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Experimental investigation eco-waste in concrete with partial replacement of coarse aggregate

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ABSTRACT

This paper gives a review on replacement of coarse aggregate with industrial by products like ceramic tiles. Through this study a combined replacement of crushed tile as coarse aggregates in the replacement ration of 0, 12.5%, 25%, 37.5% and 50% were used and conducted a detailed experimental study on compressive, split tensile and flexural strength tests. The test results provide a potential use of ceramic tiles in production of concrete and effective utilization of industrial waste.

Key words : *Ceramic waste, Compressive strength, Tensile strength, Flexural strength*

Introduction

Concrete is a one of the main construction materials. More than two centuries, it has been used in construction industry in varies field. Approximately, the whole bulk of the concrete is used in one year is more than one ton a piece. Therefore, doing research about using modern technologies in production concrete is of great importance. Furthermore, one of the most critical problems of the world has been related to remove the wastage and reusing of it. Ceramic tiles are structural or decorative items used to cover floors, roofs and walls. It might be extended to consist of very small flat pieces of surfacing material. So that is not ceramic material. Such as carpet, wood, stone or cork. Ceramic titles are slabs which varying in thickness from 5 mm to 30 mm and their shapes are square, rectangular and hexagonal or any other shape.

Types of Ceramic Tiles

The ceramic tiles may classify in two categories like Glazed Porcelain Tile and Glazed Ceramic Tile.

Glazed Porcelain Tile

In producing porcelain type tile, various colour glazes are added to the surface of the tile to enhance the visual presentation. For this type of tile withstands temperature at extremes. It may be used in specific exterior applications including pool linings.

Glazed Ceramic Tile

Glazed Ceramic Tile has the same glaze on top of the surface of the body of the tile. So that is applied to a porcelain body tile. The body of the tiles can be coloured like yellow to reddish brown or else they can be whitish. It depending on the raw materials used.

Mosai Tile

Mosaic tiles are small tiles compared to others, it is generally 2" x 2" or smaller, and always less than six square inches in area. It may be made from either a clay body or porcelain body.

1. P.G. Students, 2. Professor, 3. Assistant Professor

Quarry Tile

Quarry tile is manufactured from natural clays and shale because it is an unglazed tile. It has a dense body with a high-resistance to moisture and staining and thick body. Through Body is porcelain tile, quarry tile has a regular colour throughout the body of the tiles.

Mix proportions

Then mix design are arrived and casting is done for this study. After 7th and 28th day testing is done for the hardended concrete. Finally result and discussion and conclusion of this study. Table 1 deal with the various mix combinations of the concrete using ceramic tile waste. The concrete is prepared by using cement fine aggregate and course aggregate with partial replacement of the ceramic tiles.

Test on Concrete

The concrete test maybe divided in to two ways to determine the properties of the concrete in fresh state and hardened state**.**

Tests on Fresh Concrete

Slump Test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It measures the slum value of the concrete denotes the flow ability of the concrete. The compaction factor defines the ratio of the partially compacted weight of the concrete **to** fully compacted concrete weight. Table 2, 3 and 4 show slump cone, compaction factor and flow table test result of the fresh concrete property like flow ability of concrete.

Flow table test is a laboratory test, which gives an indication of the flow ability of concrete with subjected to consistency, proneness to segregation and cohesiveness. In this flow table test, a standard mass of prescribed concrete is subjected to jolting of the table. Flow values are calculated in percentage.

Flow percent = (Spread diameter in cm – 25)/25 * 100. The flow value could range anything from 0 to 150 percent.

The slump value is increasing with respect to the increase in percentage of the ceramic tile waste. The compaction factor value is decreased with increase

Table 1. Mix Design

Mixing%	Cement Kg	F.A Kg	C.A Kg		Water
			C.A	C.T	
CW_0	1.80	2.26	4.90	0 .0	0.45
CW12.5	1.80	2.26	4.28	0.62	0.45
CW25	1.80	2.26	3.65	1.25	0.45
$CW_{37.5}$	1.80	2.26	3.05	1.85	0.45
CW_{50}	1.80	2.26	2.45	2.45	0.45

Table 2. Slump Test Values

Material	CW_0	$CW_{12.5}$	CW_{25}	$CW_{37.5}$	CW_{50}
Cement	1.80	1.80	1.80	1.80	1.80
Sand	2.26	2.26	2.26	2.26	2.26
Tiles	0	0.62	1.25	1.85	2.45
Aggregate	4.90	4.28	3.65	3.05	2.45
Slump in cm	24	23	23	23.5	22.7

Table 3. Compaction Factor Test Values

Material	CW_0	$CW_{12.5}$	CW_{25}	$CW_{37.5}$	CW_{50}
Cement	1.80	1.80	1.80	1.80	1.80
Sand	2.26	2.26	2.26	2.26	2.26
Tiles	0	0.62	1.25	1.85	2.45
Aggregate	4.90	4.28	3.65	3.05	2.45
Compaction ratio	0.95	0.90	0.80	0.85	0.72

Table 4. Flow table test values

Material	CW_0	$CW_{12.5}$	CW_{25}	$CW_{37.5}$	CW_{50}
Cement	1.80	1.80	1.80	1.80	1.80
Sand	2.26	2.26	2.26	2.26	2.26
Tiles	0.00	0.62	1.25	1.85	2.36
Aggregate	4.90	4.28	3.65	3.05	2.45
Flow value in cm	29.6	30.0	30.5	30.8	31.2

in the ceramic title waste for flow ability of the concrete. The flow percentage of the ceramic tile waste concrete is increased with increase in the percentage of the ceramic waste tile.

Compressive Strength

The variation of strength of hardened concrete using solid wastes as partial replacement of conventional aggregate is studied by casting cubes until 60%. The concrete was prepared in the laboratory using mixer. Table 5 and Figure 2 show the compressive strength value of the various mixes of concrete.

The compressive strength values are increased with increase in ceramic tile waste till 37.5 %of replacement of coarse aggregate. After increase in percentage of the ceramic waste title the compressive strength value is decreased. The maximum compressive strength value of the concrete is 28.397 MPa for CW37.5 mix id.

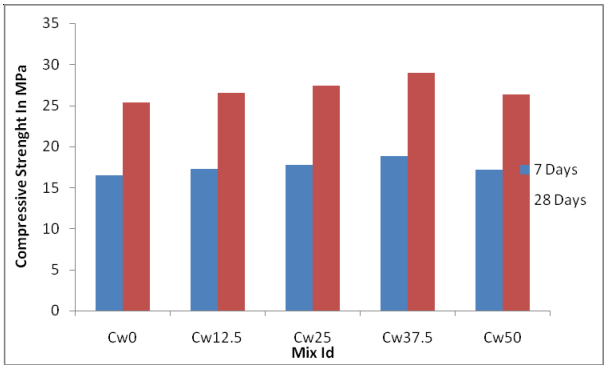

Fig. 1. Compressive strength value of concrete

Flexural strength

The concrete is produced using maximum size of coarse aggregate is 20mm and industrial waste crushed ceramic aggregate. Table 6 and Figure 3 show the flexural strength value of the concrete.

The flexural strength values are increased with increase in ceramic tile waste till 37.5 %of replacement of coarse aggregate. After increase in percentage of the ceramic waste title the flexural strength value is decreased. The maximum flexural strength value of the concrete is 6.35 MPa for CW37.5 mix id.

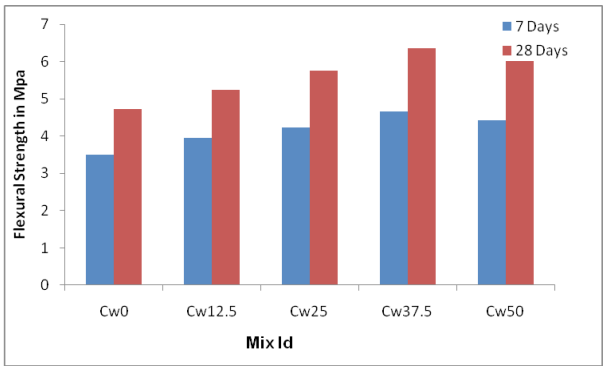

Fig. 2. Flexural strength value of concrete

Fig. 3. Split Tensile Strength Machine

Split Tensile Strength Test

Tensile strength is the capacity of a material or structure to withstand tension. It is measured on concrete cylinders of standard dimensions using a Universal Testing machine. Figure 4 shows the experimental setup of split tensile strength. Table 7 and figure 5 show the split tensile strength value of the concrete.

The split tensile strength values are decreased after 37.5 percentage of the ceramic tile waste in concrete. The tensile strength of the concrete increased upto increase in percentage of the ceramic tile waste

Table 5. Compressive strength values

Mix ID	Size (mm x mm) 7 DAYS	Compressive Strength (N/mm²)
Cw_0	150 × 150	16.45
$Cw_{12.5}$	150 × 150	17.21
Cw_{25}	150 × 150	17.74
$Cw_{37.5}$	150 × 150	18.83
Cw_{50}	150 × 150	17.12
	28 DAYS	
Cw_0	150 × 150	25.32
$Cw_{12.5}$	150 × 150	26.48
Cw_{25}	150 × 150	27.36
$Cw_{37.5}$	150 × 150	28.97
Cw_{50}	150 × 150	26.34

Table 6. Flexural strength values

Mix ID	Size (mm x mm) 7 DAYS	Flexural Strength (N/mm²)
Cw_0	100×100× 500	3.51
$Cw_{12.5}$	100×100× 500	3.95
Cw_{25}	100×100× 500	4.22
$Cw_{37.5}$	100×100× 500	4.67
Cw_{50}	100×100× 500	4.43
	28 DAYS	
Cw_0	100×100× 500	4.72
$Cw_{12.5}$	100×100× 500	5.23
Cw_{25}	100×100× 500	5.75
$Cw_{37.5}$	100×100× 500	6.35
Cw_{50}	100×100× 500	6.02

Table 7. Split tensile strength values

Mix ID	Size (mm x mm) 7 DAYS	Flexural Strength (N/mm²)
Cw_0	300× 500	1.75
$Cw_{12.5}$	300× 500	2.15
Cw_{25}	300× 500	2.54
$Cw_{37.5}$	300× 500	3.05
Cw_{50}	300× 500	2.75
	28 DAYS	
Cw_0	300× 500	2.84
$Cw_{12.5}$	300× 500	3.15
Cw_{25}	300× 500	3.56
$Cw_{37.5}$	300× 500	3.75
Cw_{50}	300× 500	3.25

37.5 %. The split tensile strength value of the concrete varies from 2.84 to 3.75 MPa.

Conclusion

The aim of this study was the effective utilization of ceramic tiles collected from demolition buildings in concrete act as a coarse aggregate.

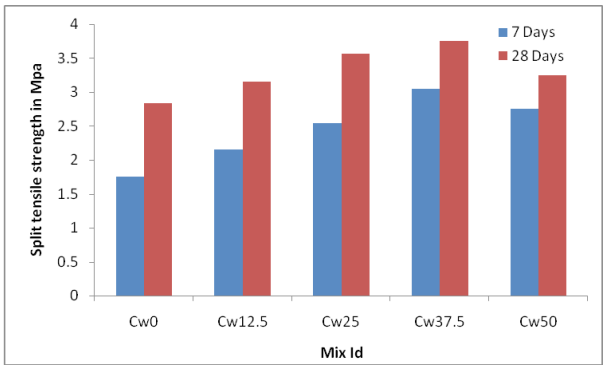

Fig. 4. Split tensile strength values of mixes

The following points are the conclusions obtained from the experimental study:

- It concluded that increasing the ceramic tile percentage from 0 to 37.5 increases in compressive strength and more than 37.5 percent in ceramic tile decreases the strength of concrete and also flexural and split tensile strength of the concrete.
- It is observed that when increasing percentage replacement of coarse aggregate by Ceramic waste, the unit weight of concrete is gradually increases.
- The workability of crushed tile aggregate concrete is equilibrium of fluidity, deformability, filling ability and resistance to segregation.

References

Frondiston, Y.S. 1977. Waste Concrete as aggregate for New Concrete. *ACI Journal*. 373-376.

Ramírez, S. 2008. Ceramic wastes as alternative raw materials for Portland cement clinker production. *Cement and Concrete Composites*. 30 : 798-805.

Rao, A., Jha, K.N. and Misra, S. 2007. Use of aggregates from recycled construction and demolition waste in concrete. *Journal of Resources Conservation and Recycling*. 50 : 71-81.

Sudharsan, N. and Palanisamy, T. 2018. A comprehensive study on potential use of waste materials in brick for sustainable development. *Ecology, Environment and Conservation*. 24 : S339–S343.

Sudharsan, N. and Saravanaganesh, S. 2019. Feasibility studies on waste glass powder. *International Journal of Innovative Technology and Exploring Engineering*. 8(8): 1644–1647.

Sudharsan, N. and Sivalingam, K. 2019. Potential utilization of waste material for sustainable development in construction industry. *International Journal of*

Recent Technology and Engineering. 8(3): 3435–3438.

Sudharsan, N. Grant, B. C. J. 2018. Comparison of static response of laced reinforced concrete beams with conventional reinforced concrete beams by numerical investigations. *International Journal of Civil Engineering and Technology*. 9(8) : 700–704.

Sudharsan, N., Palanisamy, T. and Yaragal, S. C. 2018. Environmental sustainability of waste glass as a valuable construction material - A critical review. *Ecology, Environment and Conservation.* 24 : S331–S338.

Vidhya, K. and Kandasamy, S. 2013. Study on properties of bricks manufactured using fly ash and pond ash. *Pollution Research*. 32(2) : 405–409.

Vidhya, K. and Kandasamy, S. 2014. Study on the flexural strength of coal ash brick masonry wall elements. *Journal of Structural Engineering (India).* 41(4): 410–419.

Vidhya, K. and Kandasamy, S. 2016. Experimental Investigations on the Properties of Coal-Ash Brick Units as Green Building Materials. *International Journal of Coal Preparation and Utilization*. 36(6): 318–325.