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Comparative Analysis of Different Waste Materials that can be Used in Concrete

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***Abstract*—Since the concrete production is the main element in the building construction, and the basic material used in the production of concrete is cement, but its production produces CO2 which causes various environmental problems. Therefore, an alternative method has to be found for its replacement. Hence, there are various test conducted in order to check the strength of different waste materials that can be used as cement replacement in the production of concrete. In this study, Marble dust, Sawdust, Sugarcane bagasse ash, Wood dust, and Groundnut shell- these 5 materials are chosen and a comparative analysis is done so as to the check which one on them is better.**

***Index Terms*— Concrete, Tensile strength test, Compressive strength test, Marble dust**

I. Introduction

A. What is Concrete?

Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time. Portland cement is the mostly used type of cement for production of concrete. Generally, concrete mix consists of 10-15% cement paste, 60-75% aggregate, and 15-20% water. Compressive and tensile strength of concrete at 91 days is about 50MPa (7250 psi) and nearly 5MPa (725 psi) respectively.

B. Test for Strength of Concrete

There are various test conducted to check the strength of concrete. In this paper we are mainly focusing on the following 2 tests:

- *Compressive strength test:*

Compressive Strength describes the behavior of the material when it is subjected to a Compressive load at a relatively low and uniform rate of loading until the failure occurs. Compressive Strength of Cube = Max. Load applied/C.S. Area of Cube.

- *Tensile strength test:*

The splitting test is well known indirect test used for determining the tensile strength of concrete. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a Compression Testing Machine and the load is applied until failure of the cylinder occurs, along the vertical diameter. Max. Tensile Strength of Cylinder = $2P/\pi DL$.

Fig. 1. Testing of concrete cubes

Fig. 2. Testing of cylinder specimen

II. Objective of the Study

The paper focuses mainly on the following:

1. To study various wastes generated that shows similar properties as the components of concrete.
2. The comparative analysis of the compressive and tensile strength of the 5 material used in this study.
3. Drawing conclusion from the study and the material that shows the most common features as one of the components of concrete and is experimentally performed at the end of the study.

III. Problem Formulation

The purpose of the Present work is to study the waste generated that can be used in the production of concrete so that the environment friendly construction of building can take place. Since the production of concrete produces a large amount of CO_2 gas which is harmful for our environment, it is necessary to study the materials which are naturally available that can be used as a component of concrete.

IV. Literature Review

A. Use of Marble Dust in Concrete

The objective of this paper is to study the possibility to incorporate marble sawing powder wastes as filler in concrete and also in brick products with no major sacrifice of the properties of the final product and thereby reducing the ill

effects of Marble dust.

Conclusion

- Due to the high fineness of marble dust, it proves to be effective in assuring good cohesiveness of concrete in the presence of a super-plasticizing admixture, provided that water to cement ratio was just adequate.
- The use of marble dust in construction might be cost effective because this waste is available free of cost.
- It will help in improving environmental problem due to indiscriminate disposal of huge waste generated from marble industries.
- The possibility to use the marble wastes as an alternative raw material in the production of clay-based products will also induce a relief on waste disposal concerns.
- The filler effect of marble dust on cement hydration is associated with the reduction of the porosity. It can be stated that usage of marble dust effectively decreases the porosity of the hardened concrete.

TABLE I

	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)
MD 0%	490	21.78	714	31.73
MD 25%	502.67	22.34	745	33.11
MD 50%	520	23.11	799.67	35.54
MD 100%	219.67	9.76	479.67	21.32
	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	SPLIT TENSILE STRENGTH (N/mm2)	FAILURE LOAD (KN)	SPLIT TENSILE STRENGTH (N/mm2)
MD 0%	388.33	5.50	573.33	8.12
MD 25%	364.33	5.16	560	7.93
MD 50%	338.33	4.79	488.33	6.91
MD 100%	219.67	3.11	269.67	3.82

B. Application of Sugarcane Bagasse Ash as a Partial Cement Replacement

Objective

Study the sustainability of bagasse ash produced in Wonji sugar factory, Ethiopia, as a pozzolanic material to partially replace cement in mortar and concrete production through experimental investigation.

TABLE II

	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)
MD 0%	-	35	-	41.05
MD 15%	-	39	-	45.55
MD 25%	-	31.66	-	44.83
MD 30%	-	32.66	-	43.66

Conclusion

- Up to 10% results in a better compressive strength.
- Higher consistency and longer setting time.
- The workability of the concrete has also shown a slight reduced as compared to bagasse ash.
- The water penetration depth increases.
- Its replacement reduces the level of CO_2 emission.

C. The Incorporation of Wood Waste Ash as Partial Cement Replacement Material for Making Structural Grade Concrete

Objective

The aspects of wood ash such as its physical, chemical, mineralogical and elemental characteristics as well as the influence of wood ash on properties such as workability, water absorption, compressive strength, flexural rigidity test, split tensile test, etc.

Conclusion

- Particle of ash are coarser than cement and have higher specific surface due to porous nature and irregular shape.
- Decreases slump of concrete.
- Increases water absorption capacity.
- Bulk density is decreased.

TABLE III

	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (Pa)	COMPRESSIVE STRENGTH (MPa)	FAILURE LOAD (Pa)	COMPRESSIVE STRENGTH (MPa)
MD 0%	-	16.85	-	28.35
MD 15%	-	14.18	-	21.73
MD 25%	-	14.05	-	20.35
MD 30%	-	13.88	-	19.52
	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	SPLIT TENSILE STRENGTH (N/mm2)	FAILURE LOAD (KN)	SPLIT TENSILE STRENGTH (N/mm2)
MD 0%	-	2.14	-	2.8
MD 15%	-	1.83	-	2.69
MD 25%	-	1.44	-	2.53
MD 30%	-	1.14	-	1.91

D. Partial Replacement of Sand with Sawdust in Concrete Production

Objective

This study investigates the use of sawdust as partial replacement for fine aggregates in concrete production. Sawdust was used to replace fine aggregates from 0% to 50% in steps of 10%. Concrete cubes measuring 150 x 150 x 150mm were cast and their compressive strengths evaluated at 7, 14, 21 and 28 days.

TABLE IV

	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)
MD 0%	-	13.50	-	20.80
MD 10%	-	12.25	-	16.30
MD 20%	-	1.899	-	4.82
MD 30%	-	0.17	-	0.57

Conclusion

- It has positive effect on the compressive strength of concrete.

- Help in production of lightweight concrete.
- Optimum replacement of sand with sawdust has been found to be 10%. Beyond this limit, the concrete produced did not meet code requirements for strength as per BS 8110 (1997).

E. Performance of Concrete Properties by Groundnut Shell Ash as a Partial Replacement of Cement with Sisal Fiber

Objective

- This paper highlights about the behavior of concrete when groundnut shell ash and sisal fiber are added in concrete on the various strength properties of concrete by using the mix design of M25 grade.
- Compressive and flexural strength determined by casting of cube and beam. The results are compared to the conventional concrete specimen.

Conclusion

- From the both compressive and flexural strength test analysis 5% of GSA and 2% of SF could satisfy the ability workable of conventional specimen.
- It can be recommended for the light weight structure and simple foundations.

TABLE V

	7 DAYS	7 DAYS	28 DAYS	28 DAYS
M25 GRADE	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm2)
MD 0%	-	-	-	31.20
MD 10%	-	-	-	30.57
MD 15%	-	-	-	28.08
MD 20%	-	-	-	24.80

V. Conclusion

Among the 5 materials that we studied in the above research paper shows that the compressive and tensile strength test shows better value in marble dust than the others.

TABLE VI
Experimental Analysis

S. NO.	MATERIAL (grade of concrete used M25	SPECIMEN SIZE (mm)	COMPRESSIVE STRENGTH IN 28 DAYS (MPa)	SPECIMEN SIZE (mm)	SPLIT TENSILE STRENGTH (MPa)
1	CEMENT	150x150x150	18.53	Dia 150x300 height	5.09
2	MARBLE	150x150x150	21.32 (100%)	Dia 150x300 height	3.82 (100%)
3	SUGARCANE BAGGASE ASH	Dia 150x300 height	24.16 (10%)	-	-
4	GROUNGNUT SHELL ASH	Dia 150x300 height	22.97 (20%)	-	-
5	SAW DUST	150x150x150	0.57 (30%)	-	-
6	WOOD DUST	Dia 150x300 height	19.52 (30%)	Dia 150x300 height	1.91 (30%)

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