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Experimental Study on Partial Replacement of Coarse Aggregate with Coconut Shell

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Abstract: Concrete is the premier construction material around the world and is most widely used in all types of construction works, including infrastructure, low and high-rise buildings, and domestic developments. In construction industry the rising cost of construction material is the great factor. The reason for increase in cost is high demand of concrete and scarcity of raw material. Due to this, excessive exploitation of aggregates occurs. It creates environmental issues and as a result, certain restrictions were put forward by the government, in order to stop these exploitations. Now it is essential to find out a new source of aggregates. The coarse aggregate is the main constituent of concrete mix, in this study we used coconut shell as a coarse aggregate and been discussed based on the results obtained from literature review. The use of coconut shell can also help the prevention of the environment. The aim is to analyze compressive strength and split tensile strength of concrete (M30) produced using coconut shell as substitute for conventional coarse aggregate with 0% , 5% , 10% , 15% , 20% , 25% partial replacement in 7 , 14 & 28 days to increase the strength of the concrete Myrobalan powder (Kadukkai powder) is added 30grams for each cube. Three sample cubes are prepared for M30 grade concrete mix for each proportion. Another aim of this study is to spread awareness about use of coconut shell as construction material in civil engineering.

Index terms: Replacement Material, Waste Management, Natural Admixture, New Material, Cost Efficient.

I. INTRODUCTION

The three basic needs of human are food, clothing, and shelter. Civil Engineer has relevance with all basic needs of man directly or indirectly. Man has progressed a lot in developing the method of constructing shelter. Initially man used to stay in huts and time passed it developed into house that is load bearing. In this constructed environment, the rising cost of building construction materials is the factor of great concern. The cost of building materials are raising day by day. Concrete is a composite material which composed of aggregates, cement and water. Concrete is used more than any other man made material in the world. The possibility of a complete depletion of aggregates for construction unsustainable. Now time has come to think of some alternative materials for sustainable use in concrete mix. In this study we are going to partially replace coarse aggregate with coconut shell with myrobalan powder as admixture. Coconut is grown in more than 93 countries. South East Asia is regarded as the origin of coconut. India is the third largest, having cultivation on an area of about 1.78 million hectares. Coconut shell is one of the waste material can be used as a aggregate in concrete due to some reasons like large scale cultivation of coconut in coastal region of India including Kerala, Andhra Pradesh, Goa, etc. due to tough made tissue, shell is not decomposed easily and remain as solid waste for years. Coconut shell being a hard and not easily degrade material. At present, coconut shell has also been burnt to produce charcoal and activated carbon for food and carbonated drink and filtering mineral water use. However the coconut shell is still under utilized in some places. The chemical composition of the coconut shell is similar to wood. It contains 33.61% cellulose, 36.51% lignin, 29.27% and ash at 0.61%. Until now, industrial by products and domestic wastes has been utilized in concrete, but the use of agricultural waste in concrete is in its infancy stage. Coconut shell is an agricultural waste. The materials are proportioned by their weights. The water cement ratio is obtained by conducting various workability tests. The obtained results are compared with that of conventional mix. Tests are as per the specified procedure of Indian standard codes.

II. 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. In this study we are going to partially replace coarse aggregate with coconut shell which is also a waste material.

III. PROPERTIES OF COCONUT SHELL

Coconut shell is the strongest part covered in coconut fruit. Coconut shell is located in between the coconut flesh and coconut husk. This shell is naturally created to protect the inner part of coconut. The cultivation of coconut is more in southern state of India. The states like Kerala, Goa, and Tamil Nadu cultivate more number of coconuts. So as to reduce the coconut waste, the coconut shell is used in concrete. Coconut shell is a high potential material due to its high strength and modulus properties. Coconut shell powder exhibits admirable properties compared to other materials such as low cost, renewable, high specific strength to weight ratio, low density less abrasion to machine and environmental friendly. So we are using coconut shell as a replacement to coarse aggregate.



Figure 3.1 Coconut shell

IV. PROPERTIES OF MYROBALAN POWDER

Herbal admixture Myrobalan (kadukkai) will definitely improve the strength and durability of the mortar but at the same time it does not produce any harm to our environment. It's as an admixture and medic nary plant, this plant leaves powder can also be replaced partially with cement. It is used in ancient structures. Its binding property is great and also it is a very good paste consistency. The myrobalan powder has good medicinal properties also. Terminalia Chebula (Kadukkai) is the locally available natural admixture. Generally the kadukkai is used in medicals. And in our ancestors have used various plants as admixture in construction for more than 10000 years to improve overall performance of the structure. Herbal admixture (kadukkai) will definitely improve the strength and durability of the mortar but at the same time it does not produce any harm to our environment. It's as an admixture and medic nary plant, this plant leaves powder can also be replaced partially with cement. Detail Experimental investigation is done in the laboratory to determine the optimum usage of these herbal products in cement mortar.



Figure 4.1 Myrobalan powder

V. MATRRIAL TESTING

The materials are tested and their properties are listed below like properties of corse aggregate, fine aggregate, coconut shell and cement.

Table 5.1 Properties of Cement

SI.No	Properties	Value
1	Normal Consistency	32 %
2	Fineness of cement	97%
3	Specific gravity	3.15
4	Initial setting time	32 min
5.	Final setting time	600 min

Table 5.2 Properties of Corse Aggregate

SI. No	Properties	Values
1	Fineness Modulus	9.88 %
2	Specific Gravity	2.6
3	Percentage of water absorption	5.8 %

Table 5.3 Properties of Fine Aggregate

SI.No	Properties	Value
1	Specific Gravity	2.6
2	Fineness Modulus	5.785 %

Table 5.4 Properties of Coconut Shell

SI. No	Properties	Values
1	Specific Gravity	1.57
2	Percentage of water absorption	11.66 %

VI. MIX DESIGN

The mix design is designed by analysis the properties of the material. it is designed for M30 grade of concrete using IS 10262:1982

Table 6.1 Mix design detail

Component	M ₃₀
Mix ratio	1:1.06:2.32
Water cement ratio	0.38
Cement	490 kg/m ³
Fine aggregate	523 kg/m ³
Coarse aggregate	1140 kg/m ³
Water	186 lit/m ³

The casting of cubes is done perfectly by 3 layers. The size of the cube is 150 x 150 x 150 mm. the each layer is compacted using tamping rod up to 25 blows. The concrete mixing is done with myrobalan powder diluted water. The concrete mix consist of fine aggregate, coarse aggregate, coconut shell, cement and myrobalan powder diluted water. The curing is done in pure water. The curing process is carried out for 7, 14, and 28 days. After curing process the cubes are tested using CTM.

VII. RESULT AND DISCUSSION

The molded cubes are removed from curing tank after the specified curing. Excess water is wiped out on the specimen is dried. Dimensions of the specimens are measured to the nearest 0.2 meter. The specimens are taken for the testing at compressive testing machine is cleaned and the specimens are placed in such a manner that the load is applied to the opposite sides of the cube cast uniformly. The specimen is aligned centrally on the base plate of the machine and the movable portion is rotated by hand so that it touches the top surface of the specimen. The load is applied gradually without shock and continuously at the rate of 140 kg/cm³/min till it fails. The maximum load is recorded and any usual features in type of failure are noted. A min of 3 specimens are tested at selected age. If any strength is varied by more than 15% of average strength results of such specimen should be rejected. Average of three specimens gives the crushing strength of concrete. During the compressive strength, the load P is collected and the strength was calculated

Compression Strength After 7 Days

Table 7.1 Compression test result for 7 days

S I. N O	Admix ture Myrob alan in grams	Percenta ge of coconut shell	Compressive strength for 7 days (N/mm ²)			
			Sample 1	Sample 2	Sampl e 3	Average
1	0	0	12.8	12.4	12.6	12.6
2	30	5	13.2	12.9	13.4	13.1
3	30	10	11.9	12	12.5	12.1
4	30	15	11.5	11.2	11.6	11.4
5	30	20	10.2	10	10.8	10.3
6	30	25	9.7	9.9	9.6	9.7

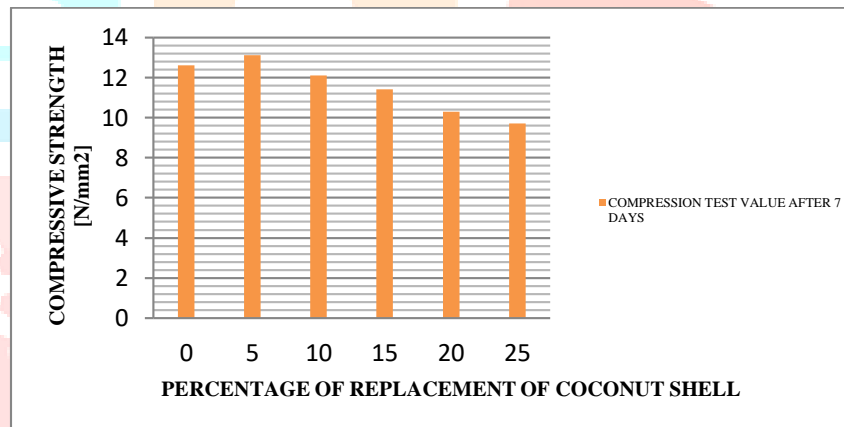


Figure 7.1 Compression test result for 7 days

Compression Strength After 14 Days

Table 7.2 Compression test result for 14 days

S I. N O	Admix ture Myroba lan in grams	Percentag e of coconut shell	Compressive strength for 14 days (N/mm ²)			
			Sample 1	Sample 2	Sample 3	Aver age
1	0	0	19.5	20.2	19.3	19.6
2	30	5	20.6	21.2	20.9	20.9
3	30	10	18.9	19.6	19.1	19.2
4	30	15	18.5	18.3	18.7	18.5
5	30	20	17.2	17.5	17.9	17.6
6	30	25	16.8	17.2	17.5	17.1

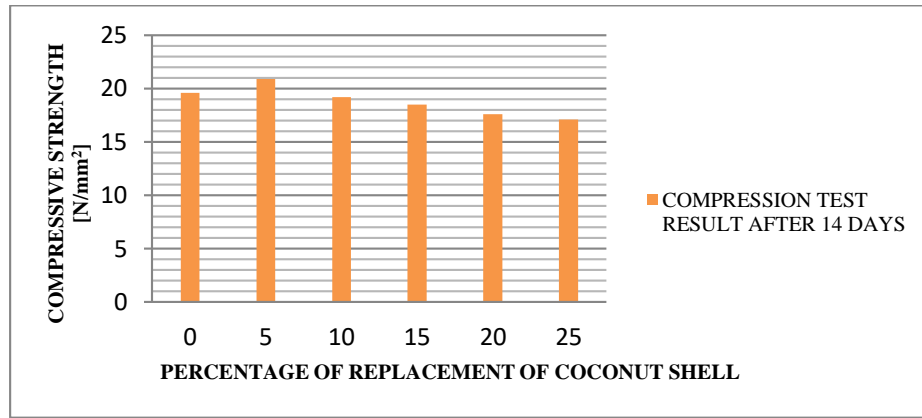


Figure 7.2 Compression test result for 14 days

Compressive Strength After 28 Days

Table 7.3 Compression test result for 28 days

S I. N O	Admixture Myrobalan in grams	Percentage of coconut shell	Compressive strength for 28 days (N/mm ²)			
			Sample 1	Sample 2	Sample 3	Average
1	0	0	30	29.7	30.2	29.9
2	30	5	30.2	30.5	30.8	30.5
3	30	10	29.5	29.6	29.2	29.4
4	30	15	28.8	27.8	28.3	28.3
5	30	20	28	27.5	27.7	27.7
6	30	25	27.7	26.8	26.6	27.3

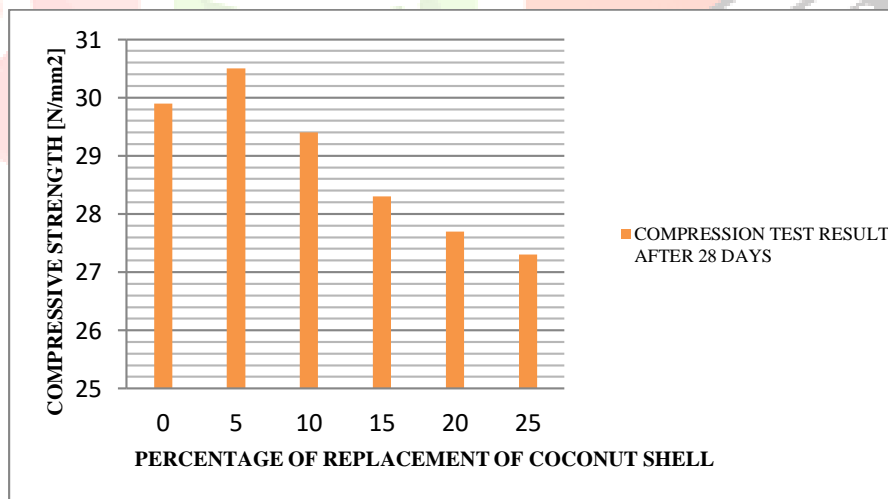


Figure 7.3 Compression test result for 28 days

VIII. CONCLUSION

The experimental study on partial replacement of coarse aggregate with coconut shell is done successfully. In this project we have used myrobalan powder as an admixture. In this we have replaced coconut shell in various percentages like 5 % , 10 % , 15 % , 20 % , and 25 % . For each ratio 3 samples has been casted and curing is done. The compression test was done in 3 stages, 7 days, 14 days, and 28 days. After curing process the compression test has been done.

According to the compression test result the coconut shell can be used in the concrete. Due to the use of myrobalan powder the compression strength increases in 5 % , and 10 % replacement of coconut shell. And more than 10 % the compression strength decreases gradually. So as per our study the replacement of 5 % and 10 % can be done and it is best for RCC concrete. The workability of coconut shell replaced concrete is high.

So as it is a natural material it does not affect the nature and it reduces the amount of waste and demand of construction material. The myrobalan powder is the natural admixture used by us is an ancient material which is called as kadukkai powder in Tamil which is a high strength material. This is the conclusion that coconut shell can be replaced in 5 % and 10 % and it is best in RCC Concrete.

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