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REPLACEMENT OF SAND WITH CERAMIC WASTE IN CONCRETE FOR SUSTAINABLE DEVELOPMENT

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Abstract* — The continuous reduction of natural resources and the environmental hazards posed by the disposal of Construction and Demolition (C&D) waste has reached alarming proportion such that the use of C&D waste in concrete manufacture is a necessity than a desire. Hence the fine aggregate can be replaced fully or partially by materials like M-sand, quarry dust, saw dust, rice husk ash, ceramic waste etc in concrete. Ceramic waste may be used as an alternative for natural sand. The aim of this project is to determine the strength characteristics of recycled aggregates for application in concrete, with ceramic aggregates as an alternative material to fine aggregate in concrete. A total of three batches of concrete mixes of grade M35 were designed using various percentages (10%, 20%, 30% and 40%) of ceramic waste replaced for fine aggregates. From the results it is concluded that utilization of ceramic waste in concrete is more effective in strength as well as economic aspects.

Keywords— Ceramic waste, fine aggregate, recycled aggregate, natural sand, construction and demolition waste.

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I. INTRODUCTION

Ceramic is non-metallic solid which is inorganic, produced by the action of heat and subsequent cooling. The structure of ceramic materials may be crystalline or partly crystalline, or amorphous (e.g., a glass). Since most common ceramics are available in crystalline form, the term ceramic is often referred to inorganic crystalline materials. The earliest ceramics made by humans were pottery objects, including 27,000 year old figurines, made from clay, either by itself or mixed with other materials, hardened in fire.

Then glazing and heating of ceramics is done to create a coloured and smooth surface. Ceramics now include domestic, industrial and building products and a wide range of ceramic art. In the 20th century, new ceramic materials were developed for use in advanced ceramic engineering; for example, in semiconductors.

II. SOURCES OF CERAMIC POWDER

Various products of ceramic wastes include sanitary ware, floor tiles, wall tiles, roof tiles, and ceramics from refractory and vitrified clay tiles. Ceramic waste may come from two sources: The first source is the ceramics industry, and this waste is classified as non- hazardous industrial waste (NHIW). According To Integrated National Plan on waste in 2008- 2015, NHIW is all waste generated by industrial. The second source of ceramic waste is associated with construction and demolition activity. For this project work, ceramic waste from Construction Demolition Waste is used.

III. PROPERTIES OF MATERIALS

The properties of the materials used are cement, fine aggregate, coarse aggregate and water. The properties of these ingredients are given below.

Cement

Ordinary Portland (Birla super) cement was chosen. The 53 grade ordinary Portland cement was chosen because of its greater fineness which would have effective hydration and also secondary hydration. The ordinary portland cement which conforms to IS: 8112 – 1989 was used for making concrete.

Table - 1 Physical properties of cement

Properties	Test results
Specific gravity	3.11
Standard consistency	35%
Fineness	8%
Initial setting time	55 min
Final setting time	330 min

Fine aggregate

The Indian Standard sieves used for the analysis are 4.75 mm, 2.36 mm, 1.18 mm, 600 microns, 300 microns and 150 microns. The river sand was found to be zone – II as per IS: 10262 – 2009, IS: 383-1970.

Table - 2 Physical properties of fine aggregate

Properties	Test Results
Fineness modulus	2.62
Bulk density	1.52 g/cc
Void ratio	0.5
Specific gravity	2.29
Zone	II

Coarse Aggregate

The size of sieves used for analysis are 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 microns, 300 microns and 150 microns. The sieve analysis for coarse aggregates was done as per IS 2386 – Part I. The fineness modulus of coarse aggregate (12.5 mm) was given below

Table - 3 Physical properties of coarse aggregate

Properties	Test Results
Fineness modulus	7.32
Bulk density	1.5 g/cc
Void ratio	0.75
Specific gravity	2.78
Water absorption	0.91%

Water

The water which is used is free from oil, acids, vegetable matter, alkalis, clay and it satisfy to use in concrete. Normally using water in the concrete the pH value is ≥ 6.

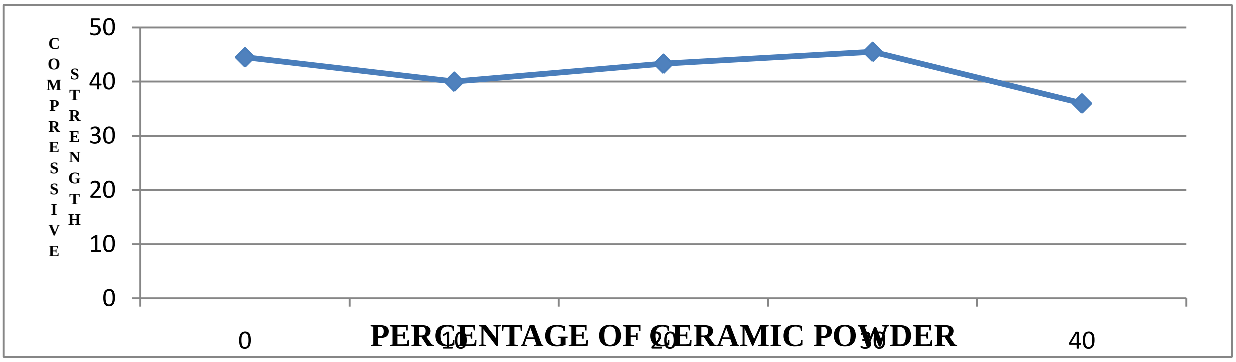
IV. RESULTS & DISCUSSIONS

Compression strength:

Table – 4 Values of compression test

Sl. No	Percentage of ceramic powder in each concrete mix (%)	Compression strength = P/A (N/mm^2)					
		7 days		14 days		28 days	
		Load (in KN)	Test value (N/mm^2)	Load (in KN)	Test value (N/mm^2)	Load (in KN)	Test value (N/mm^2)
1	**0**	640	28.44	820	36.5	1005	44.5
2	**10**	650	29	750	33.33	900	40
3	**20**	720	32	780	34	975	43.3
4	**30**	800	35.5	850	37	1025	45.5
5	**40**	540	24	620	27.5	810	36

Graph - 1 Values of compression test (28 days) with different % of ceramic powder

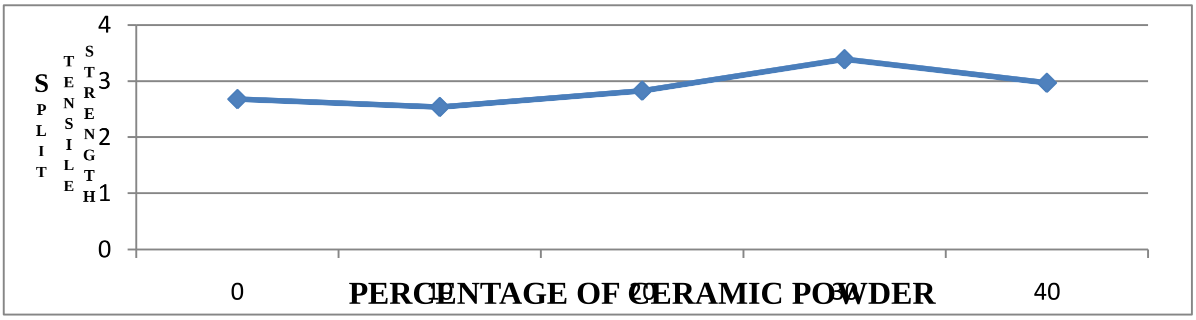


Split tensile strength:

Table – 5 Values of split tensile test

Sl.No	Percentage of ceramic powder in each concrete mix (%)	Split tensile strength = 2P/ΠDL (N/mm^2)	
		Average of 3 specimens (Load in KN)	Test value (N/mm^2)
1	**0**	190	2.68
2	**10**	180	2.54
3	**20**	200	2.83
4	**30**	240	3.39
5	**40**	210	2.97

Graph – 2 Values of split tensile test with different % of ceramic powder

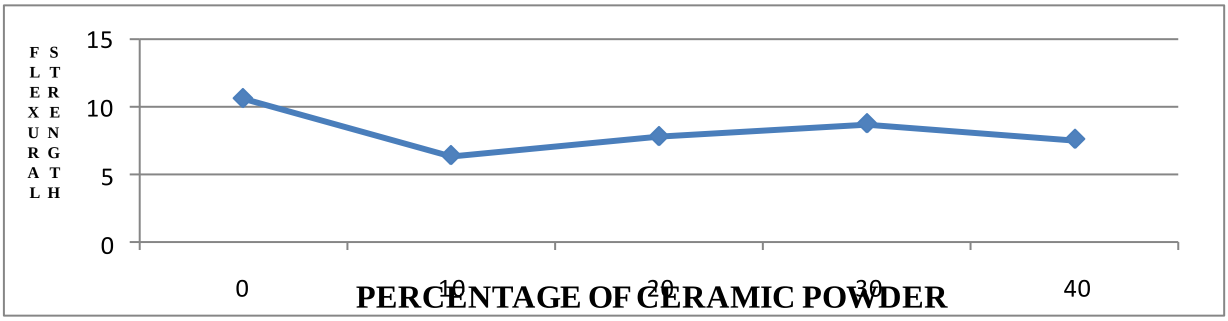


Flexural strength:

Table – 6 Values of flexural strength

Sl. No	Percentage of ceramic powder in each concrete mix (%)	Flexural strength = Pl/bd^2 in (N/mm^2)	
		Load (in KN)	Test value (N/mm^2)
1	**0**	21.2	10.6
2	**10**	12.8	6.4
3	**20**	15.6	7.8
4	**30**	17.5	8.75
5	**40**	15.2	7.6

Graph – 3 Values of flexural strength with different % of ceramic powder



V. Conclusions

1. Compression strength of M35 grade of concrete increases with replacement of fine aggregate with ceramic powder up to 30% and strength is decreased on further replacement.
2. Concrete on 30% replacement of fine aggregate by ceramic powder, maximum tensile strength is obtained.
3. The flexural strength of ceramic concrete is highest at 30% replacement of fine aggregate by ceramic powder and it is decreased on further replacement of fine aggregate by ceramic powder.
4. From the above study it can be concluded that, 30% replacement of fine aggregate with ceramic powder in concrete gives required strength and can be considered as optimum percentage.

VI. References

1. Replacement of cement by marble dust and ceramic waste in concrete for sustainable development by- Abdullah anwar, Sabih ahmad, Syed mohd. Ashraf husain and Syed qeel ahmad.
2. A study on properties of concrete with ceramic waste replaced for fine aggregate by- Dr. K. Ramadevi.
3. Durability aspects of concrete by partial replacement of cement by ceramic waste by: V. Praveen kumar.
4. Utilization of sanitary ceramic wastes in concrete by: N. Vimal kumar patel.
5. Replacement of cement and fine aggregate by ceramic powder and copper slag in concrete by: R. Chithra.

