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Effect of Partial Replacement of Fine and Coarse Aggregate (10mm) with Ceramic Waste on the Properties of Concrete

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Abstract: ***This present world is very much depends on the concrete for the construction of various infrastructural activities. Concrete has become a basic need for every structure nowadays. The increasing population of the world puts a lot of pressure on the civil engineer to develop a cost effective as well as an eco-friendly structure according to the need of human beings. Concrete is a heterogeneous mixture of binding material (cement or lime), coarse aggregates, fine aggregates (sand) and water. Fine and coarse aggregates are obtained from quarrying of large rocks which leads to a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. The objective of this research is to study the utilization of ceramic waste as a partial replacement of fine and coarse aggregate (10mm) in concrete. The properties such as flexural strength and compressive strength of concrete incorporating ceramic waste in partial replacement of sand and coarse aggregate (10mm) were examined and compared. The flexural strength and compressive strength was determined at the age of 7 days and 28 days. Cubes for compressive strength as dimensions 150x150x150mm and for flexural beams of dimension 500x100x100mm were casted adopting weight batching and hand mixing. The mix were designated as a mix with varying percentage of ceramic waste such as 0%,10%,20% and 30% to evaluate various properties. The research has been conducted on M25 mix grade. The results which come out from the research work are shows that the strength developed in concrete is increased, it can be equated to higher strength concrete and it can be easily used as construction material in construction work.***

Keywords: Cement, Aggregate, Ceramic Waste, flexural strength and compressive strength

1. Introduction

Today's world is a concrete jungle. With the ever increasing population of the world, in general and the developing countries there is the tremendous pressure on the Civil Engineer to develop a cost effective as well as ecofriendly structure to fulfill the need of the human being.The concrete has three basic components which are cement, fine and coarse aggregate. In these components only cement is manufactured and both fine and coarse aggregate has been obtained naturally. This has brought up with a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem.To solve both these problems use of waste materials such as concrete waste, rice husk, pond ash, quarry waste, marble waste and ceramic waste etc if are dumped in open ground is hazardous to environment. These materials have also benefits that these materials are easily available and economical. In this research these wastes are used in two forms as sand and as 10mm Coarse aggregates simultaneously. Although in earlier studies has been conducted on these wastes has already been used in concrete. But in those studies both the material has been used separately like in some studies use only partial replacement of sand or partial replacement of coarse aggregate but in this research both the components has been used parallel at equal percentage.

Ceramic Waste

The amount of ceramic tile waste on earth is enough for use as a coarse and fine aggregate in concrete. Ceramic tile is produced from natural materials sintered at high temperatures. There are no harmful chemicals in tile. Waste tiles cause only the hazard of pollution. Wherever some parts of tiles are used in cotto as flooring and also flooring in different types of structures use differently like tennis courts, walkways, cycling paths and gardens as a ground material. So due to such reasons waste tiles are stored in factory fields because of their economic value. Nevertheless, every year approximately 250,000 tons of tiles are washed out, while 100 million tiles are used for repairs. Ceramic waste can be transformed into useful Fine and Coarse aggregate. It has been calculated that about 30% of the daily production in the ceramic industry left as a waste. This waste is not recycled in any form at present. Ceramic tiles possess a broad range of properties, and certain tiles are better suited for some installations than others. Few tiles are fitted for all types of installations; consequently, good knowledge of the properties is essential for the consumer to achieve the desired and look forward value of the tile. Because so many tile installations are built around or near water, and because due to porous materials it can soak up the moisture and dock unwanted organisms, absorption is one of the most important properties, that is because, in wet-area applications, it can involve health and safety issues, and in exterior applications, it can initiate important freeze/thaw damage.Ceramic waste can be separated in two categories in compliance with the origin of raw materials. The first one are all fired waste generated by the ceramic factories that use only red paste to manufacture their products, such as brick, blocks and roof tiles. The second one is all ignited waste manufactured in stoneware ceramic such as wall, floor tiles and sanitary ware. The ceramic industry is comprised of the following sub-sectors like wall and floor tiles, sanitary ware, bricks and roof tiles, stubborn materials and ceramic materials for domestic and ornamental.

2. Properties of Materials and Methodology

Methodology

- Collection of material: for ceramic waste for concrete and materials are collected like normal grade of cement, aggregates, water.
- Weighing and mixing process: material are weighed in proper ratio as per design and after then mixed in proper way.
- Moulding process: concrete mixer is moulded in cube sized 150*150*150 mm^3 and beam size of 500*100*100 mm^3.
- Removing of mould: After 24 hours the moulds are removed.
- Curing process: concrete cubes and beams are cured in fresh water for 7 days to 28 days.
- Testing process: after removing the moulds, concrete cubes and beams are tested in campus concrete laboratory.
- Analysis and test result: after various test on cube and beams, result are calculated.

Table 1 Details of Replacement by sand and 10mm aggregate by ceramic waste:-

Sr no		*Cement*	*FA*	*CA*		*Ceramic Waste as*	
				10mm	*20mm*	*Sand*	*10mm*
1	T-0	100%	100%	100%	100%	0%	0%
2	T-10	100%	90%	90%	100%	10%	10%
3	T-20	100%	80%	80%	100%	20%	20%
4	T-30	100%	70%	70%	100%	30%	30%

Properties of Material

Table 2: Physicals properties of the Cement

Sieve Size	%age passing	Permissible limits
40mm	100	100
20mm	98.2	85-100
10mm	13.9	0-20
4.75mm	2.2	0-5

Table 3: Physical Properties of 20mm CA

Characteristic properties	Results
Water Absorption	0.68%
Free Moisture Content	0.70%
Impact Value	15.7%
Specific Gravity	2.52

Table 4: Sieve Analysis for 10mm CA

Sieve Size	%age passing	Permissible limits
12.5mm	100	100
10mm	90.2	85-100
4.75mm	11.5	0-20
2.36mm	1.6	0-5

Table 5: Physical Properties of 10mm CA

Characteristic properties	Results
Water Absorption	0.52%
Free Moisture Content	0.6%
Specific Gravity	2.61

Table 6: Sieve Analysis of Combine Aggregate

Sieve Size	%age passing	Permissible limits
40mm	100	100
20mm	97.4	95-100
10mm	38.4	25-55
4.75mm	2.8	0-10

Table 7: Physical Properties Combined Aggregates

Characteristic properties	Results
Water Absorption	0.65%
Free Moisture Content	0.67%
Impact Value	14.9%
Specific Gravity	2.68

Table 8: Physical Properties of Fine Aggregate

Characteristic properties	Results
Water Absorption	0.52%
Free Moisture Content	0.6%
Specific gravity	2.52

Concrete Mix Design

Mix design of M25 has been designed as per IS10262:2009 and the same grade used to prepare for test specimens.

Table 9: Quantities of the ingredients required for 1 cum cement concrete (M25)

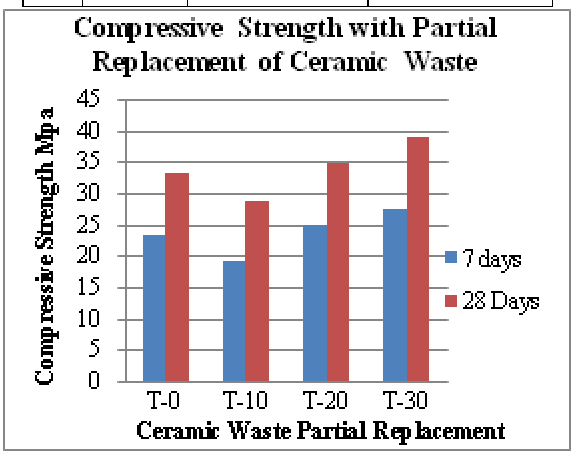
Materials	**Quantity**
Cement	384 kg/cum
Sand	658 kg/cum
Coarse Aggregate	1142kg/cum
Water	192 ltr/cum

Compressive Strength

The compressive strength test has been performed on compressive strength testing machine. In this research six concrete cube moulds are filled with concrete at every casting or with different partial percentage. Out of these six, three cubes were tested after 7days and rest of the three were tested after 28 days.

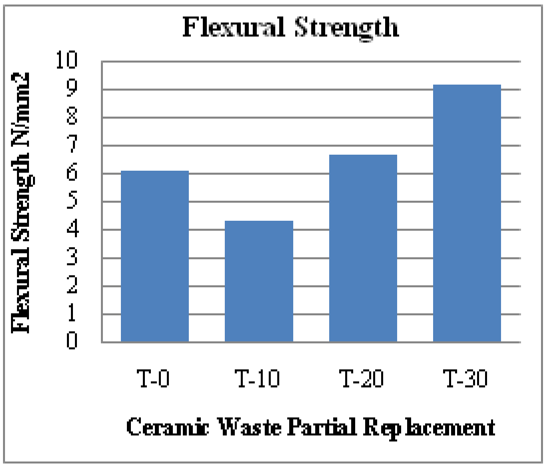
Table 10: Variation of Compressive Strength of concrete With different %age of Ceramic Waste:

Sr no.	Notation	7 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
1	T-0	23.42	33.41
2	T-10	18.99	28.75
3	T-20	24.78	34.88
4	T-30	27.41	39.04



Flexural Strength

Flexural tensile strength, also determines as modulus of rupture is explained as the material ability to resist deformation under load or in other words load at which the concrete members may crack. It is determined by the standard testing specimens of 500x100x100mm over a span under symmetrical two point load.



3. Conclusions

1) Ceramic waste initially there is decrease of 23.32% in compressive strength of 7days when partially replacement of 10%, but after that while replacing 20% there is increase of 5.48% and with 30% there is increase of 14.56% increases respectively in initial compressive strength with respect to normal concrete mix. The reason behind this is that the ceramic waste (sand) behaves as micro filler in concrete. When the ceramic waste replaced as 10% the amount of micro filler is not enough to exhibit required strength but further increase in amount of ceramic waste (sand) fill more voids in concrete mix due to which the compressive strength increased.
2) Ceramic waste initially there is decrease 16.20% in compressive strength of 28days when partially replacement of 10%, but after that while replacing 20% there is increase of 4.2% and with 30% there is increase of 14.42% increases respectively in final compressive strength with respect to normal concrete.
3) Initially there is decrease by 39.49% in flexural strength (28days) when partially replacement of 10%, but after that while replacing 20% there is increase of 8.57% and with 30% there is increase of 33.40% increases respectively in flexural strength with respect to normal concrete.

4. Future Scope

1) The research will do on different grades of mix design.
2) The research will do with varying percentage.
3) The waste materials which are used in study like sand and 10mm aggregate will be used separately.

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