ANALYSIS OF THE STRENGTH OF CONCRETE REPLACING THE FINE AGGREGATE BY SAWDUST.

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A thesis submitted to the Department of Civil Engineering of Sonargaon University in partial fulfillment for the degree of Bachelor of Science in Civil Engineering.



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Dedicated

To

Our Honorable Teachers

&

Parents

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ABSTRACT

Sawdust was used in place of fine sand in the 1:1.5:3 concrete mix ratio, which was created using a water/cement ratio of 0.65 and sand replaced by sawdust of 0%, 25%, 50%,75% and 100%. The purpose of this experimental study was to create a workable concrete mixture that could be used in place of fine aggregate in building construction, specifically for residential class concrete slabs. It also aimed to examine the impact of sawdust concrete mixture on aggregate adhesion, surface quality. In order to help the industry save the environment and to give contractors new information, this also aims to identify the factors affecting the sawdust concrete mixture's performance in terms of humidity and temperature. It also aims to design a sawdust concrete mixture as an alternative fine aggregate for residential class concrete slabs that will meet the requirements of the American Society for Testing and Materials (ASTM).The compressive strength of concrete made with 0%, 25%, 50%, 75% and 100% sawdust after 21 days of curing are 15.77MPa, 10.71MPa, 2.70MPa, No strength gained, No strength gained. The compressive strength of concrete made with 0%, 25%, 50%, 75% and 100% sawdust after 28days of curing are 16.57MPa, 11.28MPa, 4.58MPa, No strength gained, No strength gained. The compressive strength of concrete made with 25% replacement of sand by sawdust shows good strength behavior among the four mix designs.

TABLE OF CONTENT

1.1 Background and Motivations. xi

1.2 Research Objectives and Overview xiv

1.3 Organization of the thesis xiv

2.1 Introduction xv

2.2 Review of Some Existing Literature about Sawdust as fine aggregate xv

2.3 Summary xvi

3.1 Introduction xvii

3.2 Material Collection. xvii

3.3 Mix Design Ratio. xviii

4.1 Introduction. xxiv

4.2Test Result: xxiv

4.2.1 Compressive strength after 21 days of curing xxiv

4.2.2 Compressive strength after 21 days of curing xxv

Fig .4.2.2 Compressive strength after 21 days of curing xxvi

4.2.3 Compressive strength after 21 days of curing xxvi

4.2.4 Compressive strength after 21 days of curing xxvii

4.2.5 Compressive strength after 28 days of curing. xxviii

4.2.6 Compressive strength after 28 days of curing. xxix

5.1 Conclusions xxx

5.2 Limitations xxx

5.3 Recommendations for Future work xxx

LIST OF FIGURES

Fig. No.	Title	Page No.
3.2	Concrete Materials Collection	17
3.4	Fine Aggregate	19
3.5	Sieve analysis of Fine Aggregate	19
3.7	Concrete Casting	20
3.8	Concrete Curing	21
3.9	Compressive Strength Test	22

LIST OF TABLES

Table No.	Title	Page No.
4.2.1	Compressive Strength Test after 21 days curing	24
4.2.2	Compressive Strength Test after 21 days curing	25
4.2.3	Compressive Strength Test after 21 days curing	26
4.2.4	Compressive Strength Test after 28 days curing	27
4.2.5	Compressive Strength Test after 28 days curing	28
4.2.6	Compressive Strength Test after 28 days curing	29
A.1	Sieve Analysis (Course Aggregate)	34
A.2	Sieve Analysis (Fine Aggregate)	35
A.3	Sieve Analysis (Sawdust)	36

CHAPTER 1

INTRODUCTION

1.1 Background and Motivations.

Sawdust, which is made up of tiny pieces of wood, is a byproduct of chopping, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool additionally, some animals, birds, and insects that live in wood produce it as a byproduct, including both the carpenter ant and the woodpecker. The 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 may produce 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 building as a whole can be decreased because sawdust often be acquired for free or at a very low cost from sawmills. Construction industry uses a lot of water for curing process. In the future the construction industry has to switch for an alternative curing method, not only to save water but for the sustainable development of the environment but also to promote all construction activities even in remote areas where there is scarcity and shortage of water.[1]

Concrete is widely used as construction materials for various types of structures due to its durability. For a long time it was considered to be very durable material requiring a little or no maintenance. Many environmental phenomena are known significantly the durability of reinforced concrete structures. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments and many other hostile conditions where other materials of construction are found to be nondurable. So the use of concrete is unavoidable. At the same time the scarcity of aggregates are also greatly increased nowadays. Utilization of industrial soil waste or secondary materials has been encourage in

Construction field for the production of cement and concrete because it contributes to reducing the consumption of natural resources. They have been successfully used in the construction industry for partial or full replacement of fine and coarse aggregates.[2]

Concrete that includes sawdust is known as sawdust concrete. In this kind of concrete, the fine 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 chips make up its material.[1]

Globally, there is a resurgence of interest in this era of information revolution and environmental awareness. However, modern applications are being discovered and several are based on wood's unique physical and mechanical properties like strength at its ease in shaping. In this changing time, sawdust particles might just be one of an infinite number of solutions for low cost housing.[3]

The study on replacement of sand with sawdust in concrete, perhaps can give positive outcomes. The significance of sawdust concrete production is to reduce the sawdust waste that could save the environment for a long term run. This is because almost all sawmill dumped the sawdust at landfill which causing the landfill to pile up and increased its volume day by day [4]

Sawdust is an unpopular material that is hardly employed in the construction as a building material, but it is commonly discarded as waste from furniture manufacturing industries and sawmill and because it is plentiful and has no practical value. From the literature studied, India Produces approximately 30,000-33,000.[5]Therefore, the purpose T of this study is to investigate the usage of locally accessible building materials such sawdust as fine aggregate replacements in concrete. . A proportionate blend of fine, coarse aggregate, cement, and a particular amount of water make up the building material known as concrete. Concrete is becoming a more important building material every day. Sawdust-covered surfaces Modes 2concrete hollow bricks have outstanding adhesion which guarantees a successful coating with various paints and varnishes, or other finishing materials variety of paints, varnishes, or other finishing materials. Sand has the best component adhesion when used as a primary fine aggregate in concrete.

It gives a mixture strength by acting as tiny fillers. Sand particles are joined with cement to form a solid sand mixture. The feasibility of synthesizing cement to bind wood fiber adhesion so that it resembles that of trees will also be investigated in this study. This will also evaluate its effect on building costs to the current practice, which uses sand as fine aggregate. The study lays the path for the acknowledgment and acceptance of employing waste building materials for affordable housing construction in light of the escalating costs of construction supplies. It suggests alternate materials, specifically sawdust for fine aggregate. The entire study examines the issue of affordable housing and recycling leftover construction materials waste as it relates to the impoverished and underprivileged sector of society. Sand as a primary fine aggregate possesses superior adhesion of components in concrete. It provides strength by serving as small fillers in a mixture. Cement binds sand particles together forming one solid sand mix. This study will also explore the possibility of creating wood fiber adhesion which can mimic that of the trees by synthesizing its bond using cement. This will also cite its impact on cost of structures compared when using its reigning counterpart that applies sand as fine aggregate.

This study will aid in the reduction of building waste. So encouraging the best possible use of every piece of wood harvested from the natural world and supporting the environmental awareness movement. While getting rid of their waste, it will give lumber firms an extra money, while also allowing others to benefit from a new business endeavor. It will highlight fresh directions and choices for advancing this development as well as others. Additionally, it inspires future researchers to recycle other waste materials and incorporate them into new composite materials. It also inspires the general population to become more environmentally conscious by expanding their perspectives on recycling and conservation, highlighting gluttony as a negative trait that should be avoided, which is the overconsumption of one excellent thing be in control.

1.2 Research Objectives and Overview

The objectives of the research work are as follows:

a) To evaluate the compressive strength of concrete using sawdust instead of sand and normal aggregate with different mixing ratio.

b) To evaluate and differentiate the strength of normal concrete and concrete using sawdust instead of sand.

1.3 Organization of the thesis

Typically, a thesis contains the following chapters: an introduction; a literature review; a description of methodology; a report and discussion of results; and conclusion.

Chapter 1: Introduction and Objective. This chapter provides the background and motivations of the research. The overall objectives and expected outcomes are.

Chapter 2: Literature Review. This chapter reviews the related works in the concrete strength test field with a special focus on sawdust instead of sand.

Chapter 3: Methodology. This chapter describes the methodology adopted to carry out the research.

Chapter 4: Results and Discussion. This chapter describes the results of sawdust instead of sand.

Chapter 5: Conclusions and Future Work. This chapter summarizes the conclusions and major contributions of this study and provides recommendations for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter includes overview of some previous work. Some isolated worked had been carried out in the past in different countries and some information is available about our study.

2.2 Review of Some Existing Literature about Sawdust as fine aggregate

In specifically for residential concrete slabs, the goal of this study is to create a workable concrete mix that uses sawdust in place of fine aggregate. The effects of sawdust concrete on adhesion, thermal insulation, workability, and surface quality are assessed to create a mixture that satisfies ASTM requirements, performance-affecting variables like temperature and humidity are examined. In order to improve construction techniques and sustainability, cost comparisons with traditional concrete are also carried out.[6]

The study examines the incorporation of sawdust into concrete and examines how it affects the material's hydration and characteristics. Different ratios of sawdust from a wood plant in Bangladesh are added. Results show improved compressive strength when 10% sawdust is substituted. Microstructural analysis reveals that sawdust inclusion, offset by sulphate immersion, has resulted in more cracks and holes in the cement matrix. A higher sawdust content reduces workability. In summary, the study suggests that replacing sawdust by 10% is the best and most economical way to improve the performance of concrete. [7]

This study looks towards replacing some of the fine aggregate in concrete with durian sawdust in order to increase sustainability. The following sawdust replacement percentages are investigated: 0%, 5%, 10%, and 15%. Evaluations of hardened concrete (compressive strength and UPV) and new concrete (compacting factor and slump) are among the tests conducted. Our findings indicate that durian sawdust replacement at a ratio of 5% works well for both structural and non-structural applications. [8] The global housing crisis is largely due to the rising cost of building materials. Agricultural leftovers have potential as additional ingredients in concrete, offering a sustainable approach to disposing of trash. Studies on their integration point to possible advantages. This review evaluates the effects of using agricultural wastes in mortar and concrete on characteristics including workability, strength, and durability by looking at a number of studies in this area. The

article concludes that concrete and mortar qualities can be improved by using the right treatment techniques and materials.[9] The study used sawdust from Afara and Doka wood species to examine acceptable sawdust kinds as partial replacements for fine aggregate in concrete. The compressive strength and water absorption of three sets of concrete cubes—control, Doka sawdust, and Afara sawdust concrete—were created and examined. Findings showed that Doka sawdust concrete worked better than Afara sawdust concrete, indicating that Doka sawdust is a more practical choice for replacing certain fine aggregate.[10]The study looks towards replacing some of the fine aggregate in concrete with durian sawdust. Test results highlight the potential for waste utilization in construction to have positive effects on the economy and environment by showing that a 5% replacement ratio is appropriate for both structural and non-structural applications.[11] In an effort to combat rising building costs, sawdust is investigated as a potential partial replacement for fine particles in concrete. Compressive strength decreases as sawdust content rises. The best results are obtained with 10% sawdust, which produces a compressive strength of 7.41 N/mm² and is appropriate for non-structural uses.[12]Studies evaluate sawdust's use in the manufacturing of concrete. The addition of cassava starch increases compressive strength while sawdust volume decreases. Density decrease was seen, albeit it was less with cassava starch. suggests that using sawdust (<8%) in place of sand and 1% cassava starch can help with waste management.[13]The study looks into replacing sand in concrete with sawdust at weight percentages ranging from 5% to 25%. It seeks to evaluate how it affects attributes. Admixture of metakaolin improves bonding. Concrete specimens are put through tests for split tensile, flexural, and compressive strength.[14]The study evaluates sawdust concrete's ability to partially substitute river sand with the goal of reducing construction costs and environmental issues. Material and cube testing are used to evaluate several sawdust replacement percentages (5%, 10%, and 15%) in order to identify the ideal combination. Testing in the environment verifies that there are no health risks. 10% sawdust replacement was used to create the best design possible based on compressive.[15]

2.3 Summary

Every chapter, except the Introduction and Conclusions chapters, may contain a summary. The summary section should summarize key points of the chapter and act as a bridge between the current chapter and the following chapter. The summary section can be 4-5 sentences long.

CHAPTER 3

METHODOLIGY

3.1 Introduction

The Concrete is used in worldwide in all major and minor civil engineering projects. The ingredients which are used for making concrete provides durability and strength to concrete. These ingredients are sand, cement, aggregates, water in definite water cement ratio for better performance of concrete. Use of waste material (saw dust) in place of sand up to a certain proportion with all other ingredients modifies the properties of concrete. However, by reducing content of sand and using waste material makes concrete light in weight. Generally concrete is a composite mixture of binding material, filler material (coarse & fine aggregate) & water; which combines the whole mass. The aim of concrete mix design is to achieve maximum durability and compressive strength as possible as without any compromise with the quality. Engineers and scientists are further trying to increase its limits with the help of innovative chemical admixtures and various supplementary binding & filler materials along with modified manufacturing techniques. Now a day's lots of technology is used in the field of concrete technology that modifies concrete properties. Saw dust is waste which when burnt, produce lot of carbon emissions which pollutes the environment. If this waste is used in concrete, then there will be less emissions of carbon dioxide in environment; as we are using the saw dust material in concrete. The replacement of fine aggregates with saw dust can be beneficial for the building Components. Thus, the properties such as workability, compression test, elongation index etc. of concrete changes.

3.2 Material Collection.

Materials used for this research was ordinary Portland cement (Fresh brand).
Sylhet sand of 2.47 mm maximum size and stone chips of 20 mm maximum size were used as fine and coarse aggregates respectively. Clean tap water fit for drinking was used for mixing the materials. The two different types of sawdust were obtained from local timber cutting saw mill. The sawdust was sieved, washed and dried under sun before use. The homogenized mixture was

then introduced into dia 4" x 8" height metal moulds; the concrete de- moulded after 24hour and cured, while compressive strength was performed after 21 days and 28 days.



Fig: No 01 Fine aggregate (Sylhet Sand)



Fig: No 02 Coarse aggregate (Stone chips)



Fig: No 03 Cement (OPC)



Fig: No 04 Fine aggregate (Sawdust)

3.3 Mix Design Ratio.

For this study four mix designs were created. The mix design is as follows:

Concrete used for this study was prepared using mix ratio of 1: 1.5 : 3 and a water to cement (W/C) of 0.45; while batching of materials was done by volume due to the remarkable differences in the specific gravities of cement, sand and sawdust. The percentage replacements of fine aggregates by sawdust were varied from, 25%, 50%, and 100% .This was done to determine the optimum percentage that would give the most favorable result. However, dry mix method was used for concrete constituent before the addition of water.

3.4 Fine Aggregate Ratio.

MIX	SAWDUST (SD)	SAND
SD0	0%	100%
SD25	25%	75%
SD50	50%	50%
SD75	75%	25%
SD100	100%	0%

Table No: 01 Mix Design.

3.5 Sieve Analysis.

Sieve analysis of fine aggregate is used to determine the particle size distribution & fineness modulus of fine aggregate. The particle size of an aggregate as
Determ9ine by sieve analysis is termed grading of aggregate. The test method for
Sieve analysis of fine aggregate conforms to the ASTM standard requirements of specification C136. The value of F.M.



Fig No: 05

3.5.1 Sieve Analysis (Course Aggregate)

Grain Size Analysis of course aggregate.

Weight of sample taken = 5.00 KG

FM: 7.30

3.5.2 Sieve Analysis (Fine Aggregate)

Grain Size Analysis of Sylhet Sand

FM: 2.47

3.5.3 Sieve Analysis (Sawdust)

Grain Size Analysis of Saw Dust.

FM: 1.97

3.6 Water cement ratio.

Water is essential in the production of concrete in order to precipitate chemical with the cement, to wet the aggregate, and to lubricate the mixture for workability. Since the quality of water affect the strength, it is necessary to go into the purely of water. In this study drinking water has been used in mixing of concrete .water cement ratio is 0.55.

3.7 Casting.

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting. When we casting the cylinder, moulds should be filled in 3 equal layers and each layer rodded uniformly 20 times with a 10 mm diameter x 450 to 600 mm long

Hemispheric ally tripped still road. The strokes shall be distributed uniformly over the cross section of the mold. The bottom layer shall be rodded throughout its depth. For each upper layer, the road shall be penetrate about 25 mm into the underline layer. If void are left by the rod the side of the mold should be tapped to close void before adding the next layer of material. After filing the mold strike off the surface with the tamping rod, handheld float or trowel to produce a flat, even surface. Install the mold cap and move the cylinders to an initial curing place for storage.



Fig No 06: Casting

3.8 Curing.

After finishing & marking, specimens were stored for 24 to 48 hours in normal room temperature for specified concrete strength of 40MPa or higher, Specimens should be protected from direct sun light, radiant heating devices to prevent the loss of moisture. Heating and cooling machineries may be used for this purpose .After all test specimens are stored, a large amount of water needs to be disposed of on the curing side. But water cooler than 50°C is not suitable for curing concrete. As the hydration reaction in concrete expels heat and keeps concrete warm, using cold water less than 50°C on concrete may lead to cracking and failing. Alternate drying and wetting on the concrete surface causes volumetric changes in concrete and ultimately leads to cracking.

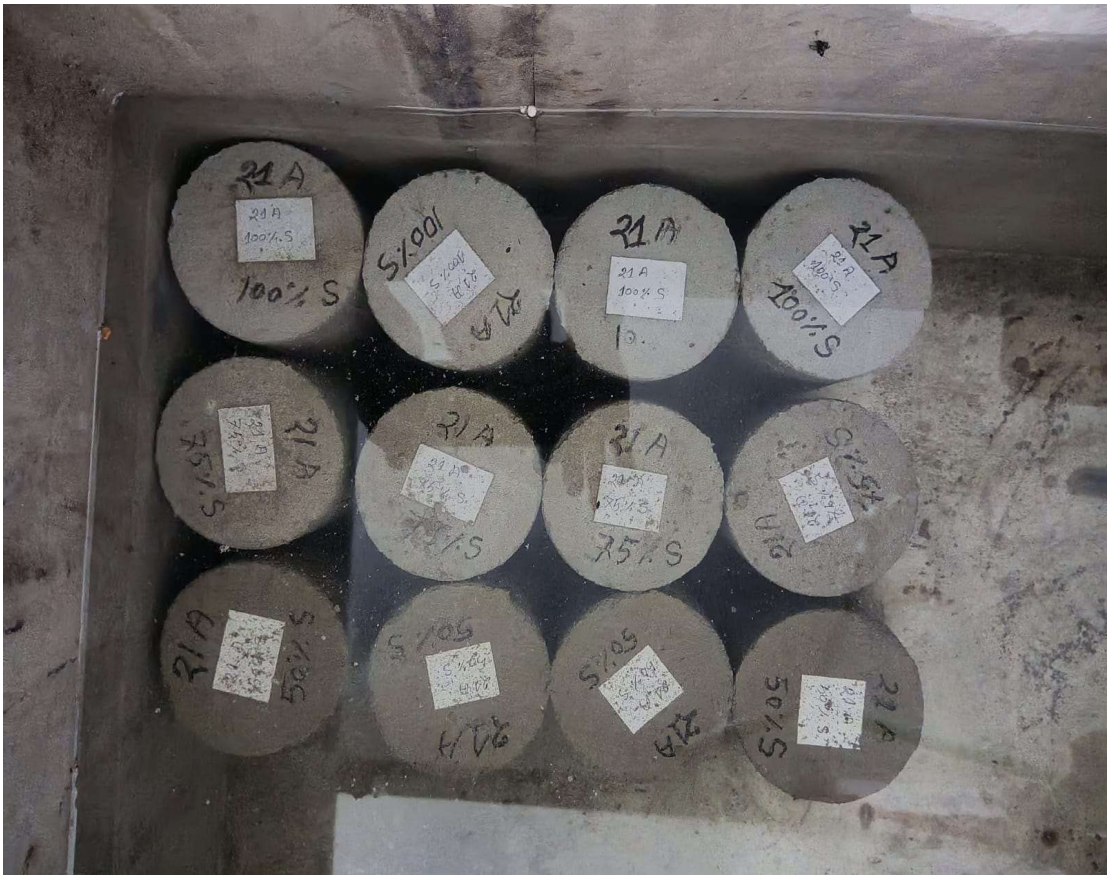


Fig No 07: Curing.

3.9 Compressive Strength Test.

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compression-testing machine by a gradually applied load.



Fig No 08: Compressive Strength Test.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction.

Testing of harden concrete plays an important role in controlling and confirming the quality of cement concrete work. To perform this study in total 12 standard cylinder specimens were made. All specimens are tested after 21 days and 28 days normal water curing.

The compressive strength of geo polymer building blocks were tested as per ASTM C67/C67M – 20 (ASTM International. 2021)

4.2Test Result:

The compressive strength of geo polymer building blocks were tested as per ASTM C67/C67M – 20 (ASTM International. 2021)

4.2.1 Compressive strength after 21 days of curing

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
21	1:1.5:3	1:0	101.64	204	8113.7	128	15.00
21	1:1.5:3	1:0	102.99	207	8330.7	130	15.60



Fig 4.2.1 Compressive strength after 21 days of curing.

4.2.2 Compressive strength after 21 days of curing

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
21	1:1.5:3	3:1	102.92	206	8319.37	85	10.200
21	1:1.5:3	3:1	101.81	206	8140.88	85	10.400



Fig .4.2.2 Compressive strength after 21 days of curing

4.2.3 Compressive strength after 21 days of curing

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
21	1:1.5:3	1:1	101.9	204	8155.28	22	2.70
21	1:1.5:3	1:1	102.88	205	8312.90	23	2.767

4.2.4 Compressive strength after 21 days of curing

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
28	1:1.5:3	1:0	103.73	206	8450.83	140	16.57
28	1:1.5:3	1:0	102.68	206	8280.61	132	15.94



Fig.4.2.4 Compressive strength after 28 days of curing

4.2.5 Compressive strength after 28 days of curing.

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
28	1:1.5:3	3:1	100	205	7854.0	85	10.80
28	1:1.5:3	3:1	102.42	205	8238.73	93	11.200



Fig.4.2.5 Compressive strength after 28 days of curing.

4.2.6 Compressive strength after 28 days of curing.

Day of curing	Cement: FA:CA	Sand: sawdust	Cylinder size (mm)		Cross sectional area(mm ^2)	Failure load (KN)	Compressive strength (Fc) Mpa
			Dia	Height			
28	1:1.5:3	1:1	101.42	205	8078.63	37	4.50
28	1:1.5:3	1:1	102.22	205	8206.59	37	4.50



Fig.4.2.6 Compressive strength after 28 days of curing

CHAPTER 5

CONCLUSIONS AND FUTURE WORKS

5.1 Conclusions

From the test results and analysis, the following conclusion may be drawn. It may be emphasized here that future investigations are necessary to these findings

a. The compressive strength of concrete made with 0%, 25%, 50% sawdust after 21 days of curing are 15MPa, 10.23MPa, 2.7MPa.
b. The compressive strength of concrete made with 0%, 25%, 50% sawdust after 28 days of curing are 16.62MPa, 10.77MPa, 4.59MPa.
c. The compressive strength of concrete made with 25% replacement of sand by sawdust shows good strength behavior among the four mix designs
d. The compressive strength decreases with increasing amount of sawdust.
e. Sawdust can be used by a partial replacement of sand to a maximum value of 25% for low strength concrete works.

5.2 Limitations

Concrete's characteristics are affected when sawdust is used in part place of sand in the production process. The results of the analysis indicate that while the workability of concrete decreases when sawdust is used in part to replace sand at a constant water-cement ratio, the strength of the concrete decreases when sawdust replacement at a high percentage of sand replacement occurs. The same level of strength is required when sawdust is used in place of sand, though, with a 25% weight replacement ratio. Consequently, replacing some of the sand with sawdust (0–25%) will help to reduction in sawdust waste generated in the society without adversely affecting concrete strength. Eventually 75% & 100% using sawdust cylinder are not bonding due to keep proper time. Needed Admixture use for increase strength gain.

5.3 Recommendations for Future work

In this project, sand is partially replaced by sawdust. The goal of this experimental study was to create a workable concrete mixture that could be used in place of fine aggregate in building construction, specifically for residential class concrete slabs. It also examined the impact of the

sawdust concrete mixture on aggregate adhesion to develop a sawdust concrete mixture as a substitute for fine aggregates. Eventually 75% & 100% using sawdust cylinder are not bonding due to keep proper time. Needed Admixture use for increase strength gain.

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APPENDIX-A

A1. Sieve Analysis (Coarse Aggregate)

Table A1: Grain Size Analysis of course aggregate.

Weight of sample taken = 5.00 KG

Sieve Size	**Weight Retained (in Kg)**	**Cumulative weight retained (in kg)**	**%Cumulative Retained**	**Cumulative %Passing**
80mm	0	0	0	100.00
40mm	0	0	0	100.000
20mm	1.519	1.519	30.380	69.620
10mm	3.444	4.963	99.260	0.740
4.75mm	0.037	5.000	100.000	0.000
2.36mm	0.000	5.000	100.000	0.000
1.18mm	0.000	5.000	100.000	0.000
600micron	0.000	5.000	100.000	0.000
300 micron	0.000	5.000	100.000	0.000
150 micron	0.000	5.000	100.00	0.000
TOTAL	5.000		729.64	

Fineness Modulus = 729.64/100 = 7.30

A2. Sieve Analysis (Fine Aggregate)

Table A2: Grain Size Analysis of Sylhet Sand

Sieve No	**Size (mm)**	**Wt.of retained (gm)**	**% of Retained**	**Cumulative % of Retained**	**%of Finer**	**FM**
No.4	4.75	2.5	0.5	0.5	99.5	
No.8	2.36	17	3.4	3.9	96.1	
No.16	1.18	77.5	15.5	19.4	80.6	
No.30	0.6	148.8	29.76	49.16	50.84	2.47
No.50	0.3	155.5	31.1	80.26	19.74	
No.100	0.15	65.5	13.1	93.36	6.64	
Pan	-	33.2	-	-	-.	
Sum		500		246.58		

Fineness Modulus = 2.47

A3. Sieve Analysis (SAW DUST)

Table A3: Grain Size Analysis of Saw Dust

Sieve Size mm	**Weight Retained (in Kg)**	**Cumulative weight retained (in kg)**	**%Cumulative Retained**	**Cumulative %Passing**
10	0	0	0	100.00
5	3.1	3.10	3.10	96.99
2.36	7	10.10	9.80	90.20
1.18	7.9	18.00	17.46	82.54
0.600	13.8	31.80	30.84	69.16
0.300	42	73.80	71.58	28.42
0.150	23.2	97.00	94.08	5.92
0.075	4.6	101.60	98.55	1.45
PAN	1.5			
TOTAL	103.1		FM = 1.97	

Fineness Modulus = 1.97