JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PERFORMANCE OF CONCRETE BY PARTIAL REPLACING RAW MATERIALS WITH SUGARCANE BAGASSE ASH AND CERAMIC WASTE AGGREGATE

Arvind Kumar[1], Dr. Hemant Sood[2]

[1] ME Student Civil Engineering Department, National Institute of Technical Teachers Training & Research Chandigarh, India 160019.

[2]Professor& Head Civil Engineering Department, National Institute of Technical Teachers Training & Research Chandigarh, India-160019.

Abstract: Over the last decade, many researchers have been working on different research topic and introducing different aspects of the utilization of waste in concrete by replacing cement and aggregates. Bagasse ash replaces cement and ceramic waste replaces aggregates in many studies. This current experimental study has various objectives to determine the behavior of waste materials in concrete. For this, control concrete mix and modified concrete mixes of grades M-25 & M-30 were prepared using Sugar-Cane Bagasse Ash (SCBA) as a partial replacement of cement in proportions of 10, 20, 30 & 40% and coarse aggregates were replaced by ceramic waste aggregates at proportion of 5%, 10% and 20%. Different aspects of fresh and hardened concrete were explored in the laboratory by performing different test. The results were scrutinized and final outcome of the study was revealed in terms of optimum dosage of waste materials.

Keywords: Replacement Concrete, Bagasse Ash, Ceramic Waste.

I. INTRODUCTION

Concrete is a very commonly utilized construction ingredient all over the globe. It has 4 basic components i.e. water, cement, coarse aggregate (gravels), and fine aggregate (sand). Being used extensively in concrete, the raw aggregates are being mined every day which has a detrimental impact on the environment. Now, researchers from all over the globe are practicing new methods and techniques by utilizing either waste from agriculture or waste from various industries through which the problems related to the production of concrete can be solved. Not only cement but raw aggregates are also being replaced partially or fully with waste materials to make the concrete eco-friendly material with minimal environmental effects. The utilization is not only solving the problem related to the environment or overexploitation of raw ingredients but it is the most economical solution by saving billions of money. Over the last decade, many researchers have been working on different research topic and introducing different aspects of the utilization of waste in concrete. Out of which, few researchers have introduced bagasse ash in concrete while replacing cement. These researchers came to realize that the chemical composition of bagasse ash resembles cement and shows cementitious behavior.

On the other hand, Ceramic wastes are categorized into two categories in accordance with the source of raw materials: One category is made through generated fired ceramic wastes by structural ceramic factories that use only red pastes for product (brick, blocks and roof tiles) manufacture. When these ceramic wastes (powder and gravel) are used in concrete by replacing raw aggregates, the fresh and hardened properties improved. The utilization of ceramic waste will reduce the cost and environmental effects due to the disposal of the waste.

MIS DESIGNATION:

Different designations of various concrete mixes are represented below:

Table: 1. Various Mix Designations.

Mix Designation	Replacement of cement with bagasse ash (SCBA)	Replacement of Raw coarse Aggregates with Ceramic Waste Aggregate (CWA)
CM	0%	0%
PCWA1	10%	5%
PCWA2	10%	10%
PCWA3	10%	20%
QCWA1	20%	5%
QCWA2	20%	10%
QCWA3	20%	20%
RCWA1	30%	5%
RCWA2	30%	10%
RCWA3	30%	20%
SCWA1	40%	5%
SCWA2	40%	10%
SCWA3	40%	20%

II. MATERIAL USED:

Cement: OPC (brand name M P BIRLA cement) of grade 43 was collected and used in current study which confirms to IS: 8112. Various parameters such as setting time and fineness of cement were determined with different laboratory tests.

Table: 2. Physical Properties of OPC 43 grade.

Property	**Cement**
Specific gravity	3.15
Initial Setting Time (min.)	89
Final Setting Time (min.)	219

Fine Aggregates: Crushed sand was used as a fine aggregate. The determination of sand zone of sand was done with the help of sieve analysis (gradation) according to the guidelines of IS: 383-1970.

Table: 3. Physical Properties of Fine Aggregates

Test	**Value Obtained**
Specific Gravity	2.48
Fineness Modulus	2.31
Silt Content	4.16 %

Coarse aggregates: Crushed aggregates of nominal size 20mm and 10mm (shape: angular) was mixed together in ratio of 2:1 and gradation by sieve analysis was carried out. Different physical properties of the coarse aggregates were determined in laboratory

Table: 4. Physical Properties of Graded Coarse Aggregates

Test	**Results**
Specific Gravity	2.76
Water Absorption	0.58 %

Bagasse Ash: Replacement material (sugarcane bagasse ash) was gathered from Rajasthan State Ganganagar sugar mill Ltd Jaipur. The specific gravity of sugarcane bagasse ash is 1.89 g/cc.

Ceramic Waste Aggregate: This material was obtained from Hindustan Tiles Trading company, Jhunjhunu. The specific gravity of ceramic waste aggregate is 2.91 g/cc.

III. RESULTS AND DISCUSSION

Slump test results:

To determine the workability of the various concrete mixes, the slump flow test was carried out in the laboratory. The results of the slump flow test are as follows.

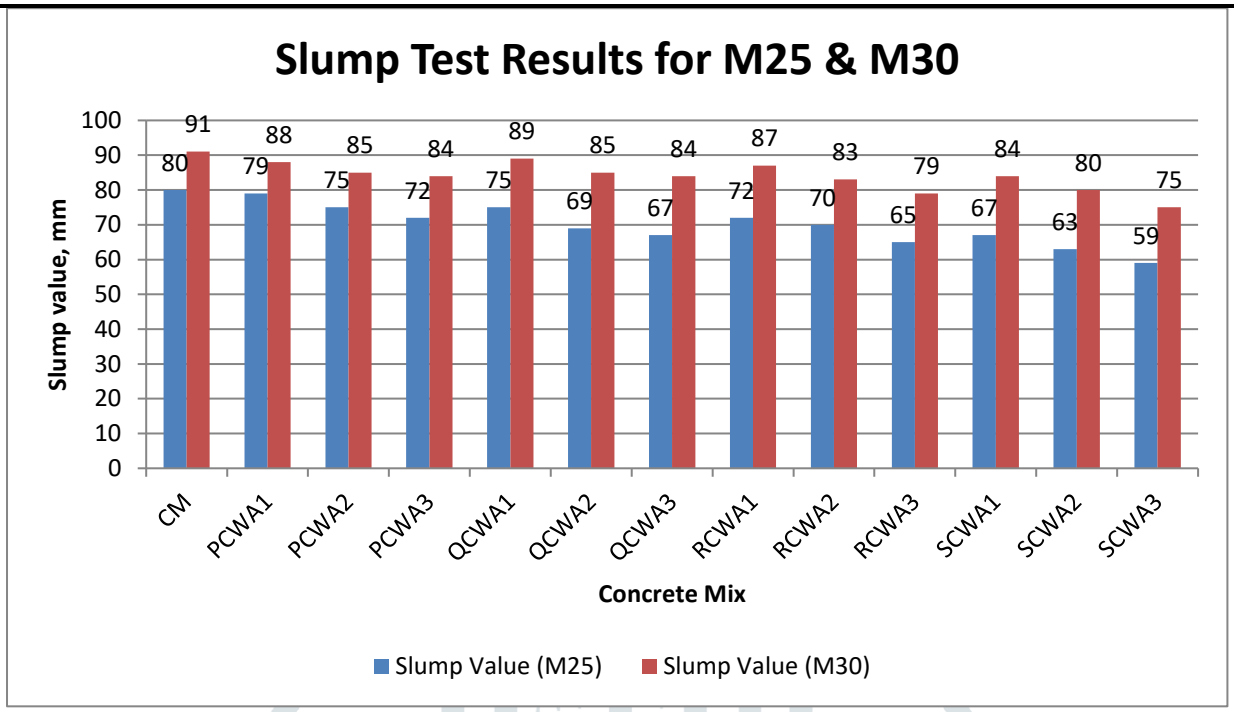

Figure1. Slump Values for different concrete mixes of M25 & M30.

The percentage decrease in the slump value with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is -1.25%, -6.25%, -10.00%, -6.25%, -13.75%, -16.25%, -10.00%, -12.50%, -18.75%, -16.25%, -21.25% and -26.25% respectively.

The percentage decrease in the slump value with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is -3.30%, -6.59%, -7.69%, -2.20%, -6.59%, -7.69%, -4.40%, -8.79%, -13.19%, -7.69%, -12.09% and -17.58% respectively.

Compaction Factor Test:

To determine the degree of compaction for the various concrete mixes of concrete grade M25 and M30, the Compaction Factor test was carried out in the laboratory. The results of the compaction factor test are as follows.

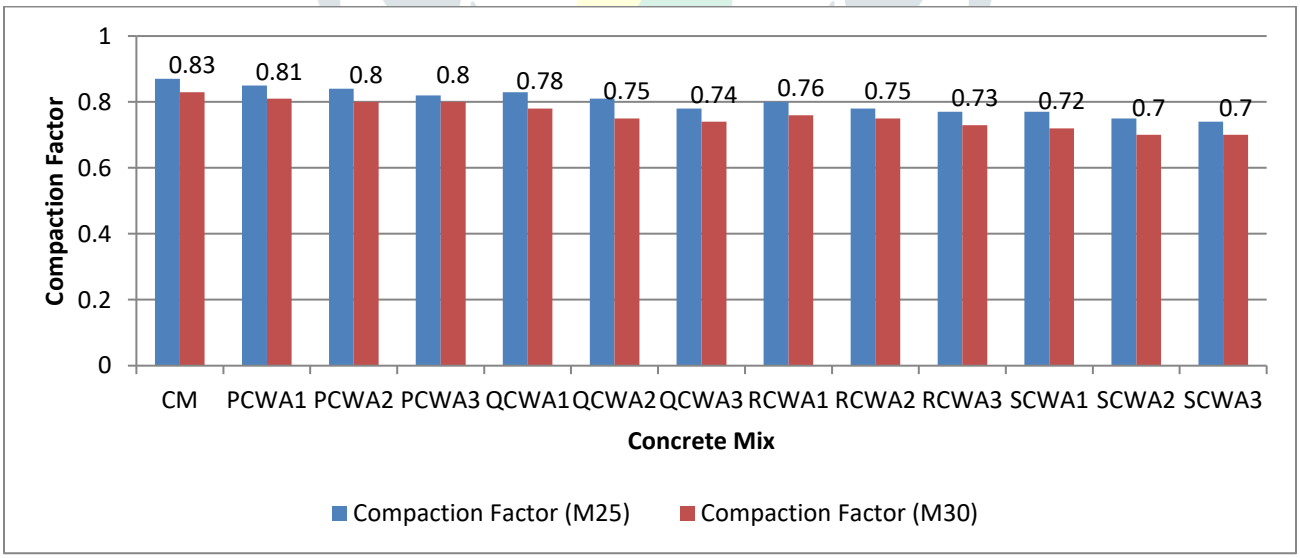

Figure2. Compaction Factor Test Results for different concrete mixes of M25 & M30

The percentage decrease in the compaction factor with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is -2.30%, -3.45%, -5.75%, -4.60%, -6.90%, -10.34%, -8.05%, -10.34%, -11.49%, -11.49%, -13.79% and -14.94% respectively.

The percentage decrease in the Compaction Factor with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is -2.41%, -3.61%, -3.61%, -6.02%, -9.64%, -10.84%, -8.43%, -9.64%, -12.05%, -13.25%, -15.66% and -15.66% respectively.

Compressive Strength:

To determine the compressive strength of various concrete mixes, 3 cube samples of each concrete mix were tested at 7 days and 28 days of concrete grade M25 and M30 in the laboratory. The results of the Compressive Strength test are as follows.

Table: 5. Compressive Strength Test Results.

Mix Designation	Compressive Strength for grade M25		Compressive Strength for grade M30	
	7 days	28 days	7 days	28 days
CM	21.11	32.15	25.64	39.01
PCWA1	21.45	32.79	25.89	39.35
PCWA2	22.05	33.61	26.45	39.95
PCWA3	21.79	33.09	26.19	39.61
QCWA1	21.99	33.12	26.38	40.11
QCWA2	22.88	34.2	26.79	41.15
QCWA3	22.36	33.74	26.57	40.55
RCWA1	21.74	33.01	26.14	39.89
RCWA2	22.13	33.59	26.58	40.49
RCWA3	21.98	33.24	26.44	40.16
SCWA1	21.59	32.98	25.94	39.51
SCWA2	21.24	32.29	25.72	38.97
SCWA3	20.69	31.85	25.41	38.42

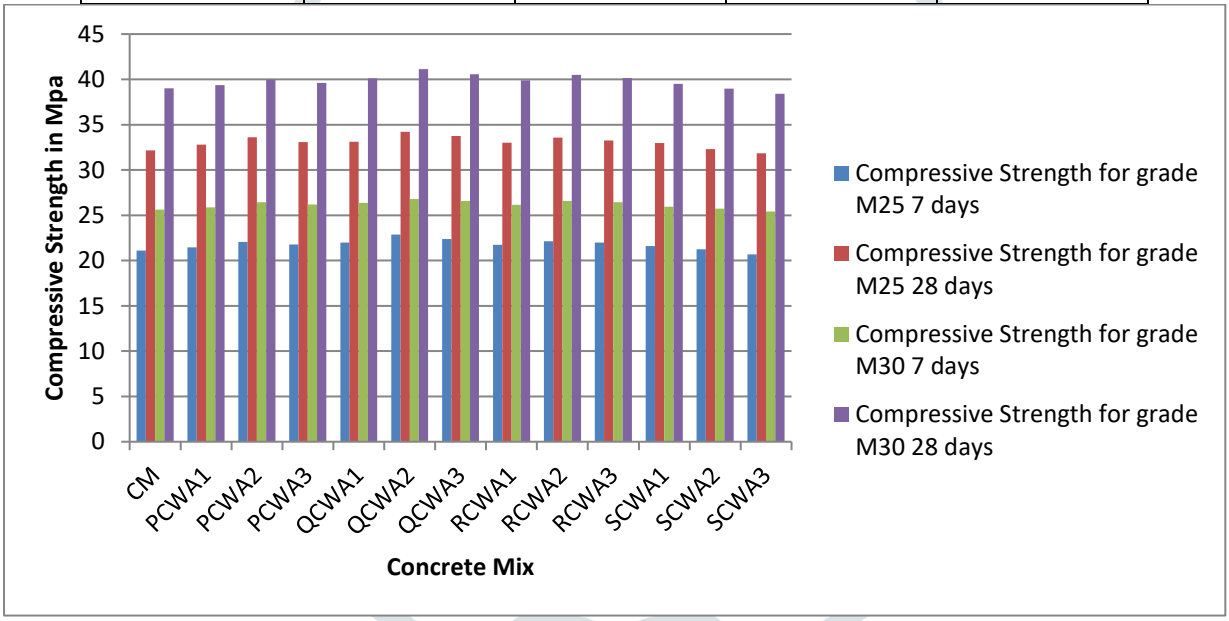

Figure 3. Variation of Compressive Strength for different concrete mixes of M25 & M30

The percentage increase/decrease in the Compressive Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 1.61%, 4.45%, 3.22%, 4.17%, 8.38%, 5.92%, 2.98%, 4.83%, 4.12%, 2.27%, 0.62% and -1.99% respectively.

The percentage increase/decrease in the Compressive Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 0.87%, 2.41%, 1.54%, 2.82%, 5.49%, 3.95%, 2.26%, 3.79%, 2.95%, 1.28%, -0.10% and -1.51% respectively.

Split Tensile Strength:

To determine the split tensile strength of various concrete mixes, 3 cylindrical samples of each concrete mix were tested at 7 days and 28 days of concrete grade M25 and M30 in the laboratory. The results of the Spit Tensile Strength test are as follows.

Table: 6. Spit Tensile Strength Test Results.

Mix Designation	Split Tensile Strength for grade M25		Split Tensile Strength for grade M30	
	7 days	28 days	7 days	28 days
CM	2.41	3.68	2.65	4.01
PCWA1	2.52	3.89	2.94	4.38
PCWA2	2.89	4.54	3.38	4.89
PCWA3	2.81	4.16	3.29	4.49
QCWA1	2.97	4.42	3.15	4.71

QCWA2	3.29	4.81	3.41	4.93
QCWA3	3.24	4.75	3.33	4.69
RCWA1	2.81	4.19	3.09	4.61
RCWA2	3.11	4.54	3.38	4.9
RCWA3	2.75	3.99	3.28	4.77
SCWA1	2.58	3.76	2.89	4.29
SCWA2	2.42	3.49	2.71	3.94
SCWA3	2.13	3.14	2.58	3.76

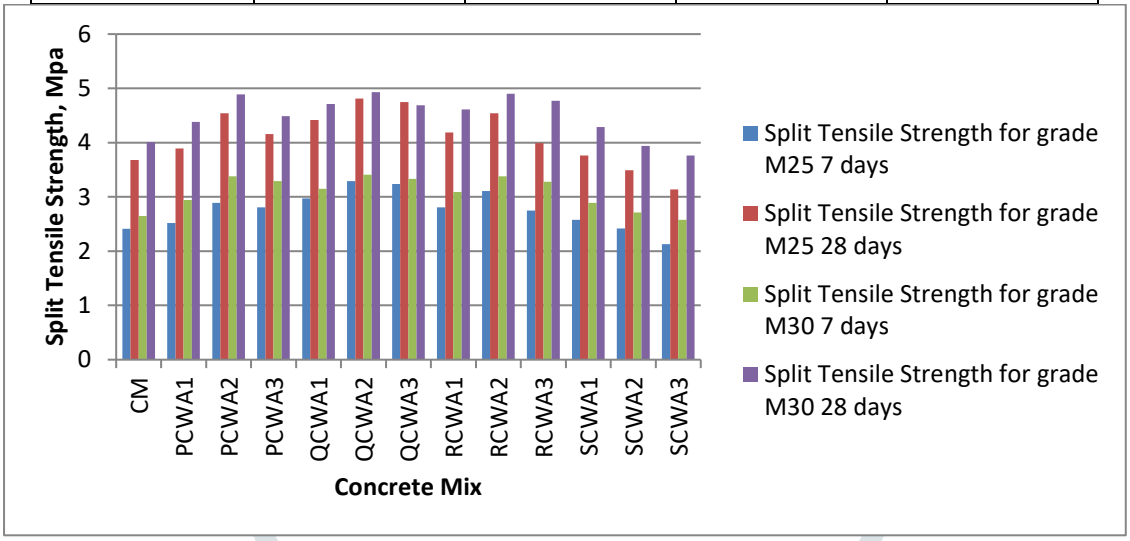

Figure 4. Spit Tensile Strength for different concrete mixes of M25 &M30

The percentage increase/decrease in the Spit Tensile Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 5.71%, 23.37%, 13.04%, 20.11%, 30.71%, 29.08%, 13.86%, 23.37%, 8.42%, 2.17%, -5.16% and -14.67% respectively.

The percentage increase/decrease in the Spit Tensile Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 9.23%, 21.95%, 11.97%, 17.46%, 22.94%, 16.96%, 14.96%, 22.19%, 18.95%, 6.98%, -1.75% and -6.23% respectively.

Flexural Strength:

To determine the Flexural strength of various concrete mixes, 3 beam samples of each concrete mix were tested at 7 days and 28 days of concrete grade M25 and M30 in the laboratory. The results of the Flexural Strength test are as follows.

Table: 7. Flexural Strength Test Results.

Mix Designation	Flexural Strength for grade M25		Flexural Strength for grade M30	
	7 days	28 days	7 days	28 days
CM	3.49	5.08	3.87	5.57
PCWA1	3.52	5.29	4.03	5.86
PCWA2	3.75	5.59	4.42	6.35
PCWA3	3.68	5.51	4.29	6.19
QCWA1	3.71	5.58	4.38	6.49
QCWA2	3.94	5.89	4.51	6.67
QCWA3	3.83	5.74	4.29	6.36
RCWA1	3.68	5.48	4.25	6.35
RCWA2	3.84	5.76	4.38	6.44
RCWA3	3.72	5.57	4.11	5.99
SCWA1	3.53	5.29	4.13	6.06
SCWA2	3.42	5.11	3.87	5.68
SCWA3	3.29	4.95	3.68	5.45

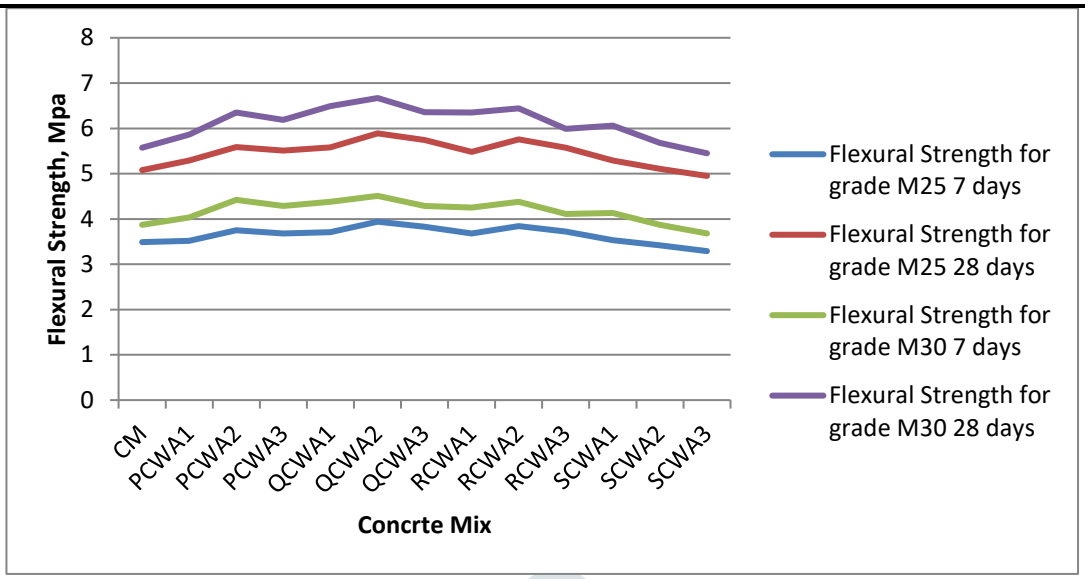

Figure 5. Flexural Strength for different concrete mixes of M25 & M30

The percentage increase/decrease in the Flexural Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 4.13%, 10.04%, 8.46%, 9.84%, 15.94%, 12.99%, 7.87%, 13.39%, 9.65%, 4.13%, 0.59% and -2.56% respectively.

The percentage increase/decrease in the Flexural Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 5.21%, 14.00%, 11.13%, 16.52%, 19.75%, 14.18%, 14.00%, 15.62%, 7.54%, 8.80%, 1.97% and -2.15% respectively.

IV. CONCLUSION

The final conclusions which have been drawn for the present study are as follows:

1. The percentage decrease in the slump value with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is -1.25%, -6.25%, -10.00%, -6.25%, -13.75%, -16.25%, -10.00%, -12.50%, -18.75%, -16.25%, -21.25% and -26.25% respectively. Whereas, the percentage decrease in the slump value with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is -3.30%, -6.59%, -7.69%, -2.20%, -6.59%, -7.69%, -4.40%, -8.79%, -13.19%, -7.69%, -12.09% and -17.58% respectively.
2. The percentage decrease in the compaction factor with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is -2.30%, -3.45%, -5.75%, -4.60%, -6.90%, -10.34%, -8.05%, -10.34%, -11.49%, -11.49%, -13.79% and -14.94% respectively. Whereas, the percentage decrease in the Compaction Factor with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is -2.41%, -3.61%, -3.61%, -6.02%, -9.64%, -10.84%, -8.43%, -9.64%, -12.05%, -13.25%, -15.66% and -15.66% respectively.
3. The percentage increase/decrease in the Compressive Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 1.61%, 4.45%, 3.22%, 4.17%, 8.38%, 5.92%, 2.98%, 4.83%, 4.12%, 2.27%, 0.62% and -1.99% respectively. Whereas, the percentage increase/decrease in the Compressive Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 0.87%, 2.41%, 1.54%, 2.82%, 5.49%, 3.95%, 2.26%, 3.79%, 2.95%, 1.28%, -0.10% and -1.51% respectively. Therefore, the maximum increase in the compressive strength for grade M25 and M30 comes out to be 6.38% and 5.49% respectively for QCWA2.
4. The percentage increase/decrease in the Spit Tensile Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 5.71%, 23.37%, 13.04%, 20.11%, 30.71%, 29.08%, 13.86%, 23.37%, 8.42%, 2.17%, -5.16% and -14.67% respectively. Whereas, the percentage increase/decrease in the Spit Tensile Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 9.23%, 21.95%, 11.97%, 17.46%, 22.94%, 16.96%, 14.96%, 22.19%, 18.95%, 6.98%, -1.75% and -6.23% respectively. Therefore, the maximum increase in the split tensile strength for grade M25 and M30 comes out to be 30.71% and 22.94% respectively for QCWA2.

5. The percentage increase/decrease in the Flexural Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M25 grade is 4.13%, 10.04%, 8.46%, 9.84%, 15.94%, 12.99%, 7.87%, 13.39%, 9.65%, 4.13%, 0.59% and -2.56% respectively. Whereas, the percentage increase/decrease in the Flexural Strength at 28 days with respect to control mix for PCWA1, PCWA2, PCWA3, QCWA1, QCWA2, QCWA3, RCWA1, RCWA2, RCWA3, SCWA1, SCWA2 and SCWA3 for M30 grade is 5.21%, 14.00%, 11.13%, 16.52%, 19.75%, 14.18%, 14.00%, 15.62%, 7.54%, 8.80%, 1.97% and -2.15% respectively. Therefore, the maximum increase in the Flexural strength for grade M25 and M30 comes out to be 15.94% and 19.75% respectively for QCWA2.

Therefore, in the end, it is recommended to use the 20% of Bagasse Ash and 10% of Ceramic Waste Aggregates to obtain the maximum strength of concrete of grade M25 and M30.

V. REFERENCES

1. J. Garcı´a-Gonzalez, D. Rodrı´guez-Robles, A. Juan-Valdes, J.M.Moran-del Pozo, M.I. Guerra-Romero, (2014) “Ceramic ware waste as coarse aggregate for structural concrete production”, Environ. Technol. 36, pp- 1–10.
2. Loganayagan, S., Chandra Mohan, N., & Dhivya bharathi, S. (2021) “Sugarcane bagasse ash as alternate supplementary cementitious material in concrete:, Materials Today: Proceedings, 45, pp- 1004–1007.
3. Nuntachai Chusilp, Chai Jaturapi takkul and Kraiwood Kiattikomolin, (2009) “Utilization of bagasse ash as a pozzolanic material in concrete”.
4. Mangi Sajjad Ali, Jamaluddin N, (2017) “Utilization of sugarcane bagasse ash in concrete as partial replacement of cement”.
5. Amin Muhammad Nasir, Ashraf Muhammad and Kumar Rabinder, (2020) “Role of Sugarcane Bagasse Ash in Developing Sustainable Engineered Cementitious Composites”.
6. A. E. Souzaa, S. R. Teixeiraa, G. T. A. Santosa, F. B. Costaa and E. Longo, (2011) “Reuse of sugarcane bagasse ash (SCBA) to produce ceramic materials”.
7. Sofia A. Lima, Humberto Varum, Almir Salesand Victor F.Netoin, (2012) “Analysis of the mechanical properties of compressed earth block masonry using the sugarcane bagasse ash”.
8. Rattapon Somna, Chai Jaturapi takkuland, Made M. Madein (2012) “Spectroscopic investigation on the production of clay bricks with SCBA waste” .
9. Rattapon Somna, Chai Jaturapitakkul, Pokpong Rattanachu, and Wichian Chaleein (2012) “Effect of ground bagasse ash on mechanical and durability properties of recycled aggregate concrete”.
10. Kawee Montakarntiwong, Nuntachai Chusilp, Weerachart Tangchirapat and Chai Jaturapitakkulain, (2013) “Strength and heat evolution of concretes containing bagasse ash from thermal power plants in sugar industry”
11. Gritsada Suaiam and Natt Makul, (2013) “Use of increasing amounts of bagasse ash waste to produce self-compacting concrete by adding limestone powder waste”.
12. A. Bahurudeen, A.V. Marckson, Arun Kishore and Manu Santhananin (2014) “Development of sugarcane bagasse ash-based Portland pozzolana cement and evaluation of compatibility with super plasticizers”.
13. IS 4031:1988 (Part VI), Methods of tests for compressive strength of cement, Bureau of Indian Standards, New Delhi.
14. IS 4031:1988 (Part V), Methods of tests for determination of initial and final setting time of cement, Bureau of Indian Standards, New Delhi.
15. IS 4031:1988 (Part IV), Methods of tests for standard consistency of cement, Bureau of Indian Standards, New Delhi.
16. IS 2386:1963 (Part III), Methods of tests for sieve analysis of coarse and fine aggregates, Bureau of Indian Standards, New Delhi.
17. IS 456:2000, Code of practice Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.
18. Ray, S., Haque, M., Sakib, M. N., Mita, A. F., Rahman, M. D. M., & Tanmoy, B. B. (2021) “Use of ceramic wastes as aggregates in concrete production: A Review”, Journal of Building Engineering, 43, https://doi.org/10.1016/j.jobe.2021.102567.