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Influence of CoconutFiber and Shell on Concrete

Prem Prateek, Sukriti Srivastava, Priti Kumari, Chandan Kumar, Krishna Murari

Abstract: ***Concrete is a Composite material which is composed of Cement, fine aggregate, coarse aggregate binded together with a definite proportion of water. Concrete is widely used in every single construction work around the world. Due to large scale construction activities using conventional coarse aggregate such as granite as a constructional material extreme reduction in the natural stone deposit has been encountered and is affecting the environment, hence causing ecology imbalance. In current situation of construction, price factor and the wide range of extraction and processing of materialsis matter of great concern for the people as well as environment. Therefore,introduction of alternate waste material in place of natural aggregate in concrete production not only protects environment but also make concrete a suitable, economical and environment friendly construction material. Different material like Coconut Shell and Fiber can also be used alternatively. In this project CoconutShell and fiber are used as partial replacement for coarse aggregate as well as fine aggregate, respectively. To study characteristic properties of concrete 10% and 20% for coarse aggregate and 1%, and 2% for fine aggregate are replaced by its weight with coconut shell and fiber.***

Keywords: CoconutShell, Coconut Fiber, Flexural Strength and Tensile Strength.

I. INTRODUCTION

According to the research, the high cost of conventional building materials plays a major role implanting housing delivery around the world. This leads a necessitated research to accommodate alternative material for future construction. Research for coconut shell and fiber to use as aggregate material, leads to reduction of cost as well as weight of the concrete and enhancing its strength. As introducing coconut shell and fiber as a suitable material, we are accounting for environmental impacts as well.**It will be the first project to use coconut fiber and shell together as aggregate material in concrete.**

Coconut shell and fiber are byproduct of agriculture. Once the extraction of fruit is done, shell wasthrown as waste material which are rarely used for ornamental work. Coconut shell effectively reduces vulnerability of concrete: against alkalinity, acid, and salt.Coconut fiber haveTensileStrength of 21.5MPa which is the toughest among all natural fibers. They are capable of taking 4-6 times more strains than other fibers.

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* Correspondence Author
Prem Prateek*, UG Student, Department of Civil Engineering, Netaji Subhash Institute of Technology, Bihta (Patna), India.
Sukriti Srivastava, UG Student, Department of Civil Engineering, Netaji Subhash Institute of Technology, Bihta (Patna), India.
Priti Kumari, PG Scholar, Department of Nano Science & Nano Technology, AKU (Patna), India.
Chandan Kumar, (Corresponding Author) Assistant Professor, Department of Civil Engineering, Netaji Subhash Institute of Technology, Bihta (Patna), India. E-mail: chandan.csir@gmail.com
Dr. Krishna Murari, Professor, Department of Civil Engineering, BIT Sindri, Dhanbad (Jharkhand), India.

Although it is a cheap and efficient, a major hindrance towards its wide scale use is high rate of water absorption, which can be reduced by providing oil coating. The advantages of Coconut fiber are: low cost, reasonable specific strength, low density, ease of availability, enhanced energy recovery, biodegradability, Although it is a cheap and efficient, a major hindrance towards its wide scale use is high rate of water absorption, which can be reduced by providing oil coating. The advantages of Coconut fiber are:ability to be recycled in nature in a carbon neutral manner, resistance to fungi moth and rot, excellent insulation to sound, flame, moisture,dampness , toughness, durability and resilience. Whereas coconut shell has high strength and modulus properties. It also has added advantage of high lignin content which makes the composite more weather resistant. it has low cellulose content due to which it absorb less moisture as compare to other agricultural waste. As Coconut being naturally available, its shell are non-biodegradable; they can be used readily in concrete which may fulfill almost all qualities of nominal concrete**.**

II. MATERIALS AND METHODS

1) **Cement**–Cement is a binding material used in building construction and civil engineering construction.It is made by grinding calcined limestone and clay to a fine power, which can be mixed with water and poured to set as a solid mass and adheres to other materials to bind them together. In this project work we are going to use Pozzolana Portland Cement (PPC) of brandBirla Cement.

- **The physical properties of OPC as determined given in the table (1).**

S.NO	Properties	Experimental Value
1.	Normal consistency % (IS:4031-Part-4-1988)	39%
2.	Initial setting time	41 min
3.	Final setting time	225 min
4.	Soundness of Cement (Le chatelier expansion)	2.75mm
5.	Fineness of Cement (IS:4031-Part-1-1996)	8.5
6.	Specific gravity	3.064
7.	Bulk Density	1450 kg/m^3
8.	Compressive strength at 7 days 28 days	 542.267KN 560.80KN

Fig1. Lab work of Consistency of cement

2) **Fineaggregate:** - aggregates are inert materials mixed with binding material for construction purposes. It is the widely mined material in the world. For fine aggregate we will use locally available sand which pass through 4.75mm sieve. M sand available at NSIT,Bihta having the following characteristics has been used. Sand after Sieve analysis confirm to Zone-2 has been used as per specification IS:456-2000; IS:2386-Part-1-1963; IS:383-1970.

• The physical properties of aggregate are given in table (2)

S.NO	Properties	Experimental Value
1	Fineness Modulus	2.616
2	Water absorption	0.80%
3	Specific gravity	2.7
4	Bulk Density	1695 kg/m^3

Fig.2 Picture of coconut fiber.

Raw Fiber:-Procured from Coconut Mattress Manufacturing Unit.
Coconut Fiber:-Where the material is available as waste.
Processed Fiber:-Collected from Rope manufacturing unit.

Fig.3 Picture showing fine aggregate lab work.

3) **Coarse Aggregate: -** Locally available black crushed stone in Bihta with nominal size passing through 20mm IS sieve have been used. The physical properties for coarse aggregate are found through laboratory test in accordance to IS:2386-Part-1-1963; IS:383-1970: IS:456-2000.

• The physical properties of aggregate are given in table (3)

S.NO	Properties	Experimental value
1.	Aggregate Crushing Value	10.45
2.	Aggregate Impact Value	7.92
3.	Specific Gravity	2.9
4.	Water Absorption	0.35%
5.	Bulk Density	1590 kg/m^3

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Fig.4 Picture of coconut shell as a coarse aggregate.

Coconut Shell:-Normal Indian Coconut. They are sun dried before being crushed. Particle size range from 12mm to 20mm. The surface texture of shell was fairly smooth on concave face and rough on convex face.

Fig.5 showing coarse aggregate lab work

4) **Water: -** Water is used as a raw material during the manufacturing of various civil materials and in construction. It plays an important role in concrete preparation as binding the cement with other aggregate and play major role in the chemical process of releasing heat of hydration and hence imparting strength to it. The pH value of water used in concrete should always be greater than 6. In general, water fit for drinking is suitable for mixing concrete.

5) **Admixture:** -admixture are natural or manufactured chemicals which are used to give special properties to fresh and hardened concrete. It increases the workability without increasing water content or to decrease the water content at the same workability. In this project we have used CONMIX SP 1030 admixture from Radhekrishna Chemical Company.

Technical data of admixture is present in following table 4: -

S.NO	Properties	Data
1.	Appearance	Brown liquid
2.	Main Base	Sulphonated Naphthalene Formaldehyde
3.	Ph	7-8
4.	Chloride Content	Nil
5.	Specific gravity	1.2 at room temperature
6.	Shelf life	12 months in original packing

Fig.6 Picture of admixture used.

6) **Concrete Mixes:** -Mix design is defined as the process of selecting suitable ratio of ingredient to be mixed to form concrete of certain maximum strength and durability as economically as possible. The concrete mixes will be assigned with the use of type of fine aggregate and grade of the concrete. In this project we are usingconcrete of grade as M30. A mix design was conducted as per IS:10262-2009 to arrive at M30 mix concrete. The percentage replacement of aggregate added by 10% and 20% by weight with a w/c ratio of 0.442%. The mix proportion of 2.72: 3.43: 7.63 (where 2.72 is for cement 3.43for fine aggregate and 7.63 for coarse aggregate of size 10mm to 20mm).

IS method of concrete mix was used to achieve a mix with strength of 30 MPa. Mix proportions were arrived and coconut shell and fiberwas added to the concrete mix with a w/c ratio 0.442%. Control mix concrete and modified concrete with varying percentage of coconut shell and fiber and the percentage for various replacement levels are presented in Table 5.

- **Table 5. Details of concrete fiber and shell mix percentage**

Mix Specification	Control mix (M_0)	Modified Mix 1(M_1)	Modified Mix 2 (M_2)	Modified Mix 3 (M_3)	Modified Mix 4 (M_4)
Proportion of Coconut Shell added	0%	10%	20%	10%	10%
Proportion of Coconut Fiber added	0%	0%	0%	1%	2%

7) **Mixing, Casting And Curing Of Concrete:** -The coarse aggregate and fine aggregate were weighted,and the concrete mixture was prepared by hand mixing on a water tight platformand mixed thoroughly until a uniform color is obtained, later to it mixture of coarse aggregate was added and mixed thoroughly. Then water is added carefully, making sure no water is lost during mixing process. Water is added in stages for hydration of the cement which was carried out with preventive measure in place to avoid bleeding which may affect strength formation of concrete. Cleaned and oiled mould was placed on a vibrating table, then concrete mix was placed in three layer, each layer first went through vibration to release air formed during mixing and vibration were stopped as soon as the cement slurry appeared on the top surface of the mould.

The specimen were allowed to remain in the steel mould for the first 24hrs at ambient condition of temperature 27˚± 2˚ C. After that specimen were demoulded with care to prevent edges from breaking apart and specimen were placed in the tank at the ambient temperature for curing. After demouldingof the specimen by loosening the screws of steel mould,they were placed in the water for 7 days, 14 days and 28days. The specimen shall not be allowed to become dry at any time until they have been tested.

Casting Coconut Fiber and Coconut Shell Concrete:-

The calculated amount of cement and fine aggregate are mixed together until a uniform mix is obtained. Fibers at varying amount of 1%, and 2% to that of wt. of cement are taken. It is then added to mix until uniform color is obtained.Coarse aggregate are then added to the same and mixed, followed by addition of water. Care should be taken to add water slowly in stages so as to prevent bleeding which may affect the strength formation of concrete. It is placed in mould of standard dimension, compacted and finished. Casting is done as per IS:516-1959.

- **Table 6. Details of test specimens**

Test Details	Shape and Dimension of Specimen
Compressive Strength	Cube: 150 × 150 × 150mm
Splitting Tensile Test	Cylinder: 150 × 300mm
Flexural Strength	Beam: 100 × 100 × 500mm
Durability Test	Cube: 150 × 150 × 150mm

Fig.7 Picture showing casting of concrete work.

III. RESULTS

(1) CONVENTIONAL CONCRETE TEST RESULTS-

S.NO	Compressive strength (MPa)			Split tensile strength (MPa)		
Days	3	7	28	3	7	28
1.	14.45	22.65	36.15	5.23	6.13	7.33
2.	12.98	22.28	35.78	4.29	5.09	6.17
3.	13.43	22.43	34.87	4.40	5.85	6.34

(2) 10% REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE-

S.NO	Compressive strength (MPa)			Split tensile strength (MPa)		
Days	3	7	28	3	7	28
1.	15.87	25.79	35.32	4.46	5.66	7.13
2.	14.45	25.23	34.00	3.45	4.45	6.00
3.	15.40	25.45	34.48	3.52	4.59	5.83

(3) 20% REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE-

S.NO	Compressive strength (MPa)			Split tensile strength (MPa)		
Days	3	7	28	3	7	28
1.	16.58	24.19	33.41	4.06	4.80	6.93
2.	15.79	23.38	32.07	3.15	4.00	5.48
3.	16.17	22.81	30.14	3.27	4.72	5.64

(4) 10% COCONUT SHELL AGGREGATE + 1% COCONUT FIBER REPLACEMENT-

S.NO	Compressive strength (MPa)			Split tensile strength (MPa)		
Days	3	7	28	3	7	28
1.	16.56	23.55	35.52	5.53	6.36	7.32
2.	15.67	23.81	36.06	5.58	6.84	7.51
3.	16.68	23.45	35.70	5.79	6.50	7.60

(5) 10% COCONUT SHELL AGGREGATE + 2% COCONUT FIBRE REPLACEMENT-

S.NO	Compressive strength (MPa)			Split tensile strength (MPa)		
Days	3	7	28	3	7	28
1.	17.10	23.08	35.87	5.46	6.11	7.43
2.	15.60	23.45	36.15	5.39	5.86	7.92
3.	16.03	23.19	35.79	5.39	6.33	7.35

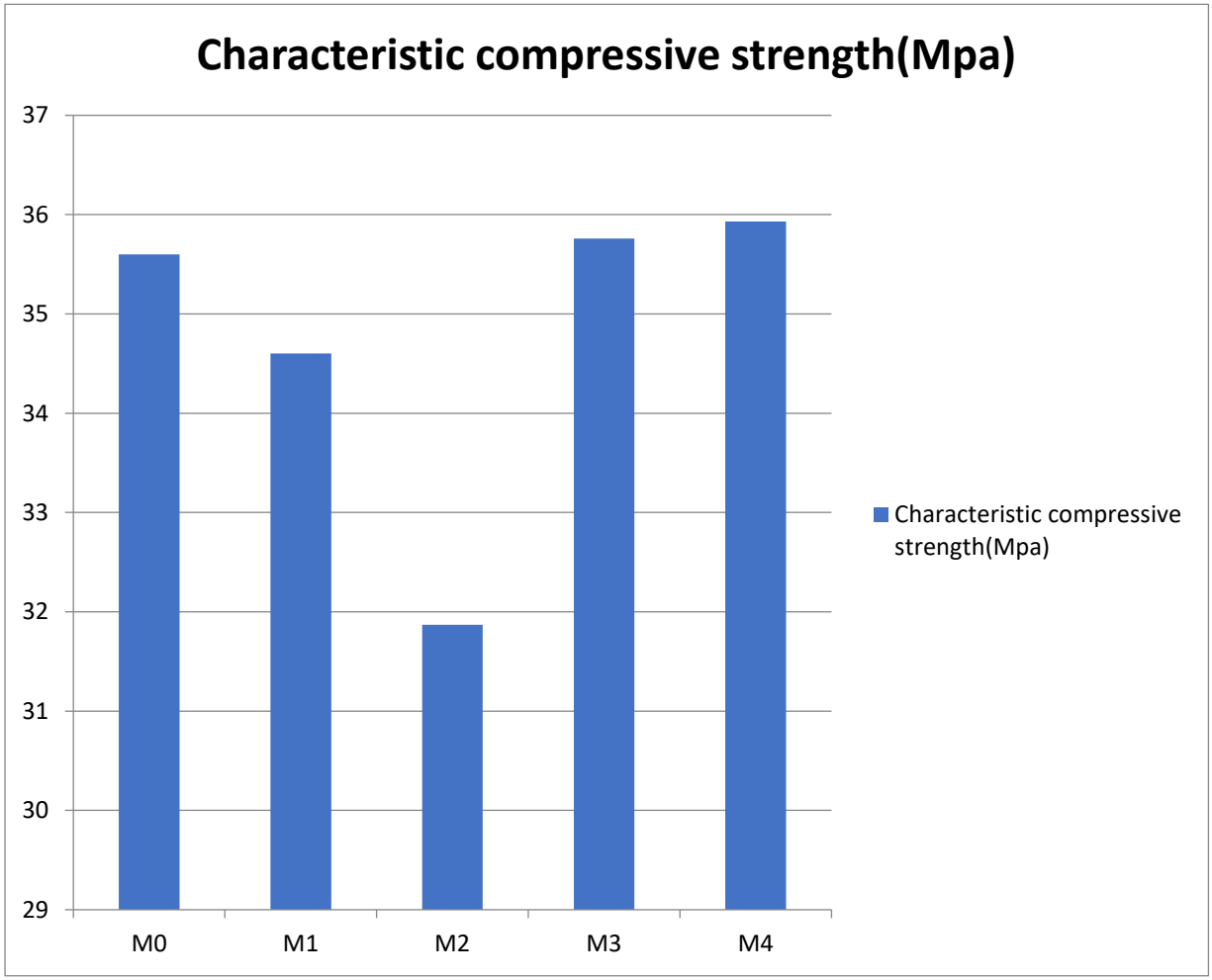
(6) COMPARISON OF RESULTS: (COMPRESSIVE STERNGTH)

DAYS	CONVENTIONAL CONCRETE	10% COCONUT SHELL	20% COCONUT SHELL	10% COCONUT SHELL + 1% COCONUT FIBER	10% COCONUT SHELL + 2% COCONUT FIBER
3 days	13.62	15.34	16.18	16.30	16.24
7days	22.45	25.49	23.46	23.60	23.24
28 days	35.6	34.6	31.87	35.76	35.93

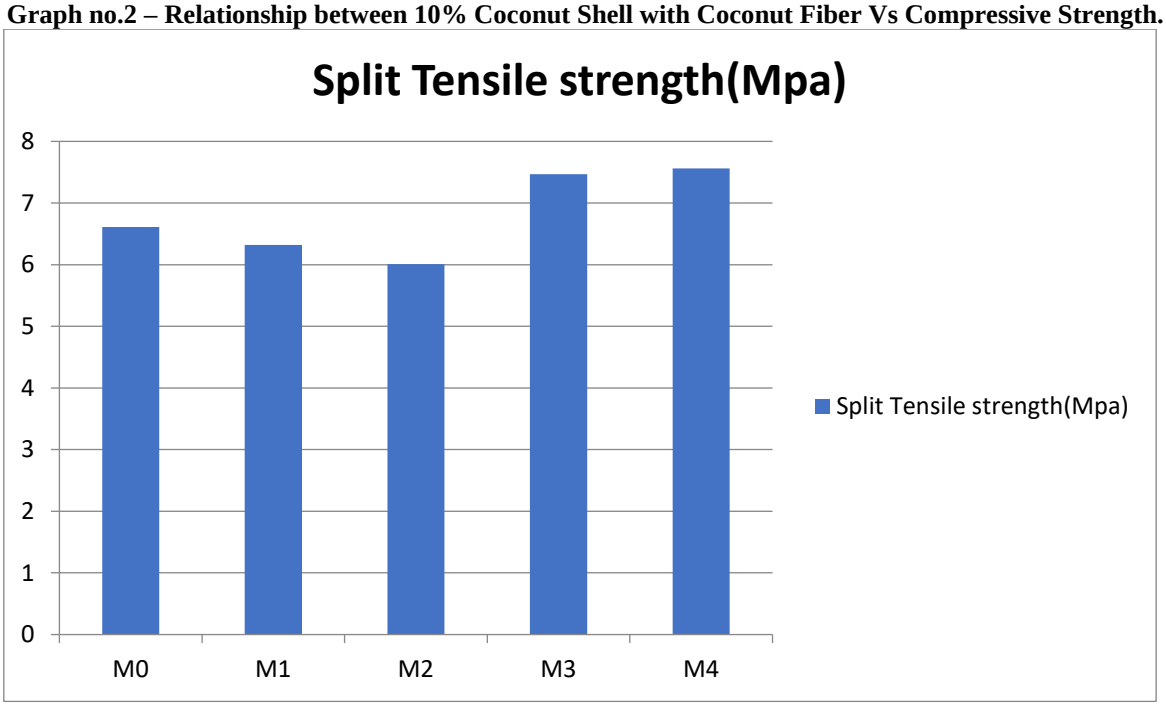
(7) COMPARISON OF RESULTS: (SPLIT TENSILE STERNGTH)

DAYS	CONVENTIONAL CONCRETE	10% COCONUT SHELL	20% COCONUT SHELL	10% COCONUT SHELL + 1% COCONUT FIBER	10% COCONUT SHELL + 2% COCONUT FIBER
3 days	4.64	3.81	3.49	5.63	5.41
7days	5.69	4.9	4.50	6.56	6.1
28 days	6.61	6.32	6.01	7.47	7.56

➢ **Graph no.1 – Relationship between % Replacement of coconut shell and fiberVs Compressive strength.**



➢ **Graph no.2 – Relationship between 10% Coconut Shell with Coconut Fiber Vs Compressive Strength.**



IV. CONCLUSION

Result of following test of Compressive strength and Split tensile strength for given proportion of coconut shell and fiber replacement have been represented with those of conventional concrete. The coconut shell containing concrete shows a minimal variation than normal aggregate concrete. **While addition of coconut fiber with coconut shell shows an increase in the compressive as well as tensile strength than conventional concrete.**

The following conclusions are made by observing the result of this project:

1). The replacement of coarse aggregate with 10% coconut shell, decreases to minimal variation of 2.7% in compressive strength and 2.72% in split tensile strength.

2). The replacement of coarse aggregate with 20% coconut shell, decreases to minimal variation of 7.5% in compressive strength and 5.45% in split tensile strength.

3). With the addition of coconut fiber in earlier coconut shell concrete, increase in the compressive as well as split tensile strength has been noted.

4). When 1% of coconut fiber is replaced with cement weight, increase of 0.44% in conventional concrete and 3.24% in the coconut shell concrete in compressive strength has been noted, respectively.

5). When 2% of coconut fiber is replaced with cement weight, increase of 0.92% in conventional concrete and 3.70% in the coconut shell concrete in compressive strength has been notes, respectively.

6). When 1% of coconut fiber is replaced with cement weight, increase of 11.51% in conventional concrete and 15.39% in the coconut shell concrete in splittensile strength has been noted, respectively.

7). When 2% of coconut fiber is replaced with cement weight, increase of 8.57% in conventional concrete and 12.58% in the coconut shell concrete in split tensile strength has been notes, respectively.

8). From the graph no.1, the compressive strength of concrete will decrease with increase of coconut shell percentage.

9). From the graph no. 2, the compressive strength of concrete increases with addition of coconut fiber with shell.

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AUTHOR'S PROFILE

Chandan Kumar, He received his bachelor degree in civil engineering and a master's degree in Structural engineering, granted by B.I.T Sindri in 2014. he received senior research fellowship from CSIR New Delhi during 2015 to 2018. He is currently working as assistant professor, Dept of civil engineering, NSIT Bihta, Patna (India). His research interest includes ageing effect of concrete, soi structure interaction, composite materials, waste water purification using nano-materials, utilization of waste material in concrete, structural dynamic study in different zone of India.

Prem Prateek, He is pursuing Bachelor's degree in Civil Engineering from NSIT, Bihta Patna during academic year 2016-2020, Aryabhatta Knowledge University, Bihar. He is currently working on "utilization of different types of waste in conventional concrete.

Sukriti Srivastava, She is pursuing Bachelor's degree in Civil Engineering from NSIT, Bihta Patna during academic year 2016-2020, Aryabhatta Knowledge University, Bihar. She is currently working on "utilization of different types of waste in conventional concrete.

Priti Kumari,She received her Bachelor's degree in Civil Engineering granted by NSIT, Bihta Patna during academic year 2014-2018, Aryabhatta Knowledge University Bihar and persuing a master's degree in Nanoscience and Nanotechnology, granted by Aryabhattacentre for Nanoscience and nanotechnology patna during academic year 2019-2021. She is currently working on "utilization of different types of waste in conventional concrete and nanotechnology in civil and environmental engineering.

Dr. Krishna Murari, He received his bachelor degree in civil engineering granted by NIT Calicut and a master's degree in Geotechnical engineering, granted by B.I.T Sindri. He is currently working as professor, Dept of civil engineering, BIT sindri, Dhanbad (India). His research interest includes ageing effect of concrete, soil structure interaction, composite materials, waste water purification using nano-materials, utilization of waste material in concrete, soil dynamic study in different zone of India.