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An Experimental Study on Concrete with Waste Coconut Shell as a Partial Replacement to Coarse Aggregates

S. Vandana[1], M. Harihanandh[2]
[1]*Under Graduate Student, MLRITM, Hyderabad, Telangana, India*
[2]*Associate Prof. in Civil Engineering Dept., MLRITM, Hyderabad, Telangana, India*

Abstract: In developing countries where concrete is highly used, the day-by-day increasing cost of raw material used in concrete has made construction very expensive. The amount of concrete requires various materials like Cement, Fine Aggregate and Coarse Aggregate. Therefore an alternate material is used for partial replacement of Coarse aggregate in concrete. This project is done to reduce the cost of concrete.

In this research work, experiments have been conducted with a collection of materials required and the data required for mix design Therefore this is the most priority of all human being to encourage or research on sustainable material which will help to use such waste material as a construction material with less cost and safety The coarse aggregate is the main constituent of concrete mix, hence in this paper, we used waste coconut shell replaced as a coarse aggregate has been discussed based on the results obtained from test results.

The use of coconut shells can also help the prevention control of waste to several years decomposing. The paper aims at analyzing mechanical properties of concrete mix design of M20 (M20-1:1.5:3) produced using coconut shell as a substitute for conventional coarse aggregate with 0%, 5%, 10%, 15% partial replacement. six sample cubes are prepared for the M20 grade concrete mix for each three of 7days curing and other 3 for 28days curing. Another aim of this paper is to know awareness about the use of waste coconut shells as construction material in civil engineering. Keywords: Construction material, coconut shell, mechanical properties of coconut shell, Coconut shell concrete, Waste Utilization

Keywords: Coconut shell, compressive strength, split tensile test, flexural modulus.

I. INTRODUCTION

In growing countries, they were much development to the infrastructure. The common ingredients to the infrastructure development are cement, fine aggregates, and coarse aggregates. Due to more development the cost of the materials also increasing day-by-day.to control the cost the waste materials are invested in the replacement to the building materials. For all materials, the replacement is done and finding the properties of the replacing concrete. In this paper, the replacing material is coconut shell. There is a large amount of waste which is occurred in the temple, restaurants, tiffin Centre's...etc. due to the large amount of waste that can't decompose as many years ago.

Due to soft tissue contained in the coconut shell which cant de generable. And other reasons for selecting the replacement to other material to coarse aggregate. There are different processes to quarry the coarse aggregates. By using the hand tools and machinery or by using the explosive materials. While the quarrying the changes in the temperature will occur. By using explosive materials than due to sound the hearing loss will occur and due to smoke the air gets contaminated and get the harmful diseases, it gets the effect the to decrease the number of coarse aggregates the replacing has to do.

Some of the countries are stared the replacing but our country is still lacking replacing the aggregates. As many of the projects done for the replacement of coconut shells. All they notice that after 2nd percentage replacement the strength as getting decrease. because the soft layer is present below the shell so the bonding is not good .in this paper the shells are got hatched by the sharp materials to create the good bonding to the building materials the replacing is done for the different proportions like With the grade mix to find the properties of materials.

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II. LITERATURES

MANDAL B., TIWARI ET…, (2018). they investigated the paper by adding the coconut shell and coconut fiber to concrete with the mix design of M20 of different proportions like coconut shell 6%, 8%, 10%, 12%, and 14% to coarse aggregates and coconut fiber of 3%, 4% and 5% of cement content and they concluded that a first proportion the strength and split tensile will get on increased and at and by increasing the it also say that it decreases the density.it also helps to abate the environmental problems occurring due to the disposal of coconut waste.

WADE RASHMI PURUSHOTTAM et.., al(2017) they did research on to study characteristics of concrete with partial replacement of coarse aggregate with coconut shell they concluded that the increase of different proportions are getting a decrease in the strength of concrete in 7 and 21 days curing and the first 2 proportion are getting increased to the strength after that it gets reducing they mentioned that the overall cost of the construction will get decrease due to replacing of coconut shell to coarse aggregates.

VIPUL MHATRE, NIMESH PANDEY...et.al(2018) they did the project they investigated Concrete Using Coconut Shell As A Coarse Aggregate the workability test and compressive test are conducted in this project the slump cone increases for all increasing in the proportion at the same time in the different proportions the compressive strength is seeing increasing at some proportion and with increasing proportions the strength will get decrease.

III. METHODOLOGY

1) *Step 1:* Literature Study
2) *Step 2:* Material Collection
3) *Step 3:* Tests on Materials

Physical properties of materials

a) Cement
   i) Specific Gravity
   ii) Initial and final setting time

b) Fine Aggregate
   i) Specific gravity
   ii) Sieve analysis
   iii) Bulk density
   iv) Water absorption

c) Coarse Aggregate
   i) Specific gravity
   ii) Water absorption
   iii) Aggregate impact and crushing value

d) Coconut shell
   i) Specific gravity
   ii) Water absorption
   iii) Aggregate impact and crushing value

4) *Step 4:* Preparation of design mix for M20 grade (Replacement of coconut shell 5%, 10% & 15%)
5) *Step 5:* Test conducted on fresh and hardened concrete

Tests on fresh concrete:

a) Slump cone test Tests on hardened concrete: For the curing period of 7, 14 and 28 days
b) Compression test on cubes
c) Split tensile test on cylinder
d) Modulus of rupture test on prism

A. Material Used

1) *Cement:* The 43 Grade Ordinary Portland cement used for this research conforms to the IS standards (IS 12269-1987 (1997)) as it is tested as per IS 4031 – 1998.

Table.1 Physical properties of cement

Test particulars	Results obtained	Requirements of IS 8112-2013
Fineness (m^2/kg)	370	Minimum 225
Initial Setting Time (min)	45	Minimum 30
Final Setting Time (min)	450	Maximum 600
Specific Gravity	3.1	-

2) *Fine aggregate:* The natural river sand chemically inert, clean, containing sharp and angular grains and well graded one has been used as fine aggregate for this investigation as it conformed to the grade zone 3

Table.2 Physical properties of fine aggregate

Test particulars	Results obtained
Specific Gravity	2.56
Fineness Modulus	2.83
Bulk Density (kg/m^3)	1600
Water Absorption (%)	1

3) *Coarse Aggregate:* The coarse aggregate, crushed rock aggregates, is an important ingredient as it occupies more than 85% of the volume of concrete. As already mentioned, the maximum size of the coarse aggregate is limited to 20 mm. This maximum size of 20 mm yields to get the maximum increase in the compressive strength. A good quality crushed granite stones received from a local quarry have been used in this experimental investigation

Table.3 Physical properties of coarse aggregate

Test particulars	Results obtained
Specific Gravity	2.75
Bulk Density (kg/m^3)	1650
Aggregate Impact value	18
Aggregate Crushing value	20
Water Absorption (%)	0.28

4) *Coconut Shell:* The coconut shell which is used as partial replacement with coarse aggregate in the concrete by 5%, 10% and 15%. Their physical properties are displayed in Table 4.

Table.4 Physical properties of Coconut shell

Test particulars	Results obtained
Specific Gravity	1.77
Bulk Density (kg/m^3)	809
Aggregate Impact value	6
Aggregate Crushing value	5
Water Absorption (%)	25

5) *Water:* The presence of water makes the chemical reaction with the cement in concrete and with lime in bricks very effective. Without water, concrete and bricks won't results in hardening and thus, water becomes an inevitable element. The water used in this experimental investigation is found confirming to the requirements of IS 456-2000.

IV. EXPERIMENTAL INVESTIGATION

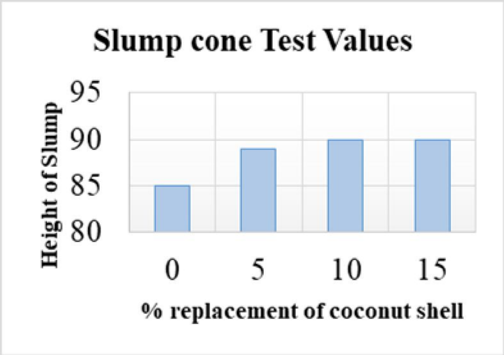
A. *Fresh Concrete*

1) *Slump Cone Test:* The slump cone test results are displayed in the following figure. In this test result, its proven that the replacement of coconut shell with the coconut shell did not made any deviation in the fresh concrete. As per the Indian standard, the minimum and maximum values of the slump between 50mm to 125mm for RCC work. Our concrete has the values between 85mm to 90mm. Therefore this concrete should not affect the workability and coconut shells can be used for partial replacement material for coarse aggregate in concrete.

Table 5 Slump cone test results

Concrete Mix	Height of Slump cone (mm)	Height of slump after collapse (mm)	Slump value (mm)
CC	300	215	85
M1	300	211	89
M2	300	210	90
M3	300	210	90

Figure 1: Slump cone test values



B. *Hard Concrete Test*

1) Compressive Test

2) Compressive test for 7 days for different proportions like 0%, 5%, 10%15%.

Table 6: Compressive test for 7 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen. 1	310×10^3	150×150×150	$310\times10^3/150\times150$	13.77
Specimen 2	315×10^3	150×150×150	$315\times10^3/150\times150$	14.00
Specimen 3	307×10^3	150×150×150	$307\times10^3/150\times150$	13.64
Average compressive strength N/mm²				13.803

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Table 7: Compressive test for 7 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen .1	325×10^3	150×150×150	$325\times10^3/150\times150$	14.44
Specimen 2	319×10^3	150×150×150	$319\times10^3/150\times150$	14.177
Specimen 3	322×10^3	150×150×150	$322\times10^3/150\times150$	14.31
Average compressive strength				14.309

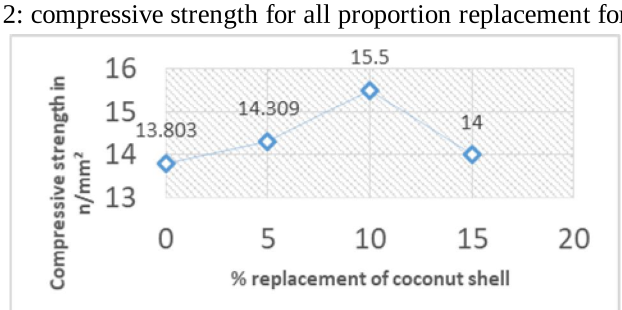
Table 8: Compressive test for 7 days of 10% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen. 1	330×10^3	150×150×150	$330\times10^3/150\times150$	14.66
Specimen 2	397×10^3	150×150×150	$397\times10^3/150\times150$	17.64
Specimen 3	320×10^3	150×150×150	$320\times10^3/150\times150$	14.22
Average compressive strength N/mm²				15.5

Table 9: Compressive test for 7 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen. 1	322×10^3	150×150×150	$322\times10^3/150\times150$	14.3
Specimen 2	331×10^3	150×150×150	$331\times10^3/150\times150$	14.7
Specimen 3	300×10^3	150×150×150	$300\times10^3/150\times150$	13.3
Average compressive strength N/mm²				14.1

Figure 2: compressive strength for all proportion replacement for 7 days



Compressive test for 28days for different proportions like 0%,5%,10%15%

Table 10: Compressive test for 28 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen .1	611×10^3	150×150×150	$611\times10^3/150\times150$	27.15
Specimen 2	613×10^3	150×150×150	$613\times10^3/150\times150$	27.24
Specimen 3	609×10^3	150×150×150	$609\times10^3/150\times150$	27.00
Average compressive strength N/mm²				27.13

Table 11: Compressive test for 28 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen .1	630×10^3	150×150×150	$630\times10^3/150\times150$	28.00
Specimen 2	639×10^3	150×150×150	$639\times10^3/150\times150$	28.40
Specimen 3	632×10^3	150×150×150	$632\times10^3/150\times150$	28.08
Average compressive strength N/mm²				28.16

Table 12: Compressive test for 28 days of 10% replacement

	Load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen .1	655×10^3	150×150×150	$655\times10^3/150\times150$	29.55
Specimen 2	660×10^3	150×150×150	$660\times10^3/150\times150$	29.33
Specimen 3	669×10^3	150×150×150	$669\times10^3/150\times150$	29.73
Average compressive strength N/mm²				29.53

Table 13: Compressive test for 28 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{load}{area}$	Strength N/mm²
Specimen .1	620×10^3	150×150×150	$620\times10^3/150\times150$	27.55
Specimen 2	628×10^3	150×150×150	$628\times10^3/150\times150$	27.91
Specimen 3	640×10^3	150×150×150	$640\times10^3/150\times150$	28.44
Average compressive strength N/mm²				27.96

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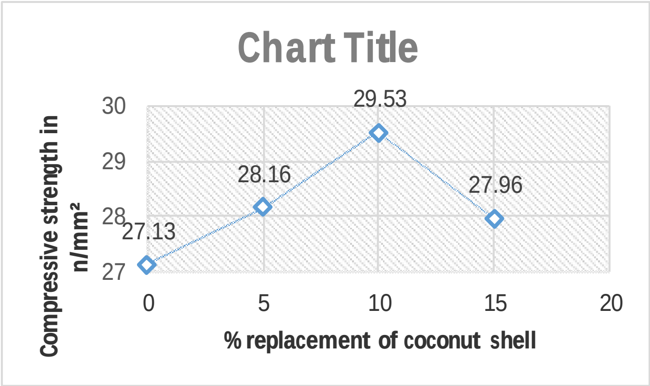
Figure5: compressive strength for all proportion replacement for 28 days



3) Split Tensile Strength

Split Tensile Strength for 7 days for different proportions like 0%,5%,10%15%.

Table 14: Split Tensile Strength test for 7 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm²
Specimen .1	100×10^3	Dia =150 Height=300	$\frac{2\times100\times10^3}{\pi\times150\times300}$	1.414
Specimen 2	105×10^3	Dia =150 Height=300	$\frac{2\times105\times10^3}{\pi\times150\times300}$	1.485
Specimen 3	103×10^3	Dia =150 Height=300	$\frac{2\times103\times10^3}{\pi\times150\times300}$	1.457
Average compressive strength N/mm²				1.352

Table 15: Split Tensile Strength test for 7 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm²
Specimen .1	99×10^3	Dia =150 Height=300	$\frac{2\times99\times10^3}{\pi\times150\times300}$	1.40
Specimen 2	106×10^3	Dia =150 Height=300	$\frac{2\times106\times10^3}{\pi\times150\times300}$	1.49
Specimen 3	104×10^3	Dia =150 Height=300	$\frac{2\times104\times10^3}{\pi\times150\times300}$	1.47
Average compressive strength N/mm²				1.45

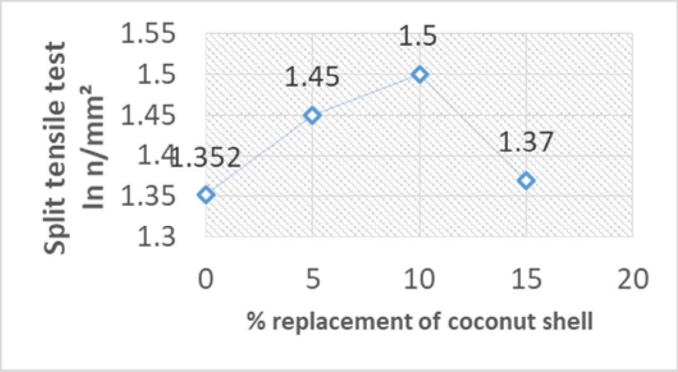
Table 16: Split Tensile Strength test for 7 days of 10% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm^2
Specimen .1	98×10^3	Dia =150 Height=300	$\frac{2\times98\times10^3}{\pi\times150\times300}$	1.38
Specimen 2	109×10^3	Dia =150 Height=300	$\frac{2\times109\times10^3}{\pi\times150\times300}$	1.62
Specimen 3	115×10^3	Dia =150 Height=300	$\frac{2\times115\times10^3}{\pi\times150\times300}$	1.51
Average compressive strength N/mm²				1.5

Table 17: Split Tensile Strength test for 7 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm^2
Specimen .1	101×10^3	Dia =150 Height=300	$\frac{2\times101\times10^3}{\pi\times150\times300}$	1.42
Specimen 2	94×10^3	Dia =150 Height=300	$\frac{2\times94\times10^3}{\pi\times150\times300}$	1.32
Specimen 3	97×10^3	Dia =150 Height=300	$\frac{2\times97\times10^3}{\pi\times150\times300}$	1.37
Average compressive strength N/mm²				1.37

Figure 3: split tensile strength for all proportion replacement for 7 days



Split Tensile Strength for 28 days for different proportions like 0%,5%,10%15%.

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Table 18: Split Tensile Strength test for 28 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm²
Specimen .1	205×10^3	Dia =150 Height=300	$\frac{2\times205\times10^3}{\pi\times150\times300}$	2.90
Specimen 2	200×10^3	Dia =150 Height=300	$\frac{2\times200\times10^3}{\pi\times150\times300}$	2.82
Specimen 3	211×10^3	Dia =150 Height=300	$\frac{2\times211\times10^3}{\pi\times150\times300}$	2.98
Average compressive strength N/mm²				2.90

Table 19: Split Tensile Strength test for 28 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm²
Specimen .1	215×10^3	Dia =150 Height=300	$\frac{2\times215\times10^3}{\pi\times150\times300}$	3.04
Specimen 2	219×10^3	Dia =150 Height=300	$\frac{2\times219\times10^3}{\pi\times150\times300}$	3.09
Specimen 3	220×10^3	Dia =150 Height=300	$\frac{2\times220\times10^3}{\pi\times150\times300}$	3.11
Average compressive strength N/mm²				3.08

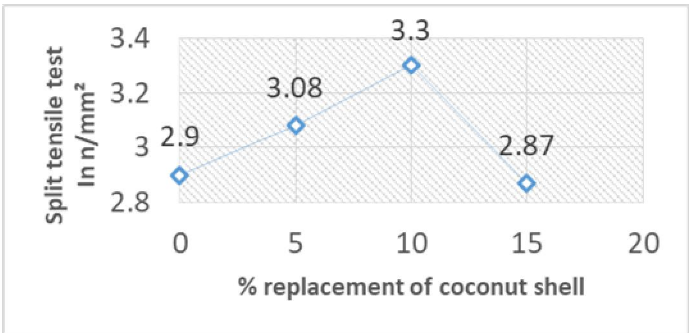
Table 20: Split Tensile Strength test for 28 days of 10% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm²
Specimen .1	230×10^3	Dia =150 Height=300	$\frac{2\times230\times10^3}{\pi\times150\times300}$	3.25
Specimen 2	232×10^3	Dia =150 Height=300	$\frac{2\times232\times10^3}{\pi\times150\times300}$	3.28
Specimen 3	239×10^3	Dia =150 Height=300	$\frac{2\times239\times10^3}{\pi\times150\times300}$	3.38
Average compressive strength N/mm²				3.30

Table 21: Split Tensile Strength test for 28 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{2p}{\pi dl}$	Strength N/mm^2
Specimen .1	206×10^3	Dia =150 Height=300	$\frac{2\times206\times10^3}{\pi\times150\times300}$	2.91
Specimen 2	201×10^3	Dia =150 Height=300	$\frac{2\times201\times10^3}{\pi\times150\times300}$	2.84
Specimen 3	204×10^3	Dia =150 Height=300	$\frac{2\times204\times10^3}{\pi\times150\times300}$	2.88
Average compressive strength N/mm²				2.87

Figure 6: split tensile strength for all proportion replacement for 28 days



4) Flexural Strength Of Modulus Test

Flexural strength of modulus test for 7 days for different proportions like 0%,5%,10%15%.

Table 22: The flexural strength of modulus test for 7 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	4.2×10^3	L=500,B=100 D=100	$\frac{4.2\times10^3\times500}{100\times100^2}$	2.1
Specimen 2	5×10^3	L=500,B=100 D=100	$\frac{5\times10^3\times500}{100\times100^2}$	2.5
Specimen 3	4×10^3	L=500,B=100 D=100	$\frac{4\times10^3\times500}{100\times100^2}$	2
Average compressive strength N/mm²				2.2

Table 23: The flexural strength of modulus test for 7 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	5.4×10^3	L=500,B=100 D=100	$\frac{5.4\times10^3\times500}{100\times100^2}$	2.7
Specimen 2	6×10^3	L=500,B=100 D=100	$\frac{6\times10^3\times500}{100\times100^2}$	3
Specimen 3	5.8×10^3	L=500,B=100 D=100	$\frac{5.8\times10^3\times500}{100\times100^2}$	2.9
Average compressive strength N/mm²				2.88

Table 24: The flexural strength of modulus test for 7 days of 10% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	6.2×10^3	L=500,B=100 D=100	$\frac{6.2\times10^3\times500}{100\times100^2}$	3.1
Specimen 2	6.5×10^3	L=500,B=100 D=100	$\frac{6.5\times10^3\times500}{100\times100^2}$	3.25
Specimen 3	6.9×10^3	L=500,B=100 D=100	$\frac{6.9\times10^3\times500}{100\times100^2}$	3.45
Average compressive strength N/mm²				3.26

Table 25: The flexural strength of modulus test for 7 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	5.2×10^3	L=500,B=100 D=100	$\frac{5.2\times10^3\times500}{100\times100^2}$	2.60
Specimen 2	4.9×10^3	L=500,B=100 D=100	$\frac{4.9\times10^3\times500}{100\times100^2}$	2.45
Specimen 3	5.3×10^3	L=500,B=100 D=100	$\frac{5.3\times10^3\times500}{100\times100^2}$	2.65
Average compressive strength N/mm²				2.56

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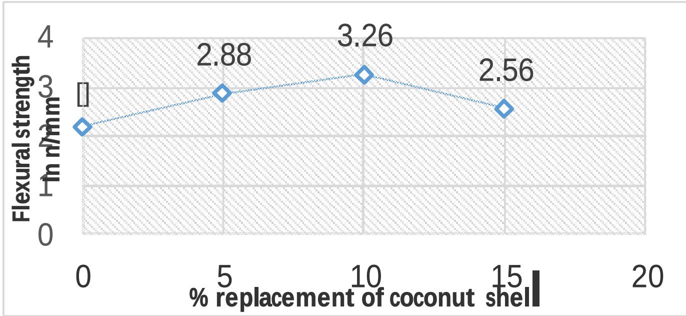
Figure 4: flexural strength of modulus for all proportion replacement for 7 days



Flexural strength of modulus test for 28 days for different proportions like 0%,5%,10%15%.

Table 26: The flexural strength of modulus test for 28 days of 0% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	6.1×10^3	L=500,B=100 D=100	$\frac{6.1\times10^3\times500}{100\times100^2}$	3.05
Specimen 2	5.9×10^3	L=500,B=100 D=100	$\frac{5.9\times10^3\times500}{100\times100^2}$	2.95
Specimen 3	6.8×10^3	L=500,B=100 D=100	$\frac{6.8\times10^3\times500}{100\times100^2}$	3.40
Average compressive strength N/mm²				3.13

Table 27: The flexural strength of modulus test for 28 days of 5% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm²
Specimen .1	6.5×10^3	L=500,B=100 D=100	$\frac{6.5\times10^3\times500}{100\times100^2}$	3.25
Specimen 2	6.9×10^3	L=500,B=100 D=100	$\frac{6.9\times10^3\times500}{100\times100^2}$	3.45
Specimen 3	6.4×10^3	L=500,B=100 D=100	$\frac{6.4\times10^3\times500}{100\times100^2}$	3.2
Average compressive strength N/mm²				3.30

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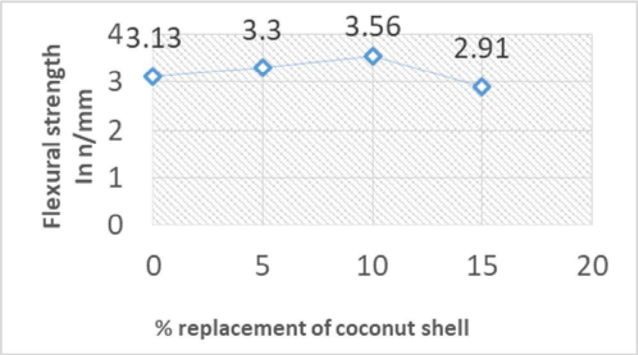
Table 28: The flexural strength of modulus test for 28 days of 10% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm^2
Specimen .1	7.1×10^3	L=500,B=100 D=100	$\frac{7.1\times10^3\times500}{100\times100^2}$	3.55
Specimen 2	6.8×10^3	L=500,B=100 D=100	$\frac{6.8\times10^3\times500}{100\times100^2}$	3.40
Specimen 3	7.5×10^3	L=500,B=100 D=100	$\frac{7.5\times10^3\times500}{100\times100^2}$	3.75
Average compressive strength N/mm²				3.56

Table 29: The flexural strength of modulus test for 28 days of 15% replacement

	load in N	Dimensions In mm	Formulae $\frac{pl}{bd^2}$	Strength N/mm^2
Specimen .1	6.3×10^3	L=500,B=100 D=100	$\frac{6.3\times10^3\times500}{100\times100^2}$	3.15
Specimen 2	5.5×10^3	L=500,B=100 D=100	$\frac{5.5\times10^3\times500}{100\times100^2}$	2.75
Specimen 3	5.7×10^3	L=500,B=100 D=100	$\frac{5.7\times10^3\times500}{100\times100^2}$	2.85
Average compressive strength N/mm²				2.91

Figure 8: flexural strength of modulus for all proportion replacement for 28 days



V. CONCLUSION

A. In this project, our research paper says that partial replacement of coconut shell to coarse aggregates in concrete can replace successfully up to 10% nearly it is increasing the strength of concrete up and it decreasing to 15% in 1n/mm^2.

B. While increasing the replacement the workability also getting increasing so it has good workability for replacing coconut shells to coarse aggregates.

C. The compressive strength, split tensile strength and flexural modulus for 5% when it compares to 0% the strength will getting increased up to 10%.

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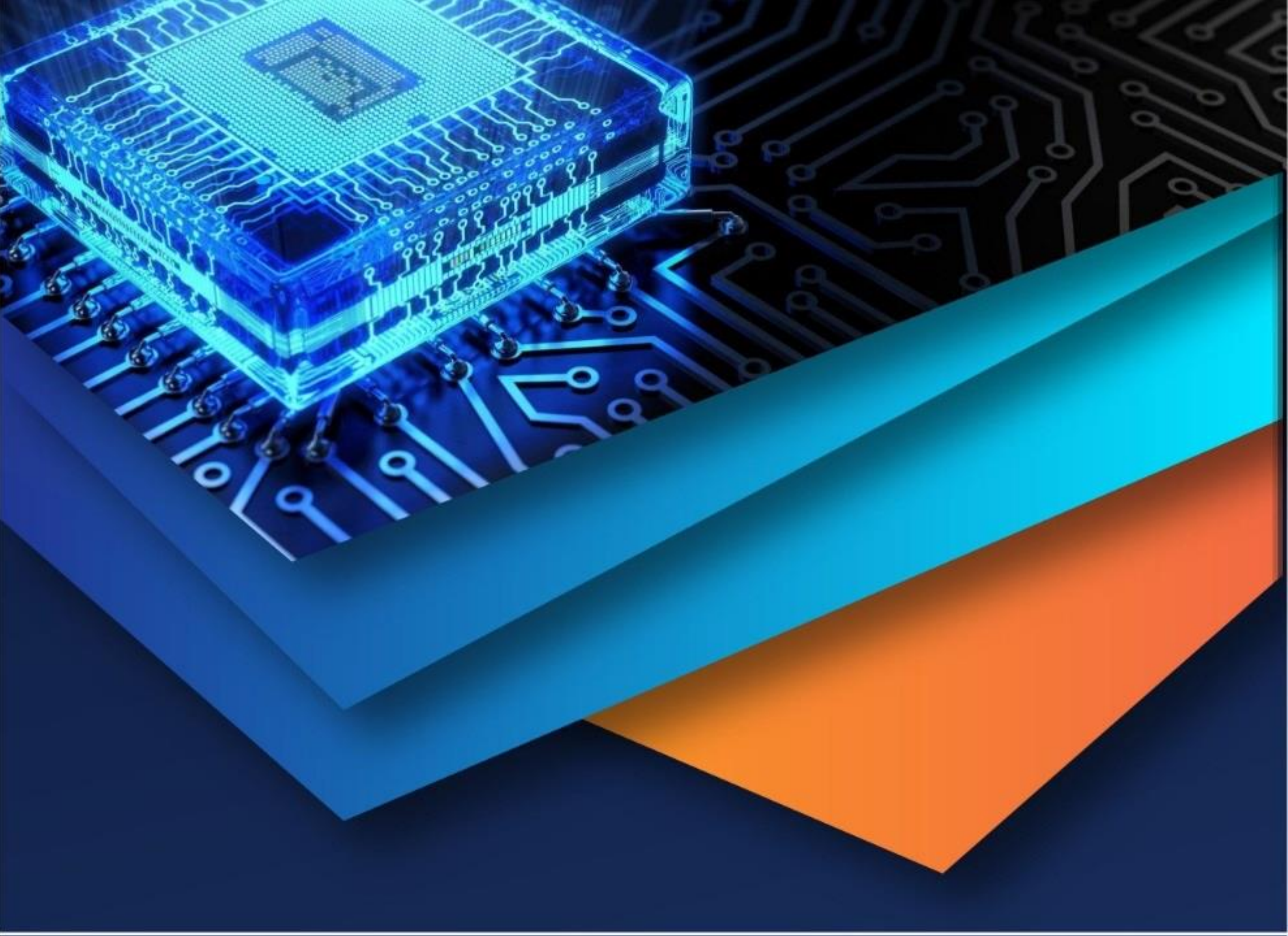

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