



Utilisation of Agriculture Waste In Concrete To Enhance Its Properties

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Abstract— Concrete is the most extensively used man-made construction material in the world. Its most important quality is its versatility and the ability to design the concrete of any required properties according to the environment. Human development in today's scenario is impossible without the excessive use of concrete. Cement is the most important component of concrete. Unfortunately production of cement emits a very large amount of greenhouse gases and possess a very potential threat to the atmosphere. Thus it is inevitable for the sustainable development of human life that the dependency on cement to obtain strength in concrete should be lowered. This is the main reason to obtain a suitable replacement of cement to obtain high strength concrete at a low cost incurred. Also the modern constructions require very high strength in concrete which is only possible by mixing a suitable quantity of admixtures in the concrete. The earth is abundant with RHA and sawdust. However, disposing of such large amounts of agricultural waste has become a major environmental threat. Research has shown that the byproducts of both materials have pozzolanic properties that allow them to be partially substituted for cement in the construction industry, creating environmentally friendly concrete and reducing the emission of harmful gases that are produced when cement reacts during concrete formation. Their disposal has gotten more expensive as a result of the most recent laws and regulations. Therefore, it's imperative to identify a suitable and beneficial application for these waste materials. Due to their high siliceous content and pozzolanic qualities, these materials can be added to concrete mixes as an additive to achieve high strength or utilized in place of cement. The two main factors that affect how well concrete performs in any field application are its flexural and compressive strengths. It is therefore important to find out how these admixtures affect the concrete's compressive and flexural strengths. One way to determine which admixture is best for a given case is to conduct a comparison research that evaluates the relative effects of these admixtures on concrete strength.

Keywords— Rice Husk Ash, Saw Dust Ash, Concrete, Environment Friendly.

I. INTRODUCTION

One of the most often used building materials is concrete. All things considered, it is a combination of water, additive, aggregate (filler materials), and cement (binding substance). It offers a broad range of design strength, is easy to work with, and can be shaped into any required shape. It is consequently used in almost all construction projects that have charitable purposes. For concrete to function as a binding substance, cement is essential. Nevertheless, there are a lot of natural hazards associated with producing concrete, including resource depletion due to the extraction of crude materials, noise pollution, air contamination, vibrations in the ground, and cement dust. Gases from cement factories mostly consist of CO₂, N₂, O₂, SO₂, water vapor, and microscopic components like CO and NO_x. One of the two largest industries in the world for carbon dioxide (CO₂) production, accounting for up to 8% of the gas produced by humans, half of which comes

from chemical reactions and the other 40% from fuel consumption. It is estimated that 410 kg/m³ of CO₂ is created by structural concrete. For every metric ton of concrete produced, about 900 kg of CO₂ emissions are released. A significant greenhouse gas is CO₂. In this sense, the process of making cement releases greenhouse gases into the atmosphere through the simple breakdown of calcium carbonate and the additional expenditure of energy, particularly from the burning of fossil fuels. Therefore, it is anticipated that we will find alternative optional materials for concrete in place of cement. Should we be prepared to replace a little percentage of cement in concrete, it will help reduce carbon dioxide emissions. From various investigation projects, certain mechanical wastes are found that can reduce the amount of concrete in cement without compromising its important qualities (e.g. durability). A variety of industrial wastes can be used as reinforcing cementitious materials, including fly ash, silica fume, granulated blast furnace slag, and rice husk ash.

A. Rice Husk Ash (RHA)

Rice husk ash (RHA) plays two roles in concrete constructions. The first role is using rice husk as a substitute for Portland cement which leads to the reduction of the cost of concrete, and the other role is as an admixture in the production of high strength concrete. Note that the kind of rice husk ash used in concrete is not crystalline, but rather amorphous, making it appropriate for pozzolanic activity. In addition to being used in roofing shingles and ceramic glaze, rice husk ash has many uses in construction, including high-performance concrete, insulation, green concrete, bathroom floors, and industrial manufacturing flooring.

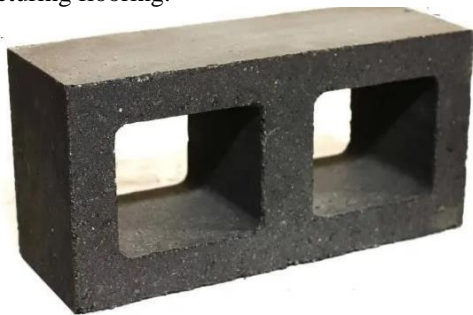


Fig 1: Rice Husk Ash Used to Replace Part of Cement for the Construction of Concrete Blocks

B. Saw Dust Ash

A collection of fine wood particles, sawdust is a byproduct of drilling, grinding, cutting, sanding, or other wood-pulverizing operations with a saw or other tool. Additionally, some creatures, birds, and insects—like woodpeckers and carpenter ants—that live in wood produce it as a byproduct. Particularly when it comes to combustion, it may pose a risk to manufacturing businesses. Particleboard is the primary ingredient in sawdust. Sawdust is mostly used to make particleboard; coarse sawdust is used to make wood pulp. Additional useful applications for sawdust include mulching, fueling, and replacing clay cat litter. Until the advent of refrigeration, it was mostly used in icehouses to maintain ice frozen during the hot season. It has been used in artistic displays, and as scatter. Occasionally, it is also used to absorb liquid spills, making it simple to sweep or collect the spill. It was therefore frequently seen on barroom flooring in the past. Mostly, it is utilized to manufacture cutter's resin. Pykrete, a significantly stronger, slowly-melting type of ice, is created when water is mixed with it and then frozen. To make charcoal briquettes, sawdust is utilized.

II. LITERATURE REVIEW

Rakesh and Rao (2023) The author's main area of interest is the partial substitution of rice husk ash (RHA) for cement in the manufacturing of geopolymer concrete. An agricultural waste product that is widely accessible and frequently thrown away as waste is rice husk ash. The goal of adding RHA to geopolymer concrete M40 was to assess

how well it performed as a cement substitute in geopolymer concrete prepared with varying ratios of rice husk ash. Results indicated a significant enhancement in the physical and mechanical properties of concrete with a maximum replacement of 8% by weight with rice husk ash. This substitution leads to a 30% reduction in construction costs, particularly advantageous when cement availability is limited or distant. Moreover, the utilization of rice husk ash as a replacement material reduces the need for waste disposal, thereby mitigating environmental pollution.

Haque et.al (2023) in the research paper, synthetic hydrocarbon polymer called polypropylene fibre (PPF) used as partial replacement of fine aggregate was added to the concrete to increase its compressive and split tensile strength. A variety of specimens using different amounts of polypropylene waste, including (0%, 0.25%, 0.5%, 0.75%, and 1.00%) was created. The compressive strength and split tensile strength of the fiber reinforced concrete (FRC) were measured after 7 and 28 days of curing, whereas the density of the FRC was assessed right away after the preparation of the concrete mix.

Results stated that adding polypropylene fibre causes the density of new fiber-reinforced concrete (FRC) to slightly or barely decrease from 2397 kg/cm³ to 2393 kg/cm³. For all curing ages up to a specific point, adding discarded polypropylene fibre increases the strength of fibre reinforced concrete (FRC). The strength of the Fibre Reinforced Concrete (FRC) suddenly decreases after that. For maximal strength with a low coefficient of brittleness, 0.5% polypropylene fibre addition was advised. The Fibre Reinforced Concrete (FRC)'s compressive strength increases by 10% and its split tensile strength by 17% with the addition of 0.5% waste polypropylene fibre.

Punitha and Ambiga (2023) A study documented how the mechanical qualities of concrete, such as compressive strength, were affected by the behavior of concrete composed of cement containing different amounts of RHA and Bentonite. A comprehensive experimental study was conducted to examine the effects of replace cement with a gradually increasing percentage of RHA by 5% and a concurrent decrease in cement by adding a constant 10% of Bentonite (as admixture) in combined proportions ranging from 0 percent RHA to 100% cement mix together in concrete. The final proportion was 15 percent RHA and 85 percent cement with 10 percent of Bentonite as admixture. The hardened concrete tests were destructive in nature, including a compressive test on a cube for size (150×150×150mm) 3, 7, 14 and 28 days of curing as per IS: 516-1959.

Jangral et.al (2022) The study report examined the qualities of rice husk ash, which was added to concrete as a cementitious additive. Examining the concrete's strength and workability criteria was another endeavor. Mix design for regular concrete was created using the Indian Standard (IS) technique as a guide, and mix design for rice husk ash substitution was created using this method as well. In terms of the replacement approach, four distinct replacement

levels—10%, 15%, 20%, and 5%—are chosen and examined. Compressive strength of the concrete The mixtures with and without rice husk ash were compared after seven and twenty-eight days of curing.

Muleya et.al (2021) The purpose of the author's study was to examine the integrity of concrete made in Zambia that had been partially replaced with cement by rice husk ash (RHA). The principal objective was to perform a cost-benefit analysis for the application of RHA in concrete. At ratios of 10%, 20%, and 30%, RHA was utilized to partially replace cement.

The best 18 MPa concrete strength results were obtained at a water/binder ratio of 0.5 when a 20% cement replacement mix was used, according to the data. In tangible terms, this resulted in a 12.5% cost decrease, which is especially noteworthy for larger concrete quantities. Low-income communities can profit from the produced concrete by using it for lightly laden buildings like surface beds, foundation footings, and pathways. Additional findings showed that because RHA transportation costs were lower, RHA-based concrete was more economical to use in buildings near rice-growing regions.

Pandey and Kumar (2021) To ascertain the criteria of concrete strength, the author carried out a research utilizing varying amounts of cement and rice husk ash supplementation. We tested M20 grade concrete, which is designed in accordance with Indian regulations, with cement amounts substituted by 2.5%, 5%, 7.5%, 10%, and 15% of the total weight.

Diverse strengths The test results show that rice husk can replace 5% of cement in a construction project and yet achieve an increase in strength of 9.78% and 25.09% in compressive strength and flexural strength, respectively, above the control mix. The modified concrete's pulse velocity test, conducted with rice husk ash replacing 5% of the cement, verifies that the dense concrete matrix is "good."

Manan et.al (2021) The author's goals were to ascertain the material engineering characteristics of banana skin ash (BSA) and concrete that contains BSA, quantify the increase in concrete strength brought about by BSA, and pinpoint the best way to use BSA as supplemental cement material (SCM) in concrete. X-ray fluorescence (XRF) and Blaine's air permeability were used to evaluate the BSA characterisation. Slump test, universal testing machine (UTM), and scanning electron microscope (SEM) were used to analyze the workability, compressive strength, and microstructures of concrete containing BSA.

III. MATERIAL AND PROPERTIES

A. General

The physical and chemical properties of materials used in the experimental analysis are presented in this section which includes cement, coarse aggregate, fine aggregate, ceramic waste powder, water and admixture.

B. Cement

Ordinary Portland Cement of Grade 53 is used, which conforms to IS 12269:53 grade cement of ultratech with remarkably high CS₃ (tricalcium providing long-lasting) durability of concrete constructions. Produces highly durable and sound concrete due to really low percentage of alkalis chlorides, magnesium oxide.



Fig: 2 Cement

Table 1 Physical properties of cement

Test Parameter	Result
Normal Consistency	29.50%
Initial Setting Time	30 minutes
Final Setting Time	600 minutes
Specific Gravity	3.13
Fineness	4%
Soundness	1.3 mm

C. Fine Aggregate

Natural river sand conforming to Zone II as per IS 383 (1987) was employed. The fineness modulus of sand used is 2.64 with a specific gravity of 2.59. As fine aggregate (FA), river sand that was readily available in local area was used for concrete preparation whose physical properties were as presented in the table below. The sand was thoroughly cleaned for removal of any deleterious contents before the testing.

D. Coarse Aggregate

Crushed granite coarse aggregate conforming to IS: 383 (1987) was used. Coarse aggregate of size 20mm down having the specific gravity of 2.77 and fineness modulus of 7.21 was used.



Fig:3 Aggregate

E. Rice Husk Ash (RHA)

Burning rice husks results in RHA. Silicate deposits are crucial because they replace a significant amount of the rice husk's evaporable components, which are eventually

lost during consumption. Rice husk arrangement, consuming temperature, and consuming time all affect the characteristics of the debris. RHA is produced in around 25 kg for every 100 kilogram of husks used in a heater, for example. A dependable supplier, "Narmda Rice Mill," located in Bankhedi, Piparia, provided the rice husk ash needed for this experimental project.



Fig 3: Rice Husk and Rice Husk Ash

F. Saw Dust

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding or otherwise pulverising wood with a saw or other tool; it is composed of fine particles of wood. Sawdust or wood waste was taken from T.T furniture, Old city, Bhopal where furniture of different types are constructed on a large scale. Sawdust is collected and then burning process of saw dust continues for 18 hours and cooling operation of saw dust continues for 10 hours and saw dust are ready to apply.



Fig 4: Saw Dust

IV. METHODOLOGY

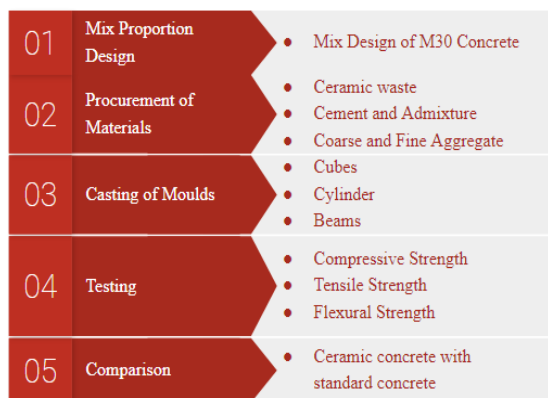


Fig 5: Methodology

V. EXPERIMENTAL PROCEDURE AND TESTING

A. Slump Cone Test

Objective of the Slump Cone Test

The word —workability or workable concrete signifies much wider and deeper meaning than the other terminology —consistency often used loosely for workability. The word "consistency" is used generally to describe how flexible or mobile something is. The following variables aid in the greater lubricating effect of concrete, lowering internal friction and facilitating easier compaction: (a) water content; (b) mix proportions; (c) Aggregate Size (d) Aggregate Shape (e) Aggregate Surface Texture (f) Aggregate Grading (g) Utilizing Blends.

The most popular technique for determining the consistency of concrete, which can be done in a lab or on the job site, is the slump test. For concrete that is extremely dry or wet, this approach is inappropriate. It does not always accurately reflect the placeability of the concrete and does not quantify every component that affects workability. Beyond the slump value, it also reflects the concrete's nature. A real slump is observed in concrete when the slump is uniform. Shear slump is the term used when one side of the cone slides down. When a shear slump occurs, the height difference between the mold's height and the average subsidence value is used to calculate the slump value.

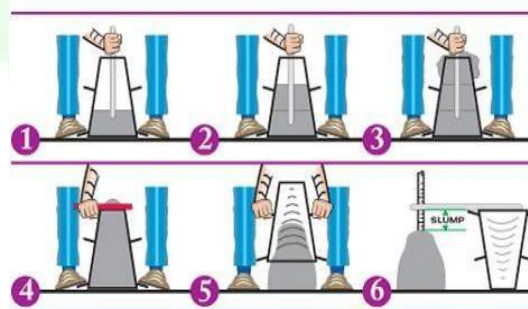


Fig:6 Concrete Slump Test Procedure

B. Procedure of Slump Cone Test

a) In the event that this test is conducted in the field, sample mixed concrete must be acquired. When concrete has aggregate that is larger than 38 mm in maximum size, it must be wet-sieved through a 1.5-inch screen to remove any aggregate particles that are larger than 38 mm.

b) Before starting the test, it is necessary to completely clean the interior surface of the mold and remove any excess moisture and set concrete. The mold needs to be set up on a leveled metal plate or another smooth, horizontal, sturdy, and non-absorbent surface. The mold needs to be securely held in place during the filling process.

c) Three layers, each roughly one-quarter the height of the mold, must be filled in. The rounded end of the tamping rod should be used to tamp each layer 25 times. In order for the second and succeeding layers to penetrate the underlying layer, the strokes must be evenly dispersed throughout the mold's cross-section.

d) All the way to the bottom, the layer must be compacted. Once the uppermost layer has been rodded, the concrete needs to be leveled using a trowel or tamping rod to ensure that the mold is precisely filled.

e) Once the top layer has been rodded, use the tamping rod to roll and screed the concrete surface to remove any remaining material.

f) It must be cleaned up if any mortar seeped out between the base plate and the mold. The mold must be swiftly removed from the concrete by cautiously and slowly elevating it vertically. This enables the concrete to sink, and the slump may be quickly determined by comparing the height of the tested specimen's highest point with the height of the mold.

g) Within two minutes of sampling, the aforementioned procedures must be completed in a location free from shock or vibration.

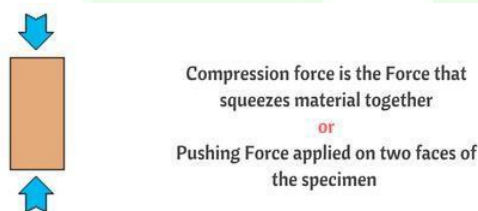


Fig 7: Compressive Force

C. Compressive Strength of Concrete (Cube Test, Procedure, Apparatus & Results)

Concrete is naturally curious because it is the second most consumed substance after water. Concrete's strength mostly comes from its aggregates, although cement and sand also help the material flow and bind together.

The Compressive Strength of Concrete is the subject of this extensive article. If the purpose of your visit is to learn how to test concrete's compressive strength.

Compressive strength of Concrete and its importance Numerous variables, including the specific compressive strengths of the material's elements (cement, sand, and aggregate), the quality of the materials used, the ratio of water to cement, the curing process, and the effects of temperature, all affect how strong the concrete is.

Compressive strength provides an indication of total strength and the previously described components. This test makes it simple to determine the concrete strength in pounds per square inch and the caliber of the concrete that is produced.

D. Procedure for Compressive Strength Test:

The test is carried out using 150mm concrete cubes on a Universal Testing Machine or compressive testing machine. (a) Apparatus: As per IS: 516-1959 Compressive testing machine (2000Kn), 15cm×15cm×15cm steel cube moulds or Cylinder having Dia 15 cm and length 30 cm are used.



Fig:8 Steel Cube 150mm x 150mm x 150mm

(b) Procedure:

- Place the prepared concrete mix in the steel cube mould for casting.
- Once it sets, After 24 hours remove the concrete cube from the mould.
- Keep the test specimens submerged underwater for stipulated time.
- The specimen needs to be kept in water for seven, fourteen, or twenty-eight days, and the water needs to be changed every seven days.



Fig: 9 Cube Curing



Fig: 10 Universal Testing Machine (UTM)



Fig: 11 Compressive Strength Test

VI. RESULTS AND DISCUSSION TESTING

A. Compressive Strength

The strength of concrete is evaluated on parameters of compressive strength, flexural strength and tensile strength and results are compared for control mix with ratio 0%, 5%, 10%, 15%, 20%, 25% and there different combination. The cube size of 150mm x 150mm x150mm is used in this experimental study to identify the compressive strength of concrete. For each type of mix cubes were casted for 7days and 28 days. 14 Cubes were casted for two different waste materials and its combination and placed in curing tank up to testing date.

Table 2 Compressive Strength in N/mm²

Compressive Strength in N/mm ²		
Concrete Mix	7 Days	28 Days
0%	17.89	31.95
5% RHA	16.95	35.36
10% RHA	14.78	33.29
15% RHA	9.1	26.34
20% RHA	8.92	20.63
25% RHA	7.94	15.58
5% SD	19.25	33.65
10% SD	20.32	34.54
15% SD	18.98	33.81
20% SD	16.84	31.57
25% SD	13.26	26.35
5% RHA+15%SDA	14.79	32.1
10% RHA+10%SDA	19.21	35.47
15% RHA+5%SDA	12.97	27.98

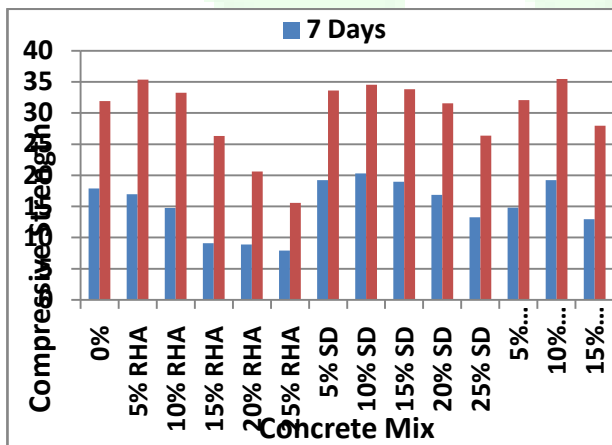


Fig 12: Compressive Strength in N/mm²

Inference- .With an increase in the percentage of rice husk ash in the concrete mixes, the compaction factor value falls. The fact that the compacting factor value has decreased indicates that the concrete is less workable. The fact that the percentage of rice husk ash has increased indicates that the mixture is becoming more workable as additional water is added. Because there is more silica in the mixture, rice husk ash concrete requires more water. Up to a 10% replacement of rice husk ash in the concrete mix boosts the mix's compression strength; after that, a progressive decline in compressive strength is observed. Test results shows that the compressive strength of the material is increased by the addition of sawdust ash. The best combination is visible for combination of 10% RHA and

10% SD with increase of 11.1% in compressive strength when compared to conventional concrete mix.

B. Flexural Strength

The unreinforced beam of 100 x 100mm x 500mm is used. Because of the concrete brittleness, the failure occur suddenly and single crack will be obtained at the time of failure of a beam. This test is conducted under Universal Testing Machine. The average load carrying capacities of unreinforced sawdust ash concrete with conventional is little bit high at different mix.

Table 3 Flexural Strength in N/mm²

Flexural Strength in N/mm ²		
Concrete Mix	7 Days	28 Days
0%	2.85	4.36
5% RHA	2.98	4.85
10% RHA	2.36	4.43
15% RHA	1.42	3.63
20% RHA	1.27	2.18
25% RHA	1.15	1.69
5% SD	2.39	3.46
10% SD	2.25	3.76
15% SD	2.82	4.18
20% SD	2.41	3.92
25% SD	2.29	3.35
5% RHA+15%SDA	2.17	3.24
10% RHA+10%SDA	2.92	3.97
15% RHA+5%SDA	2.47	3.38

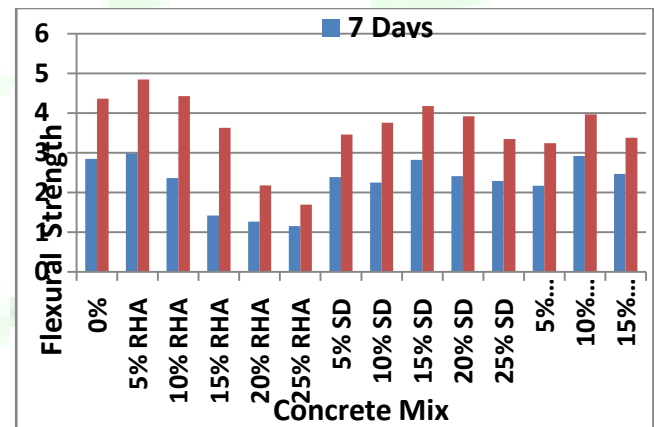


Fig13: Flexural Strength in N/mm²

Inference- The rice husk ash concrete's flexural strength indicates an increase in RHA concrete's strength. The conventional mix's flexure strength after seven days is 2.85, but the addition of 5% rice husk ash results in a 2.98 strength increase. All other mixes then exhibit a decrease in flexural strength and a linear down of the curve. And the flexural strength after 28 days yields good results. The strength, or the replacement of 5% and 10% of rice husk ash, increases the concrete mix's strength as compared to the conventional mixture's strength of 4.36. For 5% and 10% replacement, the two mixes' flexural strengths increase to 4.85 and 4.43, respectively, while the other mixes' flexure

strength decreases after the 10% replacement. Therefore, up to 10% of the concrete mix can be replaced with rice husk ash as a replacement material. Furthermore, adding more rice husk ash than 10% of the original mix tends to reduce the concrete's flexural strength. 1.2% increase is visible for 5% RHA sample compared to conventional mix and decrease of 6.3% when considering 5% SD.

C. Split Tensile Strength

Tensile strength of concrete was determined by using UTM. The split tensile strength of concrete was tested using 100mm x 300mm cylinder specimens are carried out by placing a specimen between the loading surfaces of UTM and the load was applied until the failure of the specimen. The average value of specimens for each mix at the age of 7 days and 28 days.

Table 4 Split Tensile Strength

Split Tensile Strength in N/mm ²		
Concrete Mix	7 Days	28 Days
0%	2.45	2.79
5% RHA	2.89	3.86
10% RHA	2.37	2.83
15% RHA	2.12	2.65
20% RHA	1.91	2.09
25% RHA	1.26	1.78
5% SD	1.83	2.73
10% SD	1.77	2.61
15% SD	1.92	2.97
20% SD	1.79	2.68
25% SD	1.67	2.59
5% RHA+15%SDA	1.93	2.9
10% RHA+10%SDA	2.26	3.21
15% RHA+5%SDA	2.07	2.87

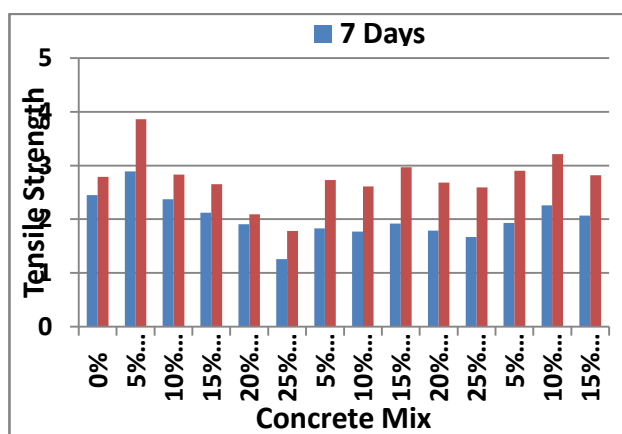


Fig14: Split Tensile Strength in N/mm²

VII. CONCLUSION AND FUTURE SCOPE

The utilization of saw dust ash and rice hush ash in concrete was found to be economical and free of cost. It was recognized that the workability of concrete was decreased by the addition of the alternative materials

which has increased the demand of water while mixing concrete when compared to conventional concrete. The use of such materials in concrete conserves resources, notably cement, and thereby ensures the long-term sustainability of the concrete construction sector.

- Up to a certain point, cement can be used to partially replace agricultural waste like RHA and SDA, according to the study. In the case of RHA, cement replacement is allowed up to 20%, but for optimal strength, it should only be changed up to 5%. In contrast, SDA cement replacement is allowed up to 10%, but only up to 5% for good strength. Concrete's strength may diminish if certain limits are exceeded. Because RHA provides good strength, it is preferable than SDA when it comes to partial replacement with cement.

- In addition to forming more environmentally friendly concrete, substituting these agricultural waste for cement can benefit our environment by reducing the toxic gasses released during the cement-water reaction.

- With an increase in the percentage of rice husk ash in the concrete mixes, the compaction factor value falls. The fact that the compacting factor value has decreased indicates that the concrete is less workable. The fact that the percentage of rice husk ash has increased indicates that the mixture is becoming more workable as additional water is added. Because there is more silica in the mixture, rice husk ash concrete requires more water. Up to a 10% replacement of rice husk ash in the concrete mix boosts the mix's compression strength; after that, a progressive decline in compressive strength is observed. Test results shows that the compressive strength of the material is increased by the addition of sawdust ash.

- The best combination is visible for combination of 10% RHA and 10% SD with increase of 11.1% in compressive strength when compared to conventional concrete mix.

A. Recommendation for Future Study

The findings of this research suggest a number of potential topics for future studies. Some open questions are pointed out as follows:

- The effects of various curing conditions on the hardened properties of OPC mortar and concrete, including the drying shrinkage, should be examined.

- Chloride diffusion resistance of RHA concrete may be studied for a different type of cement rather than one type of cement (high strength cement).

- The effect of RHA on the durability of OPC concrete at low water to binder ratio (w/b), should be investigated.

- The impact of RHA properties on the fresh and hardened properties of OPC concrete should be investigated for different types and sizes of coarse aggregate.

- The effects of unburnt carbon content and the internal water curing of RHA on the hydration and microstructure development of cement paste should be evaluated.

- Effect of combustion temperature on the time of the silica structure transformation needs more investigation to produce ash with ultimate reactivity.
- The effect of mineral admixtures may also have a positive impact on the durability of concrete should be evaluated.

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