WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal Homepage: www.ijrpr.com ISSN 2582-7421

Utilization of Sawdust as a Partial Replacement of Fine Aggregate for Sustainable Hollow Concrete Block Production

Aashish Mahour[1], Mr. Ujjawal Bhargava[2], Dr. Manoj Sharma[3]

[1]M. Tech Students, IPS College of Technology &Management, Gwalior M. P., India.
[2]Asst. Professor, IPS College of Technology & Management Gwalior M. P., India.
[3]Professor, IPS College of Technology & Management Gwalior M. P., India.

ABSTRACT-

Hollow concrete blocks are widely used in residential, industrial, and multi-store construction. They are generally produced using Portland cement, fine aggregates, and water. Compared with conventional concrete, block mixtures typically contain a higher proportion of fine aggregate and lower water content.

The increasing demand for natural fine aggregates has led to resource depletion and environmental concerns, creating a need for sustainable alternative materials. Sawdust, a readily available waste material, can be utilized as a partial replacement for fine aggregate in hollow concrete blocks.

The objective of this experimental study is to evaluate the suitability of sawdust as a partial replacement for fine aggregate in hollow concrete blocks and to determine an optimum replacement level that provides acceptable strength, density, and overall performance. The study also aims to promote waste utilization, conserve natural resources, and support the development of more sustainable and economical construction materials.

The study was a laboratory experimental study conducted by preparing two types of HCB test samples. The first test sample of HCB was produced by using mix proportion 1:2:1:2 of cement, sand, gravel 00 and crushed aggregate respectively as a control group. The second sample HCBs were produced by replacing sand with sawdust in 4% increment in volume 4%. 8%, 12%, 16%, 20%, and 24%. but the result between 8% and 12% replacement shows high difference therefore 10% replacement is needed to get the intermediate result.

The experimental results indicate that the control hollow concrete block (HCB) without sawdust achieved a mean compressive strength of 5.09 MPa. With the incorporation of sawdust as a partial replacement for fine aggregate, the mean compressive strength decreased to 4.01 MPa at 10% replacement and 2.13 MPa at 20% replacement. Based on the strength requirements, 10% sawdust replacement was found suitable for Class B HCBs, while 20% replacement was considered acceptable for Class C HCBs.

The density and water absorption results also demonstrated the influence of sawdust incorporation. A 4% volumetric replacement of sand with sawdust reduced the block density by approximately 3.86%, while water absorption increased by about 2%. In addition, the use of sawdust resulted in a reduction in material cost compared with conventional HCBs. At 4% volumetric replacement, the material cost decreased by approximately 2.17rs (2%).

Keywords: Compressive Strengths, Fine aggregate, Hollow Concrete Block, Sawdust, HCB, Sand

INTRODUCTION

Concrete blocks are widely used in modern construction due to their strength and lightweight properties. Sawdust can be used as a partial replacement for fine aggregate (sand). This study investigates the use of sawdust in hollow concrete blocks in the Gwalior region. The study evaluates compressive strength, density, water absorption, and cost at different replacement levels. The results are compared with IS 2185 to check the suitability of sawdust for economical and lightweight blocks.

Statement of the problem

1. **Scarcity of Natural Sand:** Increasing demand and limited availability of natural fine aggregate have created a need for alternative materials in hollow concrete block production.

2. **Sawdust Waste Utilization:** Large quantities of sawdust are generated by wood and furniture industries in Gwalior. Its use as a partial replacement for fine aggregate can reduce waste, environmental pollution, and construction costs.

General Objective

- To determine the optimum quantity of sawdust as a partial replacement for fine aggregate.
- To produce strong, lightweight, and economical Hollow Concrete Blocks (HCBs).

Specific Objectives

1. To study the effect of sawdust on the physical properties of HCBs.
2. To evaluate compressive strength as per IS 2185 (Part 1):1979.
3. To determine the economic feasibility of using sawdust in HCB production.

Scope of the Study

1. To study the use of sawdust as a partial replacement for fine aggregate in hollow concrete blocks.
2. To test sawdust replacement levels from 0% to 24% at 4% intervals.
3. To prepare standard-sized hollow concrete blocks of 20 × 20 × 40 cm.
4. To examine the physical properties of sand, crushed aggregate, and sawdust.
5. To evaluate compressive strength, density, moisture content, and water absorption.
6. To compare the performance and production cost of sawdust blocks with conventional concrete blocks.

LITERATURE REVIEW

A. Raheem and O. K. Sulaiman (2013) This study investigates the use of Saw Dust Ash (SDA) as partial replacement for ordinary Portland cement (OPC) in sandcrete blocks. Some units of sandcrete hollow blocks were produced by partially replacing the cement content with 5% to 25% by weight of SDA, using vibrating block moulding machine. Sandcrete blocks without SDA serve as the control.

Pinki Kumari Md Daniyal (2020) The need for natural aggregates has intensified in the field of building and construction lately which, by default, is bringing about a tremendous diminution of resources, soaring of prices and simultaneously, the developing nations are perturbed about the management of the wood waste or sawdust To assess the performance of timber crete blocks at multiple replacement percentages and experimental study was conducted.

T. U. Ganiron Jr, (2013) 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.

Shoab Hussain, Savinth Kumar (may 2017) In Partial replacement of fine aggregate with Sawdust and Quarry dust. In this study the effect of quarry dust and sawdust, by adding 10%,15% and 20% with the fine aggregate, a matured fine aggregate has prepared.

Vignesh b, Lingaraju D (Dec 2016) In the research of partial replacement of quarry dust and saw dust in fine aggregate was experimentally carried out to investigate properties of both sawdust and quarry dust when used as partial replacement in brick

Pinki Kumari ,Md Daniyal ,Sajad Ahmad ,Bhat Yash Goyal(2020) "Effect of Replacement of Fine and Coarse Aggregate by Sawdust in Solid Concrete Blocks for Different Mix Proportions". JETIR.

Satya Prakash Sharma, Sanjit Kumar Yadav (2021) This paper reports the study of compressive strength of concrete involving brick powder and saw dust in different proportions of M-20 grade of concrete was taken for experimental study. Brick powder content was used 10 % partial replacement of cement and saw dust were used from 10% by replacing the fine aggregate. Brick powder were obtained by brick. The compressive strength of concrete was checked at 14 days and 28 days of curing period. The results show that concrete samples having saw dust and brick powder showed better strength as compared to controlled concrete samples. In the most recent decade, the use of waste materials in concrete production, particularly in addition to concrete has turn into an essential part.

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

Joefil Carl Osabel Dacorro

*

, Tomas Jr Aquino Diquito

Joefil Carl Osabel Dacorro, Tomas Jr Aquino Diquito. (2022) The construction industry has been grappling with what waste material can substitute for sand in producing quality hollow concrete blocks this gap motivated the researches to conduct this study which aimed to investigate the rigidity of concrete blocks using saw duct as a substitute for sand.

Nim Prasad Sharma (2026) Concrete is building material made by mixing cementing material and mineral aggregate with sufficient water to cause cement to set and bind entire mass. Now a day, due to demand of concrete increasing in construction work, it is necessary to develop such sources or material which can replace cement and sand in concrete. However, the cost of cement is rising due to high expenses of production and transportation.

Hollow Concrete Block-

1. Hollow concrete blocks are lightweight building materials containing one or more hollow cavities.
2. They are made from cement, aggregates, water and sometimes admixtures.
3. They are economical, easy to place and reduce foundation costs and cement consumption.
4. They provide faster construction, less labour, uniform quality and greater durability than conventional bricks.

Advantages of Hollow Concrete Blocks (HCB)

The important advantages of Hollow Concrete Blocks (HCB) from structural, architectural, construction, and environmental points of view are as follows:

1. **High Strength and Durability**: Hollow concrete blocks provide good load-bearing capacity, fire resistance and long-term durability.

2. **Lightweight and Economical:** Their hollow cavities reduce structural dead load, construction time and overall cost while providing thermal and sound insulation.

3. **Environment Friendly:** HCBs can incorporate waste materials such as fly ash and sawdust, reducing the use of natural resources.

RAW MATERIALS FOR HCB

Portland cement, fine aggregates and water are commonly raw materials used to make concrete mixture for production of hollow concrete blocks.

Cement

OPC (IS 269) is preferred for early strength development, while PPC (IS 1489 Part 1) is suitable for improved durability and long-term performance in hollow concrete blocks. Proper cement quality, fineness, mixing, compaction and curing are essential to achieve the required strength and quality as per IS 2185 (Part 1): 2005.

Ordinary Portland Cement (OPC): Commonly used for concrete block production and provides adequate early and ultimate strength.

Table No. 1 Chemical composition of cement

Oxide	**Function**	**Composition (%)**
CaO	Control strength and soundness. Its deficiency reduces strength and setting time	60-65
SiO_2	Gives strength. Excess of it causess low setting.	17-25
Al_2O_3	Responsible for quick setting, if in excess, it lower the strength	3-8
Fe_2O_3	Gives color and help in fusion of different ingredients	0.5-6
MgO	Important color and hardness. If in excess, it causes cracks in mortar and concrete and unsoundness	0.5-4
Na_2O+K_2O	These are residues and if in excess efflorescence and cracking	0.5-6
TiO_2		0.1-0.4
P_2O_5		0.1-0.2
SO_3	Makes cement sound	1-2

Aggregates

1. Aggregates are the major constituents of concrete, occupying about 70–80% of its volume and influencing strength, durability, workability and economy.

2. They are classified into fine and coarse aggregates, which provide bulk, reduce voids and improve the overall performance of concrete.

Coarse Aggregate: -

1. Coarse aggregate consists of particles retained on the 4.75 mm sieve and is obtained from natural rocks or by crushing stones.

1. Coarse aggregate consists of particles retained on the 4.75 mm sieve and is obtained from natural rocks or by crushing stones.

2. Its maximum size may be up to 80 mm, depending on the member thickness, reinforcement spacing and construction requirements.

3. For reinforced concrete, aggregate size should be selected carefully to ensure proper mixing, placing and compaction.

Fine aggregate: -

1. Fine aggregate consists of particles passing through the 4.75 mm sieve and includes natural sand, crushed stone sand and crushed gravel sand.

2. Based on particle size distribution, fine aggregates are classified into four grading zones.

3. Proper grading and proportioning of fine aggregate improve the strength, density, workability and economy of concrete.

Water for Hollow Concrete Blocks

The purpose of using water with cement is to cause hydration of the cement. Water in excess of that required for hydration acts as a lubricant between coarse and fine aggregates and produces a workable and economical concrete. Water is also used for washing aggregates and curing.

SAWDUST

1. Sawdust is used as a partial replacement for natural fine aggregate in hollow concrete blocks to reduce weight and utilize waste material.

2. Its effect on compressive strength, density, water absorption and workability is studied at different replacement percentages.

3. The study aims to determine the optimum sawdust replacement level for producing lightweight, economical and durable concrete blocks.



Fig. no. 1 Sawdust

Table No.2 Properties of saw dust

Si. No	Parameters	Value
1	Fineness Modulus	1.9
2	Moisture Content	9.80%
3	Bulk Density	615kg/m3

Chemical Composition –

(i) Carbon: approximately 49–50% (ii)Hydrogen: approximately 6%

(iii) Oxygen: approximately 44–45% (iv)Nitrogen**:** approximately 0.1–1%

The approximate composition of wood is cellulose 40–45%, hemicellulose 15–35% and lignin 17–35%**,** depending on the wood species.

RESEARCH METHODOLOGY

Production of HCB

The HCB produced for the research was class B and has the conventional dimension 40cm*20cm*20cm (L, W and H).

Production Process of HCB

Aggregate–Cement Ratio

1. The aggregate–cement ratio is selected based on the required strength, workability and density of concrete blocks.

2. In this study, Class B hollow concrete blocks are prepared using a cement-to-aggregate ratio of 1:6 by volume as per IS 2185 (Part 1):2005.

Volume beaching was used for the proportioning of materials. Two box were prepared for measuring materials, the first on was the conventional box used to proportioning material that have the volume of $0.04M^3$or 50cm* 40cm *20 cm (L, W and H) in dimension and the other one is that used to measure quantity of sawdust 4% of the total quantity of sand in one mix. The total quantity of sand in the mix was $2*0.04M^3= 0.08M^3$. Therefore 4% of sawdust from the total quantity of sand in one mix is $(4*0.08)/100 = 0.0032M^3$ or 20cm*16cm*10cm (L, W and H) in dimension



Figure No.2 Measuring box

The first sample was prepared by replacing 0% of fine aggregate with sawdust that was used as a control mix and the other sample mixes was prepared by increasing the percentage of sawdust replacement in 4%. The replacement was continued up 28%.



Figure No. 3 Batch mix

(ii)Water -Cement Ratio

1. A water-cement ratio of 0.50 was adopted for the control mix as per IS 2185.

2. Water content was adjusted in sawdust mixes due to the high water absorption capacity of sawdust to maintain proper workability.

Table No.3 water cement ratio

% of sawdust	**Amount of cement in Kg**	**Amount of water in Liter**	**Water cement ratio**
0	50	25	0.5
4	50	25.3	0.506
8	50	25.7	0.514
10	50	26.1	0.522
12	50	26.5	0.53
16	50	27	0.54
20	50	27.5	0.55
24	50	28.2	0.564

The table shows the relation sheep between water cement ratio and sawdust replacement percentage. When the amount saw dust increase, the water cement ratio also increases, the reason for this relation sheep is due to the moisture absorption property of sawdust.

cm x 20 cm x 20 cm (L, W, and H) and there was a proper curing for 14 days.

Batching

1. Batching is the process of measuring concrete ingredients in the required proportions.

2. Materials should preferably be batched by weight to ensure accuracy and uniformity.

3. Proper batching improves the quality and consistency of hollow concrete blocks as per IS 2185.

Mixing

1. Cement and aggregates are thoroughly mixed to obtain a uniform mixture before adding water.

2. Water is added gradually to achieve a cohesive, semi-dry mix suitable for moulding.

3. Mechanical mixing using a pan mixer ensures better uniformity and quality as per IS 2185.

Moulding

1. The concrete mix is placed uniformly into the mould in layers and compacted using vibration or mechanical compaction.

2. The surface is levelled, and blocks are carefully demoulded after sufficient hardening.

3. Proper curing is carried out as per IS 2185 to achieve the required strength and durability.




Figure No. 4 Casting procedure and casting machine

Curing

1. After moulding, blocks are protected from direct sunlight and drying winds for about 24 hours.

2. Water curing is carried out by keeping the blocks continuously damp.

3. Proper curing as per IS 2185 helps achieve the required strength and durability.

Drying Shrinkage

1. Drying shrinkage is the reduction in length of concrete blocks due to moisture loss during drying.

2. It depends on aggregate type, cement content, moisture content and curing conditions.

3. As per IS 2185 (Part 1):2005, the average drying shrinkage of three specimens should not exceed 0.1%.

Test

Then after there were laboratory tests within 7^{th}, 14^{th} and 28^{th} days for the compressive strength of HCB and at 28^{th} day such as, density, moisture content and absorption test for the HCB has been carryout then comparison are made between the mixes and with different standards specification.

Compressive Strength - Compressive strength of HCB depends on density, water–cement ratio, degree of compaction, cement content, curing and age of the block. As per IS 2185 compressive strength is determined at 28 days by testing the specified number of blocks in a compression testing machine.

The compressive strength is calculated as:

Compressive Strength = Maximum Load / Gross Cross-sectional Area

The average strength and individual block strength shall satisfy the minimum requirements specified in IS 2185 for the respective class of concrete masonry units.

Table No. 4 Compressive strength of hollow concrete block at 28 days

Types of hollow concrete block	**Class**	**Minimum compressive strength (N/mm2)**	
		Average of 6 unit	**Individual unit**
Load bearing	A	5.5	5
	B	4	3.2
Non load bearing	C	2	1.8

Table No. 5 Compressive strength of hollow concrete block at 28 days

Types of hollow concrete block	**Class**	**Density of block kg/m3**	**Minimum compressive strength (N/mm2)**	
			Average of 8 unit	**Individual unit**
Load bearing	A	Not less than 1500	3.5	2.8
			3.5	3.6
			5.5	4.4
			7.5	5.6

Types of hollow concrete block	**Class**	**Density of block kg/m3**	**Minimum compressive strength (N/mm2)**	
			Average of 8 unit	**Individual unit**
	B	1000-1500	2	1.6
			3	2.4
			5	4
Non load bearing		1000-1500	1.5	1.2

Sampling Procedure and Sample Size

The sampling procedure was purposive sampling, therefore the sample size was determined accordingly to the test specimen number required to conduct compressive strength, density, moisture content and absorption test for HCB. Therefore, there were 6 samples for compressive strength and 3 samples for moisture content, absorption and density tests in each % replacement and age. Table No. 6 total number of sample required

% of sawdust	**Number of sample**				**Total**
	For compressive strength test			**Density, moisture content and absorption test**	
	7th	**14th**	**28th**	**28th**	
0%	6	6	6	3	21
4%	6	6	6	3	21
8%	6	6	6	3	21
10%	6	6	6	3	21
12%	6	6	6	3	21
16%	6	6	6	3	21
20%	6	6	6	3	21
24%	6	6	6	3	21
Total number of sample					168

RESULT

Physical Properties of Materials

Sand

Size Gradation

Sieve analysis was carried out in accordance with IS 2386 (Part 1): 1963, and the test results are presented in the table below

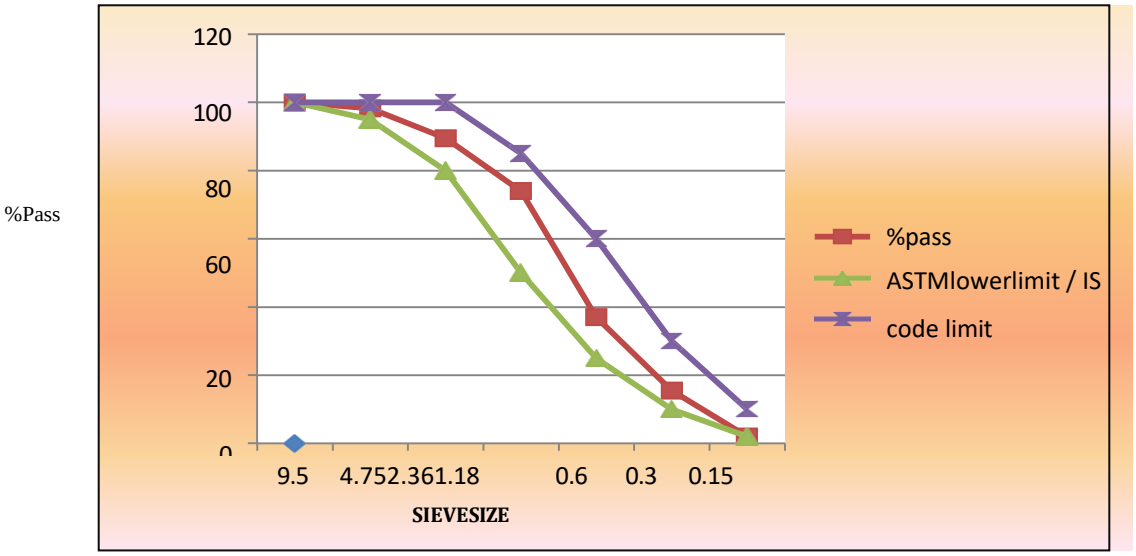
Table No. 7 sieve analysis of sand

Sieve size	**% pass**	**IS 383:2016 Standard (% Passing)**	**Remark**
9.5	100	100	ok
4.75	98.25	95-100	ok
2.36	89.5	80-100	ok
1.18	74	50-85	ok
0.6	37	25-60	ok
0.3	15.5	10-30	ok

Sieve size	**% pass**	**IS 383:2016 Standard (% Passing)**	**Remark**
0.15	2	2-10	ok
pan	0	FM=2.83	

According to IS 383:2016, the fineness modulus of fine aggregate generally lies within the range of 2.00 to 3.50. The sand used in this study has a fineness modulus of 2.83, which falls within the specified range. The grading curve also lies within the specified limits of IS 383:2016, as shown in the figure below.

Fig. no. 5 sieve analysis result graph



Both the table and figure show that the sand satisfies the requirements of IS 383:2016**.** Therefore, the sand is suitable for use as fine aggregate in the production of Hollow Concrete Blocks (HCB)**.**

Specific gravity and absorption

According to IS 2386 the specific gravity and water absorption of the sand were determined, and the test results are presented in the table below.

Table No. 8 Specific gravity and absorption test result

Description	**Variable**		**Weight in kg**	
sample		**sample 1**	**sample2**	**sample3**
Mass of saturated surface dry sample	A	0.5	0.5	0.5
Mass of pycnometer + water + sample	B	1.81	1.814	1.799
Mass of pycnometer +water	C	1.5	1.5	1.5
mass of oven dry sample	D	0.49	0.492	0.494
bulkSp.gr.(SSD)=A/(A-(B-C))	Sg	2.631	2.688	2.487
Mean bulk Sg				2.602
Absorption(A-D/D)*100	Abs	2.040	1.626	1.214
min Absorption				1.627



Figure No. 6 Pycnometer

According to IS 383:2016, the specific gravity and water absorption of the fine aggregate were determined, and the test results are presented in the table below. The results obtained were found to be satisfactory for the use of the material as fine aggregate in concrete.

Silt content

According to the test method specified in IS 2386 the percentage of material finer than 75 µm in the sand was determined by washing, and the test results are presented in the table below

Table No. 9 Silt content result

Description	**measurement**		
Sample	**sample 1**	**sample 2**	**sample3**
Weight of sample A	1	1	1
Weight of oven dry sample after washing B	0.97	0.972	0.975
Material finer than 75 µm (%) %(A-B/A)*100	3	2.8	2.5
Mean silt content	2.76		

According to IS 383:2016, the permissible limits for material finer than 75 µm in fine aggregate depend on the type and source of aggregate. The test results showed that the mean material finer than 75 µm in the sand was 2.76%**.** Therefore, the sand was considered suitable for use as fine aggregate in the production of Hollow Concrete Blocks (HCB)**.**

(iv) Moisture content

Table No. 10 Moisture content test result

Description	**Sample 1**	**Sample 2**	**Sample 3**
Weight of wet sample, A (kg)	0.500	0.500	0.500
Weight of oven-dried sample, B (kg)	0.493	0.492	0.494
Moisture content (%)	1.420	1.626	1.215

Formula**:**

Moisture Content (%)=A−B / B ×100

Mean moisture content:

=1.420+1.626+1.2153=1.420 %

Result: The mean moisture content of the sand sample is 1.420%.

The moisture contents should be within 0.5 % to 2%. The sand used to produce the HCB are within the limits.

Bulk unit weight

According to the test method specified in IS 2386 (Part 3): 1963, the bulk density of fine aggregate was determined, and the test results are presented in the following table.

Table No. 11 Bulk unit weight test result

Description	**Sample 1**	**Sample 2**	**Sample 3**
Weight of empty container, A (kg)	1.060	1.060	1.060
Weight of container + aggregate, B (kg)	8.600	8.630	8.655
Weight of aggregate, D = B − A (kg)	7.540	7.570	7.595
Volume of container, C (m^3)	0.005	0.005	0.005
Bulk unit weight, D/C (kg/m^3)	1508	1514	1519

Calculation:

Bulk Density = B−A/ C

For Sample 1:

$$= \frac{8.600-1.060}{0.005}$$

$$= \frac{7.540}{0.005}$$

1508 kg/m3

Mean bulk unit weight**:**

$$= \frac{1508+1514+1519}{3}$$

=1513.67 kg/m3

Equivalent to approximately 1.514 kg/L, the unit used in IS 2386 (Part 3): 1963.

Sawdust

(i) Size Gradation

The sieve analysis of sawdust was carried out to determine its particle size distribution. The test procedure was based on the sieve analysis method specified in IS 2386 (Part 1). The obtained results were compared with the grading limits for fine aggregates specified in IS 383:2016, Table 9. The results are presented in

Table No.12 Sieve Analysis Test Results of Sawdust Compared with IS 383:2016

Sieve size (mm)	**Percentage passing (%)**	**IS 383:2016 Grading Limits (%)**
9.5	100	100 for all zones (10 mm sieve)
4.75	97	90–100 (Zones I–III); 95–100 (Zone IV)
2.36	91	Zone I: 60–95; Zone II: 75–100; Zone III: 85–100; Zone IV: 85–100
1.18	84	Zone I: 30–70; Zone II: 55–90; Zone III: 75–100; Zone IV: 90–100
0.60	58	Zone I: 15–34; Zone II: 35–59; Zone III: 60–79; Zone IV: 80–100
0.30	32	Zone I: 5–20; Zone II: 8–30; Zone III: 12–40; Zone IV: 15–50
0.15	10	0–10 for all zones

According to IS 383:2016, fine aggregates are classified into four grading zones based on their particle size distribution. The test results indicate that 97% of the sawdust passes through the 4.75 mm sieve, while 32% passes through the 0.30 mm sieve.

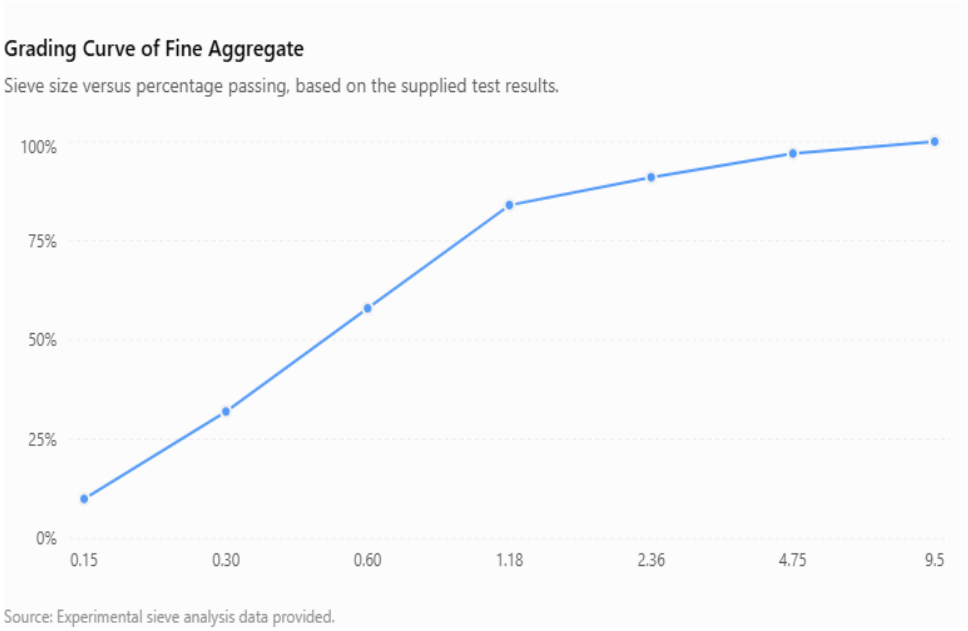


Figure No. 7 sieve analysis test result graph

Specific gravity and absorption

The specific gravity and water absorption of sawdust were determined to evaluate its physical properties for potential use as a partial replacement for fine aggregate in concrete. The test was conducted with reference to IS 2386.Methods of Test for Aggregates for Concrete: Specific Gravity, Density, Voids, Absorption and Bulking. The test results are presented in Table

Table No. 13 Specific Gravity and Water Absorption Test Results of Sawdust

Description	**Symbol**	**Sample 1**	**Sample 2**	**Sample 3**
Mass of saturated surface-dry sample (kg)	A	0.100	0.100	0.100
Mass of pycnometer + water + sample (kg)	B	1.520	1.519	1.521
Mass of pycnometer + water (kg)	C	1.470	1.470	1.470
Mass of oven-dry sample (kg)	D	0.096	0.097	0.095
Bulk specific gravity (SSD)	—	2.000	1.961	2.041
Water absorption (%)	—	4.167	3.093	5.263

The average bulk specific gravity (SSD) calculated from the three samples is approximately 2.001, and the average water absorption is approximately 4.174%**.**

Moisture content

The moisture content of sawdust was determined by the oven-drying method to evaluate the amount of moisture present in the material. The test was carried out with reference to IS 2386. Methods of Test for Aggregates for Concrete: Specific Gravity, Density, Voids, Absorption and Bulking. The experimental results are presented in table

Table No. 14 Moisture Content Test Results of Sawdust

Description	**Symbol**	**Sample 1**	**Sample 2**	**Sample 3**
Initial mass of sample (kg)	A	0.100	0.100	0.100
Mass of oven-dried sample (kg)	B	0.099	0.098	0.0979
Moisture content (%)	(A−B)/B×100(A-B)/B \times 100	1.010	2.041	2.145

The average moisture content of the sawdust was calculated to be approximately **1.732%**.

Bulk unit weight

The bulk unit weight of sawdust was determined to evaluate its bulk density in the loose or compacted condition, depending on the adopted filling procedure. The test was carried out with reference to IS 2386 (Part 3):1963, Methods of Test for Aggregates for Concrete: Specific Gravity, Density, Voids, Absorption and Bulking. The experimental results are presented in

Table No.15 Bulk Unit Weight Test Results of Sawdust

Description	**Symbol**	**Sample 1**	**Sample 2**	**Sample 3**
Weight of empty container (kg)	A	1.06	1.06	1.06
Weight of container + sawdust (kg)	B	2.02	2.00	2.04
Weight of sawdust (kg)	D = B − A	0.96	0.94	0.98
Volume of container (m^3)	C	0.005	0.005	0.005
Bulk unit weight (kg/m^3)	D/C	192	188	196

The average bulk unit weight of the sawdust was calculated as follows:

Average unit weight= $\frac{192+188+1963}{3}$ =192 kg/m3

Hollow Concrete Block Test Result

After the hollow concrete blocks are casted and cured to determine the physical requirement of HCB deferent laboratory tests like, compressive strength, density, absorption and moisture content are carryout that help us to compere the result between different percentage of sawdust and with standard specification.

Compressive strength

Compressive strength of the7^{th},14th and 28^{th} days of HCB was tested in the laboratory in different age of the HCB. A total of six (6) samples for each age and percentage of sawdust are taken and the results are shown below.



Figure No.8 test of HCB

The hollow concrete blocks (HCBs) were produced with reference to Indian Standard IS 2185 (Part 1):2005, using a mix ratio of 1:5 (cement to aggregate) or 1:2:1:2 (cement, sand, crushed fine aggregate, and crushed coarse aggregate). The target mean compressive strength was 4.0 MPa. The final grade of the blocks was to be determined based on compressive strength testing and compliance with the requirements of IS 2185.

Table No. 16 Compressive Strength Result of HCB

% of sawdust	**Mean compressive strength in MPa (average of six (6) HCB)**		
	7th day	**14th day**	**28th day**
0	2.6	3.71	5.09
4	2.44	3.5	4.76
8	2.27	3.4	4.5
10	2.2	3.33	4.01
12	1.92	2.99	3.58
16	1.74	2.17	2.73
20	1.67	1.98	2.13
24	1.21	1.42	1.69

The results show that compressive strength decreases as the percentage of sawdust replacement increases. The 7-day compressive strength was also compared with the 28-day strength, as concrete typically achieves approximately 50–75% of its 28-day strength at 7 days.

Table No. 17 7th day Compressive Strength Test Result

% of sawdust content	**7th day**	**Desired strength for class B HCB in MPa at the 28th day**	**% of strength achievedatthe7th day**
0	2.6	4	65
4	2.44	4	61
8	2.27	4	56.75

% of sawdust content	**7th day**	**Desired strength for class B HCB in MPa at the 28th day**	**% of strength achievedatthe7th day**
10	2.2	4	55
12	1.92	4	48
16	1.74	4	43.5
20	1.67	4	41.75
24	1.21	4	30.25

The first four replacement levels (0%–10%) achieved more than 50% strength at 7 days, while higher replacement levels showed lower strength gain. The compressive strength of HCBs increased with age due to cement hydration and curing.

Table No.18 28th day Compressive strength Test Result

% of sawdust	**Mean compressive strength in MPa (average of six (6) HCB)**		
	7th day	**14th day**	**28th day**
0	2.6	3.71	5.09
4	2.44	3.5	4.76
8	2.27	3.4	4.5
10	2.2	3.33	4.01
12	1.92	2.99	3.58
16	1.74	2.17	2.73
20	1.67	1.98	2.13
24	1.21	1.42	1.69

The maximum compressive strength was obtained at 0% sawdust replacement. Based on the experimental results, up to 10% sawdust replacement achieved the target strength of 4 MPa, while up to 20% achieved 2 MPa. The results indicate that increasing sawdust content reduces the compressive strength of HCBs compared with conventional blocks.

i)Naturally sawdust has low strength ii) Due to high amount of water in the mix.

In the process of mixing, when the percentage of sawdust increase, the amount of water to get the desired workable mix was also increased and it leads to the presence of high amount of water in the mix. The relationship between strength and water cement ratio is inversely proportional therefore, when the amount of sawdust replacement increase the compressive strength of the HCB had decreased. Due to low bonding characteristics of sawdust with other materials.

Moisture Content, Absorption and Density

Laboratory tests were conducted to determine the moisture content, absorption, and density of hollow concrete blocks (HCBs) in accordance with ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units, with reference to the applicable requirements of IS 2185. Three (3) samples were tested for each percentage replacement, and the results are described below.



Figure No 9 Density, Moisture content& Absorption test

Moisture Content

According to ASTM C140/C140M, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units, with reference to IS 2185 (Part 1): 2005, Concrete Masonry Units—Hollow and Solid Concrete Blocks, the moisture content of the unit at the time of sampling was calculated as a percentage of total absorption using the following equation*:*

(when *Wr* is measured) as follows:

Moisture Content% of total absorption =[(*Wr*–*Wd)*/ *(Ws*– *Wd)]x*100

where:

Wr=received weight of unit, kg, , *Wd*=oven-dry weight of unit, kg, and

Ws = saturated weight of unit, kg

Table No 19 Density, Moisture content & Absorption Test Result

% of sawdust	**Sample weight(Mr) in Kg**	**Weights in water(Wi) in Kg**	**SSD weight (Ws) in Kg**	**Oven dray weight (Wd) in Kg**	**Moisture content, % of total absorption**
0	15.6	8.7	16.1	14.8	61.94
4	15.38	8.5	16	14.4	60.12
8	15.14	8.2	15.9	14.05	58.6
10	14.89	8	15.8	13.6	57.33
12	14.62	7.7	15.7	13.2	56.34
16	14.33	7.4	15.6	12.7	55.55
20	14.02	7.1	15.5	12.2	54.87
24	13.69	6.8	15.4	11.7	54.3

As we see from the above table the moisture content, % of total absorptions lightly decreases when the amount of sawdust increase.

Water Absorption

The water absorption test of hollow concrete blocks incorporating different percentages of sawdust was carried out in accordance with IS 2185 (Part 1): 2005, Annex E. Water absorption was calculated using the following equations:

Water absorption (%) {A-B}{B}\100

Water absorption (kg/m³)

{A-B}{A-C}\1000

Where:

- (A) = Saturated mass of the specimen, kg
- (B) = Oven-dry mass of the specimen, kg
- (C) = Suspended mass of the specimen immersed in water, kg

The water absorption results for different sawdust replacement percentages are presented in

Table No. 20 result for absorption

Sawdust replacement (%)	**Sample mass (kg)**	**Immersed mass, C (kg)**	**Saturated mass, A (kg)**	**Oven-dry mass, B (kg)**	**Absorption (%)**	**Absorption (kg/m³)**
0	15.60	8.70	16.10	14.80	8.78	175.44
4	15.38	8.50	16.00	14.40	11.11	212.77
8	15.14	8.20	15.90	14.05	13.17	237.23

Sawdust replacement (%)	Sample mass (kg)	Immersed mass, C (kg)	Saturated mass, A (kg)	Oven-dry mass, B (kg)	Absorption (%)	Absorption (kg/m³)
10	14.89	8.00	15.80	13.60	16.18	278.35
12	14.62	7.70	15.70	13.20	18.94	320.00
16	14.33	7.40	15.60	12.70	22.83	339.51
20	14.02	7.10	15.50	12.20	27.05	351.52
24	13.69	6.80	15.40	11.70	31.62	329.67

According to IS 2185 (Part 1): 2005, the water absorption of concrete blocks shall not exceed 10% by mass, based on the average of three units. The results indicate that water absorption increases with an increase in sawdust content. Replacing sand with 10% and 20% sawdust by volume increased water absorption by approximately 7% and 16%, respectively, compared with the control mix. Therefore, the sawdust replacement level should be selected carefully to satisfy the specified requirements.

Density

According to ASTMC140 calculate oven-dry density as follows: Density, (D), $kg/m^3 = [Wd/ (Ws – Wi)]$ x 1000

Where:

Wd = oven-dry weight of specimen, kg, *Ws*=saturated weight of specimen, kg, and *Wi* = immersed weight of specimen, kg

Table No.21 result for density of HCB.

% Of sawdust	Average Sample mass(Mr) in Kg	Average Weightsin water(Wi) in Kg	Average SSD weight(Ws)in Kg	Average Oven dray weight (Wd) in Kg	Average Density inKg/m³
0	15.6	8.7	16.1	14.8	2000.05
4	15.38	8.5	16	14.4	1921.54
8	15.14	8.2	15.9	14.05	1829.13
10	14.89	8	15.8	13.6	1743.41
12	14.62	7.7	15.7	13.2	1657.76
16	14.33	7.4	15.6	12.7	1549.09
20	14.02	7.1	15.5	12.2	1452.65
24	13.69	6.8	15.4	11.7	1309.04

CONCLUSION

1. Sawdust can replace sand up to 10% in Class B and 20% in Class C hollow concrete blocks while satisfying the required compressive strength.

2. Sawdust replacement increases water demand and water absorption due to its porous nature.

3. Compressive strength decreases with increasing sawdust content because of its lower strength and weaker bonding with cement.

4. The density of HCBs decreases by 12–26%, producing lighter concrete blocks.

5. Sawdust replacement reduces material costs by approximately 5–10%, saving ₹6.51 for Class B and ₹10.86 for Class C HCBs.

Reference

(1) S.T. Tyagher et al (2011), long man science and technology, Horrow esses, U.K, Proportion of concrete.

(2) Maharani Riziki et al (2010), Journal of forestry research, scrutiny of physical properties of Sawdust from tropical countries wood species: Effect of different mills and Sawdust particle size.

(3) L.O. Ettu, et al (2013), Variation of OPC- Rice Husk Ash- Saw Dust Ash composites strength with mix proportion ISSN:2277-9655 Impact factor: 1.852 Ettu. 2(8): August,2013)

(4) Daniel Yaw osier et al (2016), international journal of scientific research, compressive strength of concrete using Sawdust as aggregate. © 2020 JETIR June 2020, Volume 7, Issue 6 www.jetir.org (ISSN-2349-5162) JETIR2006084 Journal of Emerging Technologies and Innovative Research (JETIR)

(5) Adebakin I. Adeyemi A., Adu J. T,.Ajayi F., Lawal A. O.(2012) "Usesof sawdust as admixture in production of lowcost and light-weight hollow sandcrete blocks"

(6) Divatar Y., Manjunath S., Aswath M.U., (2012). "Experimental Investigation on Behaviour of Concrete with the Use of Granite Fines". International Journal of Advance Engineering .

(7) Kumar, Dilip and Singh, Smita and Kumar, Neetesh and Gupta, Ashish 2014 "Low Cost Construction Material for Concrete"

(8) Elinwa A.U and Abdulkadir S., (2011). "Characterizing Saw Dust Ash for Use as an Inhibitor for Reinforcement Corrosion". New Clues in Sciences, 1, 1 -10.

(9) Mageswari M. and Vidivelli B., (2010). "The Use of Sawdust Ash as Fine Aggregate Replacement in Concrete". Journal of Environment Research and Development,3

(10) Dr.Suji.D,Narayanan. A. M,etal (June 2016),"Experimental Study on Partial Replacement of Fine Aggregates with Quarry dust and Sawdust".

(11) K.Gopinath,K.Anuratha (August 2015). "Utilization of Sawdust in Cement mortar and Cement Concrete".

(12) Shoab Hussain, Savinth Kumar (may 2017**).** "Experimental Study on Partial replacement of fine aggregate with Sawdust and Quarry dust.

(13) Vignesh b, Lingaraju D (Dec 2016). "Experimental study on partial replacement of quarry dust and saw dust in fine aggregate".

(14) Application, Innovative and Sawdust,of and Used, Wastage,{2016}

(15) T. U. Ganiron Jr, "Investigation on the use of Coco Coir Polypropylene as Thermal Insulator", International Journal of Advanced Science and Technology, vol. 59, (2013).

(16) Satya Prakash Sharma , Sanjit Kumar Yadav (2021) Experimental Investigation On Partial Replacement Of Cement With Brick Powder And Fine Aggregate With Saw Dust." ijarse

(17) Joefil Carl Osabel Dacorro, Tomas Jr Aquino Diquito. (2022) Utilization of Sawdust in Making Concrete Blocks: An Experimental Research on Hollow Concrete Block's Rigidity. International Journal of Industrial and Manufacturing Systems Engineering.

(18) Nim Prasad Sharma (2026) **"**Experimental Study on Physical and Mechanical Characteristics of Concrete with Partial Replacement of Cement by Wood ash and Partial Replacement of Fine Aggregate by Saw Dust Dowder". Journal of Physical and Life Sciences.