A Comprehensive Study on Partial Replacement of Cement with Sugarcane Bagasse Ash, Rice Husk Ash & Marble Dust

Ravi Bhushan kumar[1] Ashraf Hussain[2]
[1]Resident Engineer [2]PG Student
[1]MSV International INC [2]Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Abstract— Incorporation of supplementary cementitious materials in concrete is necessary for sustainability. Supplementary cementitious materials are not only sustainable but also mechanical and durability properties of concrete. In this study sugarcane bagasse ash, rice husk ash and marble dust are incorporated in concrete as replacement of cement. The levels of replacement of cement by sugarcane bagasse ash, rice husk ash and marble dust are 5%, 10%, 15% and 20%. The properties which are determined and compared in this study are workability, 7 days compressive strength and 28 days compressive strength. It is found in study that optimum replacement level of cement by sugarcane bagasse ash and rice husk ash is 15% and compressive strength of concrete is significantly increased. The marble dust can be incorporated as replacement of cement upto 5%

Key words: Sugarcane Bagasse Ash; Rice Husk Ash; Marble Dust; cement

I. INTRODUCTION

Concrete exists as an indispensable construction material in modern world. Portland cement is used primarily as binder for concrete. Production of cement poses major environmental threats. Sugar cane bagasse ash and Rice husk ash are agricultural and industrial by-products which have pozzolanic properties. [1]

These supplementary cementitious materials are incorporated as partial replacement of cement in concrete or as additive in concrete. Partial replacement saves the cement which in turn decreases the environmental threats of cement production. Portland cement releases the calcium hydroxide as a by-product when reacts with water. Pozzolanic materials utilize this calcium hydroxide. Thus these pozzolanic materials not only save the cement but also utilize the lime which is generated during hydration reaction and increase the mechanical and durability properties of concrete. [2]

Marble dust is also a waste product from marble industry. Marble dust can be incorporated in concrete as replacement of fine aggregate or as replacement of cement or as additive in concrete. [3]

The utilization of these supplementary materials saves the cement and decreases the pollution. The aim of this study is to compare the compressive strength, flexural strength and workability of normal concrete, sugar bagasse ash blended concrete, rice husk ash concrete and waste marble dust blended concrete as a partial replacement of cement with these supplementary materials at 5%, 10%, 15% and 20% replacement level.

II. LITERATURE SURVEY

Research is being carried out for the incorporation of sugarcane bagasse ash, rice husk ash and waste marble dust in concrete.

Ganesan et al. [1] investigated the use of sugarcane bagasse ash as partial replacement of cement in concrete. it was found that 15% replacement of cement with sugar cane bagasse ash significantly increases the 28 days compressive strength. Slump value for 10% replacement of cement with sugarcane bagasse ash was more than normal concrete.

Ganesan et al. [1] also investigated cement blended with rice husk ash. It was found that up to 30% of replacement of cement with rice husk could be adopted. 28 days compressive strength increases up to 15% of replacement of cement with rice husk ash.

Shirule et al. [3] carried out study on replacement of cement with marble dust in M20 grade Concrete. It was concluded that 28 days compressive strength increases up to 10% replacement of cement with marble dust.

III. EXPERIMENTAL PROGRAM

A. Materials:

The details of materials used in present experimental study is given as follows.

1) Cement

43 grade Ordinary Portland Cement conforming to IS: 8112-1989 is used in this study. The specific gravity of cement is 3.15.

2) Water

Water conforming to guidelines given in IS: 456-2000 is used in this research.

3) Fine Aggregate

Natural river sand of Zone-III conforming to IS: 383-1970 is used as fine aggregate. The specific gravity and water absorption of sand is 2.63 and 1% respectively. The fineness modulus of fine aggregate is 2.76.

4) Coarse Aggregates

Crushed natural rock aggregate conforming to IS: 383-1970 is used in this study. The maximum size selected for study is 20mm. The specific gravity and water absorption of coarse aggregate is 2.7 and 1% respectively.

5) Sugarcane Bagasse Ash

Sugarcane bagasse ash is obtained from local sugar industry.

6) Rice Husk Ash

Rice husk ash is obtained from rice mill industries.

7) Marble Dust

Marble dust is obtained from local marble factory. The marble dust is sieved from 1mm sieve to remove large granules of marble.

B. Properties of Concrete Mix Which Are Determined In This Study:

1) 7 days compressive strength

The 7 days compressive strength of concrete specimen is determined at the age of 7 days as per IS: 516- 1959. Three specimen are casted for each mix for replication.

2) 28 days compressive strength

The 28 days compressive strength of concrete specimen is determined as per IS: 516- 1959. Three specimen are casted for each mix for replication.

3) Workability

The workability of concrete mix is determined on the basis of slump value. The slump value for each mix is calculated according to specifications given in IS: 7320-1974.

IV. MIX DESIGN

M25 grade is selected for mix design. The mix design is done according to specifications given in IS 10262-2009. The water to binder ratio is kept 0.51. The replacement levels of cement by sugarcane bagasse ash, rice husk and marble dust are 5%, 10%, 15% and 20%. The detail of mix design of concrete is given in Table 1.

Mix ID	Cement in Kg	Water in Kg	Sugarcane bagasse ash in Kg	Rice husk ash in Kg	Marble dust in Kg	Fine aggregate in Kg	Coarse aggregate in Kg
C	372	191.58	0	0	0	653.6	1192.89
B5	353.4	191.58	18.6	0	0	653.6	1192.89
B10	334.8	191.58	37.2	0	0	653.6	1192.89
B15	316.2	191.58	55.8	0	0	653.6	1192.89
B20	297.6	191.58	74.4	0	0	653.6	1192.89
R5	353.4	191.58	0	18.6	0	653.6	1192.89
R10	334.8	191.58	0	37.2	0	653.6	1192.89
R15	316.2	191.58	0	55.8	0	653.6	1192.89
R20	297.6	191.58	0	74.4	0	653.6	1192.89
MD5	353.4	191.58	0	0	18.6	653.6	1192.89
MD10	334.8	191.58	0	0	37.2	653.6	1192.89
MD15	316.2	191.58	0	0	55.8	653.6	1192.89
MD20	297.6	191.58	0	0	74.4	653.6	1192.89

Table 1: Mix proportions

V. RESULTS AND DISCUSSIONS

The result of slump value, 7 days compressive strength and 28 days compressive strength is obtained from laboratory test which are as follows:

A. *Workability:*

The slump value of different concrete mixes is shown in Table 2. Graphical representation is shown in Fig. 1. Results of slump value show that workability of concrete increases up to 10% replacement of cement with sugarcane bagasse ash and rice husk ash. The workability of marble dust concrete decreases when cement is replaced by marble dust.

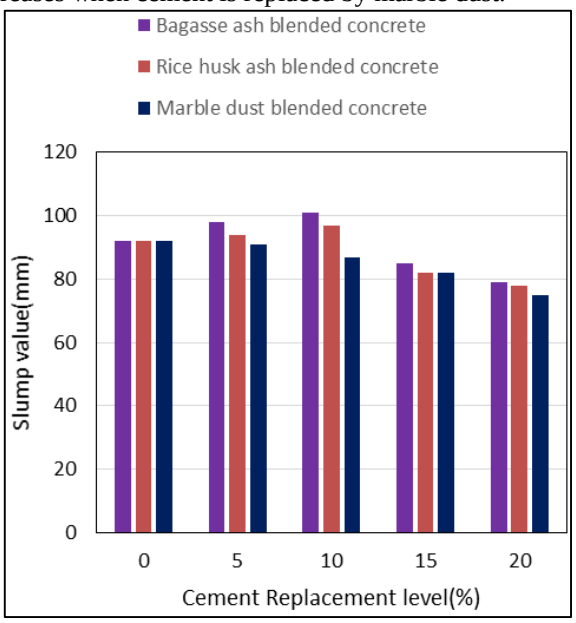

Fig. 1: Slump value

Designation	Replacement (%)	Slump (mm)
C	0% Sugarcane bagasse ash	92
B5	5% Sugarcane bagasse ash	98
B10	10% Sugarcane bagasse ash	101
B15	15% Sugarcane bagasse ash	85
B20	20% Sugarcane bagasse ash	79
R5	5% Rice husk ash	94
R10	10% Rice husk ash	97
R15	15% Rice husk ash	82
R20	20% Rice husk ash	78
MD5	50% Rice husk ash	91
MD10	10% Marble dust	87
MD15	15% Marble dust	82
MD20	20% Marble dust	75

Table 2: Slump value

B. *Compressive Strength:*

The compressive strength of concrete specimens at the age of 7 days and 28 days is shown in Table 3. The graphical representation of compressive strength of 7 days compressive strength of concrete specimen is shown in Fig. 2. Similarly

the 28 days compressive strength is shown in Fig 3. The results of sugarcane bagasse ash blended concrete shows that the 7 days and 28 days compressive strength increase up to 10% replacement of cement with sugarcane bagasse ash. The results of rice husk ash blended concrete also shows that 7 days and 28 days compressive strength increase up to 15% replacement of cement with rice husk ash. The 7 days and 28 days compressive strength of marble dust blended concrete increases up to 5% replacement of cement with marble dust.

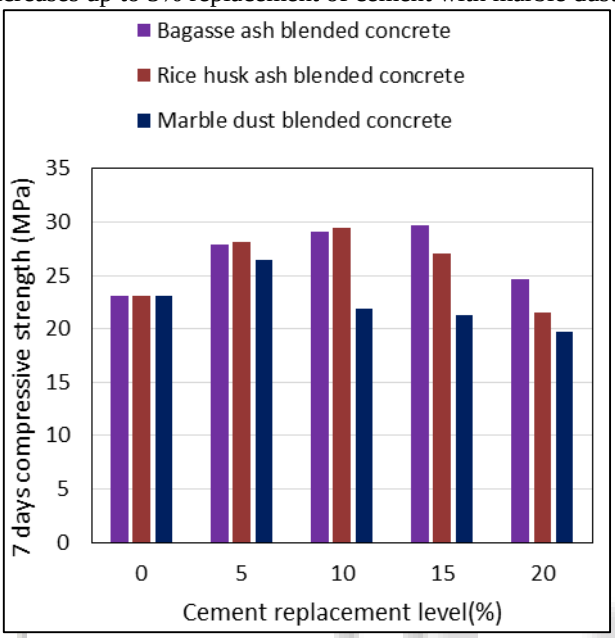

Fig. 2: 7 Days Compressive Strength

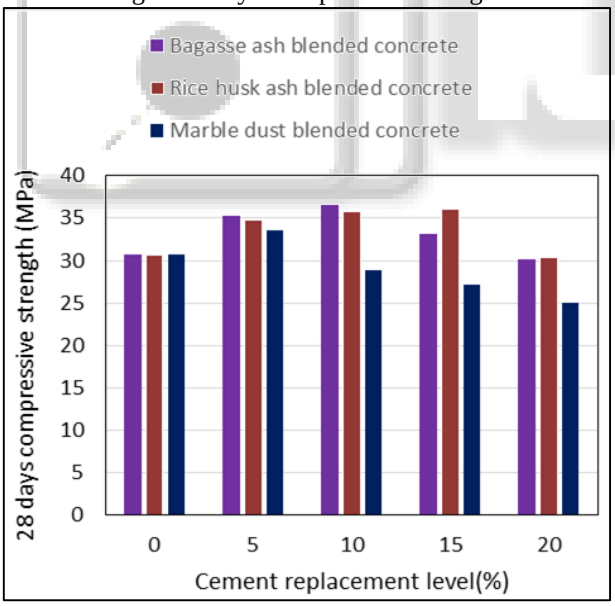

Fig. 3: 28 days compressive strength

Designation	Replacement (%)	7 days compressive strength (MPa)	28 days compressive strength (MPa)
C	0% Sugarcane bagasse ash	23.1	30.7
B5	5% Sugarcane bagasse ash	28.1	35.2
B10	10% Sugarcane bagasse ash	29.5	36.5
B15	15% Sugarcane bagasse ash	27.0	33.1
B20	20% Sugarcane bagasse ash	21.5	30.1
R5	5% Rice husk ash	27.9	34.7
R10	10% Rice husk ash	29.1	35.8
R15	15% Rice husk ash	29.7	36.1
R20	20% Rice husk ash	24.7	30.4
MD5	5% Marble dust	26.5	33.5
MD10	10% Marble dust	21.9	28.9
MD15	15% Marble dust	21.3	27.1
MD20	20% Marble dust	19.7	25.0

Table 3: Compressive strength

VI. Conclusion

From above study following conclusions can be drawn:

1) 15% replacement of cement by sugarcane bagasse ash is optimal replacement in the context of 28 days compressive strength. The workability of sugarcane bagasse ash blended concrete decreases in case of more than 15 % replacement of cement.
2) 15% replacement of cement by rice husk ash is also optimal replacement.
3) Marble dust can be incorporated as 5% replacement of cement. Replacement more than 5% replacement of cement with marble dust leads decrease in 28 days compressive strength and workability.

References

[1] K. Ganesan, K. Rajagopal and K. Thangavel, "Evaluation of bagasse ash as supplementary cementitious material," Cement and Concrete Composites, vol. 29, pp. 515-524, 2007.
[2] M. S. Shetty, Concrete Technology Theory and Practice, New Delhi: S. Chand & Company LTD., 2012, p. 175.
[3] P. A. Shirule, A. Rahman and R. D. Gupta, "Partial Replacement of Cement with Marble Dust Powder," International Journal of Advanced Engineering Research and Studies, vol. 1, pp. 175-177, 2012.
[4] IS:10262-2009, Bureau of Indian Standard.
[5] IS:516-1959, Bureau of Indian Standard.

[6] IS:456-2000, Bureau of Indian Standard.
[7] IS::8112-1989, Bureau of Indian Standard.
[8] IS:7320-1974, Bureau of Indian Standard.
[9] IS:20262-2009, Bureau of Indian Standards.
[10] IS:2386-1963, Bureau of Indian Standard.
[11] IS:383-1970, Bureau of Indian Standard.
[12] IS:4031-1988, Bureau of Indian Standard.
[13] A. N. Patel and J. Pitroda, "Stone Waste :Effective Replacement Of Cement For Establishing Green Concrete," International Journal of Innovative Technology and Exploring Engineering, vol. 2, 2013.
[14] S. M. Hameed, A. S. Sekar, L. Balamurugan and V. Saraswathy, "Self-Compacting Concrete Using Marble Sludge Powder and Crushed Rock Dust," KSCE Journal of Civil Engineering, vol. 6, no. 6, pp. 980-988, 2012.

