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Experimental Investigations on Green Concrete

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***Abstract*—** *Concrete is out and away the foremost wide used construction material these days. Now we are living in the age which related to concrete. But now-a-days due to rapid growth in construction cement is very costly. Also due to large growth in industrialization there is a large amount of wastes generated, which is hazardous to environment and living beings. To overcome above problems, wastes generated can be used as alternative materials in conventional concrete to produce eco-friendly concrete named as Green Concrete. By using this type concrete requires minimum amount of energy and causes least harm to the environment.*

This project analyses the Comparison of marble dust, crushed coconut shell, broken ceramics waste and rice husk ash in concrete by partial replacement of cement, coarse aggregate and fine aggregate respectively at the ratio of 0%, 5%, 10%, 15% & 20% concrete specimens were casted and subsequently all test specimens were cured in water at 7 and 28 Days with the specified combinations The experimental study examines the mechanical properties of flexural strength compressive strength. In this project M20 Concrete is designed for various combinations. Nowadays, all over the world aimed at increasing the reuse and recycling products, where it is technically, economically or environmentally acceptable.

***Keywords*—** *Green Concrete, Eco-Friendly Concrete, Marble Dust, Crushed Coconut Shell, Broken Ceramics Waste And Rice Husk Ash (RHA).*

I. INTRODUCTION

Green Concrete has nothing to do with colour. It is a concept of using eco-friendly materials in concrete with concrete wastes. This green concrete is the concrete which reduces the environmental impact for e.g. Energy saving, co_2 emissions, waste water. Marble powder is created from the marble process plants throughout the cutting, shaping and polishing. Coconut shells are cheap and readily available in high quantity. This has very high potential to use in the places wherever and whenever the crushed stones are expensive. Ceramic product is made from natural materials that contain a high proportion of clay minerals. Ceramics are very hard and chemically non-reactive and also have ability to withstand the high temperatures. The ceramic waste required for our project is brought from Vennar Ceramics Industry- kaikaluru, Krishna District, Andhra Pradesh. The rice hulling work offers rice husk. Rice husk ash is used in concrete construction as an alternative of fine aggregate.

II. REVIEW OF LITERATURE

The study about the behaviour of concrete, having partial replacement of cement with marble waste M25 grade for which the marble powder is replaced by an experimental study was carried out and the effect on compressive strength and split tensile strength characteristics (0%, 4%, 8%, 12%, 16%, 20%) was studied. It minimize the costs for construction with usage of marble powder which is freely or cheaply available more importantly. It was concluded by Jashandeep singh,Er. R S Bansal (2015). Tests were performed by Raghavendra, Prof. M. K. Trivedi (2017) to examine the strength and durability performance of concrete mix with marble dust replaced at the concrete with 5%, 10%, 15%, 20% & 25% of cement and then compared with Conventional concrete. Dr. B. Rajeevan (2015) concluded that Disposal of coconut shells poses environmental issues as it is not easily degradable. Aggregates are formed by crushing coconut shells are effectively employed in concrete by partly substitution of coarse mixture up to a certain quantity. This will not totally scale back the unit weight of evolved concrete assembled, but also provides an efficient solution to the disposal of coconut shells. The project paper of B. Damodhara Reddy, S.Aruna Jyothy, Fawaz Shaik (2014) aims at analyzing flexural and compressive strength characteristics of with partial replacement using M30 grade concrete. The project additionally aims to point out Coconut shell mixture may be a potential construction material and at the same time reduces the surroundings drawback of solid. S. O. Ehikhuenmen, E. E. Ikponmwosa (2017) concluded in his paper that the results of tests show that workability, density, compressive and flexural strength of concrete decreased with increase in ceramic waste content when it is partially replaced with the coarse aggregate. According to Yiosese A. O. Ayoola A. R., Ugonna M. C., Adewale A. K. (2018) study reports on experimental investigation on the quality of the utilization of broken tiles as partial replacement for crushed granite in concrete production and ended that strength depends to an oversized extent on sensible bonding between the cement paste and also the aggregates. The experimental study of Thomas U.Ganiron Jr (2013) aimed to determine how rice husk differ with other ordinary concrete mix as fine aggregate in terms of elasticity. RHA, produced after burning of Rice husks (RH) has high reactivity and pozzolanic property and concluded that RHA minimizes alkali-aggregate reaction, reduces the expansion. The paper of Obilade, I.O. (2014) results revealed that the compacting factor, bulk density and compressive strength decreased as the percentage replacement of sand with rice husk increased and also revealed that there is

the possibility of subtitution fine mixture with rice husk within the production of structural concrete.

III. OBJECTIVES OF STUDY

The objectives of this experimental project study are

1. Developing mix design for normal concrete relevant to IS: 10262-2009.
2. To study the strength properties of normal concrete of grade M20.
3. To study the influence of partial replacement of cement with marble dust and coarse aggregate with crushed coconut shells and to compare it with the compressive and tensile strength of ordinary M20 concrete.
4. To study the influence of partial replacement of coarse aggregate with broken ceramics waste and fine aggregates with a rice husk ash dust and fine aggregates with a rice husk ash and to compare it with the compressive and tensile strength of ordinary M20concrete.
5. We are also trying to find the percentage of marble dust, crushed coconut shell, broken ceramics waste and rice husk ash replaced in concrete that makes the strength of the concrete maximum.

Scope of the project:

The experimental investigation is planned as under:

1) By using IS method we can obtain the mix proportions of the control concrete.
2) To conduct compression test on cube and control concrete on standard IS specimen, size150*150*150mm.(cube)
3) To conduct Flexural test on egg shell powder and coconut shell ash on standard IS specimen size, Height 300 mm, diameter 150mm(cylinder).

IV. MATERIALS USED

A. Cement

With the combination of cement powder and the water it becomes a cement paste. This paste acts like glue and holds or bonds the aggregates with each other. There are many types of cements. Each variety of cement can turn out the concrete with separate properties. The most common types of cement are OPC & (Blended cements) BC.

TABLE 1. For Portland cement chemistry

Oxide	Percent, content
Lime (CaO)	60 to 67
Silica (SiO_2)	17 to 25
Alumina (Al_2O_3)	3 to 8
Iron oxide (Fe_2O_3)	0.5 to 6
Magnesia (MgO)	0.1 to 4
Alkalies (K_2O,Na2O)	0.4 to 1.3
Sulphur (SO_3)	1.2 to 3

B. Coarse Aggregates

Fine and coarse aggregate structure the majority of a concrete mixture. The presence of amalgamation greatly will increase the lustiness of concrete higher than that of cement that otherwise could be a brittle material and so concrete could be a true material. Locally available crushed coarse aggregate was used. Sieve analysis of the coarse aggregate was carried out in the laboratory.

C. Fine Aggregates

Locally available dry aggregate satisfying the requirements of IS 383:1970 was used in the concrete mixes. The sand obtained from the stream beds or Quarries is employed as fine aggregate. The fine aggregate alongside the hydrous cement paste fill the clearance between the coarse aggregate.

D. Marble Dust

Marble powder is obtained from the marble process plants throughout the cutting, shaping and polishing. Utilizing this marble mud in industry itself would facilitate to guard the atmosphere from dumpsites of marble and additionally limit the excessive mining of natural resources of sand. This material is used in the partial replacement of cement and taking it as case 1. The marble dust is substituted in the cement with the percentage of 0%, 5%, 10%, 15%, 20%. The mix ratio adopted was 1:1.5:3 by weight and volume respectively.

TABLE 2. Chemical properties of marble dust

Test conducted	Test Results
Silica SiO_2 (% by mass)	9.04
Alumina Al_2O_3 (% by mass)	0.88
Iron oxide fe_2O_3 (% by mass)	0.86
Calcium oxide CaO(% by mass)	49.77
Magnesium by mass(% by mass)	0.71

E. Crushed Coconut Shell

Coconut shells are cheap and readily available in high quantity. This has sensible potential to use in areas wherever crushed stones are expensive. After crushed the coconut shells, they were sieved and the aggregates passing 20mm sieve size was used for this investigation. This material is used in the partial replacement of coarse aggregate. The crushed coconut shells are substituted in the coarse aggregate with the percentage of 0%, 5%, 10%, 15%, 20%. The mix ratio adopted was 1:1.5:3 by weight and volume respectively.

F. Broken Ceramic Waste

The ceramic waste required for our project is brought from Vennar Ceramics Industry- kaikaluru, Krishna District, Andhra Pradesh. Ceramic merchandise are made from natural materials that contain a high proportion of clay minerals. The usage of tile aggregate as replacement to coarse aggregate in concrete has the benefits in the aspects of cost and reduction of pollution from construction industry. This material is used in the partial replacement of coarse aggregate and taking it as case 2. The broken ceramics are substituted in the coarse aggregate with the percentage of 0%, 5%, 10%, 15%, 20%. The mix ratio adopted was 1:1.5:3 by weight and volume respectively.

G. Rice Husk Ash

Rice husk ash is used in concrete construction as an alternative of fine aggregate. The rice husk is obtained from the paddy milling industries. Optimum use of RHA improves the workability, strength & durability of concrete. RHA depicts a better static modulus of flexibility compared to the conventional concrete. This material is used in the partial replacement of fine aggregate and taking it as case 2. The rice

husk ash is substituted in the fine aggregate with the percentage of 0%, 5%, 10%, 15%, 20%. The mix ratio adopted was 1:1.5:3 by weight and volume respectively.

TABLE 3. Chemical properties of RHA

Silica (SiO_2)	90-95%
Potassium Oxide (K_2O)	1-3%
Unburned carbon	< 5%

H. Water:

Water is an important ingredient of concrete, and a properly designed concrete mixture, typically with 15 to 25% water by volume, will possess the desired workability for fresh concrete and the required durability and strength for hardened concrete. Too much water reduces concrete strength, while too little makes the concrete unworkable. Because concrete must be both strong and workable, a careful selection of the cement-to-water ratio and total amount of water are required when making concrete.

V. PROPERTIES OF MATERIALS

1. Marble Dust

TABLE 4. Physical properties of marble dust

S.no	Properties	Result
1.	Specific gravity	3.03
2.	Colour	White
3.	Form	Powder
4.	Odour	Odourless
5.	Fineness	3%

2. Crushed Coconut Shell

TABLE 5. Physical And Mechanical Properties Of Coconut Shell Aggregate

Property	Value
Specific gravity	1.29
Bulk density(kg/m3)	1681
Void ratio	0.894
Porosity (%)	47.2
Aggregate abrasion value	4.66
Impact value (%)	5
Aggregate crushing value (%)	5
Fineness modulus	1.4

3. Broken Ceramics Waste

TABLE 6. Properties of Ceramic tile aggregate

S.no	Description Test	Results
1.	Origin Rock	Feldspar
2.	Impact value of crushed tiles	12.5%
3.	Specific gravity of crushed tiles	2.6
4.	Specific gravity of tile powder (C.F.A)	2.5
5.	Water absorption of crushed tiles	0.19%
6.	Water absorption of Tile powder(C.F.A)	0.13%

VI. MIX DESIGN

Mix design for M20 grade concrete

- Step1:

Target mean strength (Fck') =Fck+(1.65*s)
=20+(1.65*4)
=26.6 kN/mm^2

- Step2:

Water content calculation:

w/c=0.5
slump=50mm
assume 20mm of nominal size of aggregates =186 lit
watercontent =186 lit
Cement content(w/c) =0.5

186/c=0.5
cement content =372 kg
minimum cement < required cement
300 < 372
hence ok.

- Step3:

Calculation of volume of C.A and F.A:
zone ii
nominal size of aggregates =20mm
volume of C.A =0.62
for w/c ratio =0.5
Volume of F.A. = 1- C.A.
= 1- 0.62
= 0.38

- Step4:

Calculation of mix proportions:
volume of concrete =1m^3
absolute volume of cement =(372/3.15)*(1/1000)
=0.118 m^3
volume of water =186/1000
=0.186

- Step5:

Absolute volume of aggregates:
=1-(volume of cement +volume of water)
=1-(0.118+0.186)
=0.696 m^3
Weight of C.A.= total volume of aggregates*volume of C.A*Specific gravity of C.A*1000
= 0.696*0.62*2.8*1000
= 1208.2 kg/m^3
weight of F.A.= total volume of aggregates*volume of F.A*Specific gravity of F.A*1000
= 0.696*0.38*2.7*1000
= 714 kg/m^3

- Step6:

Mix proportions:
Cement F.A C.A water
1 : 1.91 : 3.24 : 0.5

C.A =coarse aggregate
F.A =fine aggregate
Fck =compressive strength of concrete
w/c =water cement ratio

VII. EXPERIMENTAL WORK

Case 1:

Actual materials	Partial replacing materials
Cement	Marble waste
Coarse aggregate	Crushed Coconut shell
Fine aggregate	_____

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Case 2:

Actual materials	Partial replacing materials
Cement	_____
Coarse aggregate	Broken Ceramics waste
Fine aggregate	Rice husk ash

Casting of Specimens:

The cement and sand were first added and mixed thoroughly in the dry state until homogeneity was achieved. The dry coarse aggregate were added to the mixture and again mixed thoroughly. Water was slowly added and mixed thoroughly for 3 min. After combination all the ingredients, concrete specimens were solid exploitation steel moulds and compacted with a table vibrator in 3 layers. For each mix, six 150*150*150 mm cubes and cylinders of 150mm diameter and 300mm length were produced for measurement of the compressive strength and split tensile strength respectively.

Concrete Mix Materials Replacement

Based on the Indian Standard (IS: 10262 - 1982), design mix for M_{20} grade of concrete was prepared by partially replacing cement with five different percentages by weight of marble dust, crushed coconut shell, broken ceramics and rice husk ash (0%, 5%, 10%, 15%, 20%).

Casting of Specimens with Marble Dust and Crushed Coconut Shell

Marble dust and crushed coconut shell were added in concrete (0%, 5%, 10%, 15%, and 20%). For each percent of marble dust and crushed coconut shell replacing cement and coarse aggregate respectively 2 cubes were casted for 7 days and 28 days. Grades of concrete with varying percentage of marble dust and crushed coconut shell for the concrete mix.

Casting of Specimens with Broken Ceramics and Rice Husk Ash

Marble dust and crushed coconut shell were added in concrete (0%, 5%, 10%, 15%, and 20%). For each percent of broken ceramics and rice husk ash replacing coarse aggregate and fine aggregate respectively 2 cubes were casted for 7 days and 28 days. Grades of concrete with varying percentage of broken ceramics and rice husk ash for the concrete mix.

Curing of Concrete

Concrete derives its strength by the hydration of the cement particles. The association of cement isn't a impermanent action however a method continued for a while. Of course, the rate of hydration is fast to start with, but continues over a long time at a decreasing rate. The quantity of the merchandise of association and consequently the number of gel fashioned depends upon the extent of association.

Curing may also be delineate as keeping the concrete wet and heat enough so the association of cement can continue. Concrete, while hydrating releases high heat of hydration. This heat is harmful from the purpose of read of volume stability. If the warmth generated is removed by some means that the adverse result due to the generation of warmth will be reduced. This can be done by thorough water curing.

VIII. RESULTS & DISCUSSION

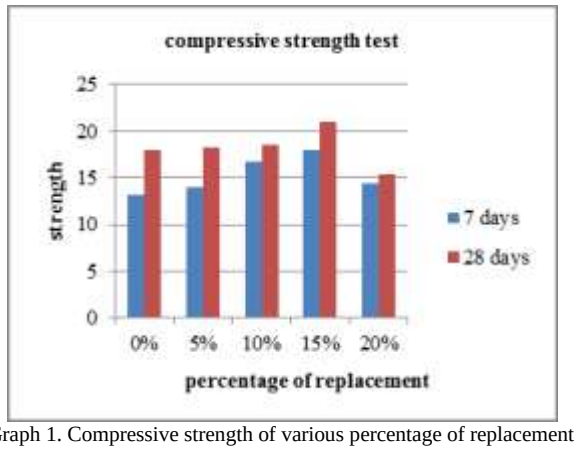
Compressive Strength Test

Concrete is weak in tension and robust in compression that the concrete ought to be strong to realize high compression. In this study for each mix 3-samples were tested and the average strength is compared with nominal mix of M_{20} Mix. Compressive strength take a look at finds out the high quantity of compressive load a substance will bear below facture limit. The results of compressive strength at the age 7th day & 28th day.

Case 1 Compressive Strength

TABLE 7. Compressive strength test result

Mix design	Concrete mix for both marble waste and coconut shell	7days (N/mm^2)	28days (N/mm^2)
M20	0%	13.20	18.03
	5%	14.01	18.19
	10%	16.70	18.51
	15%	18.01	21.03
	20%	14.40	15.40

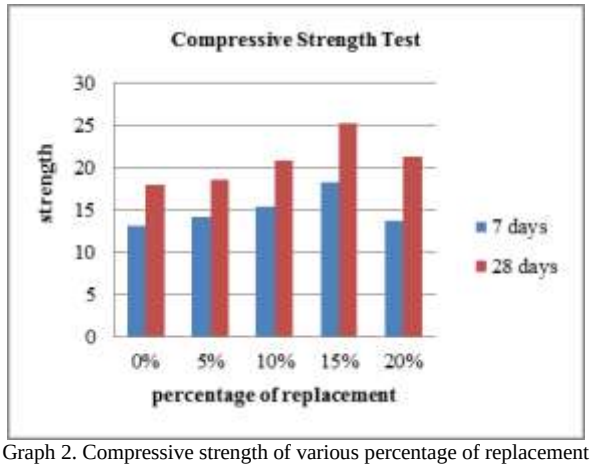


Graph 1. Compressive strength of various percentage of replacement

Case 2 Compressive Strength

TABLE 8. Compressive strength test result

Mix design	Concrete mix with ceramics waste and rice husk ash	7 days (N/mm^2)	28days (N/mm^2)
M20	0%	13.20	18.03
	5%	14.26	18.66
	10%	15.46	20.80
	15%	18.32	25.30
	20%	13.70	21.36



Graph 2. Compressive strength of various percentage of replacement

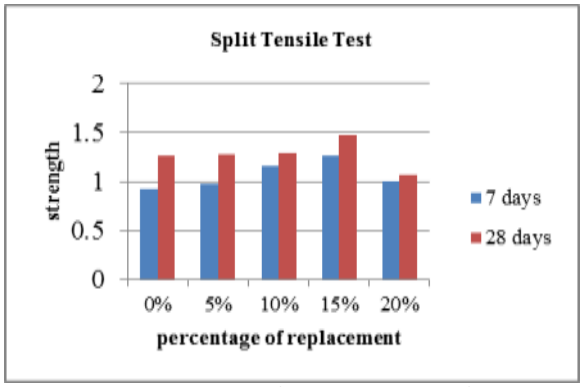
Split Tensile Test

The concrete mix is prepared for M_{20} grade and cement is replaced by marble waste, coarse aggregates are replaced with coconut shells and broken ceramics, and fine aggregate is replaced by rice husk ash as certain percentages. The Split Tensile Test is done graphs which shows the 7 days and 28days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete.

Case 1 Split Tensile Test

TABLE 9. Split tensile test result

Mix design	Concrete mix for both marble waste and coconut shell	7days (N/mm^2)	28days (N/mm^2)
M20	0%	0.92	1.26
	5%	0.98	1.27
	10%	1.16	1.29
	15%	1.26	1.47
	20%	1.00	1.07

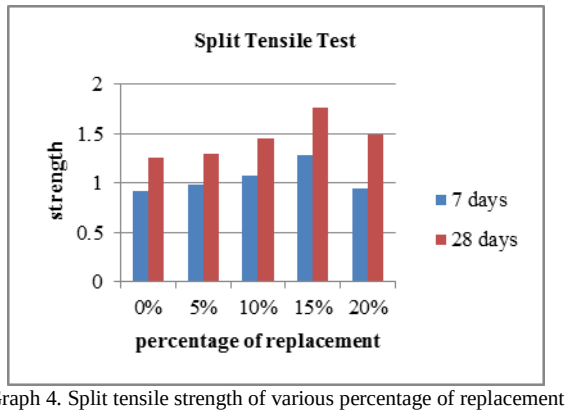


Graph 3. Split tensile strength of various percentage of replacement

Case 2 Split Tensile Test

TABLE 10. Split tensile test result

Mix design	Concrete mix with ceramics waste and rice husk ash	7days (N/mm^2)	28days (N/mm^2)
M20	0%	0.92	1.26
	5%	0.99	1.30
	10%	1.08	1.45
	15%	1.28	1.77
	20%	0.95	1.49



Graph 4. Split tensile strength of various percentage of replacement

IX. CONCLUSION

- From this investigation, the Marble dust particles are waste of low cost material which would help to resolve solid waste disposal problem and protect environment from pollution.
- Cost of Concrete production reduces when Marble dust is used as a bonding material with cement in concrete.
- Marble dust behaves similar to cement as it contains Silica (SiO2) similar to cement.
- Addition of Marble dust increases the density of concrete thereby increasing the Self-weight.
- The test results obtained from this study provides significant understanding on basic properties of coconut shell aggregate concrete.
- The properties of coconut shell and coconut shell aggregate concrete were determined and the use of coconut shell aggregate as coarse aggregate in concrete was examined.
- The study established that coconut shell aggregate can replace conventional coarse aggregate in the production of lightweight concrete structures effectively without compromising on strength aspects.
- Based on the results obtained, replacement of 40% or less crushed granite with broken ceramic tiles can be used in reinforced concrete production.
- There exists a potential reduction in the cost of concrete production by replacing crushed granite with broken ceramic tiles.
- There exists a high potential for the use of rice husk when substituted in the fine aggregate produces the lightly reinforced concrete. Weight-Batched Rice Husk Concrete and Volume-Batched Rice Husk Concrete show similar trends within the variation of bulk density, workability and compressive strength.

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