Available online: www.ijsrmes.com

International Journal for Scientific Research in Modern Engineering and Science

International Journal for Scientific Research in Modern Engineering and Science, 3(3): 6-16 (2022)

THE EFFECT OF COIR FIBRE, COCONUT SHELL AND COCONUT SHELL ASH AS SUBSTITUTE OF COARSE AGGREGATE AND CEMENT REPLACEMENT MATERIAL IN CONCRETE WITH 28 DAYS STRENGTH

Ankit Kumar Gupta[1]*, Mitali Shrivastava[2]

[1]*M. Tech, Civil Engineering Department, Shri Shankaracharya technical Campus, Bhilai-490020 Chhattisgarh, India,*

[2]*Assistant Professor, Civil Engineering Department, Shri Shankaracharya technical Campus, Bhilai-490020 Chhattisgarh, India.*

Abstract

As developing nations strive for economic sustainability, effort is geared towards exploiting biomass materials that could have alternative uses to their conventional low valued uses in order to achieve this goal. In this Research paper discusses the comparative study between coconut shell, fiber material obtained from coconut and coconut shell ash in a concrete mix and the behaviour of the concrete matrix with coconut constituents are monitored upon. Basic strength tests like compressive, tensile and flexure properties were studied upon and the results were tabulated. The coconut shell were added at 5- 25%, coir fibers were added at 1- 5% and the coconut shell ash at 5- 25% in the concrete mix.

Keywords: Coir Fibre, Coconut Shell, Ash, Aggregate, Cement.

* *Corresponding author*

1. Introduction

1.1 Coir Fibre, Coconut Shell, Coconut Shell Ash

Coir or coconut fibre is a natural fibre obtained from the husk or the mesocarp of coconut. Since the fibre is typically golden colour after cleaning up, it is reffed to as golden fibre. It is a fibrous, tough and naturally resistance to water. Individual fibre celles of coir fibre are hallow and narrow having thick walls containing cellulose which is a strength containg compound in concrete.

Coconut shell is an agricultural waste and is available in plentiful quantities throughout tropical countries worldwide. In many countries, coconut shell is subjected to open burning which contributes significantly to CO2 and methane emissions. The coconut fruit yields 40 % coconut husks containing 30 % fiber, with dust making up the rest. The chemical composition of coconut husks consists of cellulose, lignin, pyroligneous acid, gas, charcoal, tar, tannin, and potassium. Coconut dust has high lignin and cellulose

content. The materials contained in the casing of coco dusts and coconut fibers are resistant to bacteria and fungi.

Coconut Shell Powder is also widely used in production Such as decorative materials, ropes, etc. Due to its low cellulose content, the shell also absorbs less water (Gummadi 2012). This study focus on the study of increased efficiency of coconut shell particles as a natural material for reinforcing epoxy resins towards their Flexural properties. Coconut shells have no economic value, and their disposal is not only expensive but can Ecological problems. Coconut shell is suitable for making carbon black due to its excellent natural structure and low ash quantity. Coconut shell ash is obtained from coconuts shell, coconuts shell was burnt under controlled combustion arrangement at 500 ℃ to 550 ℃ temperatures for two hours to produce ash. The coconut shell ash was sieved through #200 sieves and it can be used as a cement replacement material in concrete.

1.2 Properties of Coir Fibre, Coconut Shell, Coconut Shell Ash

The separation of tightly bound fibres i.e. extraction of fibres can be done by manual and/or mechanical means. Fibre is attached to the mesoderm with pectinous matter. So, for extraction of fibre, the husk is to be essentially softened. In the addition of coconut fibre the Compressive Strength of concrete increases. coconut fibres in reinforced concrete to reduce cracking. The advantage of using such fibres provides generally a low cost construction and the elimination of the need for waste disposal in landfills. Utilization of these fibres in concrete leads to an effective solid waste management Technique. The introduction of fibres is a solution to develop concrete with enhanced Compressive Strength and Split tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement.

The concrete obtained using Coconut Shell aggregates satisfies the minimum requirements of concrete. Concrete using Coconut Shell aggregates resulted in acceptable strength required for structural concrete. Coconut Shell may offer itself as a coarse aggregate as well as a potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid wastes simultaneously. The Coconut Shell-cement composite is compatible and no pre-treatment is required. Coconut Shell concrete has better workability because of the smooth surface on one side of the shells. The impact resistance of Coconut Shell concrete is high when compared with conventional concrete. Moisture retaining and water absorbing capacity of Coconut Shell are more compared to conventional aggregate. The amount of cement content may be more when Coconut Shell are used as an aggregate in the production of concrete compared to conventional aggregate concrete. The presence of sugar in the CS as long as it is not in a free sugar form, will not affect the setting and strength of concrete.

Coconut shells ash as partial replacement of cement. It has also been established that amorphous silica found in some pozzolanic materials which react with lime more readily than those of crystalline form. Use of such pozzolana can lead to increase in compressive and flexural strengths. The raw materials used for the manufacturing of cement consist mainly of lime, silica, alumina, and iron oxide. Generally the

chemical analysis of coconut Shell ash reveals that it contains some quantities of these elements. Hence coconut shells ash can be used effectively as a supplementary cementitious material.

Table 1. Chemical composition of coconut shell ash and cement

Ingredients	Coconut Shell Ash (%)	Cement (%)
CaO	4.98	64.0
SiO_2	37.90	20.70
Al_2O_3	24.12	5.75
MgO	1.89	1.00

1.3 Advantages

- Addition of coir fibre, coconut shell and coconut shell ash enhanced the compressive strength and durability of concrete.
- The impact value of coconut shell is lower, which indicates that these aggregates have good absorbance to shock.
- The compressive strength of coconut shell ash concrete increased with curing aging.
- It provide excellent insulation against temperature and sound.
- Coconut shell ash increase the compressive strength and workability of concrete.
- Coconut fibre are unaffected by moisture and dampness
- Coconut fibre tough, durable, resilient.
- Concrete structure springs back to shape even after constant use, totally static free and easy to clean.
- It help to produce light weight concrete structure with high strength.
- Coconut materials used on concrete help to reduce cost of construction.
- Use of coconut waste in concrete can help in waste reduction and pollution reduction.
- The need of the hour is to encourage the use of the waste products as construction materials in low-cost housing.
- The maintenance and repair cost of structure are reduced thus increasing the life cycle of concrete structures.

1.4 Application

Coconut shell, coir fibre and coconut shell ash is used to make eco-friendly concrete structures in combination with ordinary Portland cement, sand, aggregate and water. A large amount of agricultural waste was disposed in most of tropical countries especially in Asia for countries like India, Thailand, Philippine and Malaysia. The high cost of conventional building materials is a major factor affecting housing delivery in India. Concrete made with coconut shell ash and cement sets mor slowly than concrete made with ordinary portland cement, depending on the amount of coconut shell ash replacement on cement, but also continues

to gain over longer period in production conditions. In these we find that lower heat of hydration and lower temperature rises but may also effect construction schedule where quick setting is required.

Uses of coir fibre an coconut shell reduces to rick of damage due to cracking while maintaining temperature absorption quality. It also make structure insulated and sound proof.

1.5 How it Should Use in Concrete

Coconut shell ash can be added to concrete in the concrete manufacture's bacthing plant along with portland cement by various percentage and coconut shell add along with coarse aggregate and the coir fibre add after mixing of sand and aggregate in two parts as in different percentage.

The percentage level vary of coconut shell ash is 5-25%, coconut shell vary 5-25% and coir fibre added 1 to 5%. It is used as partially as per mixed ratio.

2. LITERATURE REVIEW

(a) B. Anusha The cost of traditional materials used in the concrete is the major factor which is increasing cost of constructions, so it is necessary to research for alternative construction materials. In this experimental investigation, the coconut shell used as a light weight aggregate in concrete, the properties of coconut shell concrete examined, Control concrete with normal aggregate and CS concrete with 10 - 30% coarse aggregate replacement with CS were made, and Constant water to cementitious ratio of 0.5 was maintained for all the concretes. Properties like compressive strength, consistency, workability were investigated in the laboratory. The results showed that, density of the concretes decreases with increase in CS percent. Workability decreased with increase in CS replacement. Compressive strengths of CS concretes were lower than control concrete. The paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M20 grade concrete.

(b) Amarnath Gupta The most affecting factor in construction is its cost. In most of the construction work concrete is used which consist which consist cement, sand, coarse aggregate and water. The compressive and flexural strength of concrete is mostly depend on the compressive and flexural strength of coarse aggregate. In present day the coarse aggregate is obtained from natural resources for example natural rocks etc. But artificial aggregate are also in practice. In India coconut is widely used for various purposes like worship, industries etc. By use of coconut its shell remains as by-product which can be useful for construction work in place of coarse aggregate. In this experiment coarse aggregate of concrete are partially replaced by coconut shell as 5%, 10%, 15%, 20%, 25%, 30%. The concrete are examine for compressive strength and compare with conventional concrete of grade M20. All test of cement, sand, aggregate and concrete was done as per IS code.

(c) G Sravan Kumar. Utilisation of agricultural waste material in concrete enhances the properties of concrete. To study this phenomenon concrete made of fly ash, coconut fibre and coir fibre for M40 was done and evaluated. Cement is substituted with fly ash by 10%, 20%, and 30%.Coir fibres is include by weight of the binder in the proportions about 0%, 1%, 1.5%, 2%, 2.5%, 3%. Coconut shells are replaced in the place of coarse aggregate.

The breadth of coconut fibre will vary from 0.25 to 1.0 cm. The present study has illustrated that addition of coconut fibre and coir fibre to concrete enhances the properties of concrete.

(**d) V.Sai Uday** This experiment describes the behavioral study of coconut fibre in concrete structure. The addition of coconut fibre in concrete improves various engineering properties of concrete. Coconut fibre is treated as natural fiber before using in concrete. Addition of coconut fibre improves the compressive strength, flexural strength and split tensile strength of concrete. The experiment was conducted on high strength concrete with the addition of fiber with 5 mix proportions (1%, 2%, 3%, 4%, and 5%) by the weight of cement. The compressive strength and split tensile strength of cured concrete evaluated for 3days,7days, 28days.The study found the optimum fiber content to be at 1%(by the weight of the cement).This results show coconut fiber can be used in construction.

(e) Yogesh Narayan Sonawane Chetan Jaiprakash Chitte In construction industry the rising cost of construction material is the great factor. The prices of building materials are rising day by day. Therefore this is a most priority of all human being to encourage or research on sustainable material which will help to use such waste material as construction material with less cost and safety of structure. The course aggregate is the main constituent of concrete mix, hence in this paper we used coconut shell as a coarse aggregate has been discussed based on the results obtained from test results. The use of coconut shell can also help the prevention of the environment. The paper aims at analyzing compressive strength of concrete (M20-1:1.5:3) produced using coconut shell as substitute for conventional coarse aggregate with 0%, 25%, 50%, 100% partial replacement. Three sample cubes are prepared for M20 grade concrete mix for each case another aim of this paper is to spread awareness about use of coconut shell as construction material in civil engineering.

(f) Sanjay Sen , Rajeev Chandak Concrete is the construction material which is obtained by mixing of cement, water and aggregate in required proportionsthus the need to find alternative binding materials that can be used solely or in partial replacement of cement. Agricultural waste material, In this case coconut fibre ash, which is an environmental pollutant.The ash was collected and made to pass through 150 micron sieve. This work presents the results of laboratory test carried out using coconut fibre ash (CFA) as a partial replacement for cement in concrete production. Concrete cubes are cast and tested at curing aging of 7, 28, 60, & 90 days using 0, 5, 10, 15, 20, & 25 percent replacement levels. The slump test results show that the workability of the concrete decreased as the CFA content increased & the compressive strength of CFA concrete increased with curing aging but decrease with increasing the percentage of coconut fibre ash. The percentage strength gained at 90 days for 5% and 10% for the control of 0% is 96.22% & 86.12% respectively.

Problem Identification

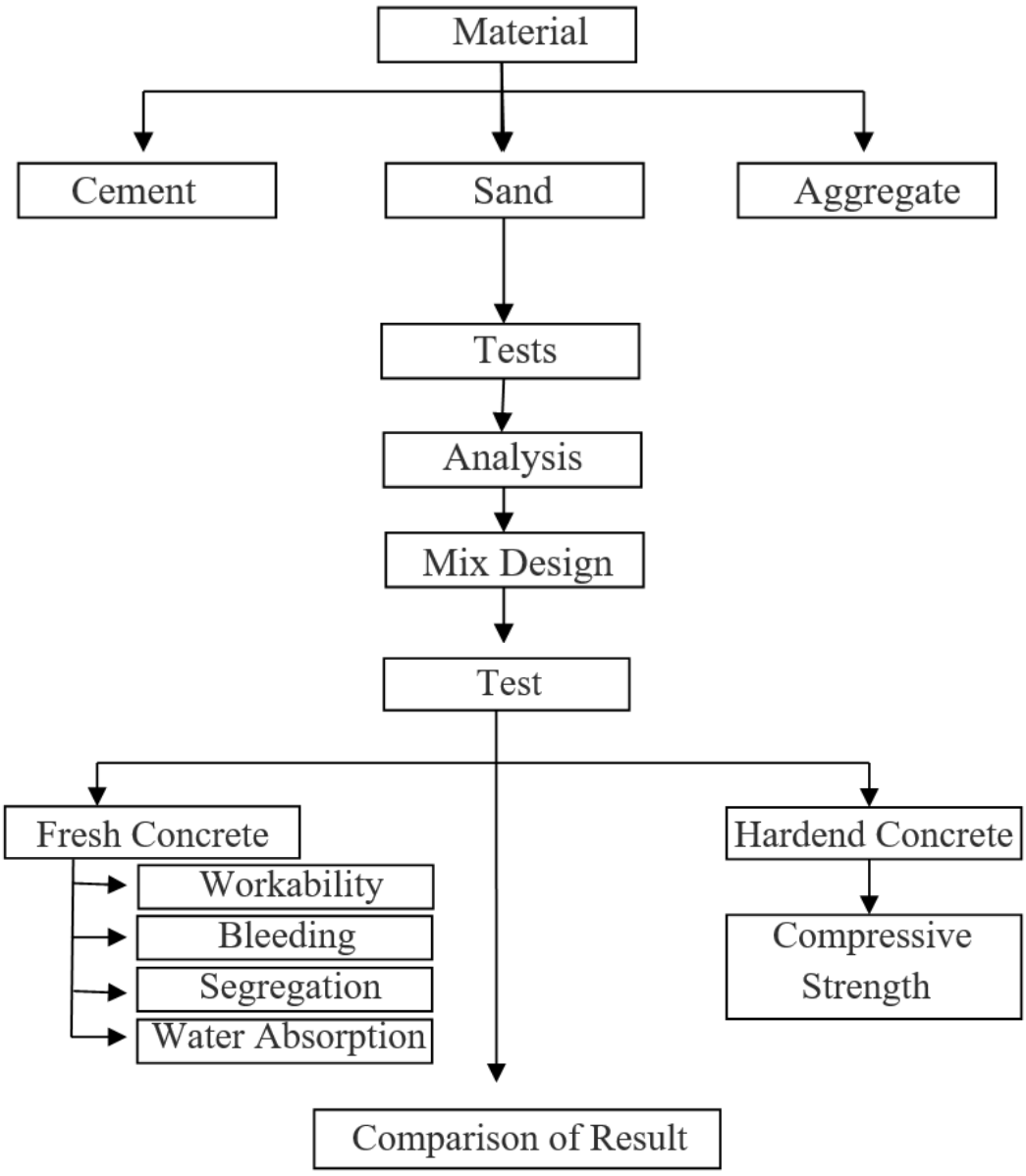
In the present study an investigation is made on properties of concrete by partil replacement of coconut shell as coarse aggregate above 10% it start to decrease strength and also decrese the workability of concrete , coemnt

replacement by coconut shell ash 5-25% above the 15% it started to strength of concrete, in addition we add coir fibre on concrete to improve its strength up to 1-5% more percentage of fibre addition decrease workability and voids on concrete.

3. Objective of the Study

The main objective of these research work is to determine the characteristics compressive strength of concrete by compaction with normal concrete to the concrete with coconut shell partially with aggregate, coconut shell ash partially with cement and additional coir fibre add.

4. Methodology



5. Result and Discussion

5.1 Properties of cement and coconut shell ash

Ordinary Portland cement confirming IS 8112:1989 was used thought the work

PROPERTIES	CEMENT	COCONUT SHELL ASH
Fineness modulus	2%	6%
Specific gravity	3.35	1.33
Consistency	28%	35%

The fine aggregate used in this work clean river sand and maximum size is 4.75 mm. Sieve analysis confirms to zone-II (accordint to IS 383:1970)

Table 2. Properties of fine aggregate

PROPERTIES	RESULT
Zone	II
Water absorption	1.1%
Fineness modulus	2.86
Specific gravity	2.66

Table 3. Properties of coarse aggregate

PROPERTIES	RESULT
Size	20mm
Water absorption	0.8%
Fineness modulus	7.2%
Specific gravity	2.79

Coconut shell particles are used as reinforcing material for investigation. Shell particles of size between 20 mm and thickness 2-6mm. Coconut shell has high strength and modulus properties.

Table 4. Properties of coconut shell

PROPERTIES	RESULT
Specific gravity	1.25
Water absorption (%)	20
Shell thickness (mm)	2-6

Table 5. Properties of coconut fibre

PROPERTIES	RESULT
Diameter of fiber	0.0406 ~ 0.05cm
Length of fiber	3cm
Aspect ratio	60
Specific gravity	1.12

Table 6. Compression test on different percentage of coconut shell ash added to concrete

S.NO.	**Percentage Replacement of Cement (%)**		**Compressive strength (MPa)**		
	Cement	**Coconut Shell ash**	**7days**	**14days**	**28days**
(A)	100	0	18.1	20.98	26.4
(B)	95	5	11.24	15.74	22.93
(C)	90	10	12.89	18.36	26.32
(D)	85	15	11.11	14.82	23.23

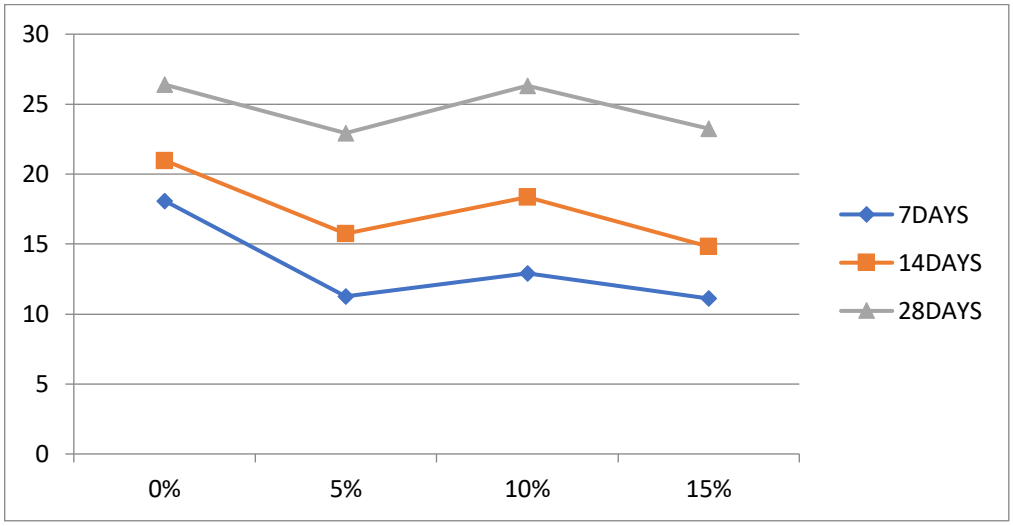


Figure 1. Compressive Strength of 7,14 & 28 days for M20 grade of concrete

Table 7. Compression test on different percentage of coconut shell added to concrete

S.NO.	**Percentage Replacement of Coarse Aggregate (%)**		**Compressive strength (MPa)**		
	Coarse Aggregate	**Coconut Shell**	**7days**	**14days**	**28days**
(A)	100	0	18.1	20.98	26.4
(B)	95	5	17.02	19.48	24.02
(C)	90	10	17.7	20.14	24.92
(D)	85	15	17.3	18.64	20.77

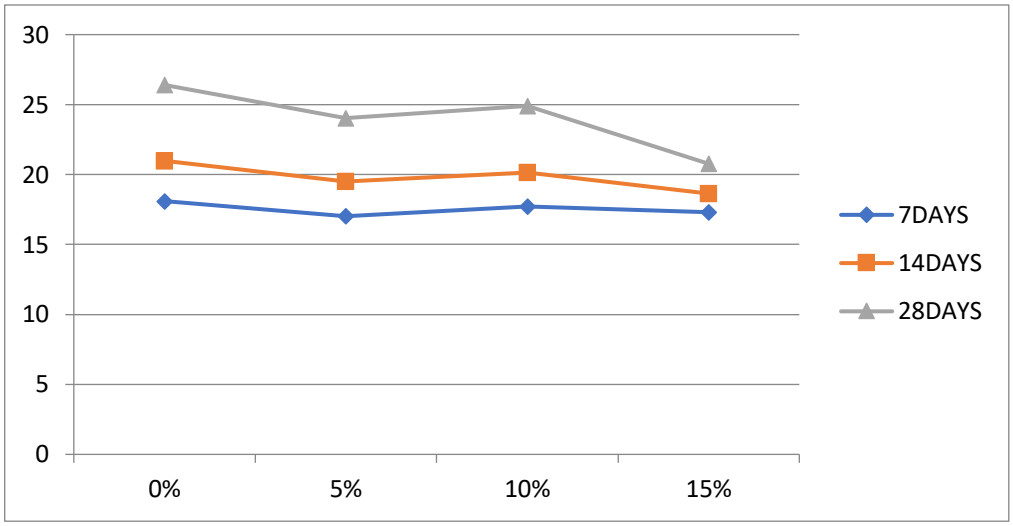


Figure 2. Compressive Strength of 7, 14& 28 days for M20 grade of concrete

Table 8. Compression test on different percentage of coconut fibre added to concrete

S. NO.	Coir Fibre %	Compressive strength (MPa)		
		7days	14days	28days
(A)	1	13.95	18.67	23.25
(B)	2	15.73	19.82	23.84
(C)	3	17.18	20.98	24.44
(D)	4	13.50.	17.39	23.29

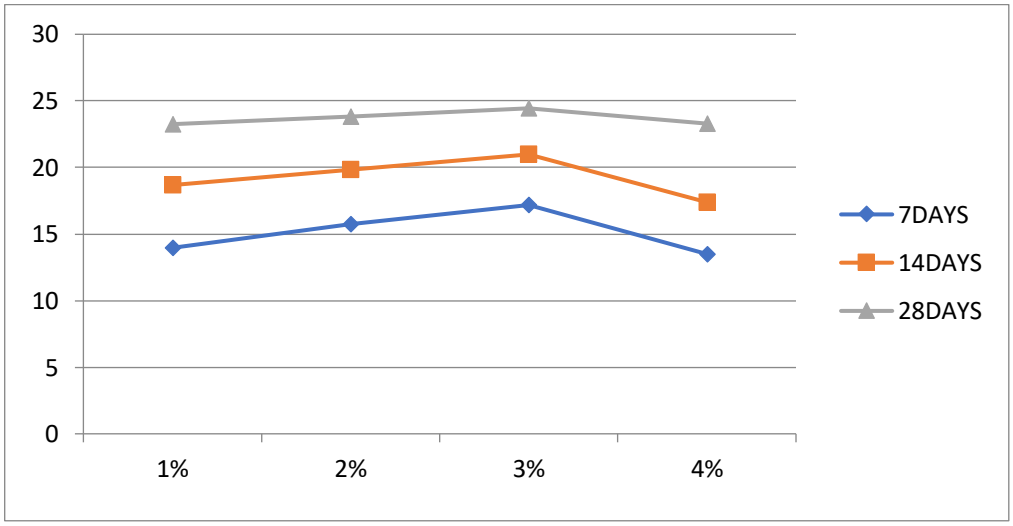


Figure 3. Compressive Strength of 7, 14& 28 days for M20 grade of concrete

Table 9. Compression test on different percentage of coconut shell ash, cocnut shell & coconut fibre added to M20 grade concrete

S.NO.	Percentage Replacement of Cement (%)		Percentage Replacement of Coarse Aggregate (%)		Coir Fibre %	Compressive strength (MPa)		
	Cement	Coconut Shell ash	Coarse Aggregate	Coconut Shell		7days	14days	28days
(A)	100	0	100	0	0	18.1	20.98	26.4
(B)	95	5	95	5	2	14.68	18.76	23.56
(C)	90	10	90	10	3	15.86	20.53	27.46
(D)	85	15	85	15	4	14.09	17.34	22.79

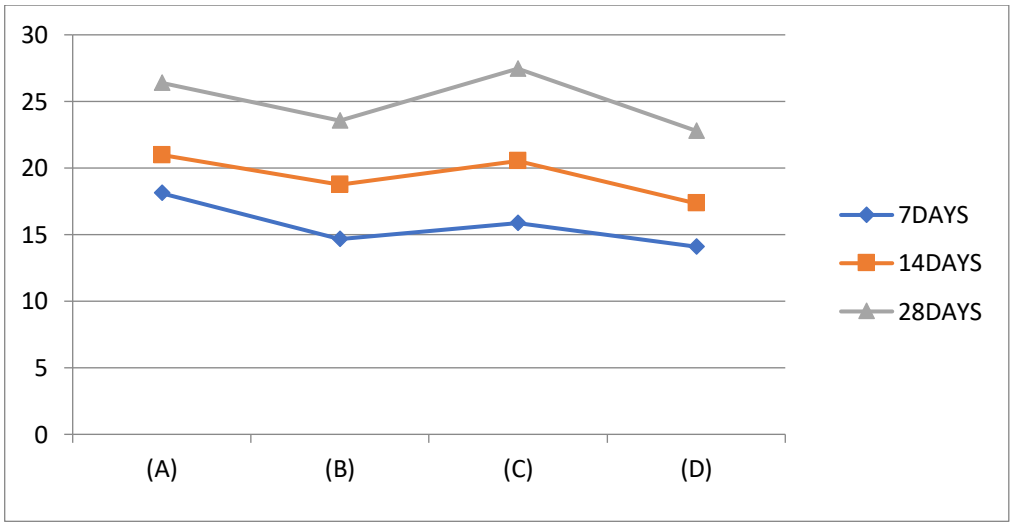


Figure 4. Compressive Strength of 7 & 28 days for M20 grade of concrete

The above graphical representation says that when the material replaced on concrete 10% of coconut shell ash,10% of coconut shell and addition 3% of coconut fibre give highest 28days compressive strength 27.46 N/mm^2, after it start decreasing so here replacement of above percentage is worthy up to some extent and limit

6. Future Scope of Work

- Coir fibre can be used as additional reinforcing material for concrete road.
- Coconut shell make concrete ecofriendly it increases compressive strength and durability.
- Coconut shell ash slow the initial setting time so it can be used on hot weather area.
- It helps us for the future scope on bridge, road and heavy construction work as it have light weight and good strength.
- It reduces cost of construction material by replacement of waste material of coconut on concrete

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