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Compressive Strength of Concrete by Using Coconut Shell

Parag S. Kambli[1], Sandhya R. Mathapati[2]
[1] *(PG Student, Department of Civil Engineering, DYPSOET, University of Pune, Pune – 411014*
[2]*(Guide & Assistant Prof., Department of Civil Engineering, DYPSOET, University of Pune, Pune – 411014*

Abstract: - The high cost of conventional construction materials is a dominating factor affecting housing system around the world. This has necessitated research work into alternative materials in the construction field. Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as course aggregate will be investigate to replace the aggregate in concrete. In this study, three different concrete mixes namely M20, M35 & M50 grade with different combination of natural material CS content in the proportion 0%, 10%, 20%, 30% and 40% will be replaced. Six sample specimen will be prepared for each concrete mixes. The parameters will be tested are compressive strength behaviour of cube specimens for 7 & 28 days.
The main objective is to encourage the use of these 'seemingly' waste products as construction materials in low-cost housing. It is also expected to serve the purpose of encouraging housing developers in investing these materials in house construction.

Keywords: - *Coarse aggregates, Coconut shell, Compressive strength, Concrete cube specimens, Grade 53 Birla cement, M20, M35, M50, CTM, etc.*

I. INTRODUCTION

Following a normal growth in population, the amount and type of waste materials have increased accordingly. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the environmental impact can be reduced by making more sustainable use of this waste. This is known as the Waste Hierarchy. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal.

1.1 Concrete:

Versatility of making concrete with locally available materials, ease in moulding it into any shape and size and economy in its making has made concrete the 2nd largest consumed material on earth.

a. Far more concrete is produced than any other man-made material. Annual production represents one ton for every person on the planet.
b. It is incredibly versatile, and is used in almost all major construction projects.
c. Aggregates are used in concrete for very specific purposes. Aggregates typically make up about 60 % to 75 % of the volume of a concrete mixture, and as they are the least expensive of the materials used in concrete, the economic impact is significant.
d. 80 % of buildings CO_2 emissions are generated not by the production of the materials used in its construction, but in the electric utilities of the building over its life-cycle.
e. Compared to other comparable building materials, concrete is less costly to produce and remains extremely affordable.

1.2 Use of waste in concrete:

A research effort has been done to match society's need for safe and economic disposal of waste materials. The use of waste materials saves natural resources and dumping spaces, and helps to maintain a clean environment. The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand and drinking water, but also two billion tons a year of Portland cement, which releases green-house gases leading to global warming. Experiments has been conducted for waste materials like- rubber tyre, e-waste, coconut shell, blast furnace slag, waste plastic, demolished concrete constituents, waste water etc. Construction waste recycle plants are now installed in various countries but they are partly solution to the waste problems.

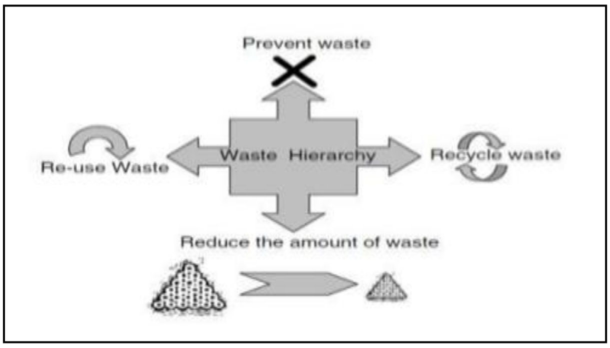


Figure 1: Waste Hierarch

II. COCONUT SHELL AS AGGREGATE

Coconut shell particles are used as reinforcing material for investigation. Shell particles of size between 20 mm – 600 µ are prepared in grinding machine. Coconut shell aggregates are potential candidates for the development of new composites because of their high strength and modulus properties. An approximate value of coconut shell density is 1.60 g/cm^3.

Figure 2: Coconut Shell

Figure 3: Coconut shell as aggregates

III. EXPERIMENTAL PROGRAMME

The target of the experimental program was to determine the contribution of natural material aggregate type to the development of the strength behaviour of the confined concrete. The experimental program comprises the following:

a. To Compute and compare the Compressive strength of M20, M35 & M50 mix concrete cube specimens with 10%, 20%, 30% & 40% replacement of aggregate by coconut shell concrete cube specimens.
b. To check various properties of coconut shell concrete mix like
- Density
- Modulus of Elasticity
- Workability
- Water-cement ratio
- Water absorption
- Slump cone
c. To investigate the feasibility of the combination of coconut shell as coarse aggregate in concrete by determining its compressive strength and durability.
d. To investigate the effect of the combination of coconut shell as coarse aggregate in concrete content and length to the workability as lightweight aggregate in concrete.
e. To determine the optimum content of the combination of coconut shell as coarse aggregate in concrete to improve the ductility and does not cause reduction in the compressive strength.
f. To compute applications of such lightweight concrete in construction & its economy.

IV. COCONUT SHELL BLENDED CONCRETE

Based on the literature review and research planning, the expected outcomes for the Research are:

4.1 Work plan –

Sr. No.	Concrete Cube	7 Days	28 Days
1	M 20 Mix	3	3
2	20% replacement Aggregate by Coconut Shell	3	3
3	30% replacement Aggregate by Coconut Shell	3	3
4	40% replacement Aggregate by Coconut Shell	3	3
5	M 35 Mix	3	3
6	20% replacement Aggregate by Coconut Shell	3	3
7	30% replacement Aggregate by Coconut Shell	3	3
8	40% replacement Aggregate by Coconut Shell	3	3
9	M 50 Mix	3	3
10	20% replacement Aggregate by Coconut Shell	3	3
11	30% replacement Aggregate by Coconut Shell	3	3
12	40% replacement Aggregate by Coconut Shell	3	3
TOTAL CUBES CAST		**36**	**36**

Total no. Of samples - 72

V. FLOWCHART OF WORK

Figure 4: Flowchart of Actual Lab Work

VI. LAB PROCESS

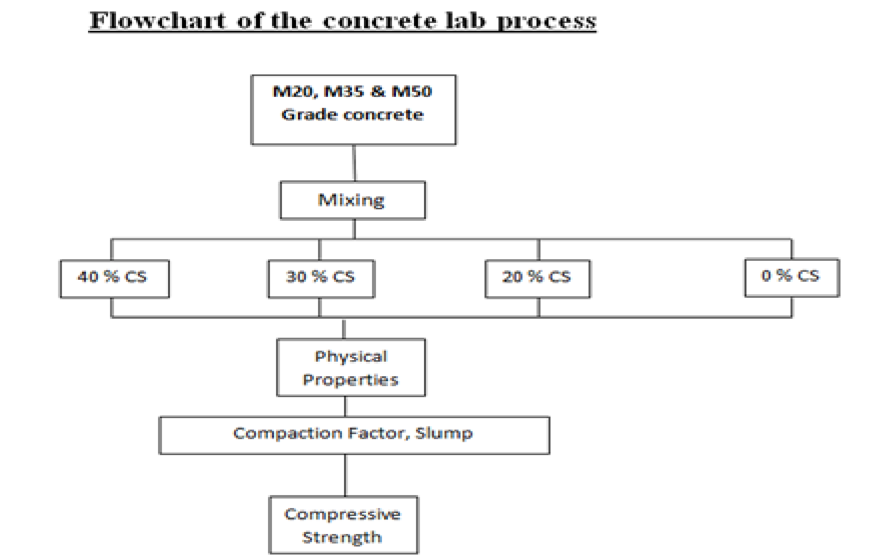


Figure 5: Lab Process diagram

6.1 Compressive strength data sheet:

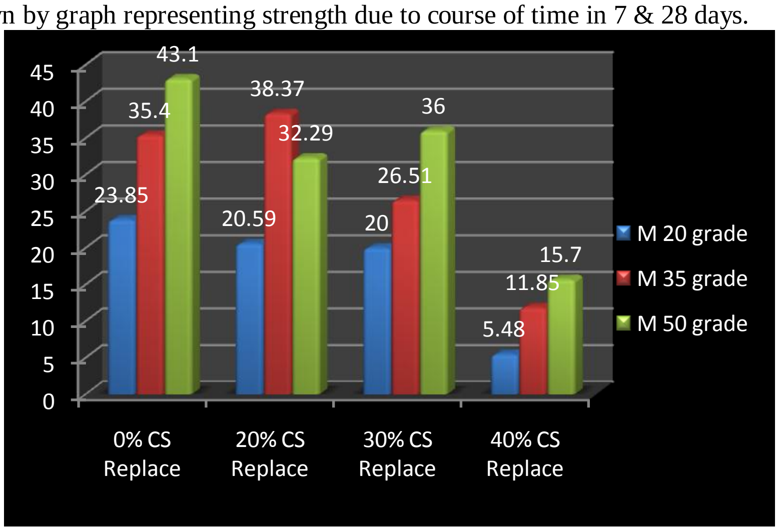
Trial	Trial details	Compressive Strength (in Mpa)					
		7 days			28 days		
M20 grade	Trial I 7/01/2014	26.67 (14/1)	24.44 (14/1)	20.44 (14/1)	31.11 (4/2)	32.44 (4/2)	30.66 (4/2)
M20 - 20% CS	Trial II 23/01/2014	20 (30/1)	21.77 (30/1)	20 (30/1)	28 (20/2)	32.88 (20/2)	30.22 (20/2)
M20 - 30% CS	Trial III 24/01/2014	18.66 (31/1)	20.88 (31/1)	20.44 (31/1)	21.33 (21/2)	23.11 (21/2)	24.44 (21/2)
M35 - 20% CS	Trial IV 28/01/2014	31.11 (4/2)	35 (4/2)	33.33 (4/2)	48.33 (25/2)	50.11 (25/2)	49.20 (25/2)
M35 - 30% CS	Trial V 30/01/2014	26.22 (6/2)	26.66 (6/2)	26.22 (6/2)	37.77 (27/2)	42.22 (27/2)	44.44 (27/2)
M50 - 20% CS	Trial VI 1/02/2014	32.44 (8/2)	31.11 (8/2)	33.33 (8/2)	56.66 (1/3)	56.44 (1/3)	54.55 (1/3)
M50 - 30% CS	Trial VII 5/02/2014	36 (12/2)	36.44 (12/2)	35.55 (12/2)	51.11 (5/3)	48.88 (5/3)	50.66 (5/3)
M35 grade	Trial VIII 8/02/2014	34.66 (15/2)	36 (15/2)	35.55 (15/2)	57.33 (8/3)	57.77 (8/3)	58.22 (8/3)
M50 grade	Trial IX 8/02/2014	42.22 (15/2)	44.44 (15/2)	42.66 (15/2)	61.33 (8/3)	57.33 (8/3)	59.55 (8/3)
M20 - 40% CS	Trial X 10/02/2014	5.77 (17/2)	6.22 (17/2)	4.45 (17/2)	9.33 (10/3)	8.44 (10/3)	8.44 (10/3)
M35 - 40% CS	Trial XI 15/02/2014	12 (22/2)	11.11 (22/2)	12 (22/2)	14 (15/3)	15.28 (15/3)	15.52 (15/3)
M50 - 40% CS	Trial XII 10/02/2014	15.11 (17/2)	13.77 (17/2)	18.22 (17/2)	22.22 (10/3)	22.66 (10/3)	21.33 (10/3)

6.2 Testing of cube specimen:

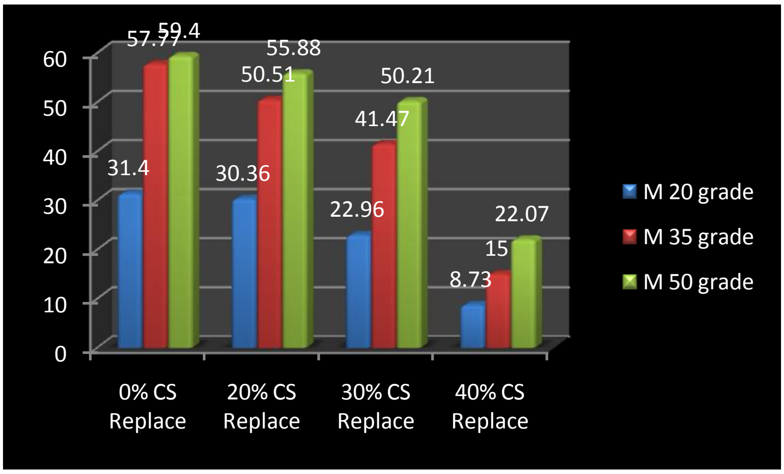
Figure 6: Coconut Shell Blended Concrete Cube Specimen after Test

VII. RESULT ANALYSIS

Every result is shown by graph representing strength due to course of time in 7 & 28 days.



Graph 1: Comparison of Compressive strength analysis of CS concrete at 7 Days



Graph 2: Comparison of Compressive strength analysis of CS concrete at 28 Days

1. From Graph 2, for M20 grade concrete cubes with 30% replacement of CS aggregates had given requisite strength of 23 Mpa at 28 days. Hence, it can be used with proportions varying from 0-30%.
2. From Graph 2, for M35 grade concrete cubes with 30% replacement of CS aggregates had given strength of 42 Mpa at 28 days.
3. From Graph 2, for M50 grade concrete cubes with 30% replacement of CS aggregates had given requisite strength of 51 Mpa at 28 days. Further we can replace CS up to 40% which gives M20 grade concrete strength so; we can use it as M20 grade concrete up to 40% CS replaced for low cost housing & the places where it is easily available.

7.1 Cost Analysis:
Cost of concrete is depending upon the quantity, quality & proportion of materials used. Coconut shell in concrete not only changes the strength property of concrete but also changes the cost of that particular design.

Table 7.1: Cost analysis for M20 grade of project – for 1m^3 of concrete

Material	Rate (Rs.)	Cost of concrete (Rs.)			
		P.C.C.	20% CS replace Concrete	30% CS replace Concrete	40% CS replace Concrete
Cement	6.4/kg	2080	2080	2080	2080
Fly ash	0.5/Kg	-	-	-	-
Crushed Sand	2800/br	545	545	545	545
10mm Aggregate	2300/br	250	200	175	150
20mm Aggregate	2300/br	305	305	305	305
Admixture	35/Kg	113	113	113	113
	Total (Rs.)	**3293/-**	**3243/-**	**3218/-**	**3193/-**

Table 7.2: Cost analysis for M35 grade of project - for 1m^3 of concrete

Material	Rate (Rs.)	Cost of concrete (Rs.)			
		P.C.C.	20% CS replace Concrete	30% CS replace Concrete	40% CS replace Concrete
Cement	6.4/kg	2624	2624	2624	2624
Fly ash	0.5/Kg	-	-	-	-
Crushed Sand	2800/br	521	521	521	521
10mm Aggregate	2300/br	212	169.6	148.5	127
20mm Aggregate	2300/br	318	318	318	318
Admixture	35/Kg	144	144	144	144
	Total (Rs.)	**3819/-**	**3777/-**	**3756/-**	**3734/-**

Table 7.3: Cost analysis for M50 grade of project - for 1m^3 of concrete

Material	**Rate (Rs.)**	**Cost of concrete (Rs.)**			
		P.C.C.	**20% CS replace Concrete**	**30% CS replace Concrete**	**40% CS replace Concrete**
Cement	6.4/kg	3200	3200	3200	3200
Fly ash	0.5/Kg	-	-	-	-
Crushed Sand	2800/br	442	442	442	442
10mm Aggregate	2300/br	195	156	136.5	117
20mm Aggregate	2300/br	362	362	362	362
Admixture	35/Kg	168	168	168	168
	Total (Rs.)	**4367/-**	**4328/-**	**4309/-**	**4289/-**

VIII. CONCLUSION

a. From the experimental results and discussion, the coconut shell has potential as lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste. Coconut Shell Concrete can be used in rural areas and places where coconut is abundant and may also be used where the conventional aggregates are costly. Coconut shell concrete is also classified as structural lightweight concrete.
b. It is concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.
c. Trying to replace aggregate by coconut shell partially to make concrete structure more economic along with good strength criteria.
d. From one cube calculation bulk amount of shell replacement can be evaluated & reduces over all construction cost.
e. This can be useful for construction of low cost housing society.

IX. FUTURE SCOPE

a. Well grinded pieces of these wastes should be checked for the replacement of fine aggregates i.e. for sand in concrete mix.
b. Durability factor can be determined by carrying some durability tests on the CS cube specimens.
c. Flexural strength can also be determined by casting CS concrete cube specimens.
d. Light weight construction units can be made by using these wastes like panels & block production, internal wall casting, outdoor furniture etc.
e. Combination with fly ash can also be an option for future experimentation.
f. Other wastes like Sugarcane bagasse, blast furnace slag & Plastic can be an option for waste utilization in construction practices.

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Article:

Parag Shantaram Kambli
[M.E. - Civil (Structure)],
PG Student, DYPSOET, Lohgaon, Pune.

Sandhya R. Mathapati
M.E. - Civil (Structure),
Project Guide, DYPSOET, Lohgaon, Pune.