International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Comparative Study on Concrete with Sawdust as a Partial Replacement for Sand by Conventional and Self-Curing Methods

Rakshith B R[1], Dharshan K[2]

[1,2]Assistant Professor, JSS Science And Technology University

Abstract

The environment is threatened by the large-scale mining of natural resources like sand. Therefore, it becomes necessary for us to consider using industrial by-products instead of natural materials in order to save the ecosystem. In this study utilization of saw dust generated by wood industry in concrete has been explored. The purpose of making sawdust concrete is to decrease the waste of sawdust, which could protect the environment in the long run. Concrete is most widely used material in the construction industry, it needs a lot of water for its curing, so it is an urgent need of research to minimize the use of water to cure concrete. Since we identify water shortage is mounting day by day, so vital research should be needed to do the curing without water. So the self-curing method is adopted to minimize the usage of water and it can be adopted where there is acute shortage of water.

As the percentage of sawdust content increased from 10% to 20% the compressive strength decreased. Optimum replacement of sand with sawdust has been found to be 10%. By comparison between conventionally and self- cured concrete with respect to its compressive strength and density, compressive strength of conventionally cured concrete gives better result than self-cured concrete. There is reduction in density of sawdust concrete with increase in percentage of sawdust in concrete and also there is decrease in density of self-cured concrete as compared with conventionally cured concrete.

Keywords: Industrial by-products; saw dust; self-curing method; compressive strength

Chapter 1
INTRODUCTION
1.1 General

In this century, sustainable development is a top priority. In order to retain resources, energy, and address environmental issues, the globe requires balance. For instance, the demand for sand is rising due to its use in the manufacture of glass, electronics, and concrete. In addition to disturbing the eco-system, the scarcity of sand has made it an expensive import from the local market. As a result, sawdust was employed in thisinvestigation to partially substitute sand in the manufacturing of concrete. By using sawdust instead of sand, concrete will become more cost-effective and ecofriendly than conventional concrete. The investigation on using sawdust instead of sand in concrete mayproduce positive outcomes. Another significance of this study is that using less sand in the concrete mix can save building costs. Additionally, by using less sand, the cost of buildingas a whole can be decreased because sawdust can often be acquired for free or at a very lowcost from sawmills.

Construction industry uses a lot of water for curing process. In the future the constructionindustry has to switch for an alternative curing method, not only to save water but for thesustainable development of the environment but also to promote all construction activitieseven in remote areas where there is scarcity and shortage of water.

1.2 Sawdust concrete

Concrete that includes sawdust is known as sawdust concrete. In this kind of concrete, thefine aggregate is partially substituted with dry sawdust. Sawdust concrete is light in weight, it is better at insulating against heat, and it is fire resistant.

Saw dust (SD) is a waste product that results from the saw milling processes. Sawdust concrete's main drawbacks are that it is brittle and has weak in tension. Still, when it comes to construction materials, concrete is the best choice. Waste products from sawing, sanding, milling, planning, and routing include sawdust (or wood dust). Small wood chipsmake up its material.

1.3 Self-curing concrete

Self-curing is a method that can be used to provide moisture to concrete in order to increase cement hydration and decrease self-desiccation by using chemical compound for self- curing. The chemicals should be able to increase water retention in regular Portland cement matrix and decrease solution evaporation.

The effectiveness of self-curing concrete, as well as its benefits and applications, are covered in this report. If concrete can keep its water content to undertake chemical reactionsto increase its strength, it is considered to be self-curing. This paper describes how self- curing concrete performs when a chemical curing agent called concure WB is used to cureit.

1.4 Advantages of self-curing method

- It is useful and saves water
- Less water in concrete makes the concrete durable
- Compressive strength variation will be less
- Lower maintenance
- Water based, therefore, non-flammable.

1.5 Advantages of sawdust concrete

- Low weight allows you to save time on the construction of a large-scalefoundation.
- Economical concrete which saves money.
- Fire resistance.
- Efficient disposal of sawdust is possible.

1.6 Difference between conventional and self -curing methods

Controlling the rate and amount of moisture loss from concrete during cement hydration isthe process of conventional curing. Curing involves regularly moistening the exposed surface, which stops moisture loss. Common techniques used to achieve this goal includeponding the surface with water. Self-curing concrete, a type of contemporary concrete, cures itself by holding onto water (moisture content, where it prevents internal water fromevaporating by using self-curing chemical compound.

1.7 Objectives of the study

After going through the literature study, it has been found that there is a need in improvingthe quality of concrete using sawdust. The main objectives are:

- To prepare light weight and economical concrete.
- To compare the strength characteristics of normal concrete and sawdustconcreteby self-curing and conventional curing method.

1.8 Scope of the study

- The goal of the project is to determine the feasibility of substituting sawdust forfineaggregate in concrete.
- Sawdust in concrete can change the material's mechanical properties.
- It promotes economy.
- To investigate the effect of Concure WB on the self-curing concrete'sstrengthcharacteristics.
- Lack of availability of fine aggregate can be compensated.

Chapter 2
LITERATURE REVIEW
2.1 General

Abdullahi et al. (2013) investigated the use of sawdust as partial replacement for fine aggregates by mass in the production of concrete. fine aggregate is replaced by Sawdust with 0% to 50% with increment of 10%. Concrete cubes of 150mmx 150mmx150mm were casted and their compressive test done at 7, 14, 21 and 28 days. Along with the increase insawdust content, the compressive strength decreased. According to the results, the strengthof the sawdust content was attained at a rate of 10%, and the resulting compressive strengthat 28 days is 7.41 N/mm2, which is within the range of the average strength of plain concrete (7–10 N/mm2). This concrete cannot be used for structural applications.

Dilip kumar et al. (2014) done the experimental investigation on the effects of introducing the cost between sand used concrete block and sawdust used concrete block.. Using somepercentage of sawdust in place of sand in concrete is used. They replaced sand with sawdust by 10%, 15% and 20%. Based on the limited study carried out on the strength behavior ofsaw dust they concluded that at the initial ages, with the increase in the percentage replacement of saw dust, the strength and also compressive strength will increase. Additionally, the weight of concrete decreases with the use of sawdust, making it lighter and suitable for use as a light construction material in many civil engineering applications.

K. Gopinath et al. (2015) introduced two reproductive form of sawdust, and they named asDry Sawdust (DSD) and Sawdust Ash (SDA). Sawdust Ash was used as partially replacement for cement and Dry sawdust was used as partially replacement for fine aggregate. 48 concrete cubes and 16 mortar cubes in total are cast. Additionally, they go through a Slump Test and a Compressive Test before being compared to a standard concreteand mortar mix. They concluded the study that, as the percentage sawdust increase the density is found to be decrease. According to the results, the density of Dry Sawdust (DSD)is 90% less than typical river sand, while the density of Sawdust Ash (SDA) is 60% to 80%less than typical Portland Cement (OPC). Compressive strength of sawdust mortar cubes for 1:4 mortar achieved 87, 82, and 71 percent of strength for 10 percent, 30 percent, and 50 percent replacement of sand, respectively, after 7 days of curing. For M20 grade concrete, design mix ratio of 1:1.5:3, Compressive strength of Dry Sawdust concrete after 28 days of curing is achieve 80%, 75% and 47% of strength for 10%, 30% and 50% replacement of Dry Sawdust for fine aggregate respectively. After 28 days of curing, the compressive strength for the same grade is 91 percent, 80 percent, and 78 percent for 5 percent, 10 percent, and 15 percent substitution of sawdust ash, respectively.

Daniel Yaw Osei et al. in (2017) conducted the experimental studies on the impact of replacing sand with sawdust on the characteristics of concrete. Sawdust was substituted forsand at percentages of 25 percent, 50 percent, 75 percent, and 100 percent by volume in the standard concrete mix of 1:2:4. The corresponding percentage reductions in compressive strength were 57.5 percent, 68.1 percent, 83.7 percent, and 87.3 percent, whereas the percentage reductions in density were 5.96 percent, 12.44 percent, 13.56 percent, and 17.93 percent, respectively. The results showed that as the sawdust replacement percentage increases, both the density and compressive strength of concrete decreased, but that the percentage reduction in compressive strength was greater when sawdust replaced sand. Where concrete strength is a concern, sawdust may be utilized as aggregate.

Abhishek Narayanan et al. (2017) have aimed to form a concrete mixture consisting of sawdust which replaces the fine aggregate. Analysis of sawdust concrete's effects on workability, strength, aggregate adhesion, and other factors are conducted. The weight difference between the original concrete and the sawdust concrete block is also examined after the concrete block has been prepared. The sawdust and concrete are mass-mixed in specific amounts. Then several tests are carried out on both freshly laid concrete and concrete that has already hardened. The analysis's findings indicate that, when sand is partially replaced with sawdust in concrete, workability decreases while the water-to- cement ratio remains constant; the compressive strength of sawdust up to 15% is nearly equivalent to that of sand ratio. Up to 15%, saw dust's compressive strength is nearly identical to that of control mix. In comparison to regular concrete, sawdust concrete is lighter and more cost-effective. The age of curing enhances the compressive strength of concrete cubes and cylinders for all mixes. The findings also suggested that, depending onthe amount of sawdust added to the concrete, both density and compressive strength couldreduce.

Swaroop Ghosh et al. (2018) have done the experimental investigation of using saw-dust as a partial replacement of sand within the properties of concrete mix. Natural sand was partially replaced with saw dust in (10%, 20%, 30% and 40%). The mixed fine aggregate was pursued through sieve size analysis together with relative density test. After this analysis of saw dust by automated spectrometer was done. This newly formed blended fineaggregate was utilized in mortar and concrete to match with natural concrete mixture.Natural fine aggregate concrete had compressive, tensile, and flexural strengths of 31.56 MPa, 3.29 MPa, and 8.56 MPa up to 28 days, respectively. These values are lower thanthose of concrete in which sawdust replaced sand by 10%. (35.23mpa, 3.7mpa, 8.87mpa).

Junaid et. al. (2016) made a comparison between the standard cured concrete and self- curing concrete by adding admixture polyethylene glycol (PEG-400 1%, 2% and three weight of cement) in concrete (grade ratio = 1:1.92:3.49) which helps in self-curing and inbetter hydration and hence strength. Compressive strength of concrete with 1% and a couple of PEG-400 dosage gives higher compressive strength as compared to conventionally cured concrete Thakare et.al (2016) carried experimental work to check between the Self CuredConcrete(SCC) and Conventionally Cured Concrete (CCC) for M20-M35 grade with plasticizer andwithout plasticizer (normal concrete). they concluded that the SCC givesbetter strength thanCCC till 14 days, at 28 days result are almost same for both concrete.

CHAPTER 3
MATERIALS FOR SAWDUST CONCRETE
3.1 General

Concrete is a hardened mass of heterogeneous materials. Its properties are influenced by alarge number of variables and related to differences in types and amounts of ingredients, differences in mixing, transporting, placing and curing. The common ingredients of sawdust concrete are cement, coarse aggregates, fine aggregates, water, and saw dust. The fifth and sixth ingredient is used to modify certain specific properties of concrete mix, which is added to concrete in percentages by weight offine aggregates. Concrete mixes are created to have the appropriate properties in the fresh and hardened states, depending on the situation, by sparingly using the components available for manufacturing concrete and properly balancing their proportions. In this section the physical and chemical properties of the concrete making materials, which influence the properties of concrete mixes, are discussed.

3.2 Cement

The word cement is derived from the Latin word "cementum" which was used by the Romans to denote the rough stone or chips of marble from which a mortar was made. Thecement is a highly fine-grained substance and has cohesive and adhesive qualities that act as a binderfor the separate elements. For civil engineering projects, they are limited to using calcareous cement, which primarily consists of lime compounds as one of its main elements and serves as a binder for both fine and coarse aggregate particles. Today cementfinds extensive use in all types of construction works, in structure where high strength is required and also in structures exposed to the action of water. Cement mortar concrete reinforced brickwork, artificial stones, plastering, pointing and partition walls are routinelyused in buildings.

The raw materials required for manufacture of portable cement are calcareous materials such as limestone and chalk and argillaceous material such as shale or clay.

The raw materials are ground, mixed closely in specific ratios based on their purityand composition, and then burned in a kiln at a temperature of roughly 1300 to 15000C to produce cement. At this temperature, the substance cinders, partially with the addition of2–3 percent gypsum. By following this process, Portland cement can be produced. To function properly in structures, the cement that will be used in construction must possess a number of characteristics. The engineer is convinced that in the majority of circumstances,the cement performance will be good when these parameters fall within a specific range. The important properties are as follows.

3.2.1 Physical Properties of Cement

- **Fineness**

The fineness of cement is a measurement of the size of cement particles andis stated in terms of a particular cement surface. The particle size distribution canbe used to compute it. It has a significant impact on how quickly strength increasesand how consistently qualityis produced. As greater surface area is available for chemical interaction, the rate of hydration increases with cement fineness.

- **Colour**

When referring to high-quality Portland cement, the colour of the cement should be grey or greenish grey. Due to oxides of iron and manganese its colour is grey which changes with the degree of burning.

- **Specific Gravity**

The specific gravity of newly burned Portland cement should be at least 3 Specific gravity does not reflect the quality of the cement. The mix proportionsare calculated using it.

- **Setting time**

The phenomena through which the plastic cement paste turns into a solid mass may be referred to as the setting time of cement. The cement setting time hasbeen arbitrarily divided into two parts: the initial setting time, which cannot be lessthan 30 minutes, and the final setting time, which cannot be more than 10 hours. The rate of setting is the maximum time allotted for mixing, transporting, putting, and compacting concrete is the rate of setting

- **Soundness**

It is crucial that there is no noticeable change in cement's volume after setting. When cement sets, some of its components may expand unintentionally, which makes cement unstable. Disintegration and severe cracking are caused by the significant volume shift that comes along with expansion. The cement's unsoundness is caused by the inclusion of free lime and magnesium. The Le- Chatelier and Autoclave tests are the two most important ones for soundness. It iscrucial to verify the soundness of cement to make sure it does not exhibit any discernible expansion. It is crucial to verify the soundness of cement to make sureit does not exhibit any appreciable expansion.

- **Hydration**

Hydration of cement refers to the chemical reaction that occurs between water and cement during the setting and hardening process. The so-called heat ofhydration is liberation as itis an exothermic reaction. The amount of heat in calories released per gram of hydration cement upon complete hydration at a specific temperature is known as the heat of hydration. The heat of hydration increases as the temperature increases where hydration takes place.

- **Compressive Strength**

When water is added to cement, it hydrates and exhibits cohesiveness andsolidity. Through adhesion, it holds the aggregates together. The kind and composition of cement determinethe strength of mortar and concrete. The fundamental data needed for mix design is compression strength. This test allowsfor the regulation of both quantity and quality whilealso determining the level of adulteration.

3.2 Aggregates

Aggregates are important in concrete, basically used as filler with binding materials in theproduction of mortar and concrete. They are either produced from blast furnace slag or sourced from igneous, sedimentary, and metamorphic rocks. The body of the concrete is made up of aggregates, which also prevent shrinkage and improve economy. They makeup between 70 and 80 percent of the concrete, thus it's important to understand more about the aggregates that constitutes more volume in concrete. The aggregate is generally utilized to give concrete bulk. The aggregate is commonly usedin two or more sizes to increase the density of the resultant mix. Fine aggregate is definedas aggregate that, passes through a 4.75mm IS sieve and only contains the amount of coarser material authorized by the specifications. The fine aggregate might be natural sand, crushed stone, or crushed gravel sand. The majority of aggregate that passes through the 4.75 mm IS sieve and contains no more fine materials which are allowed by the specification is referred to as coarse aggregate.

The coarse aggregate may be uncrushed stone or gravel, partially crushed stone orgravel, or crushed stone. The fine aggregate's primary role is to aid in the production of workability and uniformity in mixtures. Additionally, the fine aggregate helps cement paste to maintain the suspension of the coarse aggregate particles. When concrete must be transported a distance from the mixing plant to the point of placement, the actionencourages flexibility in the mixture and guards against potential paste and coarse aggregate segregation. To get virtually economy from paste, aggregates should be clean, hard, strong, and durable, and they should be sized according to size. Aggregates should be chemically stable, and they frequently show resistance to abrasion, freezing, and thawing.

3.2.1 Characteristics of Aggregates

When choosing aggregate for concrete, factors like strength, particle shape, surface roughness, specific gravity, bulk density, voids, porosity, moisture content, and bulking should be taken into account.

- **Strength**

Because the strength of the parent rock, from which the aggregates are created, does not perfectly correspond to the strength of the aggregate in concrete,we do not imply that strength when we talk about strength. The bond between the cement paste and the aggregates determines strength. Aggregates is very much essential in order to produce concrete that is durable. For the purpose of determining the strength of aggregate, three tests are often required: the crushing value, the impact value, and the 10% fines value. The standards limit the crushingvalue at 45 percent. For the wearing surface and the remaining concrete, the impactvalue should not be more than 30 and 45 percent, respectively. Toughness and hardness are two additional mechanical characteristics of aggregates that are connected. According to the aggregate abrasion value, thehardness of the aggregate is determined by its resistance to wear.

- **Aggregate Size**

The highest maximum size of aggregate that can reasonably be handled under a specific set of circumstances should be used. The cement content and drying shrinkage will both be reduced by using the largest maximum size. The largest size of aggregate that can be utilized in a given situation may be restrictedby the section thickness, the distance between the reinforcement, the clear cover, the mixing, handling, and placement methods.The aggregate’s maximum size should be as large as possible within the prescribed range, but in no circumstanceshould it be greater than 1/4 of the member's maximum thickness.

- **Shape of aggregates**

Shape is one of the physical characteristics, which influences the workabilityof fresh concrete and the bond between the aggregate and the mortar face. In general, there are fourtypes of aggregates: spherical, irregular, angular, and flaky. Round aggregates are preferred over angular aggregates from the conventional point of economy in cement required for a given water-cement ratio. Excessivelyflaky aggregate make concrete poor

- **Texture of aggregate**

The proportional degree to which particle surfaces are polished or dull, smooth or rough, determines the surface texture's measurement. The surface texture affects how well aggregate and cement paste adhere to one another. The bond, which depends on the aggregate's surface porosity and roughness, develops mechanical anchoring. The compressive and flexural strength of concrete can be increased by up to 20 percent by using aggregate with a rough, porous texture as opposed to one with a smooth surface, which can enhance the aggregate cement bond by 75 percent.

- **Specific Gravity**

The specific gravity of an aggregate is defined as the ratio of the mass of solid in a given volume of sample to the mass of an equal amount of water at the same temperature is known as the specific gravity of an aggregate. Most naturallyoccurring aggregates have aspecific gravity between 2.6 and 2.7.

3.3 Water

Water is the inexpensive component of concrete. Aside from the water used for mixing cement, which is used to hydrate it, water is also used to create the binding matrix, which holds the inert aggregate in suspension until the matrix has set. The residual water makes concrete workable by acting as a lubricant between the fine and coarse particles. For hydration, cement needs around 3/10th of its weight in water. The needed water cement ratio must be at least 0.35. But concrete that contains this amount of water will be incredibly harsh and challenging to place. Additional water is needed to lubricate the mixture, which makes concrete workable. Concrete should only require the bare minimum additional reinforcement in order to limit further strength loss. Water is essential for the formation of the cement gel that gives concrete its strength, so the quantity and quality of water must be carefully considered. Concrete mixing and curing require the use of water that is free of harmful levels of harmful substances. For mixing concrete, portable water is often regardedas satisfactory.

3.5 Sawdust

Government officials and corporate developers are worried about the rising expenses of building projects in developing nations. The use of sawdust as a partial replacement for fine particles in the making of concrete was the subject of this investigation. Sawdust is not a widely used substance in the building industry. This is either because to the fact that it is not readily available as sand or gravel, or it is because their use for such purposes has not been promoted. Recently, there have been requests for the building industry, particularly in developing nations, to employ local resources to reduce construction costs. Sawdust can be defined as loose particles or wood chips that are produced as byproducts when sawing wood into regular, practical sizes. Modern concrete technology makes extensive use of technology to alter the qualities of concrete. Saw dust is a waste that, when burned, emits large amounts of carbon dioxide that harm the environment. Because we are using sawdustin concrete, there will be fewer carbon dioxide emissions into the atmosphere if this wasteis utilized. For the building materials, replacing fine aggregates with sawdust may be advantageous. Concrete's workability, compression test, elongation index, and other qualities alter as a result.

Fig I: Sawdust used for experiment

3.6 Self-curing compound

Concure WB is a low viscosity emulsion-based water-based concrete curing product. It comes in the form of a white emulsion that dries to form a clear film. The emulsion splitswhen first applied to a brand-new cementitious surface, forming a continuous, non- penetrating white coating.

Fig II: self- curing compound

Chapter 4

TEST ON MATERIALS

4.1 Tests on cement:

4.1.1 Normal consistency of cement paste:

Objective: To determine the quantity of water required to produce a cement pasteofstandard consistency.

Standard: IS: 4031(Part 4) – 1988 (Reaffirmed 1995) Procedure: Test was conducted as per IS: 4031 (part 4) – 1988

Observations: Type of Cement: 53 grade OPC

Results: Normal Consistency of Cement paste sample = 31.5%

4.1.2 Setting Time Test:

Objective: To determine the initial and final setting time of cement.Standard: IS:4031(Part 5) – 1988 (Reaffirmed 2000)

Procedure: Test was conducted as per IS: 4031 (Part 5) – 1988 (Reaffirmed 2000)Observations:

- Type of cement: 53 grade
- OPC Standard Consistency: 31.5 %
- Time at which water is added to cement: 11:00 am
- Time at which the initial setting needle fails to penetrate cement paste by5+0.5mm: 12:50pm
- Time at which the annular ring attachment fails to make an impression oncement paste: 03:08 pm

Results:

➢ Initial Setting Time: 110 minutes

➢ Final Setting Time: 248 minutes

4.1.3 Fineness of cement

Objective: To determine the fineness of cementStandard: IS 4031 (part 1) -1996

Procedure: Test was conducted as per IS 4031 (part 1) – 1996

Observations: Type of cement: 53 grade OPCResults: Fineness of cement: 4.8

4.1.4 Specific Gravity of cement:

Objective: To determine the specific gravity of cementStandard: IS: 4031 – 1988

Procedure: Test was conducted as per IS: 4031-1988Result: The Specific Gravity of Cement is 3.13

Fig III: Le Chatelier's Apparatus

4.2 Tests on manufactured sand

4.2.1 Sieve analysis of fine aggregates:

Objective: To determine the particle size distribution of fine aggregates by sievingStandard: IS 2386 (part 1) – 1963

Procedure: The test was conducted as per IS 2386 (part 1)- 1963 and results obtainedareas follows

Observation: Weight of fine aggregates taken: 1Kg

Table I: Sieve analysis of fine aggregates

Sieve Size	Weight retained (g)	Cumulative Weight retained (g)	% Retained	% Passing
4.75mm	0	0	0	100
2.36mm	13	133	1.33	98.7
1.18mm	142	155	15.5	84.5
600µ	191	346	34.6	65.4
300µ	271	623	62.3	37.7
150 µ	256	879	87.9	12.1
<150 µ	120	999	99.9	-

Fineness modulus = Σ (Cumulative percentage retained on each sieve) / 100 =3.01Result: M sand conforms to Zone III of table 4 of IS 383: 1970

4.2.2 Specific Gravity and water absorption of sand:

Objective: To determine specific gravityStandard: IS: 2386 (Part 3) – 1980

Procedure: Test was conducted as per IS: 2720Result:

- Specific Gravity of Sand is 2.65
- Water absorption of sand is 2.0%

Fig IV: Specific Gravity using Pycnometer

4.3 Tests on Coarse aggregates:

4.3.1Water absorption and Specific Gravity of coarse aggregate:

Objective: To determine the water absorption and specific gravity of coarse aggregates.Standard: IS: 2720 (Part 3)

Procedure: Test was conducted as per IS: 2720 (Part 3)Result:

- The Specific Gravity of Coarse aggregate is 2.42
- The water absorption is 0.45%

4.4 Tests in sawdust:

4.4.1 Sieve analysis of sawdust:

Objective: To determine the particle size distribution of saw dustStandard: IS 2386 (part 1) – 1963
Procedure: The test was conducted as per IS 2386 part 1- 1963Observation: Weight of saw dust taken: 1Kg

Table II: Sieve analysis of saw dust

Sieve Size	Weight retained (g)	ımulative weight retained (g)	% Retained	% Passing
4.75mm	0	0	0	100
2.36mm	4	4	1.33	98.47
1.18mm	65	69	23	77.00
600µ	80	149	49.67	50.33
300 µ	108	257	85.67	14.33
150 µ	2.8	285	95	5
75 µ	11	296	98.67	1.33
<150 µ	1	297	99	-

Specific Gravity of Saw Fineness modulus = Σ (Cumulative percentage retained on eachsieve) / 100 = 4.52

4.4.2 Specific Gravity and water absorption of saw dust:

Objective**:** To determine the specific gravity of saw dust Standard: IS: 2720 (Part 3/ Sec.1) – 1980 (Reaffirmed)
Procedure: Test was conducted as per IS: 2720 (Part 3/ Sec.1) – 1980 (Reaffirmed)Result:

- Specific gravity of sawdust is 0.99
- Water absorption of Saw dust is 10 %

Chapter 5

MIX PROPORTIONING

5.1 Concrete mix design

5.1.1 Mix proportioning for M30

Crushed stone sand was used to cast the specimens, and mix proportions were carried outin accordance with IS 10262 - 2009**.**

5.1.2Design stipulations for proportioning:

Grade designation: M30
Type of cement: OPC 53 grade confirming to IS 8112

Maximum nominal size of aggregates: 20 mm Minimum cement content: 300 kg/m3Maximum water cement ratio:
0.45
Workability: 75 mm (slump) Exposure condition: ModerateDegree of supervision: Good
Type of aggregate: Crushed angular aggregate

5.1.3 Test data for materials:
Cement used: OPC 53 confirming to IS 8112Specific gravity of cement: 3.13
Specific gravity of aggregates

- Coarse aggregate: 2.42
- Fine aggregate: 2.65

Water absorption

- Coarse aggregate: 0.45 percent
- Fine aggregate: 2.2 percent

Fine aggregate: Conforming to Zone III of IS: 383

5.1.4 Target Strength for Mix Proportioning:
f^1ck = fck +1.65sWhere,
f^1ck= Target average compressive strength at 28 daysfck =Characteristic compressive strength at 28days,
s = Standard deviation
From Table 1 standard deviation, s = 5 N/mm2 Therefore, target strength = 30 + 1.65 x 5 = 38.25 N/mm2

5.1.5 Selection of Water Cement Ratio:
From Table 5 of IS: 456-2000, maximum water cement ratio = 0.45

5.1.6 Selection of Water Content:
From Table-2, maximum water content = 186 liters. (For 25mm – 50mm slump rangeandf20 mm aggregates.)
Estimated water content for 75 mm slump = 186 + 3/100 x186 = 192 liters

5.1.7 Calculation of admixture:
18% 0f water can be reduced192 x 0.82 = 158 kg

5.1.8 Calculation of Cement Content
Water cement ratio = 0.45
Cement content = 158/0.45 = 351 kg/m3
From Table 5 of IS: 456, minimum cement content for moderate exposure condition =300kg/m3 394 kg/m3 > 300 kg/m3, hence OK

5.1.9 Proportion of Volume of Coarse Aggregate and Fine Aggregate Content:

Volume of coarse aggregate for w/c of0.45=0.65Volume of fine aggregate content=1- 0.63 =0.37

5.1.10 Mix Calculations:

The mix calculations per unit volume of concrete shall be as followsVolume of concrete = 1 m3
Volume of cement = [351/3.13] x [1/1000] = 0.1121 m3Volume of water = [158/1] x [1/1000] = 0.158 m3
Volume of chemical admixture at 0.45% by cement weight=0.001518m3Volume of all in aggregates (d) =a – (b + c) = 0.7284 m3
Volume of coarse aggregates=d volume of CA x specific gravity of CA=1110.51 kgVolume of fine aggregates = e x Volume of FA x specific gravity of FA=716 kg

5.1.11 Mix Proportions:

Cement =51kg/m^3Water = 158kg/m^3
Fine aggregate = 716kg/m^3 Coarseaggregates =1110.51kg/m^3Water cement ratio = 0.45 Chemical admixture=1.404 kg/m^3

Table III: Mix Proportions

Cement	Fine aggregate	Coarse aggregate
351 kg	716 kg	1110.51 kg
1	2.01	3.16

Chapter 6

EXPERIMENTAL INVESTIGATIO

6.1 General

Concrete's most significant and practical property is its compressive strength. Concrete isgenerally used in structural applications to resist compressive stresses. The main aim of this investigation is to monitor the above said parameters of concrete in which certain percentage of saw dust and deformed steel fibers are added by weight of fine aggregates and cement respectively.

6.2 Experimental Procedure

The main aim of the present experimental investigation is to study the behavior of concrete containing saw dust in compression. The study is made considering 0% (reference mix), 10%, 20% of saw dust.

- 150mmX150mmX150mm concrete cubes are cast and tested for compressive test.
- M30 concrete mix design as per IS: 10262 is used in the present work. The detailsof mix design are presented in the earlier chapter.

6.3 Batching

Concrete is batch-mixed, which means that the cement, sand, coarse aggregate, and waterare all measured separately before being combined.
There are two distinct batching methods.

- Volume batching

➢ Weight batching

The correct way to measure the ingredients is technically through weigh batching. 36 cubes measuring 150mmx150mmx150mm were casted for the current experimental study. As aresult, the batching of the materials needed for casting was decided according to the mix proportion, taking a 10% wastage into account. When weigh batching is used, accurate water measurement is required.

Table IV: Quantity of materials required

Specification	ement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	wdust (kg)
Normal concrete	17.77	35.71	56.14	-
With 10% sawdust	17.77	32.14	56.14	3.57
With 20% sawdust	17.77	28.57	56.14	7.14

6.4 Mixing

The process of completely blending the components needed to create homogenous concrete is known as mixing concrete. The primary goal of mixing is to produce homogenous, workable concrete.

There are two methods used for mixing concrete.

- Hand mixing
- Machine maxing

For small-scale, minor concrete jobs, hand mixing is used. In order to compensate for thesubpar concrete generated by this approach, it is desirable to add 10% additional cement as the mixing cannot be thorough and efficient. For reinforced concrete work and medium- to large-scale mass concrete projects, concrete mixing is nearly always done by machine. When there is a lot of concrete to manufacture, machine mixing is not only effective but also cost-effective. During the current experiment, batch mixers were employed. The typical speed range for concrete mixers is15 to 29 revolutions per minute. In a well-designed mixer, it is observed that between 25and 30 revolutions are necessary for proper mixing. Using a batch mixer equipment and the components needed to make nine cubes of size 150mm , concrete was mixed in a laboratory setting. The concrete is then placed into a dry, thoroughly cleaned tray for casting. Later, mixing took place.

Fig V: Concrete Mixing Machine

6.5 Measurement of workability

The ease with which concrete may be mixed, poured, compacted, and finished is what is meant by the term "workability" of the material. The presence of a particular amount of water is crucial for providing the lubrication needed to handle concrete without segregation, to place without losing homogeneity, to compact with the amount of work required, and to complete it easily enough. Water content, aggregate size and shape, aggregate surface roughness, mix proportion, usage of admixtures, aggregate grading, and other variables all affect how workable a material is. The workability of concrete can be determined using a variety of techniques. The most widely used workability measurement tests based on concrete stiffness are the slump test, compaction factor test, and Vee-Bee consistency test. The current experimental study uses the concrete slump test to measure the concrete's workability.

6.5.1 Slump Test

The apparatus is made up of a base plate and a metallic cone-shaped mould with the following interior dimensions. Bottom diameter:20cm Top diameter:10cm Height: 30cm The slump test apparatus was oiled before four layers of concrete were added, each of which was tamped 25 times before the surface was smoothed up. The fresh concrete is then left to settle as the slump cone is lifted up. The slump value determines workability of concrete. After the mould has been removed, the vertical distance from the top of the cone to the falling concrete is known as the slump value. When slump value increases, workability of concrete also increases

Fig VI: Slump test to determine the workability of concrete

6.6 Casting

It is time to cast the concrete cubes once the freshly mixed concrete has been poured into the tray and its workability has been measured. The empty moulds are prepared, cleaned and oiled. The cubes are filled with three layers of concrete, each of which is tamped 25 times.

6.7 Compaction of concrete

The method used to release the trapped air from the concrete is called compaction. Air is likely to become trapped in the concrete during the mixing and placement processes.

The amount of air trapped increases as workability decreases. In other words, stiff concrete mix would require more compacting effort than high workable mixtures since it has a high percentage of trapped air. Concrete in the current work is compacted using a table vibrator.

6.8 Curing

Concrete cures as a result of a chemical reaction between the type of cement in the concreteand the water. Hydration describes the reaction between water and cement. Curing is the process by which concrete hardens and gains strength. Six of the cubes were preserved afterdemoulding for water curing in the curing tank, and the other six were kept for self-curing, where we coated them with a chemical compound and continually cured them for seven and a twenty eight days before testing. This offers adequate curing.

Fig VII: Curing of specimen by

Fig VIII: Curing of specimenbyconventional curing method self-curing Method

6.9 Compressive strength

On hardened concrete, the compressive strength test is the most frequently used. One of the key requirements for structural design is compression strength, which makes sure the structure can support the intended load. As the water cement ratio decreases, compressive strength increases. The cube compression test is used to test the strength of crushed concretecubes in a destructive manner. This test will provide the cube's breaking strength, which is made specifically to measure the compression strength of compacted concrete.

Fig IX: Failed specimen under compression test

Chapter 7

RESULTS AND DISCUSSIONS

7.1 General

This chapter deals with the results based on the experiments and discussions on the sawdust. The slump values, compressive strength, are tabulated and the graphs are plotted.

7.2 Slump values of fresh concrete

Table V: Slump values of Fresh Concrete

Particular	Slump (mm)	%Variation
NORMAL CONCRETE	60	100
WITH SAWDUST 10%	52	86.66
WITH SAWDUST 20%	25	41.66

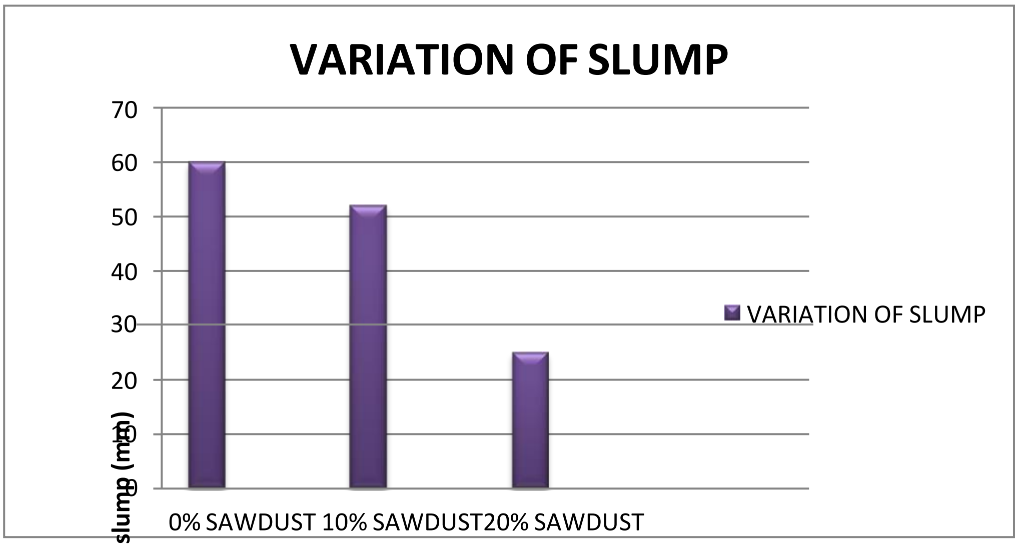

Fig X: Variation of slump (mm)

Table V gives the slump values of fresh concrete with sawdust. The slump gradually decreases from 10% to 20% use of sawdust. The decrease in the slump is shown in the figure X.

Density of concrete

Table VI: Density of concrete by conventional curing method

Particulars	Weight (kg)		Density (kg/m3)	
	7 Days	28 days	7 Days	28 days
0%	8.4	8.5	2488.88	2518.51
10%	7.9	8.2	2340.75	2429.62
20%	7.5	7.72	2222.88	2287.40

Table VII: Density of concrete by self-curing method

Particulars	Weight (kg)		Density (kg/m3)	
	7 Days	28 days	7 Days	28 days
0%	8.3	8.39	2459.25	2474.07
10%	7.8	7.9	2311.11	2340.79
20%	7.38	7.45	2186.60	2207.90

Table VI, VII shows variation in density of concrete on replacement of sawdust with 10% and 20% respectively. Figure XI and XII graphically represent the variation of density. It can be noticed that addition of sawdust reduces the density.

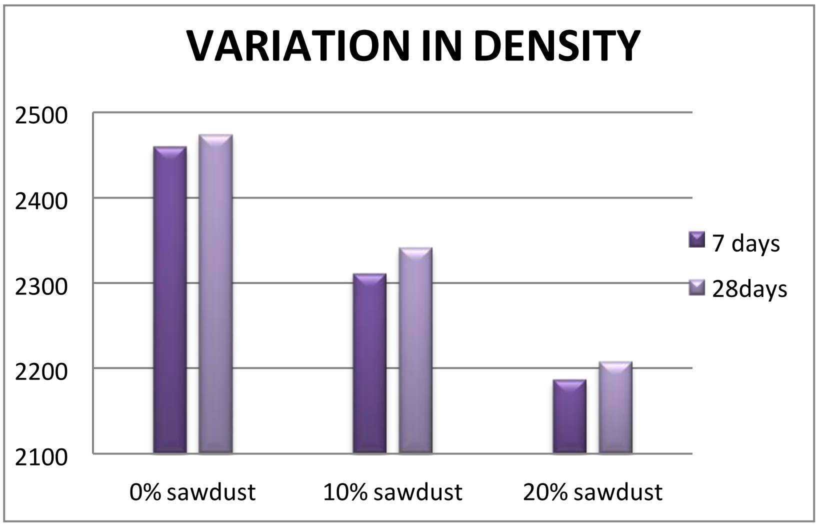

Fig XI: Density of concrete with sawdust by conventional method

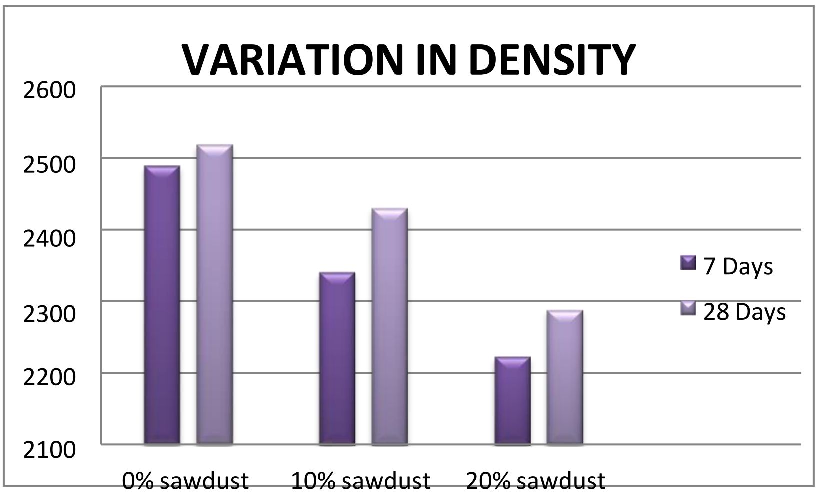

Fig XII: Density of concrete with sawdust by self-curing Method

7.3 Compressive strength of concrete

Table VIII: Compressive strength of cubes by conventionally curingmethod

Particular	Compressive strength in Mpa		Compressive strength in (%)	
	7days	28days	7 days	28days
NORMAL CONCRETE CUBES	37.33	44.44	100	100
10% OF SAWDUST	24.10	34.66	64.55	77.99
20% OF SAWDUST	18.66	26.60	49.9	59.85

Table IX: Compressive strength of cubes by self-curing method

Particular	Compressive strength in MPa		Compressive strength in (%)	
	7days	28days	7 days	28days
NORMAL CONCRETE CUBES	29.33	37.77	100	100
10% OF SAWDUST	22.10	30.32	75.34	80
20% OF SAWDUST	15.55	23.77	53.01	62.9

Table VIII and IX gives the compressive strength of sawdust concrete by conventionalandself – curing method respectively.

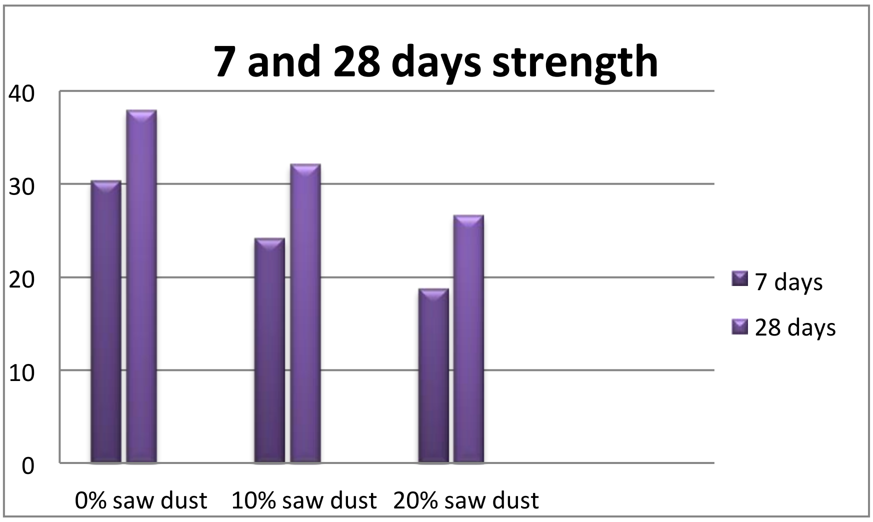

Fig XIII: Compressive strength of cubes by conventional curingMethod

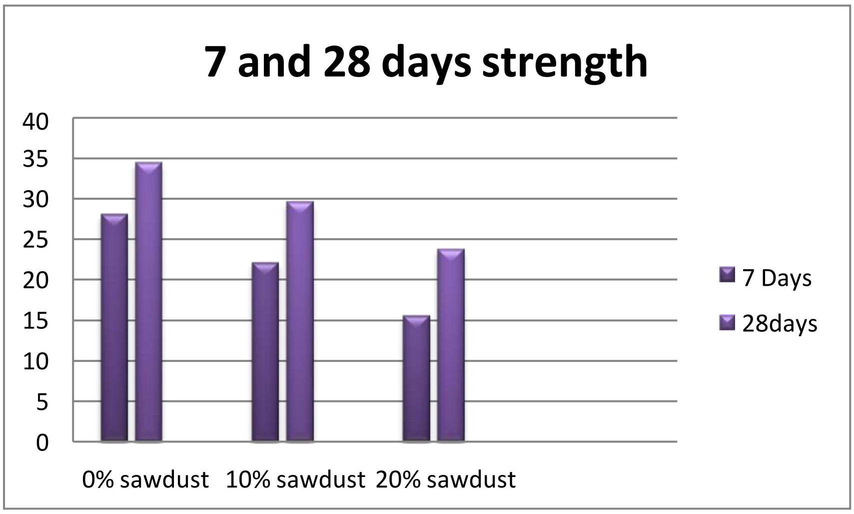

Fig XIV: Compressive strength cubes by self-curing method

Figure XIII and XIV shows the variation and comparison of compressive strengthforconcrete with and without sawdust as partial replacement of fine aggregate.

CHAPTER 8

CONCLUSIONS

The following are the conclusions that are drawn from the experimental investigations conducted on Sawdust concrete.

- The utilization of Saw dust in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of sand with Sawdust reduces the cost of making concrete.
- Saw dust concrete is light weight in nature and it proves to be environment friendly, thus paving way for green concrete.
- The result of compressive test indicated that the strength of concrete decreases with respect to the percentage of Saw dust added (10% and 20%). As the percentage sawdust content increased in the mix the compressive strength decreased.

- By comparison between conventionally cured concrete and self- cured concrete with respect to its compressive strength and density, we can conclude that compressive strength of conventionally cured concrete gives better result than self-cured concrete.
- There is reduction in density of sawdust concrete with increase in percentage of sawdust in concrete and also there is decrease in density of self-cured concrete as compared with conventionally cured concrete.
- Optimum replacement of sand with sawdust has been found to be 10% Beyond this limit, the concrete produced did not meet code requirements for strength as per BS 8110 (1997). Therefore, the strength was achieved when the replacement was donefor10% whereas the strength was not achieved when the replacement was done for20%.
- Use of sawdust as a waste in concrete decrease the pollution which is caused after burning of sawdust.

CHAPTER 9
REFERENCES

1. Abdullahi, M. Abubakar, A. Afolayan “Partial Replacement of Sand with Sawdustin Concrete Production” 3rd Biennial Engineering Conference, Federal University of Technology, Minna, May, 2013.
2. Abhishek Narayanan, Hemanth. G, Sampaul K, & Anne Mary, “Replacement of fineaggregate with sawdust”, International Journal of Advanced Research in Basic Engineering Sciences and Technology, April 2017.
3. A Sofi, Abhishek Saxena, Prateek Agrawal, Aryan Raj Sharma, Kamlesh Sharma, “Strength Predictions of Saw Dust in Concrete”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 12, December 2015.
4. Daniel Yaw Osei and Emmanuel Nana Jackson “Compressive Strength of Concrete Using Sawdust as Aggregate” International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016.
5. Dilip Kumar, Smita Singh, Neetesh Kumar and Ashish Gupta “Low-Cost Construction Material for Concrete as Sawdust” Global Journal of Researches in Engineering: Civil and Structural Engineering Volume 14 Issue 4 Version 1.0 Year 2014.
6. Gopinath. K, Anuratha. K, Hari Sundar. R, Saravanan. M, “Utilization of Saw Dust inCement Mortar & Cement Concrete”, International journal of scientific &engineeringresearch, Vol 6, 2015.
7. Mohammad Iqbal Malik, Syed Rumysa Jan, “Partial Replacement of Cement by Saw Dust Ash in Concrete a Sustainable Approach”, International Journal of Engineering Research and Development, 2015.
8. aheem. A, Olasunkanmi. B. S, Folorunso. C. S, “Saw Dust Ash as Partial Replacementfor Cement in Concrete”, Technology and management in construction, 2012.
9. S.M. Junaid, S. Saddam, M. Junaid, K. Yusuf, S.A. Huzaifa, “Self-curing concrete”, IJAFRSE. 2015; 1(Special issue).
10. Pappula Ganesh Kumar, K. Sundara Kumar, “Studies on strength characteristics offiber reinforced concrete with wood waste ash”, International Research Journalof Engineering and Technology (IRJET), Volume: 02, Dec-2015.
11. S. Tyagi. “An experimental investigation of self-curing concrete incorporated with

polyethylene glycol as self-curing agent", IRJET. 2015.
12. N. Y. ELWakkad1 KH. M. Heiza2 Prof Dr Aqial eladly3 "Review on – Self- Curing Concrete"
13. Tilak L.N, Santhosh Kumar M.B, Manvendra Singh, Niranjan "Use of Saw Dust As Fine Aggregate in Concrete Mixture" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 09 Sep 2018.
14. IS: 2386 (1963), Indian standard methods of test for aggregates for concrete, Bureau of Indian standards, New Delhi.IS: 383 (1970), Indian standard specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian standards, New Delhi.
15. IS: 4031 (1988), Indian standard methods of physical tests for hydraulic cement, Bureau of Indian standards, New Delhi.
16. IS: 12269 (2013), Indian standard ordinary Portland cement, 53 grade - specification, Bureau of Indian standards, New Delhi.
17. IS: 10262 (2009), Indian standard concrete mix proportioning - guidelines, Bureauof Indian standards, New Delhi.
18. IS: 516 (1959), Indian standard method of tests for strength of concrete, Bureau of Indian standards, New Delhi.