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Effect of Silica Fume on Conventional Concrete and Light Weight Coconut Shell Concrete

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Abstract

High standing estimation of building materials utilized for development is a component of incredible concern. Coconut shell as a completely substitution in the place of coarse aggregate may totally effective for designers in construction industry. The coconut shell concrete is a light weight solid which may decrease the self-heap of a structure. The under taken project depends on inspecting attributes of coconut shell concrete when contrasted with conventional concrete. Coconut shells going from 10mm strainer and held on 6.3mm were considered to utilize for study. For the current study M100 grade concrete is used to cast the specimens. The principle properties considered testing on coconut shell concrete and conventional concrete is compressive strength, split tensile strength and flexural strength. Examples were taken by supplanting coarse aggregate with coconut shells completely and cement is supplanted by silica fume with various extents of 5%, 10%, 15%, 20%, 25% for compressive strength test and tests were done at 3, 7, 28, 56 and 90 days of curing, it is observed that the ideal compressive strength outcomes were gotten at 10% of silica fume. Split tensile and flexural strengths of specimens were calculated with replacement of cement by silica fume with different extents of 0%, 5%, 10% and 15%, tests were done at 3, 7 and 28 days of curing. The optimum replacement percentage of cement by silica fume is 10% for compressive strength, split tensile and flexural strength. The principle question of the review is to lessen the utilization of natural aggregate by

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supplanting them with coconut shells and to decrease the density of concrete which makes concrete for simple dealing with.

***Keywords**: - Coconut Shell (CS), Compressive Strength, Conventional concrete (CC), Coconut shell concrete (CSC), Flexural Strength, silica fume, Split Tensile strength.*

INTRODUCTION

Concrete is the primary item in development industry, however there are many negative effects underway of concrete like consistent extraction of aggregates from earth, which prompts natural lopsidedness. In light of this, non accessibility of regular assets to the future era has been acknowledged [1]. Many researches were conveyed to supplant the materials of concrete without change in their properties.

In Asia, the development business yet to understand the upside of light weight concrete in elevated structures [2]. Wooden chips, plastic waste, material waste, polyethylene, rice husk ash, groundnut shell, coconut shell and so forth: are a portion of the cases for substitution of totals in concrete [3]. The present paper is to spread attention to utilizing coconut shell as substitution with coarse aggregate in concrete. However, coconut shell has great strength, high durability, scraped area resistance thus it is reasonable for long standing use [4]. However, usage of coconut shell aggregate with replacement of natural stone aggregate will helps to reduce the density of concrete, thereby making it suitable for structural applications.

CS is discarded and is unutilized commercially as a building material especially in concrete. CSC can be used for the construction of pavements, precast structural elements, low cost houses and temporary structures. Utilization of CS will be an important step towards sustainable development. More environmental and economic benefits can be achieved by utilizing waste materials as light weight aggregate in concrete.

The CSC satisfies the minimum requirements of lightweight concrete [5]. The study shows that the compressive strength tends to increase from 0-10% and then decreasing gradually from 15-25%.

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The materials in the concrete were proportioned by their weights whereas coconut shell aggregate is proportioned by volume to the weight of coarse aggregate. The water cement ratio is obtained by conducting various workability tests, tests were conducted as per specified procedures of Indian standard codes.

EXPERIMENTAL PROGRAMME

Materials Used

1. Coconut Shell

Coconut shells were collected from local dealers, which were cleaned and sundried to analyze its properties. Coconut shells passing from 100mm strainer and retaining on 6.3mm retainer were used for the study. Coconut shells were cleaned with water and sundried due to its high-water absorption quality. In current study coconut shell aggregates were replaced with coarse aggregate in a volume basis then weight basis.

2. Silica Fume

Silica fume is acquired from Aastra chemicals, Chennai. Silica fume was used as partial replacement of cement in different extents 0%, 5%, 10%, 15%, 20% and 25%.

3. Main Component of Concrete

Ordinary Portland Cement of Ultra Tech brand of 53 grade affirming to IS: 12269-1987 [7] was utilized for the review. Normal sand at zone II which is accessible from neighborhood waterway, sand passing through 4.75mm strainer and holds in 90 microns was utilized as fine aggregate with mass thickness 1860kg/m^3 conforming to IS: 383-1987[8] and coarse aggregate going through 12.5mm strainer and held in 10mm strainer was utilized for this review. Ordinary Portable tap water from SRM UNIVERSITY is used to cast the specimen and for curing. Table 1 shows the chemical composition of silica fume and OPC.

Table-1. Chemical Composition of Silica Fume.

S.No	Chemical Composition	Silica Fume (%)	OPC
1	Sio_2	90	21.6
2	Al_2o_3	0.4	1.33
3	Fe_20_3	0.4	3.7
4	Cao	1.6	63.0
5	So_3	0.4	0.88
6	Na_20	0.5	0.4
7	K_20	2.2	0.51

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Specimen Preparation

The compressive strength was determined by Coconut shell concrete and conventional concrete cubes of size 100mmx100mmx100mm were casted with various silica fume proportions of 0%, 5%, 10%, 15%, 20% and 25%, split tensile strength of cylinder size 100mm diameter and 200mm height were used and for flexural strength of beam size 500mmx100mmx100mm were used. In present study coarse aggregate is replaced with coconut shell by volume basis, to the volume of coarse aggregate taken.



Figure-1. Material Collection



Figure-2.Specimen preparation

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Mix Design Details

ACI method is utilized for planning concrete of grade M100, light weight concrete blend is typically established by trail mixes. A similar mix proportion is utilized for both conventional and coconut shell concrete, however for CSC a similar volume of coarse aggregate utilized as a part of CC is supplanted by CS. The blend extent utilized is 1:0.62:1.64 and water cement ratio of 0.3 [9].

Method of Testing

Compressive test is done at the respective ages of 3, 7, 28, 56 and 90 days of cubes, three cubes were taken out of curing for testing at the this perspective ages. The cubes are placed under the compressive testing machine in such way that the heap is connected to the inverse side of cast.

The compressive strength was assessed for different rates of cement replaced with silica fume which are 0%, 5%, 10%, 15%, 20% and 25%, the tests were done at 3, 7, 28, 56 and 90 days of curing according to IS 516-1959 [10]. The split tensile strength and flexural strength were assessed for different rates of cement replaced with silica fume which are 0%, 5%, 10% and 15%. The Split tensile strength of concrete is dictated by splitting the cylinder over the vertical width. The test was done by setting a cylindrical specimen horizontally between the loading frames of the compressive testing machine. The heap was connected until the specimen fails. Tests were done at 3rd, 7th and 28thdayscuring of concrete according to IS: 5816-1999 [11]. Flexural strength test was done according to IS: 516-1959 [12].



Figure-3.Covering of Specimens with Polythene Sheet

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Figure-4. Testing of Specimen

Table-2. Mix Proportion of Concrete

Cement replaced with silica fume in %	Percentage of Cement + S. F	Material Proportion of Coconut shell Concrete for 15 Cubes					Material Proportion of Coconut shell Concrete for 15 Cubes				
		Wt. of Cement in kg	Wt. of S.F in kg	Wt. of FA in kg	Wt. of CA in kg	Water in litres	Wt. of Cement in kg	Wt. of Silica Fume in kg	Wt. of FA in kg	Wt. of Coconut Shell in kg	Water in litres
0	**100+0**	12.15	0	7.53	19.92	3.64	12.15	0	7.53	8.75	3.64
5	**95+5**	11.54	0.61	7.53	19.92	3.64	11.54	0.61	7.53	8.75	3.64
10	**90+ 10**	10.94	1.21	7.53	19.92	3.64	10.94	1.21	7.53	8.75	3.64
15	**85+ 15**	10.33	1.82	7.53	19.92	3.64	10.33	1.82	7.53	8.75	3.64
20	**80 + 20**	9.72	2.43	7.53	19.92	3.64	9.72	2.43	7.53	8.75	3.64
25	**75 + 25**	9.12	3.03	7.53	19.92	3.64	9.12	3.03	7.53	8.75	3.64

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RESULTS AND DISCUSSION

Physical Properties of Coconut Shell Aggregate

Coconut shell is one of the horticultural wastes so as to supplant coconut shell with regular aggregate (coarse aggregate), first we have to know whether the physical properties of coconut shell matches to coarse aggregate. Table 3 demonstrates the physical properties of coconut shell.

The low density of coconut shell aggregate is advantages for coconut shell concrete which will be lighter compared to conventional concrete.

Table-3. Physical Properties of Coconut Shell.

S. No	Physical Properties	Coconut Shell
1	Specific gravity	1.18
2	Impact value	2.5%
3	Crushing value	1.29%
4	Fineness modulus	1.001
5	Abrasion value	5.6%
6	Shell thickness	2-6mm
7	Bulk Density	600Kg/m^3

Compressive Strength of Concrete

The test was done adjusting to IS 516-1959 to get compressive strength of concrete at the age of 7, 14, 28, 56 and 90 days. Cubes were tested under compressive testing machine (CTM) of limit 2000kN. The outcomes are introduced in table 4.

Table-4.Compressive Strength of Concrete

Age Days	Conventional concrete with Silica fume Replacement In (%)						Coconut shell concrete with Silica fume Replacement In (%)					
	0	5	10	15	20	25	0	5	10	15	20	25
	compressive strength in N/mm											
3	50.6	51.2	53.4	50.7	47.4	43.2	23.2	23.9	24.5	22.4	20.7	19.8
7	57.3	59.2	59.6	55.3	52	48.4	30.1	31.1	32.5	29.3	26.6	23.2

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28	74.9	76.5	78.3	70.1	67.5	61.3	31.5	32.3	34.2	30.2	28.3	24.2
56	80.4	80.8	82.1	74.3	69.8	63.8	31.8	32.8	35.2	30.8	29.1	24.8
90	84.3	85.3	86.6	77.2	72.7	68.7	32.4	33.7	35.8	31.3	29.8	25.3
Average Density in kg	2.42	2.53	2.33	2.47	2.46	2.42	1.85	1.87	1.84	1.85	1.86	1.8

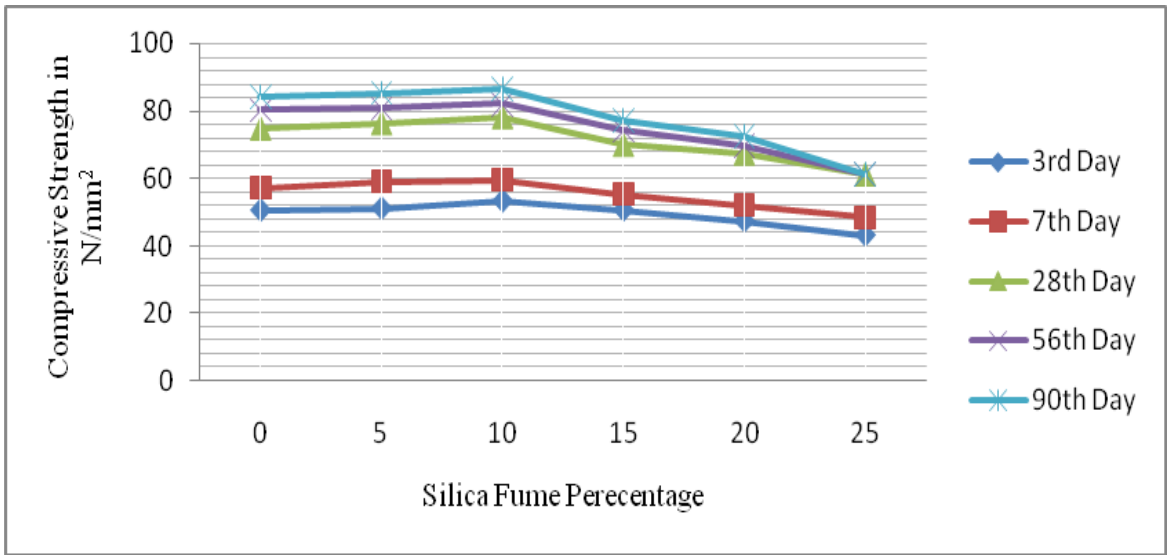


Figure-5.Compressive Strength of Conventional Concrete

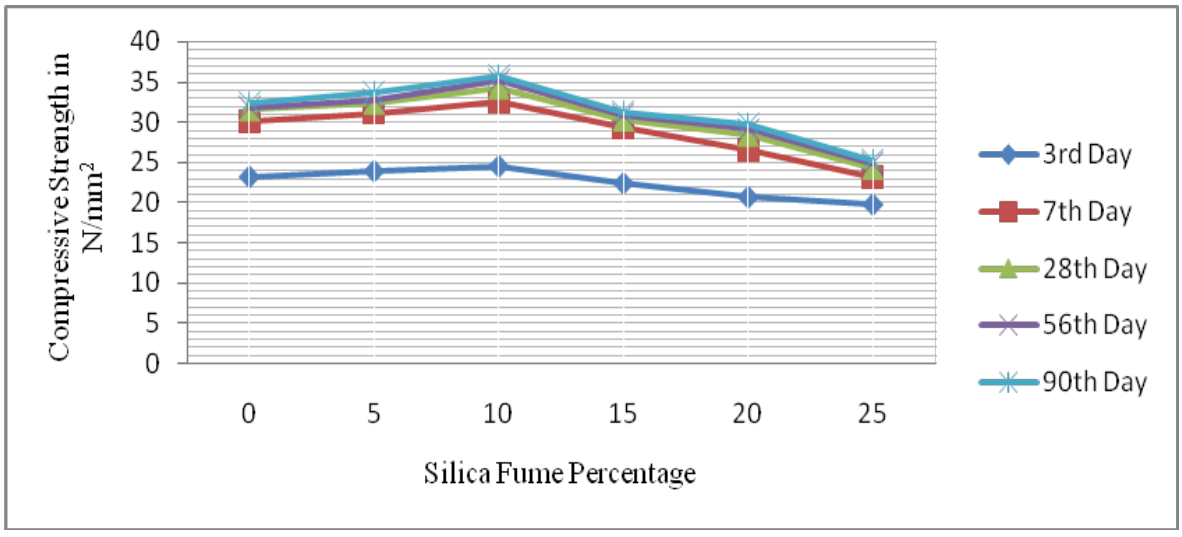


Figure-6. Compressive Strength of Coconut Shell Concrete

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Fig 5 & 6 demonstrates the compressive strength of conventional concrete and coconut shell concrete by supplanting of cement with silica fume in various percentage. The compressive quality with supplanting of cement with silica fumes increments from 0% to 10% and afterward diminishes. Thus, ideal silica fume content is 10% for both conventional and coconut shell concrete. It is observed that for conventional concrete the maximum compressive strength is 86.6N/mm2 at 10% replacement of cement with silica fume which is 2.7% more than controlled concrete and for coconut shell concrete conventional concrete the maximum compressive strength concrete is 35.8N/mm^2 at 10% replacement of cement with silica fume which is 10.5% more than controlled coconut shell.

Split Tensile Strength

The test was done adjusting to IS 516-1959 to get split tensile strength of concrete at the age of 7, 14, 28, 56 and 90 days. Cylinders were tested under CTM of limit 2000kN. Split tensile strength test on concrete cylinder is method to determine the tensile strength of concrete. Concrete is not expected to resist direct tension due to its brittle nature, therefore concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which concrete member breaks. The outcomes are introduced in table 5.

Table-5.Split Tensile Strength of Concrete

Age (DAYS)	Conventional Concrete With Silica Fume Replacement In (%)				Coconut Shell Concrete With Silica Fume Replacement In (%)			
	0	5	10	15	0	5	10	15
	Split Tensile Strength in N/mm							
	0	5	10	15	0	5	10	15
3	3.8	4.1	4.3	3.8	2	2.1	2.4	1.9
7	4.3	4.5	4.7	4.1	2.2	2.5	2.7	2
28	4.8	4.9	5.1	4.4	2.8	2.9	3.1	2.5

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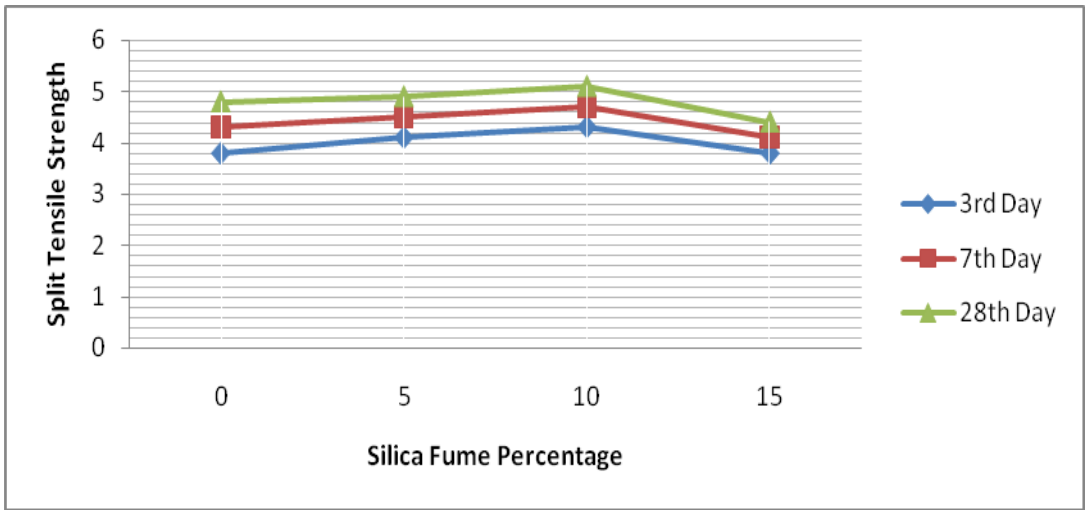


FIGURE-7. Split Tensile Strength of Conventional Concrete

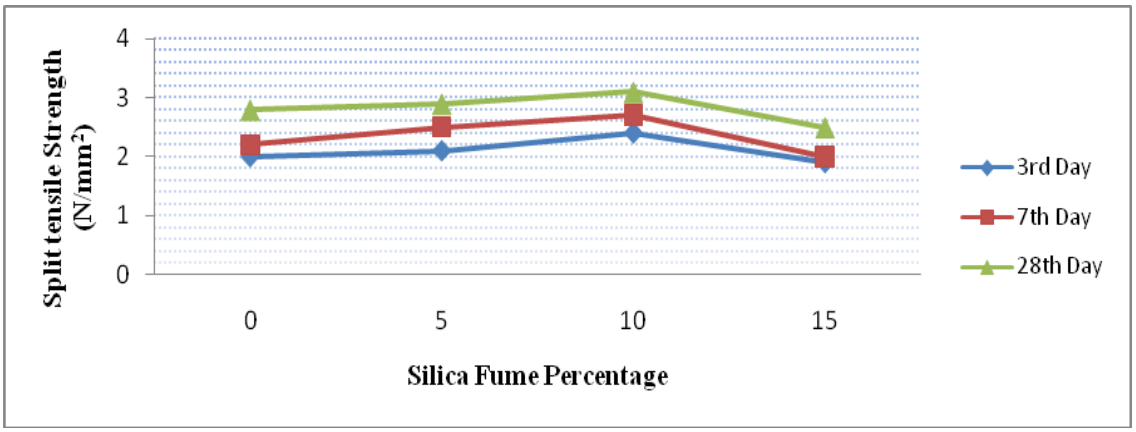


FIGURE-8.Split Tensile Strength of Coconut Shell Concrete

The split tensile strength of high-performance concrete increases with increase in silica fume percentage. It is observed that for conventional concrete the maximum split tensile strength is 5.1N/mm^2 at 10% replacement of cement with silica fume which is 6.25% more than controlled concrete and for coconut shell concrete conventional concrete the maximum compressive strength is 3.1N/mm2 at 10% replacement of cement with silica fume which is 10.7% more than controlled coconut shell concrete.

Flexural Strength of Concrete

The test was done adjusting to IS 516-1959 to get split tensile strength of concrete at the age of 7, 14, and 28. Beams were tested flexural testing machine of limit 100KN. The outcomes are introduced in table 6.

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Table-6. Flexural Strength of Concrete

Age (DAYS)	Conventional Concrete With Silica Fume Replacement In (%)				Coconut Shell Concrete With Silica Fume Replacement In (%)			
	0	5	10	15	0	5	10	15
	Flexural strength N/mm2							
	0	5	10	15	0	5	10	15
3	4.1	4.7	4.9	4	2.8	2.9	3.1	2.7
7	4.5	5.2	5.5	4.3	3.1	3.4	3.7	2.9
28	7.2	8.3	8.7	5.9	3.9	4.1	4.4	3.4

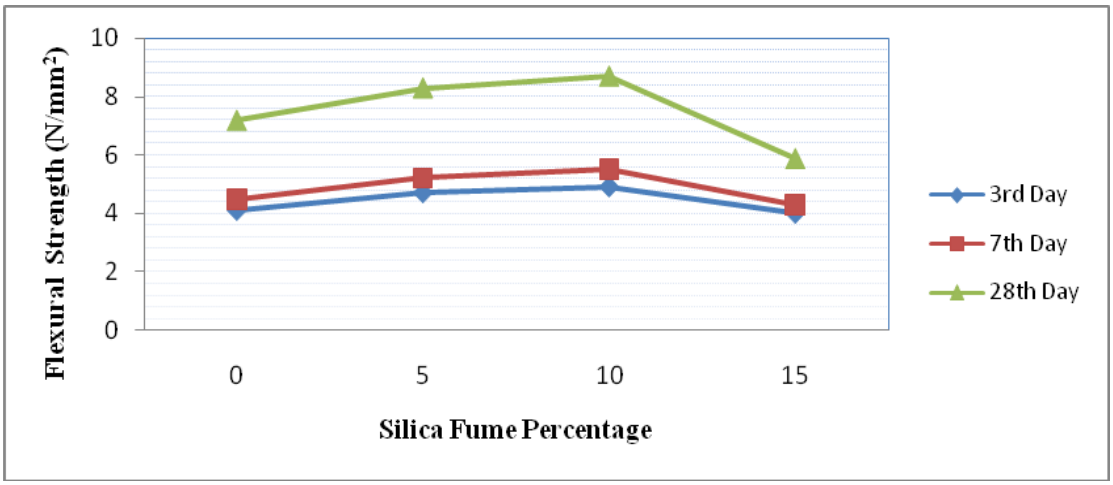


Figure-9.Flexural Strength of Conventional Concrete

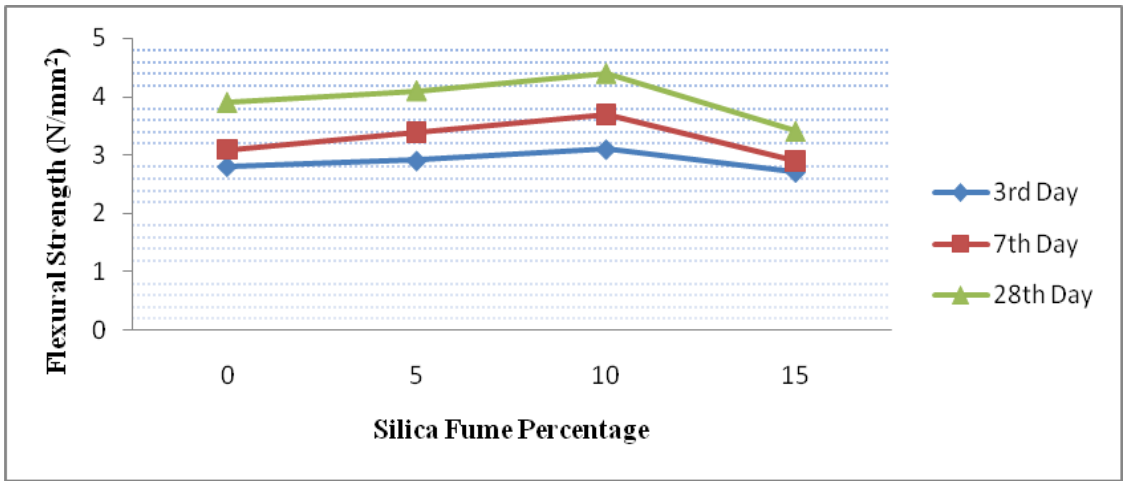


Figure-10.Flexural Strength of Coconut Shell Concrete

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The flexural strength of conventional and coconut shell concrete increases with increase in silica fume percentage upto 10% and then decreases. .It is observed that for conventional concrete the maximum flexural strength is 8.7N/mm2 at 10% replacement of cement with silica fume which is 20.8% more than controlled concrete and for coconut shell concrete conventional concrete the maximum compressive strength is 4.4N/mm^2 at 10% replacement of cement with silica fume which is 12.8% more than controlled coconut shell concrete.

CONCLUSION

1. From the outcomes it is reason that the silica fume is a superior substitution of bond. The rate of quality pick up in silica fume concrete is high. After performing all tests and analyzing their results, the accompanying conclusions were listed below:

2. 100% replacement of coarse aggregate with coconut shell aggregate tends to reduce the density of concrete and usage of natural aggregate.

3. The 90th day average compressive strength of coconut shell concrete with 10% replacement of silica fume were found to be 35.8N/mm2, which is 10.5% higher in strength compared to controlled concrete.

4. The 90th day average compressive strength of conventional concrete with 10% replacement of silica fume were found to be 86.6N/mm^2, which is 2.7% higher in strength compared to controlled concrete.

5. The average 28th day split tensile strength of coconut shell concrete and conventional concrete were found effective at 10% replacement of silica fume, for coconut shel1 concrete it shows 10.7% higher than controlled concrete and for conventional concrete it shows 6.25% higher than controlled concrete.

6. The average 28th day flexural strength of coconut shell concrete and conventional concrete were found effective at 10% replacement of silica fume, for coconut shel1 concrete it shows 12.8% higher than controlled concrete and for conventional concrete it shows 20.8% higher than controlled concrete.

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7. It is observed that replacement of cement with silica fume tends to increase from 0% to 10% further increase in silica fume tends to decrease in compressive strength, split tensile strength and flexural strength.

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