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PARTIAL REPLACEMENT OF CEMENT BY CERAMIC WASTE

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Abstract: Cement is not eco-friendly material to use.We tried to minimize the use of cement by partially replaced it with ceramic waste. For this purpose we casted cubes of M-20 and M-30 grade of concrete with 0%, 10%, 20%, and 30% replacement of cement in designed mix by selected ceramic waste. After proper curing of 7 days, 14 days and 28 days we checked strength of cubes of both mix designs by use of compressive testing machine and results are compared with conventional cubes. By this way we tried to establish maximum possible percentage of replacement by ceramic waste in concrete mix design without compromising its strength and other required qualities. To reduce the use of cement in concrete by substituting compatible waste generated from local industries and thus to solve problem of that waste disposal and to reduce the cost of concrete production by reducing cement content in it. Thus we tried to reduce soil pollution and other kinds of pollution caused by waste disposal of ceramic waste and also tried to reduce the cost of project by reducing the cement requirement in it.

Keywords: Cement, Ceramic Waste, Concrete , Strength

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INTRODUCTION

Cement is a binder, a substance that sets and hardens and can bind other materials together. The word "cement" traces to the Roman root, which used the term “opus caementiciumto” describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to as cementum, cimentum, cäment, and cement.

Environmental Effects

- Portland cement is manufactured by heating limestone or chalk with clay in a rotary kiln to a high temperature (about 1450°C) to produce hard nodules of clinker that are then ground with a little gypsum in a ball mill. The firing process consumes significant quantities of fuel, usually coal or petroleum coke. Reduced fuel use is a fundamental objective of the cement industry. The major environmental concerns of cement manufacture are outlined in the Table.

Stages in the cement making process	Major environmental concerns
1. Quarrying and processing raw material	Scarring of landscape, transport produces dust and noise
2. Burning raw material to make cement clinker	Carbon dioxide emission from heating limestone and burning fuel
	Gas emissions, such as nitrogen and sulfur oxides (NOx and SOx)
	High energy use
	Dust
3. Grinding clinker	Electrical energy
4. Delivery to mixing plant, precast works, builders merchants	Fuel, noise and traffic

Table 1Concern Due to Cement Production

OBJECTIVES

- To reduce the use of cement in concrete by substituting compatible waste generated from local industries and thus to solve problem of that waste disposal and to reduce the cost of concrete production by reducing cement content in it. Thus we tried to reduce soil pollution and other kinds of pollution caused by waste disposal of ceramic waste and also tried to reduce the cost of project by reducing the cement requirement in it.

METHODOLOGY

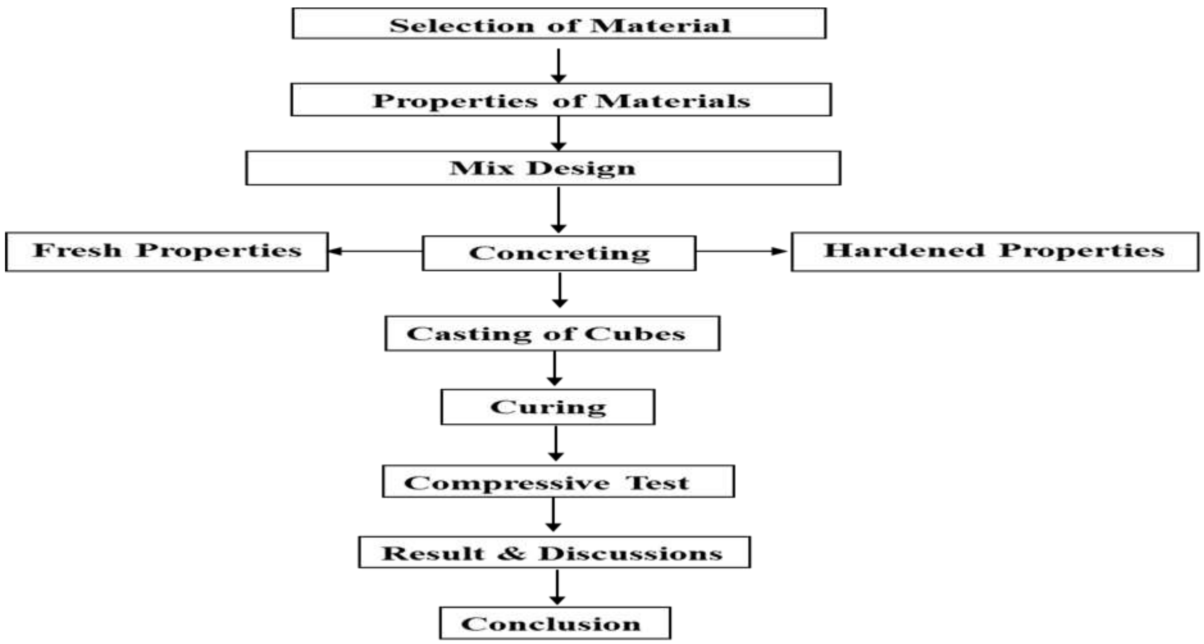

Fig. 1 Methodology Chart

MATERIALS AND METHODS

Ceramic Waste

- Ceramic waste used in our project is collected from Regent Tiles Factory situated at Himmatnagar. Lots of waste is generated during the manufacturing process of Vitrified tiles at this plant. There is no further use of the waste generated. Thus after observing the quantity of waste produced and the method of their disposal we reach to conclusion that this waste may be used for replacement of cement. We found out the following physical and chemical properties of the waste. SGS firm helps us to analyze this properties and it shows similarity with properties of cement.

Physical Properties		
Sr. No.	Description	Result
1	Specific Gravity	2.5
2	Loss on Ignition	3.12%
3	Material retain on 45 µ Sieve	8.60%

Chemical Properties		
Sr. No.	Content of	Result
1	SiO_2	67.55%
2	Al_2O_3	23.90%
3	CaO	2.30%
4	MgO	0.52%
5	Fe_2O_3	>0.1%

Table 2 Physical & Chemical Properties of Ceramic Waste

RESULT AND DISCUSSION

Sr. No.	Steps	M 20	M 25
1	Target mean strength	f_t =26.6 N/mm^2	f_t =31.6 N/mm^2
2	w/c Ratio	0.55	0.52
3	Estimate the amount of entrapped air	20mm,2% air	20mm,2%air
4	Select the water content	191.6 lit/m^3	191.9 lit/m^3
5	Select the Sand content	32.5%	31.9%
6	Determine cement content	383.20 kg/m^3	435.45 kg/m^3
7	Calculate f_a	585.98 kg	569.73 kg
8	Calculate C_a	1258.23 kg	1257.42 kg

Table 3Calculation of Mix Design

Table 4 Trial Mix for M-20 (Approx. 12 cubes qty.)

Replacement (%)	Water (in lit)	Cement (in kg)	Ceramic Waste (in kg)	Fine aggregate (in kg)	Coarse aggregate (in kg)
0	9.58	17.42	O	29.50	62.91
10	9.58	15.68	1.74	29.50	62.91
20	9.58	13.94	3.48	29.50	62.91
30	9.58	12.19	5.23	29.50	62.91

Replacement (%)	Water (in lit)	Cement (in kg)	Ceramic Waste (in kg)	Fine aggregate (in kg)	Coarse aggregate (in kg)
0	9.58	18.42	O	28.50	62.87
10	9.58	16.58	1.84	28.50	62.87
20	9.58	14..74	3.68	28.50	62.87
30	9.58	12.89	5.53	28.50	62.87

Table 5 Trial Mix for M-25 (Approx. 12 cubes qty.)

M 20						
Cement Replacement %	No. Of Cubes	Curing Period	Compressive Strength (N/mm2)	Average (N/mm2)	Weight (kg)	Slump
0	1	7	12.56	12.43	8.43	75 mm
	1		12.42		8.41	
	1		12.31		8.37	
	1	14	17.91	18.44	8.39	
	1		18.29		8.42	
	1		19.14		8.49	
	1	28	22.37	22.33	8.41	
	1		21.84		8.36	
	1		22.49		8.45	
10	1	7	13.53	13.47	8.29	55 mm
	1		13.26		8.23	
	1		13.64		8.37	
	1	14	21.33	18.99	8.62	
	1		19.4		8.48	
	1		16.24		8.34	
	1	28	15.35	18.95	8.42	
	1		20.33		8.68	
	1		21.17		8.17	
20	1	7	12.48	16.2	8.27	49 mm
	1		20.84		8.46	
	1		15.28		8.42	
	1	14	18.15	17.92	8.27	
	1		18.26		8.34	
	1		17.35		8.31	
	1	28	19.53	23.79	8.61	
	1		27.64		8.47	
	1		24.22		8.62	
30	1	7	18.64	19.59	8.49	42 mm
	1		16		8.31	
	1		24.13		8.57	
	1	14	24.06	21.76	8.36	
	1		21.6		8.47	
	1		19.62		8.52	
	1	28	21.51	23.92	8.61	
	1		28.84		8.55	
	1		21.42		8.32	

Table 6 Result table for M-20 Design Mix

M 25						
Cement Replacement %	No. Of Cubes	Curing Period	Compressive Strength (N/mm2)	Average (N/mm2)	Weight (kg)	Slump
0	1	7	19.35	19.13	8.41	90 mm
	1		21		8.47	
	1		17.05		8.38	
	1	14	28.75	26.22	8.38	
	1		28.43		8.37	
	1		21.48		8.44	
	1	28	33.66	29.71	8.48	
	1		29.68		8.48	
	1		25.8		8.46	
10	1	7	19.8	19.38	8.57	50 mm
	1		13.46		8.49	
	1		24.88		8.6	
	1	14	16.6	20.53	8.53	
	1		21.86		8.62	
	1		23.13		8.61	
	1	28	28.42	23.33	8.55	
	1		20.64		8.47	
	1		20.93		8.51	
20	1	7	21.55	21.18	8.56	40 mm
	1		22.48		8.61	
	1		19.51		8.51	
	1	14	30.42	28.4	8.5	
	1		28.55		8.54	
	1		26.24		8.68	
	1	28	28.95	28.42	8.54	
	1		28.28		8.51	
	1		28.02		8.59	
30	1	7	22.15	20.26	8.69	35 mm
	1		17.95		8.42	
	1		20.68		8.56	
	1	14	25.26	23.48	8.48	
	1		25		8.51	
	1		20.2		8.35	
	1	28	28.57	29.89	8.7	
	1		33.24		8.56	
	1		27.86		8.35	

Table 7 Result table for M-25 Design Mix

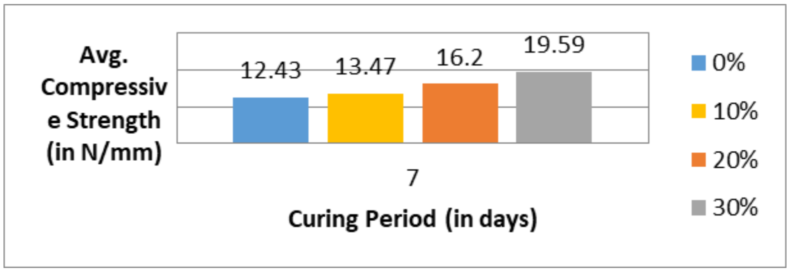

Fig.2 Comparison of compressive strength after 7 days of curing for M-20 Mix Design

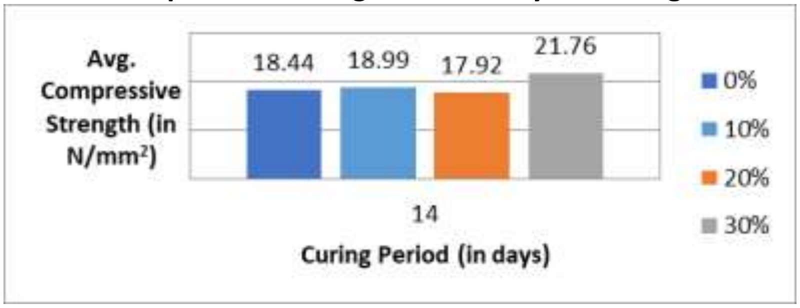

Fig.3 Comparison of compressive strength after 14 days of curing for M-20 Mix Design

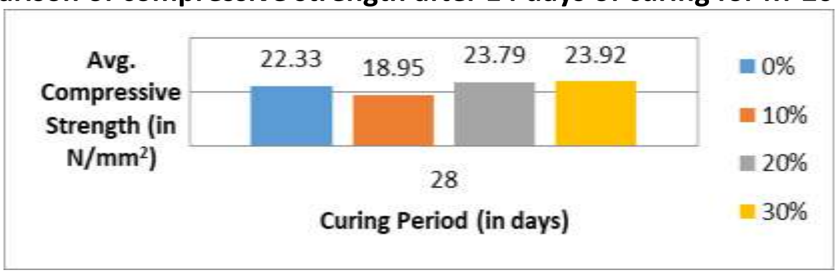

Fig.4 Comparison of compressive strength after 28 days of curing for M-20 Mix Design

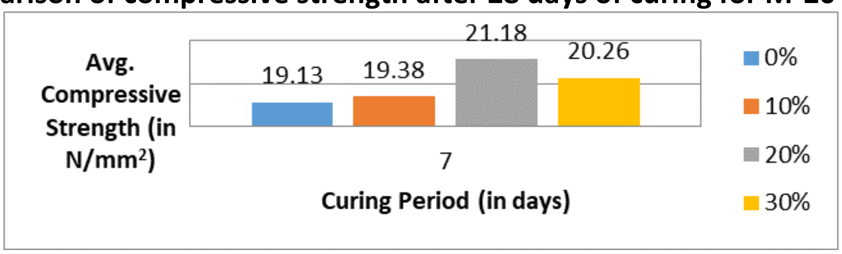

Fig.5 Comparison of compressive strength after 7 days of curing for M-25 Mix Design

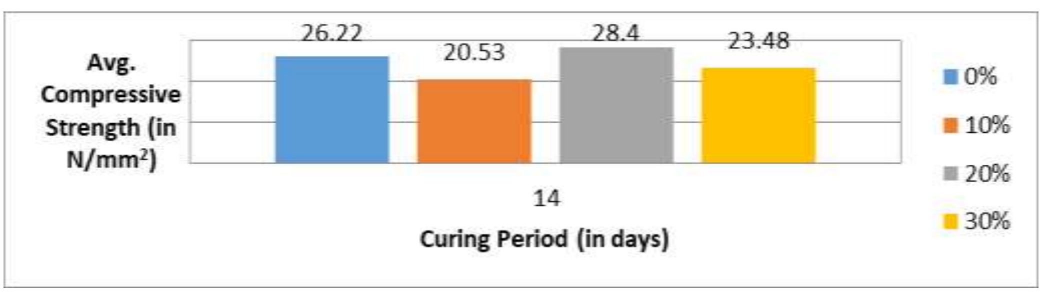

Fig.6 Comparison of compressive strength after 14 days of curing for M-25 Mix Design

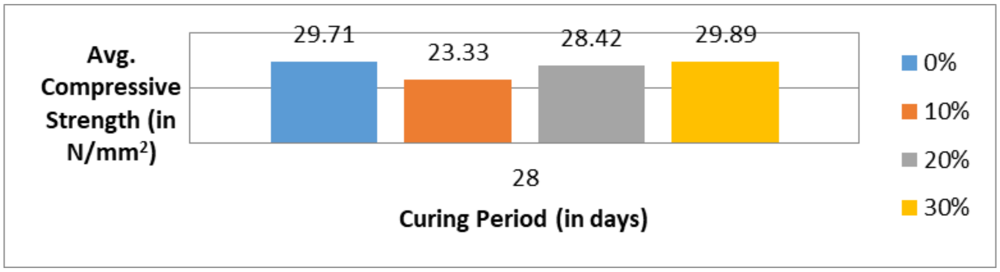

Fig.7 Comparison of compressive strength after 28 days of curing for M-25 Mix Design

CONCLUSION

- We tried to minimize the use of cement by partially replaced it with ceramic waste. For this purpose we casted cubes of M-20 and M-30 grade of concrete with 0%, 10%, 20%, and 30% replacement of cement in designed mix by selected ceramic waste. After proper curing of 7 days, 14 days and 28 days we checked strength of cubes of both mix designs by use of compressive testing machine and results are compared with conventional cubes. By this way we tried to establish maximum possible percentage of replacement by ceramic waste in concrete mix design without compromising its strength and other required qualities. In both mix designs, maximum possible replacement is noted 30% from interpretation of results obtained.

REFERENCES

1. Wikipedia
2. History of cement (Wikipedia)
3. Manufacturing Process (http://www.window.state.tx.us/taxinfo/audit/cement/ch1.htm)
4. International Journal on Mechanical Engineering and Robotics (IJMER) ISSN (Print) : 2321-5747, Volume-2, Issue-3,2014
5. 2012 IACSIT Coimbatore Conferences IPCSIT vol. 28
6. 2012 IACSIT Coimbatore Conferences IPCSIT vol. 28
7. Department of Ceramic Engineering, Afyonkocatepe University, Afyon, Turkey
8. Department of Civil Engineering, Kirikkale University, Kirkkale, Turkey
9. Addis Ababa University School of Graduate Studies
10. International Journal of Innovative Technology and Exploring Engineering ISSN:2278-3075, Volume-3, Issue-2, July-2013
11. Materials and Structures January 2011, Volume 44, Issue 1, pp 155-16
12. Department of Building Technoogy, Lagos State Polytechnic, Ikorodu, Lagos, Nigeria
13. International Journal of Innovative Technology and Exploring Engineering ISSN:2278-3075, Volume-2, Issue-5, April-2013
14. International Journal of Civil and Structural Engineering ISSN 0976-4399, Volume-3, No.-2
15. International Journal of Engineering Research Volume No. 3, Issue No. 8, pp : 501-506

16. International Journal of Emerging Technology and Advanced Engineering ISSN:2250-2459, Volume-4, Issue-3, March-2014
17. International Journal of Engineering Trends and Technology, Volume-4, Issue-6, June-2013
18. Second International Conference on Sustainable Construction Materials And Technologies ISBN 978-1-4507--1490-7
19. Cement and Concrete Research Volume 33, Issue 11, November 2003, Pages 1877-188
20. Proceedings of the International Symposium Concrete Technology Unit of ASCE and University of Dundee, March 19-20, 2001
21. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-6, May 2013
22. International Journal of Advances in Engineering, Science and Technology ISSN : 2249-913X, Vol. 1, No. 1, September-November 2011
23. BIS Specifications And SDCC norms of 53 Grade OPC
24. Aggregate Impact Value Test (IS: 2386 (Part IV) – 1963)
25. Aggregate Crushing Value Test (IS: 2386 (Part IV) – 1963)
26. Los-Angeles Abrasion Value (IS: 2386 (Part IV) – 1963)
27. Aggregate Flakiness Index Value (IS: 2386 (Part I) – 1963)
28. Aggregate Elongation Index Value (IS: 2386 (Part I) – 1963)
29. Mix Design (IS 456-2000, IS 10262-1982)
30. Batching of concrete (IS 4925-2004)
31. Compressive strength of concrete (IS 516-1959)
32. Slump Test (IS 1199-1959)