operator should be at a reasonable distance (2-3 m) behind the sound level meter. Extension cables should be used if possible when measurements are to be made in a restricted area. When the instrument makes it possible, an extension rod should be used for the microphone. For walk-through surveys, the SLM should be held well away from the body.
5. The SLM must be calibrated before any measuring session using a calibrator. If the temperature of the instrument is significantly different from the ambient temperature where it will be used, it should be first warmed up before calibration and use. The calibration must be checked at the end of the session. If the instrument is not calibrated anymore, the data might have to be discarded and the reasons for this calibration change should be investigated as this might indicate an important malfunctioning of the instrument.
6. Nowadays, it is much more advantageous to use an integrating sound level meter to determine.

Results and Discussions

Impact test results

Impact Strength test results are as given in the following tables for M_{20} Grade concrete. (Table 7)

Acoustic Test results

From the above Tables 7 & 8 shows that Impact strength of river sand is more compatibility than the M-sand, both river sand and M-sand suitable mix proportion is the 10 % replacement of saw dust to fine Aggregates.

Conclusion

1. More over with the use of sawdust 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.
2. Optimum replacement of sand with sawdust has been found to be 10% beyond thus limit the concrete produced did not meet code recruitments for strength .
3. Sawdust is to be absorbed the sound or resist the sound or certain amount hence it is to be used in noise barriers structures.
4. The use of m-sand in concrete will give good strength and not less than standard value hence it is used effectively in concrete structure.

Figure 2. Test Setup of Acoustic Condition.

Table 7. Impact test results.

MIX RATIO M_{20} (1:1.5:3)	HEIGHT IN M	WEIGHT IN KG	NO OF BLOWS FIRST CRACK	FAILURE CRACK	ENERGY J	
					FIRST CRACK	FAILURE CRACK
0%	0.3	3.8	3	4	3.42	4.56
10%	0.3	3.8	2	3	2.28	5.42
20%	0.3	3.8	2	3	2.28	4.44
30%	0.3	3.8	2	3	2.28	4.40
40%	0.3	3.8	3	4	3.42	4.20
50%	0.3	3.8	3	4	3.42	4.10

Table 8. Accoustic Results of Replacement of SAW DUST.

MIX RATIO M_{20} (1:1.5:3)	Leq-1	Lpk-1	Lmax-1	Lmin-1
0%	93.2	103.3	94.6	91.7
50%	86.4	98.8	93	80.3

5. From the impact test results the use of m-sand concrete gives more resistance for sudden impact

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