Experimental study of partial replacement of coarse aggregate with coconut shell and lathe scrap in concrete

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ABSTRACT: Using coconut shell (CS) as replacement should be urged as a priority in environmental concerns and construction cost lowering measure. The stainless-steel scrap material which is usually available in lathe industries are used in modern construction and likewise in pavement construction. Lathe waste are generated by each lathe industry, in addition to discarding of these waste materials into barren dirt also contaminates the soil and ground water, which generates an unhealthy atmosphere. The rising cost of structural material is a different concern. The explanation for enhance in cost is large demand of concrete in excess to scarcity of raw materials. Hence many researchers are focusing on technique of using waste materials in concrete as to their properties. In this particular study, M25 grade of concrete was prepared by replacing coconut shell for coarse aggregate and in addition of lathe scrap to cement. Natural resources such as coarse aggregate and fine aggregate are depleting in a shocking rate within developing nations like India. The options of using coconut shell aggregates in concrete as rough aggregate is examined inside the present study. Coarse aggregate is replaced by 3%, 6%, 9% of coconut shell in conventional aggregate. With the water – cement ratio being kept regular as 0.45 and cement have been replaced with lathe waste by 0.5% & 1%. Tests were carried out to find the compressive strength, split tensile strength and flexural strength using cube, cylinder and beam specimens respectively.The results show that a new possible exists for the usage of coconut shells as replacement of regular aggregate in the conventional concrete and light-weight RC construction.

Keywords: Concrete, Coconut Shells, Lathe Scrap, Strength Properties.

I.INTRODUCTION

Man has progressed a lot in developing the method of constructing shelter. Initially man used to live in huts and time passed it into house that is load bearing. In this constructed environment, the growth in cost of building construction materials is the factor of great concern. The rate of building materials are raising day by day. Nowadays many researchers are focusing on using waste materials in concrete in related to their properties. Concrete made of coconut shell has good workability because of their smooth surface upon one side from the covering. The strength allied associated with coconut shell concrete will be more when compared to conventional concrete. Normally the water absorption capacity of coconut shell is usually more when compared to standard aggregate. Using alternative organic materials in place of aggregate in concretemanufacturing makes concrete as lasting and environment - friendly construction materials.

India produces about 20% of coconut produced in the world. Within India, Kerala produces 45% of that. Aggregates made of crushed coconut shell can be effectively used in concrete by partly replacing normal aggregate to a certain amount. This will not only reduce the unit weight of concrete made, but also offers an efficient resolution to the discarded coconut shells.

The addition of steel scrap to cement concrete increases the engineering properties to high extent and therefore utilization of fiber strengthened concrete is increased day-by-day. The production of just one ton of cement releases around one ton of carbon dioxide to the ambiance. The steel industry likewise produces huge impacts to the environment. This is the time to consider the sustainable growth and lessen the wastes developed or perhaps reuse it. The accessible steel fiber of diverse categories in market is usually considerably expensive. The lathe scraps produced in regional lathes and workshops are usually in plenty and also usually are easily offered by low expense. Every day about 7 to 10 kg lathe waste are developed by every lathe industrial sector and dumped in barren soil there by simply polluting the soil and also ground water, which generates an environmental issue. The waste steel which are available in lathe works, tremendously can be used as stainless-steel fiber for innovative structural industry, in addition to conventional construction. Hence by taking on proper management lathe scrap together with concrete is regarded as one of the best remedies.

II.OBJECTIVES

The precise objectives of the research are as follows:

- To find cost-effective solution regarding high construction material.
- To prepare light-weight concrete by using coconut shell as coarse aggregate.
- To prove that aggregate replaced concretes which often are lightweight can end up being used for structural applications with equivalent strength on concrete.
- To investigate the use of lathe scraps as fiber in concrete.

III. LITERATURE SURVEY

S.Sakthivel et al [1] investigated on concrete along with replacing coarse aggregate with demolished waste and steel fiber. The specimen casted with 40% of Demolished Coarse Aggregate (DCA) and 1% of Steel Fiber (SF) alternative to coarse aggregate provided a good increase in compressive strength of 1.27%**,** the split tensile strength of 1.14% and flexural strength of 1.29% respectively, compared to conventional concrete. The specimen casted with 50% DCA and 1% SF alternative to coarse aggregate provided a good increase in compressive strength of 1.22%, split tensile strength of 1.06% and the flexural strength of 1.24% respectively. The alternative of DCA 60% and Steel Fiber (SF) 1% additionally, provided a good increase in compression strength (1.15%), the split tensile strength (0.95%) and the flexural strength (1.13%) when compared to normal concrete. Assessing the three different amounts of replacements, the strength will never reduce when compared to conventional concrete. Therefore, the replacement of 60% DCA and 1% SF within concrete gives more Affordable and provides better overall performance. Dr.B.Rajeevan, Shamjith.K.M [2] made an investigation on the usage of coconut shell to concrete. A thorough experimental investigation was made out to find the mechanical qualities of concrete namely, compressive, split tensile and flexural strength of concrete, an optimum exchanging coarse aggregate for coconut shell aggregate, corresponding into the mixture ratio 1:1.63:3.13, was identified as 15%. The observed value of 28 days compressive, split tensile and flexural strength were 24.6N/mm², 2.57 N/mm² and 2.89N/mm² respectively. This signifies that concrete made of coconut shell have durability comparable with conventional concrete. There is more likelihood of recycling coconut shells, which are discarded as waste generated in this present study about its future use as coarse aggregate in the growth of lightweight concrete. This study established that coconut shell can be substituted partially to coarse aggregate successfully without compromising on durability aspects. DewanshuAhlawat et al [3] investigated using coconut shell as partial replacement of coarse aggregate in concrete. The goal of this research is to spread awareness regarding the usage of coconut shell partially by coarse aggregate in concrete and deciding its compressive strength. This study concluded that is increased. Compressive strength of concrete was found to be decreased simultaneously with an increase in the percentage of coconut shell. It elevated in percentage replacement by simply coconut shell increase workability of the concrete Coconut shell works extremely well as partial substitution of coarse aggregate inside R.C.C. B.Damodhara Reddy et al [4] examined the usage of coconut shell partially substituted as light weight aggregate in concrete. It evaluated the flexural and compressive strength qualities with using M25 grade concrete. The project also seeks that coconut shell is a new potential construction material in addition to simultaneously reducing environmental hazards. When Coconut Shell Concrete (CSC) is substituted as 25% in coarse aggregate, it shows properties similar to the nominal mix, in addition to 50% replaced CSC exhibits properties just like light weight concrete that can be used as filler materials in framed structures, flooring tiles, thermal insulating concrete etc.Vasudev.R,Dr.B.G.Vishnuram [5] experimented the study regarding the applications of steel scraps as materials in concrete as a healing approach. The authors inferred that High Strength Concrete (HSC) regularly fulfills the necessities for strength and workability improvement places a lot more stern requirement on materials selection than that with respect to lower strength concrete. Consequently, the production of HSC might not need the special materials, however it definitely requires materials associated with highest quality and their own optimum proportions. In the particular production of HSC, utilization of strong, sound and thoroughly clean aggregates is important. The inclusion of steel fibers that is commercially available in marketplace boosts the budget of the particular project. But, by rehabilitating the scraps extracted through the steel lathe stores, improved the tensile qualities of concrete. It will be very much encouraging as the utilization of such scraps is cost-effective for common man. Shirule Pravin et al [6] reused the stainless-steel waste from lathe equipment as reinforced material so as to increase the characteristics of concrete. With this research, a new comparison has been made between plain cement concrete and steel scrap (i.e. 0.5%, 1%, 1.5%, 2%) by the mass of. The compressive, split tensile and flexural strength of steel fiber reinforced concrete is determined to be maximum for 1.5% steel scrap fibers. Saranya C.V et al [7] inferred the use of lathe industry waste and waste materials flux sheet. This research is targeted on the consequence of addition of fiber within a high strength cement mix, by adding each the fiber extracted through waste flux sheet and the commercial lathe scrap. Now-a-days flux sheets are majorly used for numerous advertisement works which will be non-biodegradable material. Hence usage of waste products flux sheet and decrease soil pollution was the main idea. This study may be the component of the research system on evaluating the overall performance and an excellent source of strength. Compressive strength for various mix proportions containing fiber shows good improvement in the strength properties, because of crack arresting system of fiber at numerous scales of cracking. Shrikant Varpe and Damre Shraddha [8] concluded that with 50% replacement of coarse aggregates by coconut shell, when compared to conventional concrete there is 10 to 20 % reduction in compressive strength. There is minimization of flexural strength from 10 to 15%, when there is replacement of coarse aggregates up to by coconut shells. Kishor S Sable, Madhuri K Rathi [9] that it is credible to plan a steel fiber reinforced Self Compacting Concrete (SCC) including fly ash. The SCC showed compressive strengths ranging from 17.8 to 22.7N/mm² at the finish of 3 days, from 23.79 to 29.97 N/mm² at the end of 7 days and from 32.4 to 46.10 N/mm², by the end of 28 days. The SCC developed split tensile strengths ranging from 3.82 to 7.59 N/mm² by the end of 28 days. G.Vijayakumar et al [10] had investigated the energy engagement qualities of lathe waste in concrete. There is merely considerable enhancement in split tensile strength of concrete with lathe scarp as related with Plain Cement Concrete(PCC). The outcome shows, the addition of lathe waste into PCC mixture boost the compressive strength although it lowers the workability of fresh concrete that contain lathe scrap. Typically the strength of concrete mixed with lathe waste shows improved impact durability when related with PCC. T.Sezhiyan, R.Rajkumar [11] studied the attributes of high strength concrete consuming glass powder and lathe scrap. Their aim is to utilize glass powder as a partial replacement of cement to estimate the pozzolanic activity in concrete and find their properties in concrete. Lathe scraps are collected from workshops and industries at very low cost and of 0.5 mm thick. The 30% absorption of glass powder additional in concrete was the optimal measure in this work. Daniel Yaw Osei [12] utilized a concrete of 1:2:4 as nominal concrete, where coconut shells are replaced by granite simply by volume. The density and the compressive strength of cement is found to decrease when the fraction alternative is increased. Concrete produced along with 20%, 30%, 40%, 50% and 100% replacement achieved 28 days compressive strength of 19.7 N/mm², 18.68 N/mm², 17.57N/mm², 16.64 N/mm²and 9.29N/mm² corresponding to 94%, 89%, 85%, 79.6% & 44.4% of the compressive strength of the particular concrete. The research recommended that concrete created by replacing 18.5% of the crushed granite with coconut shell combination could be sparingly used within reinforced concrete. Amarnath Yerrmalla et al [13] analyzed the properties of Coconut Shell (CS) addition and different properties of concrete along with CS as coarse combination replacement. They decided that with (a) Increase in CS proportion reduced densities associated with the concrete, (b) Along with increase in CS percentage the particular 7 days strength obtained also increased when compared to 28 days curing power. E.Mello, C.Ribelloato, E.Mohamdelhassan [14] studied on increasing concrete properties with fiber addition They have researched the concrete properties together with the addition of steel, carbon, cellulose and PET fibers. Each fiber has been added at 4% in fresh concrete, which had been moist cured for 28 days and then analyzed for compressive, flexural and split tensile strength. Results revealed that improvement in durability after addition of stainless steel and carbon fibers may possibly justify the extra cost of fibers.

IV. MATERIALS AND PROPERTIES

The raw materials used in this study were regionally available that includes Ordinary Portland Cement (O.P.C) as binding material, m-sand as fine aggregate, and coconut shell as coarse aggregate. Potable tap water was used for mixing throughout the whole investigation. The permissible and tolerance limits of potable water were checked as per I.S 456-2000.

Cement: Ordinary Portland concrete grade 53, conforming in order to I.S 12269-1987 has been used. Cement acts as a holding agent for materials. Cement is the most pricey materials in concrete and its available in several forms. Any time cement is mixed together with water, a chemical effect takes place therefore regarding which the cement substance sets and hardens into a stone mass. The properties regarding cement that have been studied usually are standard consistency, initial establishing time and specific gravitational pressure.

TABLE 1
PROPERTIES OF CEMENT

S.No	Physical Property	Test Results
1	Standard consistency	32%
2	Fineness	96
3	Specific gravity	2.72
4	Initial setting time	36 min
5	Final setting time	610 min

Fine Aggregates: Fine aggregate used for this experimental study for concrete is river sand conforming to Zone-IIas per I.S 383-1970. Fine aggregates are those whose size will be less than 4.75mm. They are generally regarded as to possess a lower dimension limit of approximately 0.07mm, also free of clay, nutrients and salt. The gravity of fine combination was found out applying pycnometer and sieve research was carried out applying IS sieves of measurements starting from 4.75mm to be able to 150 microns to determine typically the grading zone of get worse.

TABLE 2
PROPERTIES OF FINE AGGREGATE

S.No	Physical Property	Test Results
1	Fineness modulus	3.9
2	Specific gravity	2.53
3	Water absorption	17.6%

Coarse Aggregates: Materials whose particle size are above 4.75mm IS sieve is termed as coarse aggregate. It depends according to the nature of job. Coarse aggregate are made up of crushed or busted stones and stay hard, sturdy, dense, durable, clean or perhaps proper gradation. Locally accessible coarse aggregate with highest size of 20 mm were utilized in this project. Normally the aggregates should be free from dust before their use in concrete. The properties studied were specific gravity, bulk density and normal water absorption.

TABLE 3
PROPERTIES OF COARSE AGGREGATE.

S.No	Physical Property	Test Results
1	Fineness modulus	3.49
2	Specific gravity	2.75
3	Water absorption	1.2%

Coconut shell: The coconut shell utilized in this study are brought from local temple. They are sundried for five days prior to using being a combination. The coconut shell is broken into smaller pieces up to 20 mm. The breaking of coconut shell is done by using 30kg hammer. The broken pieces are passed through IS 20 mm sieve and those retained on the IS 16 mm sieve are utilized.

TABLE 4
PROPERTIES OF COCONUT SHELL

S.No	Physical Property	Test Results
1	Shell thickness	2-7 mm
2	Specific gravity	1.32
3	Water absorption	26%

Lathe scrap: Lathe scraps are generally collected from lathe workshops and other industries. These are alike the stainless-steel fiber nonetheless they don't have any regular condition and size. The condition of scrap fiber cross section is rectangular, garbled and metallic bright appearance.

TABLE 6
PROPERTIES OF LATHE STEEL SCRAP

S.No	Physical Property	Test Results
1	Type	Irregular
2	Size	2.5 mm gauge

Water: Water used in this project should have following qualities:

- It must be absolutely free from adverse amount associated with soils, acids, alkalis or even other organic and natural or inorganic impurities.
- It must be totally free from iron, vegetable issue or any other kind of substances, which are usually likely to have undesirable effect on concrete or even reinforcement.
- It should end up being fit for drinking functions.

Portable water available inside the premises utilized regarding mixing and curing regarding concrete.

V.METHODOLOGY

Concrete Mix Design:

In this study M25 grade concrete is used as per IS: 10262-2009. The concrete mix proportion is 1:1.51:2.56:0.45 and water content was 191 lit/m3.

Casting and Testing:

Total 27 cubes, 27 beams and 27 cylinders were casted. Final compressive strength, split tensile and flexural strength were tested for 7, 14 and 28 curing. The loads at which failure occurs were noted and average strengths for three specimens casted were found for each fraction of replacement.

VI. EXPERIMENTAL INVESTIGATION CONCRETE

The concrete mix proportion has been done in accordance with IS:10262-1982. By using this proportion value, the amount of cement, coarse aggregate and fine aggregate are approximated.

Test on Fresh Concrete:

The workability of concrete is determined by slump cone test to find out the consistency of concrete and also the normal water-cement ratio values for different proportions. The slump cone values of nominal concrete and replacing coconut shell (CS) of different percentages (3%, 6%, 9% CS) are displayed in graph.

Slump cone test:

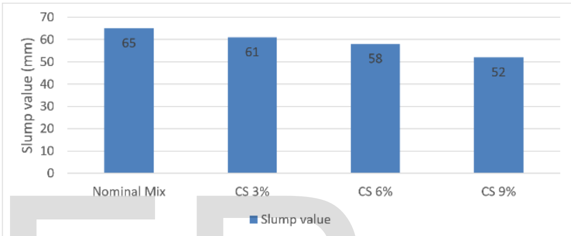

Fig. 1: Slump cone test

Test on Hardened Concrete:

1. Compressive strength test
2. Split tensile strength test
3. Flexural strength test

VII.RESULTS AND DISCUSSIONS

Compressive strength test:

The compression test is basically the alternative of the stress test regarding loading.Compression test brings the physical properties that consist of compressive yield strength, compressive ultimate strength, and compression modulus of elasticity inside compression, percentage reduction inside length etc. The compressive strength is found by using compression testing machine of capacity 1000 kN. In this test a loading rate of 2.5 kN/s had been applied as per IS: 516–1959. The test has been conducted on cube samples at 7, 14 and 28 days. All the sample are weighed just before putting to the crushing equipment to ascertain it density. The compression strength is found by

Compressive strength = Load at failure (N) / Effective Area (mm^2)

Where,

P - Load (N)
A - Area (mm^2)

TABLE. 7
DETAILS OF COMPRESSIVE STRENGTH ATTAINED

Days	Lathe scrap (%)	Coconut shell (%)		
		3	6	9
		Compressive strength (N/mm²)		
7	0	15.7	15.2	14.8
	0.5	15.8	15.1	14.8
	1	15.9	15.4	14.9
14	0	21.1	20.6	19.4
	0.5	21.2	20.8	19.8
	1	22.4	21.2	19.1
28	0	27.9	26.4	24.9
	0.5	27.9	26.3	24.8
	1	28.1	26.6	24.9

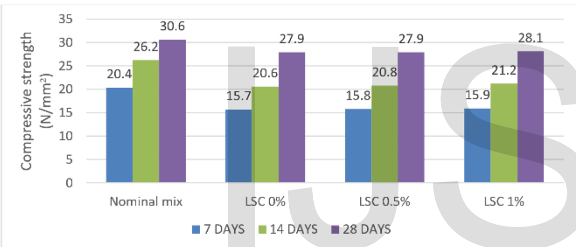

Fig. 2: Compressive strength for 3% of CS

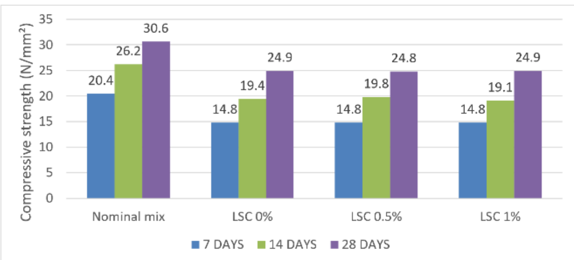

Fig. 3: Compressive strength for 6% of CS

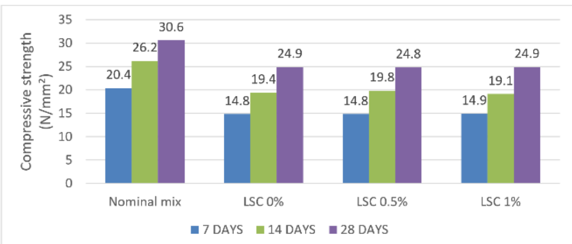

Fig. 4: Compressive strength for 9% of CS

Split tensile strength test:

This test is performed on a 1000KN capacity testing device. In the splitting pressure test a 150mm x 300 mm cylinder is subjected to compression load along with two axial lines which are usually diametrically opposite. In these types of test generally a compression force is put on the concrete specimen in such a manner that the particular specimen fails because of tensile stress developed inside the specimen. Direct tension test associated with concrete are rarely transported out, mainly since the specimen holding devices produce supplementary stresses cannot be disregarded. The steel plates are located at the leading and bottom involving the platens of testing machine in count to the cylinder.

Splitting tensile strength fc,

$$fc = 2P / \pi \, d \, l \ (N/mm^2)$$

Where
P= Load (N),
l= Span of the specimen,
d= Diameter of the specimen.

TABLE.8
DETAILS OF SPLIT TENSILE STRENGTH ATTAINED

Days	Lathe scrap (%)	Coconut shell (%)		
		3	6	9
		Split tensile strength (N/mm²)		
7	0	1.7	1.5	1.3
	0.5	1.6	1.6	1.5
	1	1.7	1.4	1.3
14	0	2.4	2.1	1.9
	0.5	2.2	2.3	2.0
	1	2.2	1.9	1.8
28	0	2.6	2.4	2.1
	0.5	2.4	2.5	2.2
	1	2.6	2.3	2.1

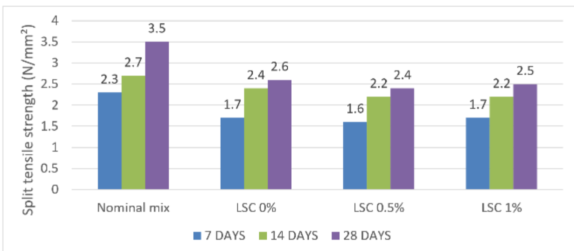

Fig. 5: Split tensile strength for 3% of CS

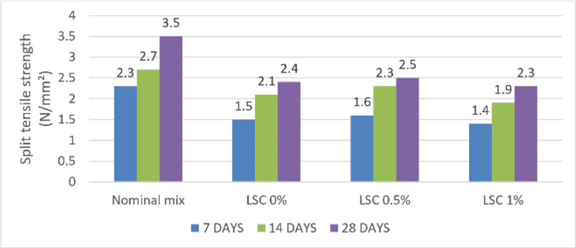

Fig. 6: Split tensile strength for 6% of CS

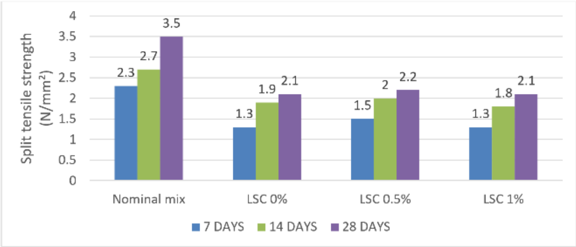

Fig. 7: Split tensile strength for 9% of CS

Fig. 8: Failure pattern of Cylinder

Flexural strength test:

The specimen of standard prism of 100 mm x 100 mm x 500mm was used to determine the flexural strength of concrete. Flexural strength is found using centre point loading system. The flexural strength is stress at failure in bending. Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture is a material property, defined as the stress in a material just before it yields flexure test.

$$f_{cr} = \frac{3}{2}\frac{PL}{bd^2} \text{ (N/mm}^2\text{)}$$

Where,
P = Ultimate load (N)
L = Centre to centre distance between the supports
b = Breadth of the specimen
d = Depth of the specimen

TABLE. 9
DETAILS OF FLEXURAL STRENGTH ATTAINED

Days	Lathe scrap (%)	Coconut shell (%)		
		3	6	9
		Flexural strength (N/mm²)		
	0	4.4	4.0	3.8
7	0.5	4.5	4.2	3.7
	1	4.6	4.3	3.7
14	0	5.6	5.2	4.8
	0.5	5.7	5.1	4.8
	1	5.9	5.5	4.9
28	0	6.3	5.8	5.4
	0.5	6.4	5.8	5.3
	1	6.6	6.1	5.5

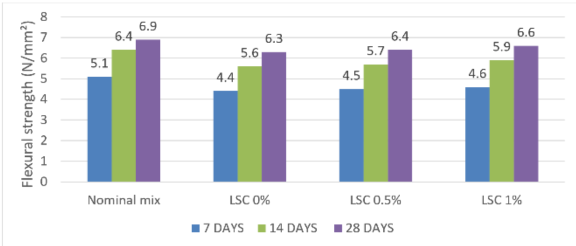

Fig. 9: Flexural strength for 3% of CS

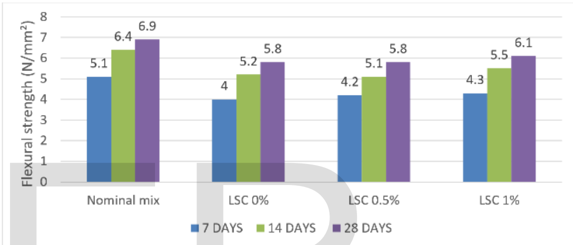

Fig. 10: Flexural strength for 6% of CS

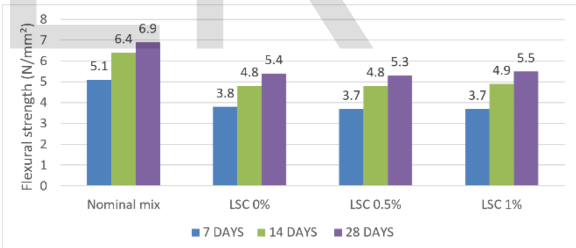

Fig. 11: Flexural strength for 9% of CS

Fig. 12: Failure pattern of Prism

VII. CONCLUSION

When the addition of coconut shell increases the workability decreases and also decreases the compressive strength, split tensile strength and flexural strength as compared to conventional concrete. An optimum of 1% of lathe scrap as an addition can be used to improve the strength of fiber reinforced concrete. Using coconut shell as replacement should be urged as an environmental security and construction cost lowering measure. The waste stainless-steel scrap material which is usually available in lathe industries are being used as steel fiber in modern construction and likewise in pavement construction. Lathe waste are generated by each lathe industry in addition to discarding of these waste materials into barren dirt contaminates the soil and ground water, which generates an unhealthy atmosphere.

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