

## **A Study on Compressive Strength of Concrete by Partial Replacement of Coarse Aggregate with Coconut Shell and with Addition of Fiber**

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### **Abstract**

This research paper discusses the effect of coconut shells and fibers (polypropylene and steel fibers) on M30 grade concrete. The fibers used in this work are Polypropylene and Steel Hooked end fibers of 0.5 mm diameter and 60mm length. As the percentage of coconut shell replacement with coarse aggregate increases the strength properties decrease. With the addition of fibers like polypropylene and steel to the concrete with coconut shell, the strength properties of concrete increase to some extent but not higher than the conventional concrete.

**Keywords:** coconut shell, compressive strength, steel fibers, polypropylene, replacement of coarse aggregate.

## **1. INTRODUCTION**

Concrete is a composite material which composed of aggregates, cement and water. Concrete is used more than any other manmade material in the world. The large scale production of concrete in construction activities using conventional coarse aggregate such as granite immoderately reduces the natural stone deposits and affecting the environment hence causing ecology imbalance.

Extraction and processing of aggregates is also a major concern for environment. Therefore consumption of alternative waste material in place of natural aggregate in concrete production not only protects environment but also makes concrete a sustainable and environment friendly construction material. Different waste material like rubber, fly ash, glass, bottom ash, artificial sand etc., has been used as alternative for replacing natural aggregates. Apart from the above mention waste material, a few studies shows that agriculture waste coconut shell can also are used as coarse aggregate for concrete.

### **Properties of Coconut Shell**

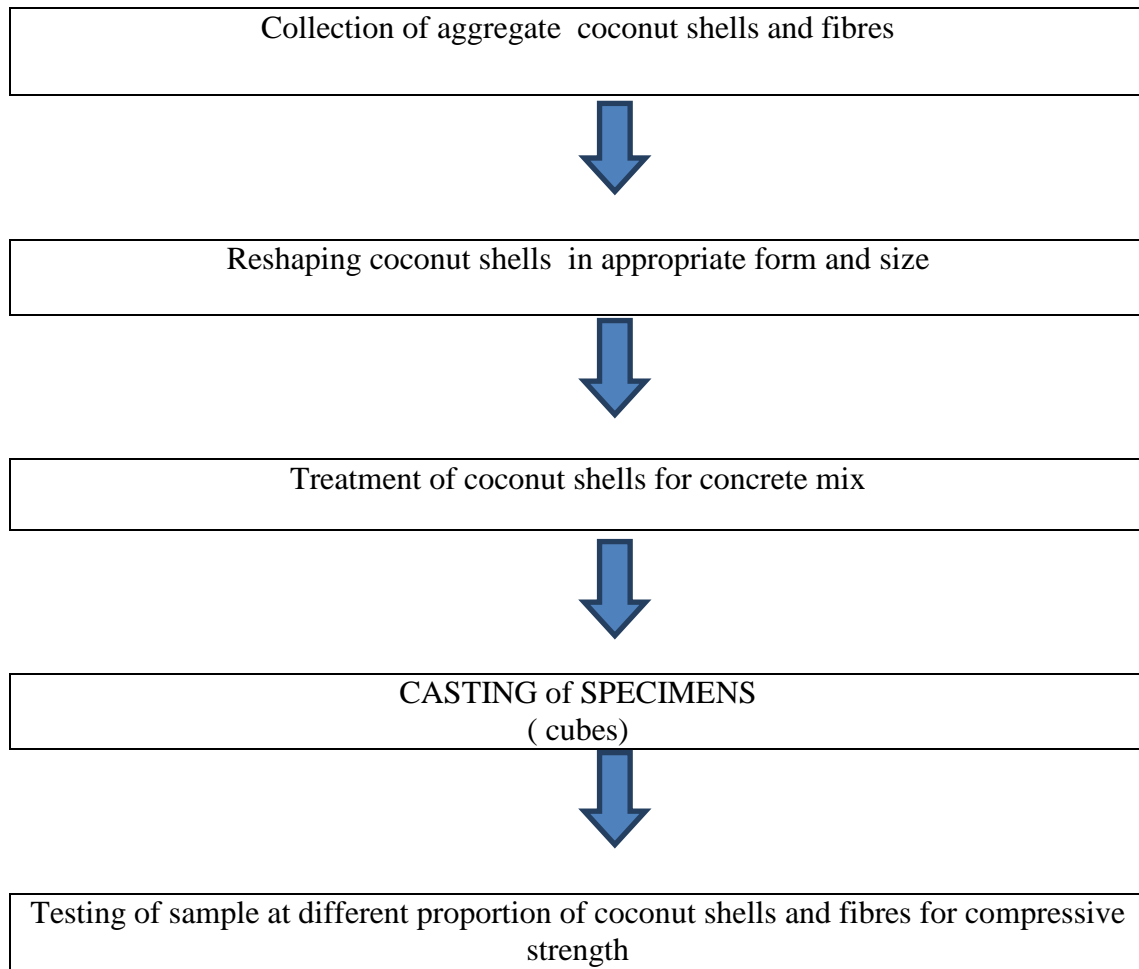
1. Coconut shell has high strength and modulus properties.
2. It has added advantage of high lignin content. High lignin content makes the composites more weather resistant.
3. It has low cellulose content due to which it absorb less moisture as compare to other agriculture waste.
4. Coconuts being naturally available in nature and since its shells are non-biodegradable; they can be used readily in concrete which may fulfill almost all the qualities of the original form of concrete.

## **2. OBJECTIVE AND METHODOLOGY**

It is proposed to study the compressive strength of M30 grade concrete by partial replacing (5%, 10%, 15%) of coarse aggregate with coconut shell and addition of fibers to achieve target strength. The fibers steel hooked end and polypropylene fibers are added at 2% by weight of concrete.

**METHODOLOGY:**

The following flow chart shows the work flow



The compressive strength of concrete is found using concrete cubes of 150mm X 150mm X 150mm. compression testing machine is used to found the compressive strength of concrete

**3. MATERIALS**

The following materials are used in this project

**3.1). Cement :** Ordinary Portland cement 53 grade KCP cement was used. The following results were obtained from tests on Cement

**Table 1:** Results of the cement tests

S.NO	CHARECTERSTICS	RESULTS
1.	Normal consistency	31%
2.	Initial setting time	30min
3.	Final setting time	210min
4.	Fineness	4.8%
5.	Specific gravity	3.15

**3.2). Fine Aggregate:** Sand conforming to Zone-II was used as the fine aggregate. The specific gravity of fine aggregate was 2.60

**3.3). Coarse Aggregate:** The coarse aggregates are taken by the size is 20mm passing through sieve of size 12.5 and normal grading is used. The specific gravity is 2.4.

**3.4). Coconut Shell:** The coconut shells are obtained from a local coconut field. They are sun dried before being crushed manually. The particle sizes of the coconut shell range from 12 to 20 mm. The surface texture of the shell was fairly smooth on concave and rough on convex faces.

**Figure 1** coconut shells

**3.5). Fibers:** The fibers used are Polypropylene Fibers(polymer fiber) and Steel Hooked end fibers of 0.5 mm diameter and 60mm length. The addition fibers increase the strength properties of concrete. Steel fiber helps in reducing crack formations in the concrete.



**Figure 2** polypropylene fiber



**Figure 3** steel hooked end fiber

**3.6). Water:** For curing and casting, water available in laboratory which is free of any foreign material is used.

**3.7). Dr S Bond:** self-curing agent used for concrete curing. Used for concrete structures, cement mortar surfaces, road dividers, curbing areas, retaining walls and all internal and external masonry surfaces, dam surfaces and other cement related products.



**Figure 4** Dr.S.Bond self-curing agent

**4. TEST PROCEDURE**

Casting:

- (1) Concrete blocks of size 150mm x 150mm x 150mm were casted.
- (2) The concrete in the cube must be fully compacted with compacting bar or concrete vibrator. After 24 hours these moulds are removed and test specimens are kept to curing.
- (3) For curing, the specimen is coated with self-curing agent and the specimen is tested after 7 and 28 days.
- (4) Minimum 4 specimens of each mix proportion containing different percentages of coconut shells (0%, 5%, 10% and 15% by weight of aggregates) and fibers will be casted.

**Table 2:** M30 grade concrete Mix Proportion

Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	w/c ratio
425	595	1147.5	0.5

Compression test on concrete is carried out using compression testing machine. For compression test of concrete cube specimens of 150 mm X 150 mm X 150 mm are used. These specimens are tested by compression testing machine after 7 days curing or 28 days curing.

$$\text{Compressive strength} = \frac{p}{A}$$



**Figure 5** Compressive strength test

## 5. TEST RESULTS

The following test results were obtained from the compression test on concrete

**Table 3:** Test results of compressive strength test

S.NO	MIX DESIGNATION	COMPRESSIVE STRENGTH (N/mm <sup>2</sup> )	
		7days	28days
1	Nominal mix	28.45	31.6
2	Mix1	16.7	18.9
3	Mix2	13.54	15.49
4	Mix3	9.89	15.93
5	Mix4	20.19	21.28
6	Mix5	16.75	17.96
7	Mix6	14.48	16.7
8	Mix7	21.9	22.42
9	Mix8	17.53	18.6
10	Mix9	15.51	16.7

Nominal mix: concrete with 0% coconut shell and 0% fibers

Mix 1: 5% replacement of coarse aggregate with coconut shell.

Mix 2: 10% replacement of coarse aggregate with coconut shell.

Mix 3: 15% replacement of coarse aggregate with coconut shell.

Mix 4: 5% replacement of coarse aggregate with coconut shell + polypropylene fibers with 2% weight of cement.

Mix 5: 10% replacement of coarse aggregate with coconut shell + polypropylene fibers with 2% weight of cement.

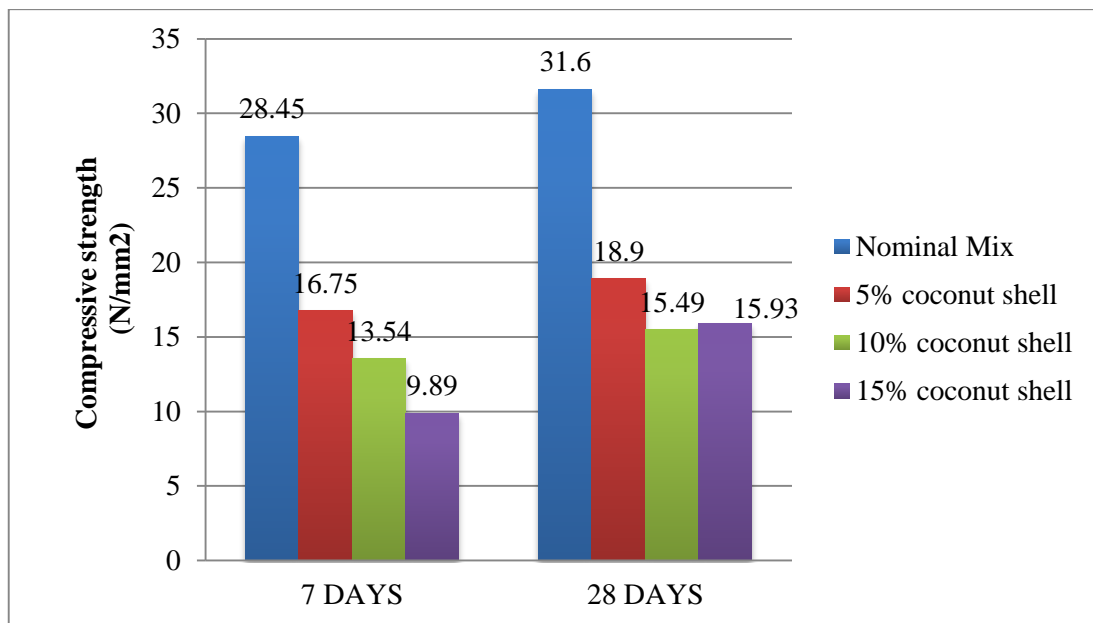
Mix 6: 15% replacement of coarse aggregate with coconut shell + polypropylene fibers with 2% weight of cement.

Mix 7: 5% replacements of coarse aggregate with coconut shell + steel fibers with 2% weight of cement.

Mix 8: 10% replacement of coarse aggregate with coconut shell + steel fibers with 2% weight of cement.

Mix 9: 15% replacement of coarse aggregate with coconut shell + steel fibers with 2% weight of cement

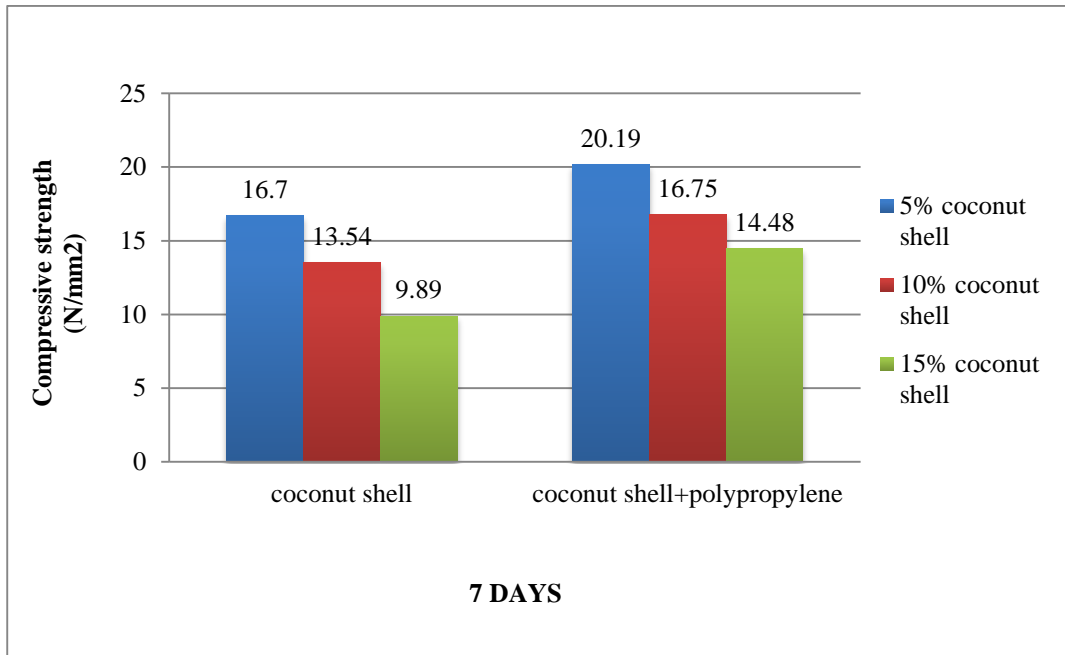
From the tabulated results the compressive strength of concrete decreases with the increasing the percentage of coconut shell as replacement of coarse aggregate in the nominal mix. The following charts were prepared to compare the compressive strength of different concrete mixes.



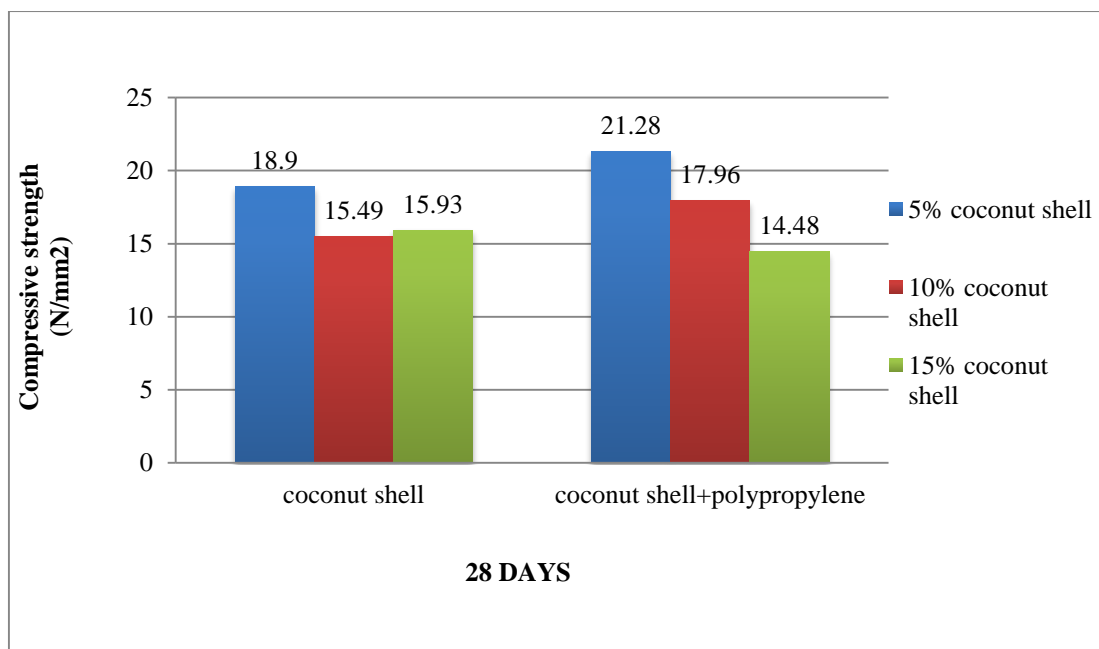
**Chart-1** compressive strength of nominal mix and mix with coconut shell

The above chart shows the comparison of compressive strength of nominal mix and concrete with coconut shell. From the above chart the compressive strength of decreases with increase in percentage of coconut shell.



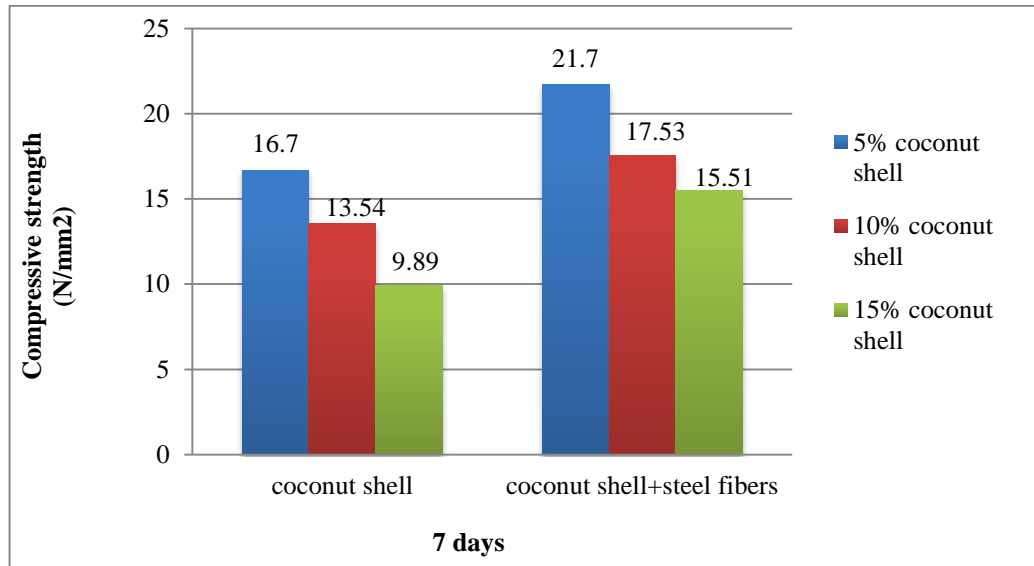


**Chart-2** compressive strength of coconut shell concrete and concrete with coconut shell + polypropylene of 7 days strength

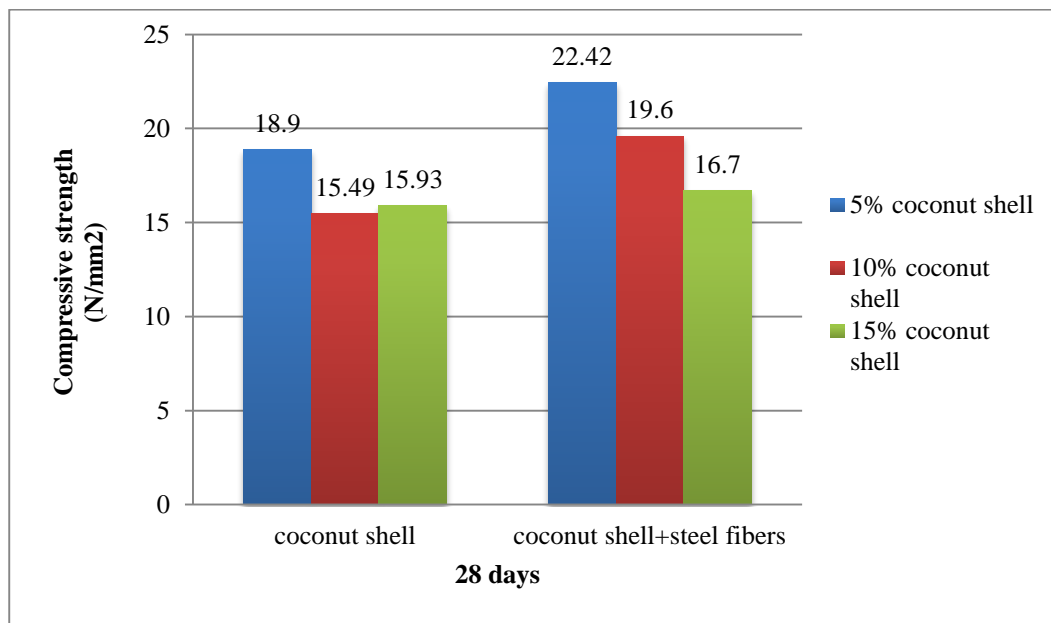


**Chart-3** compressive strength of coconut shell concrete and concrete with coconut shell + polypropylene of 28 days strength

The above charts shows the comparison of 7 days and 28 days compressive strength of concrete with coconut shell and concrete with coconut shell + 2% of polypropylene fiber. The strength increases with addition of polypropylene fiber to the concrete with coconut shell.



**Chart-4** 7 days strength compressive strength of coconut shell concrete and concrete with coconut shell + steel fiber



**Chart-5** 28 day's compressive strength of coconut shell concrete and concrete with coconut shell + steel fiber

The above charts shows the comparison of 7 days and 28 days compressive strength of concrete with coconut shell and concrete with coconut shell + 2% of steel fiber. The strength increases with addition of steel fiber to the concrete with coconut shell.

## **6. CONCLUSION**

As the percentage of coconut shell replacement with coarse aggregate increases the strength properties decreases.

The compressive strength of concrete is increased by 20% with the addition of fibers to the concrete with coconut shells.

With addition of steel fibers the compressive strength of coconut shell replaced concrete increased by 22 %, when compared to plane coconut shell concrete.

Curing agent gives better results for 7 days curing and for 28 days it does not give satisfactory results.

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