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Research Paper

Investigation on Mechanical properties of Partial replacement of Saw-Dust to Fine-Aggregate in Coconut-Shell Concrete

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Abstract

Concrete is the major composite material used in construction industry, it is strong in Compression and weak in tension and also has high self-weight. The light weight concrete was a alternative to conventional concrete due its low weight it decreases the self weight. Comparatively by using the light weight materials that occur either naturally or industrial waste, these material helps in reducing the cost and to improve the performance. Presently in India, more than 960 million tones of solid waste were being generated annually as by-products during industrial, agricultural mining and other processes. This paper deals with coconut shell concrete, which is one of the solid waste in the environment, and the use of this coconut shell as a replacement to coarse aggregate will reduce the weight of concrete by 25%. The other waste that was disposed mostly was sawdust. It was a byproduct of cutting or drilling of wood with saw or other tool. It is composed of fine particles of wood. It is having many advantages over traditional concrete like low bulk density, better heat preservation and heat insulation property. As said earlier to make concrete strong in tension coconut fiber is added, which is a waste material that left to disposal and as it is strong and stiff will hold the concrete material and also controls the crack. This study investigates on the use of saw-dust as partial replacement for fine aggregates in concrete production. Sawdust was used to replace fine aggregates in Conventional and as well as in Coconut Shell concrete from 0%, 5%, 10% and 20%. M25 grade of concrete was selected and testing is evaluated at age of 3, 7 and 28 days. From the results, increase in percentage of saw-dust in concrete cubes led to corresponding reduction in compressive strength values, and the optimum saw-dust content was obtained at 5% in conventional as well as in coconut shell concrete , coconut fiber was added at the optimum value of sawdust on conventional and coconut shell concrete at 1%,2%,3%,4% and 5%. The better strength was obtained at 2% addition of fiber in coconut shell concrete and at 3% addition in conventional concrete.

Keywords: *Conventional concrete; Light weight concrete; Coconut shell concrete; Sawdust Coconut fiber; compressive strength.*

1. Introduction

In developing countries like India, there was a lot of solid waste produced by the industries. They are as sawdust, coconut shell, coir fiber, rice husk, neem seed waste and sugar cane waste etc.

From past 40years sawdust was being used in concrete, but not widely, even though sawdust has the low-compressive strength it can make to perform well in certain floor and wall applications [Haitham H. Saeed]. This use of waste sawdust does not only decrease environmental damage, and also do same the concrete materials. This has many advantages over traditional concrete, such as low bulk density, better heat preservation and heat insulation property and lowers the pollution in the environment [Yong cheng, Wen You].

As over 960million tones of solid waste are being produced annually from the industries, mines, municipals, agricultural & other process as a by-product. Out of this 350million tones was organic waste from agricultural sources; 290million tones are inorganic waste from industrial & mining sector. Sugarcane baggage, paddy and wheat straw and husk, vegetables wastes, wooden mill waste, coconut husk, cotton stack etc., all these wastes are being produced from agricultural sources. Out of this coconut shell was the promising material that can be used as a replacement for concrete materials. The coconut production in India was reported as more than 12million tones [K. Gunasekaran].

So, using both the materials that are damaging the environment can use as a replacement to the traditional materials and can possibly reduce the pollution in the environment which the world is facing.

2. Material Properties

The materials used in this project are collected from the nearby sources. The concrete mix M25 was designed according to IS 10262(2009) and the mix ratio is as follows. The project is for investigation on mechanical properties of lightweight concrete using coconut shell, sawdust and coconut fiber.

Grade of concrete = M25
Normal concrete = 1: 2.22: 2.60:0.55
Coconut shell concrete=1: 1.47 : 0.65:0.42

For these concrete mix sand was partially replaced with sawdust

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by volume and coconut fibre was used in the proportions of 1%, 2%, 3%, 4% and 5% by volume of concrete.

2.1. Cement

The cement used for this research work was 53-grade OPC cement. The properties of cement tabulated in Table 1

Table 1 Properties of cement

S. No.	Description	Value
1	Normal Consistency (%)	31.000
2	Initial setting time, minutes	32.000
3	Specific Gravity	3.075

2.2 Coarse aggregate

Coarse aggregate is another most important ingredient in the process of manufacturing of concrete. There are many alternatives to replace the coarse aggregate due to environmental issues, in this research work the size of coarse aggregate selected is 12.5mm and the properties are given in the following table 2 .

Table 2 Properties of Coarse aggregate

S. No	Description	Value
1	Maximum size	12.500
2	Specific Gravity	2.660
3	Fineness Modulus	7.170
4	Density	1,585.000

2.3 Coconut Shell

The coconut shell was collected from nearby coconut oil mill industry. The coconut shell there was crushed and allowed to pass through 12.5mm sieve was used. The surface was properly cleaned smooth on inner side and rough on outer side. The CS has high water adsorption is expected due to its porosity, to avoid this problem CS was dipped in water for 24 hours before its use. The coconut shell as coarse aggregate has properties as shown in Table 3

Table 3 Properties of Coconut Shell

S. No	Description	Value
1	Maximum size used (mm)	12.500
2	Water Absorption (%)	24.000
3	Sp. Gravity	1.100
4	Fineness modulus	6.260
5	Crushing value (%)	2.580
6	Shell thickness (mm)	2-8

2.4 Sand

Sand contains essentially quartz as a important mineral where clay is made of many other chemically active minerals like illite, kiolinite, etc. Sand is sieved through 4.75 mm. Natural sand is available from local river beds or pits. An examination should made on the fineness of the sand and depends upon the fineness zone will be fixed. The properties are as followed in the following table 4

Table 4 Properties of Sand

S. No	Description	Sand
1	Specific Gravity	2.639
2	Fineness Modulus	2.730
3	Density	1,680.000

2.5 Sawdust

The saw dust was sourced from Sri Chakra timber shed located in S.P Koil area, Kancheepuram Dt. It was a fine powder collected from various hardwoods and softwoods such as Oak, Mahogany, Mulberry and Axle wood by cutting then in the saw-mill. The powder was collected and stored in a waterproofing bag such that to avoid the effect of fungus. The collected sawdust was dipped in water for 4 to 5 hrs before the concrete preparation. The properties of sawdust are as followed in the table 5.

Table 5 Properties of sawdust

S. No	Description	Value
1	Maximum Size used(mm)	>4.75
2	Water Content (%)	25.580
3	Sp. Gravity	0.370

2.6 Coconut fiber

It is a naturally occurring fiber which is extracted from the husk of coconut. It is used in many applications like floor mats, brushes, door mats and mattresses, but the brittle nature of the fiber made it to attract concrete research workers to make concrete strong in tension. The fiber used in this project has the diameter 0.2-0.5 mm which was cut into 50mm size in length. Thus cut down fiber was added to concrete at 1%, 2%, 3%, 4% and 5% by volume of concrete.

3. Test Results & discussions

The main theme of this research work is to investigate on the mechanical properties of concrete. These tests determine the properties of conventional concrete and coconut shell concrete, replacing fine aggregate partially with sawdust and also with addition of fiber. The optimum percentage where the ultimate strength occurs is determined to make light weight concrete and use natural by-products

3.1 Compression test

It is the test used to determine the internal resisting force of a body, object when a load is applied. The concrete specimens were casted to 100×100×100mm sized cubes, were allowed for curing and tested at the age of 3 day, 7 day and 28 day. The content of sawdust replaced is 5%, 10%, 15% and 20% in both conventional and coconut shell concrete. The following is the tabular formations that show the compressive strength of cubes with different percentages of Sawdust replacement with Volume replacement in different percentages.

Table 6 Compressive strength test results for partial replacement of sawdust in CC and CSC

Mix	Sawdust %	3rd day	7th day	28th day
Conventional concrete with saw dust	0	13.69	19.73	30.1
	5	14.23	18.17	29.47
	10	12.1	16.2	25.9
	15	9.93	15.16	21.7
	20	7.17	12.57	18.47
Coconut shell concrete with sawdust	0	12.98	18.73	25.6
	5	14.47	19.43	25.23
	10	10.53	14.03	19.93
	15	9.27	12.2	16.5
	20	2.67	2.67	4.63

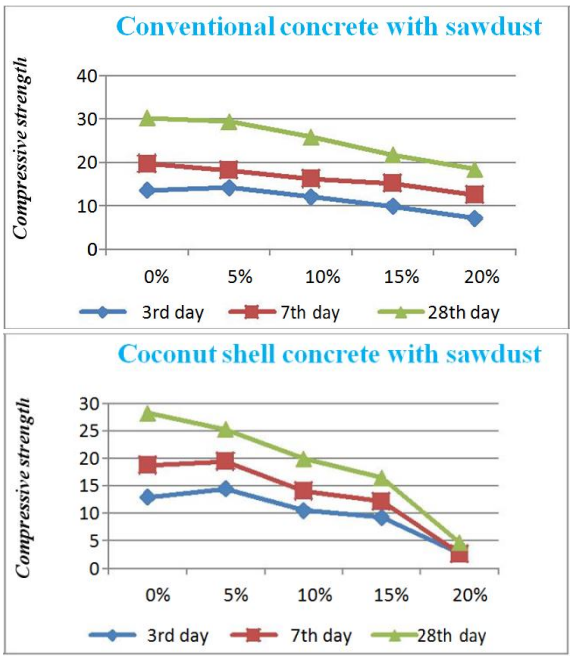
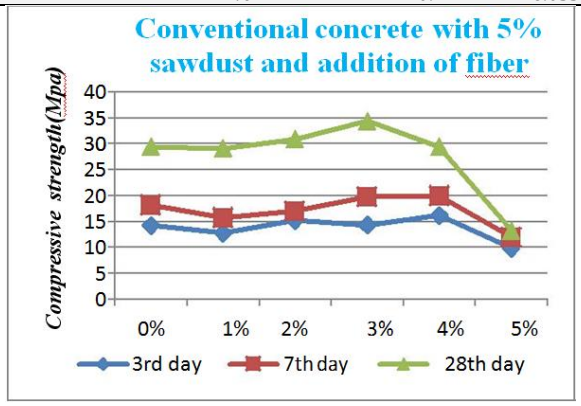


Fig 1 Line charts of CC and CSC with sawdust

From the above table 6 and figure 1 it was clear that 5% replacement of sawdust in conventional as well as in coconut shell gives better strength as 29.47Mpa and 25.23Mpa. Keeping this in view fiber was added to this 5% replacement of sawdust in CC and CSC in Percentages from 1 to 5 and the test results were as shown in the table 7

Table 7 Compressive strength test results for partial replacement of sawdust in CC and CSC with addition Fiber

Mix	Fiber %	3rd day	7th day	28th day
Conventional concrete with 5% saw dust and addition of fiber	0	14.23	18.17	29.47
	1%	12.76	15.73	29.1
	2%	15.23	17	30.96
	3%	14.3	19.73	34.43
	4%	16.2	19.96	29.47
	5%	9.83	11.93	13.23
Coconut shell concrete with 5% sawdust and addition of fiber	0	14.23	18.17	25.23
	1%	14	16.83	22
	2%	21.33	26.13	33.22
	3%	22.7	27.53	29.89
	4%	17	20.12	26.033



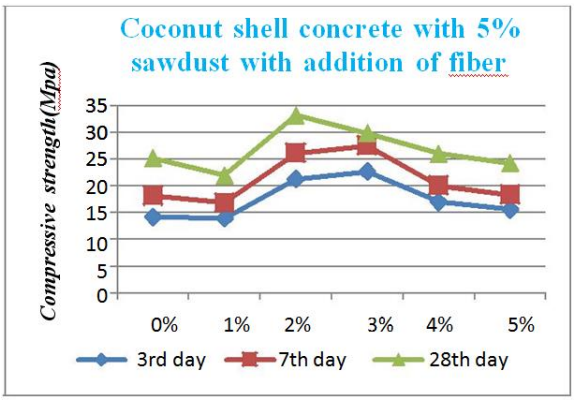


Fig 2 Line charts of CC and CSC for 5% sawdust with addition % of fiber

The above tabulated test results shows that compressive strength of concrete is more at addition 3% fiber in CCSC and at addition of 2% of fiber in CSSC. The values are as 34.33Mpa and 33.22Mpa, and this gives the optimum percentage of fiber to be continued for the Tensile, Flexure strength and Impact tests.

3.2 Split Tensile test

This test is done on the concrete cylindrical specimens which are prepared in the steel moulds of size 100×200mm.The load is applied by placing the cylinder horizontally in the compression testing machine, load should be applies till a vertical crack develops across the diameter. The value is about 0.05 – 0.12 times greater than the direct tensile strength. The mix is prepared as mentioned above the split tensile test with replacement of 5% sawdust and with addition of3% fiber in CCSC and at same percentage replacement of sawdust with 2% addition of fiber in CSSC and the values are as mentioned in the table 8

Table 8 Split tensile strength for beams with 5% sawdust and addition of fiber in CC and CSC

M25	Fiber %	3rd day	7th day	28th day
CC	0	2.35	3.82	3.7
CCSC	3	2.95	4.23	4.86
CSC	0	1.09	2.12	2.82
CSSC	2	1.89	2.97	3.19

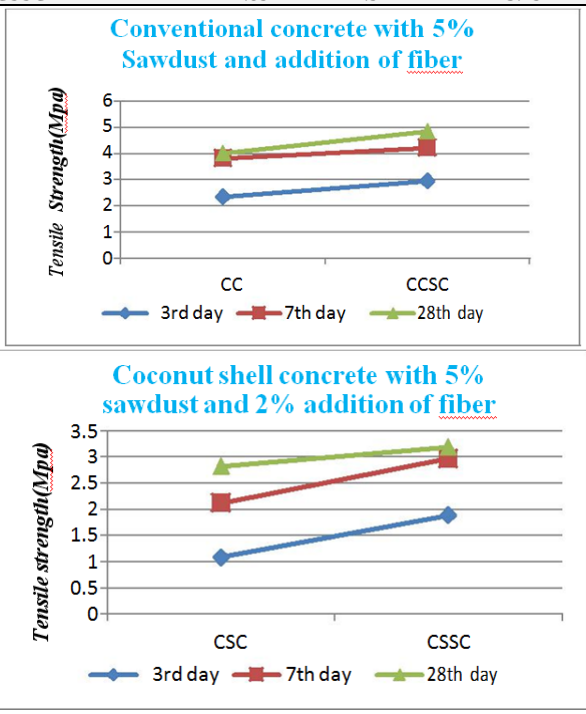


Fig 3 Line chart for CC, CCSC, CSC and CSSC with addition of fiber

3.3 Flexure test

The test is done Beams of size 100×100×500mm; it does not contain any additional reinforcement. It is a three point loading method, continues load is applied until the specimen breaks. This makes the load to divide equally between the rollers such that it gets failure the test values are given in the following table 9

Table 9 Flexural test on CC, CCSC, CSC and CSSC with addition of fiber

M25	Fiber%	3rd Day	7th Day	28th Day
CC	0	2.08	3.45	3.81
CCSC	3	2.85	4.53	5.33
CSC	0	1.93	2.42	4.23
CSSC	2	2.09	2.89	4.12

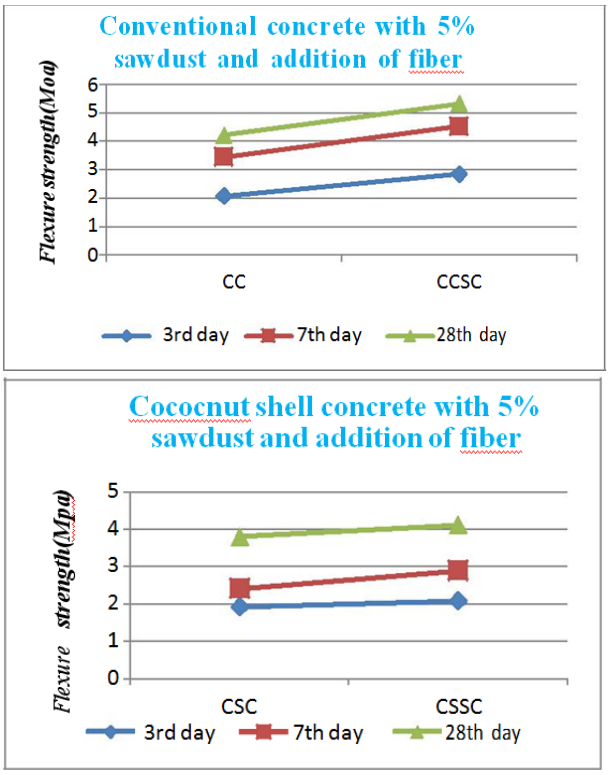


Fig 4 Line chart for CC, CCSC, CSC and CSSC with addition of fiber

3.4 Impact test

It determines the resistance against sudden load applied on the concrete specimen. This is done on the specimen sizes 65×150mm which is also impact disk. For a certain no. of blows the specimen starts fail by producing its initial crack to until it gets broken. The test results were shown in the following table 10

Table 10 Impact test on CC, CCSC, CSC and CSSC with addition of fiber

		No. of blows in 28 days	
Mix	Fiber%	Initial Crack	Final Crack
CCSC	3	266	268
CSSC	2	110	128

The impact test values are as show in the table 10, the use of fiber has given improved values. This shows that fiber usage can withstand to sudden loading, hence it can be used in manufacturing of concrete for constructions as they experience impact loads and roller loads.

4. Conclusion

4.1 Compressive strength

The specimens with replacement of sawdust to fine aggregate shows a slight decrease in strength when compared with control concrete and coconut shell concrete, but the addition of fiber has improved results. At 5% sawdust in CC with 3% fiber is 34.43Mpa (34.43Mpa – 16.8 % increase when compared to control concrete) and at 5% sawdust in CSC with 2% fiber is 33.22Mpa (33.22Mpa – 30% increase when compared to coconut shell concrete) so, from this it can be said that sawdust and coconut fiber can used alternative in construction industry.

4.2 Split tensile strength

As the optimum percentage of sawdust and addition of fiber are used for the cylindrical specimens. It showed better increment results from the table 8 , the split tensile strength of CSSC with addition of 3% fiber is 4.86Mpa and at 2% of fiber in coconut shell concrete it has a strength of 3.19Mpa. The main purpose of split tensile test is to determine the tensile resistance of concrete specimen; here the test results have attained greater improvement in tension. Hence concrete made with these materials can be used in construction

4.3 Flexure strength

The beams are also prepared for the same mix as done for the tensile test, here in this case also the concrete made with percentages has gained better results when compared to relative concretes and as from the table 9 the flexure strength of CSSC at 3% addition of fiber is 5.33Mpa (5.33Mpa – 26% increase when compared to control concrete) and for CSSC at 2% addition of fiber is 4.12Mpa (4.12Mpa - 7% of increase when compared to coconut shell concrete). From the results obtained shows that sawdust at 5% replacement and addition of fiber is an alternative to concrete.

4.4 Impact strength

From table 10, it is at 5% sawdust and 3% of fiber in CC the initial crack was occurred after 266 blows and finally after 268 blows the specimen gets totally broken. At 5% sawdust and 2% of fiber in CSC initial crack starts after 110 blows and the specimen gets totally broken at 128 blows. The values have been tremendously increased due to the usage of fiber, from this it can be predicted easily that use of fiber in concrete is beneficiary.

References

[1] Adebakin I. H. “Uses of Saw Dust as Admixture in production of low cost and light weight”, 2012 American journal of scientific and industrial research Volume 3(6): 458-463

[2] Alida Abdullah, “Composite cement Reinforced Coconut Fiber: Physical and Mechanical Properties”, 2011 Australian Journal of Basic and Applied Sciences, Volume 5(7): 1228-1240

[3] 1B. Damodhara Reddy, S. Aruna Jyothy, Fawaz Shaik, (2014). Experimental Analysis of the use of Coconut Shell as Coarse Aggregate. IOSR Journal of Mechanical and Civil Engineering , Volume 10(6), 6-13

[4] Dilip kumar, Smita singh, Neetesh kumar & Ashish Gupta, (2014). Low cost construction material for concrete as saw dust. Global journal of researchers in engineering: E civil and structural engineering, volume 14(4)

[5] Dr. R. Sri Ravindrarajah, Development of Saw Dust in Concrete for block making. Centre for Infrastructure research university of technology, Sydney, Australia.

[6] Haitham H. Saeed, “Pretreatment of Sawdust for Producing Sawdust Concrete” , 2012 Eng. & Tech. Journal, Volume 31, No. 3

[7] K. Gunasekaran, P.S. Kumar (2008) Lightweight Concrete Using Coconut Shells as Aggregate. Proceedings of international con-

ference on advances in oncrete and construction.
[8] K. Gunasekaran, P. S. Kumar, (2011). Mechanical and Bond Properties of Coconut Shell Concrete. Construction and building materials , Volume 25, 92-98
[9] Mahmud Abubakar, (2013). Partial replacement of sand with saw dust in concrete production. 3rd Biennial Engineering Conference, Federal university of technology, minna.
[10] Neetesh Kumar, Dilip Kumar, (2014). Strength Properties of Coconut Shell as Coarse Aggregate in Concrete. International journal of Computer &mathematics Sciences , Volume 3(5)
[11] Olugbenga Joseph Oyedepo, Seun Daniel Oluwajana, (2014). Investigation of Properties of Concrete Using Saw Dust as Partial Replacement for Sand. Civil and engineering research , Volume 6, No. 2
[12] Tomas U. Ganiron Jr, (2014). Effect of Saw Dust as Fine Aggregate in Concrete Mixture for Building Construction. International journal of advanced science and tehnology , Volume 63, 73-82
[13] Yong cheng, Wen You, Chaoyong Zhang, Huanhuan Li, Jian Hu, (2013). The Implementation of Waste Saw Dust in Concrete. Science research , Volume 5, 943-947