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Reuse of Ceramic Waste as Aggregate in Concrete

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Abstract - *The reuse of ceramic waste as a substitute for coarse aggregate in concrete has been investigated. The ceramic wastes are of three types, namely Tiles, Clay bricks and flowerpot were used. This study intends to use of ceramic tile aggregate in concrete production. Ceramic tiles were obtained from manufacturing industries, from construction and demolition sites, this cause's environmental pollution. The utilization of crushed tile as a coarse aggregate in concrete would also have a positive effect on the economy. Therefore, reuse of these ceramic wastes in concrete production could be an effective measure in maintaining the environment and improving the properties of concrete.*

In the present study, Ceramic tile waste were used in concrete as a replacement for natural coarse aggregate with 0%, 10%, 20% and 30% of the substitution and M20 grade concrete were used. The concrete moulds were casted and tested for Compressive Strength and Split Tensile Strength after a curing period of 3, 7 & 28 days. The results indicate that, the maximum compressive strength is obtained for the 30% replacement of ceramic tile aggregate with natural coarse aggregate.

***Key Words*: Ceramic Tile Aggregate (CTA), Normal aggregate, Water-cement ratio, Compressive strength, Split tensile strength, Specific gravity, Sieve analysis, Setting time, Water absorption…**

1. INTRODUCTION

Rapid industrial development causes serious problems all over the world such as depletion of natural aggregates and creates enormous amount of waste material from construction and demolition activities. One of the ways to reduce this problem is to utilize the waste. A large quantity of wastages produced annually in all countries, in particular construction and demolition waste contribute the highest percentage of wastes worldwide about 75%. Furthermore, ceramic materials contribute the highest percentage of wastes within the construction and demolition wastes about 54%. Ceramic waste is durable, hard and highly resistant to Biological, Chemical and Physical degradation forces. Ceramic tile aggregate are hard having considered value of specific gravity, rough surface on one side and smooth on other side, are lighter in weight than normal stone aggregates. Using ceramic tiles as aggregate in concrete not only will be cost effective but also will be good from environmental point of view.

The following section gives a brief background and some of the important pertinent studies that were carried out to the considered work, **[5]** Studied on the utilization of waste materials in concrete production which is helpful to the goal of sustainable construction. This study intends to use of Ceramic tile aggregate having 20mm maximum size of coarse aggregate. Ordinary Portland cement (OPC) 53 grade and sand were used. Compressive tests were carried out, the test results indicates that except M30 mix there is no significant effect on M20 and M25 Mixes. But beyond that, strength started decreasing gradually with the increase in the proportion of tile aggregate in concrete. **[7]** Studied by replacing crushed tile as a coarse aggregate in concrete with partial replacement of 0%, 50%, 100% of natural aggregate. The Mechanical and Physical tests were carried out. The strength and unit weight of crushed tile aggregate concrete were decreased compared to control concrete. Absorption and capillarity coefficients were increased compared to the control concrete.

In this experimental world, the reuse of solid wastes and aggregates from construction and demolition waste is showing a prospective application in construction and as alternative to primary and natural aggregates. It conserves natural resources and reduces the space required for land fill disposal.

2. MATERIALS

Cement: Cement is a fine powder, which when mixed with water and allowed to set and harden, is capable of uniting fragments or masses of solid matter together to produce a mechanically strong material. The most commonly used cement is ordinary Portland cement of 53 grade confirming to IS:12269. The tests conducted on cement are Standard Consistency, Specific Gravity and Setting time.

Fine Aggregate: Locally available free of debris and nearly riverbed sand is used as fine aggregate. The fractions ranges from 4.75 mm to 150 micron are termed as fine aggregate. The sand particles should also pack to give minimum void ratio, higher voids content leads to requirement of more mixing water. In the present study the sand conforms to zone I as per the Indian standards. The tests conducted on fine aggregates are Fineness, Specific Gravity and Water absorption.

Coarse Aggregates: The fractions above 4.75mm are termed as coarse aggregate. The crushed aggregates used were 20mm nominal maximum size and are tested as per Indian standard sand results are within the permissible limit.

Ceramic tile Aggregate: CTA are crushed uniformly to about 20mm size manually using hammer and sieved through 20mm IS: Sieve. The various test were conducted on the ceramic tiles are specific gravity, water absorption and impact test.

Water: Water available from the local sources conforming to the requirements of water for concreting and curing as per IS: 456-2000.

Figure – 2.1: Composition of materials

2.1 Material Properties

Table -2.1: Physical properties of cement

SL No.	Particulars	Obtained Values
01	Specific gravity	3.15
02	Setting time of cement Initial setting time Setting time of cement	 30 Min 285 Min

Table -2.2: Physical properties of fine aggregates

SL No.	Particulars	Obtained Values
01	Fineness modulus	2.555
02	Maximum size	2.36 mm
03	Specific gravity	2.65
04	Water absorption	1%

Table -2.3: Physical properties of coarse aggregates

SL No.	Particulars	Obtained Values
01	Fineness modulus	2.26
02	Maximum size	20 mm
03	Specific gravity	2.68
04	Water absorption	0.6%

Table -2.4: Physical properties of ceramic tile aggregates

SL No.	Particulars	Obtained Values
01	Specific gravity	2.22
02	Impact value	24%
03	Water absorption	14.4%

Table -2.5: Comparison of properties of ceramic tile aggregates and normal aggregates

SL No.	Particulars	Normal Aggregate	Ceramic Tile Aggregate
01	Shape	Angular	Flaky
02	Texture	Rough	All sides rough except top face
03	Specific gravity	2.68	2.22
04	Impact value	15%	24%
05	Water absorption	0.6%	14.4%

3. METHODOLOGY

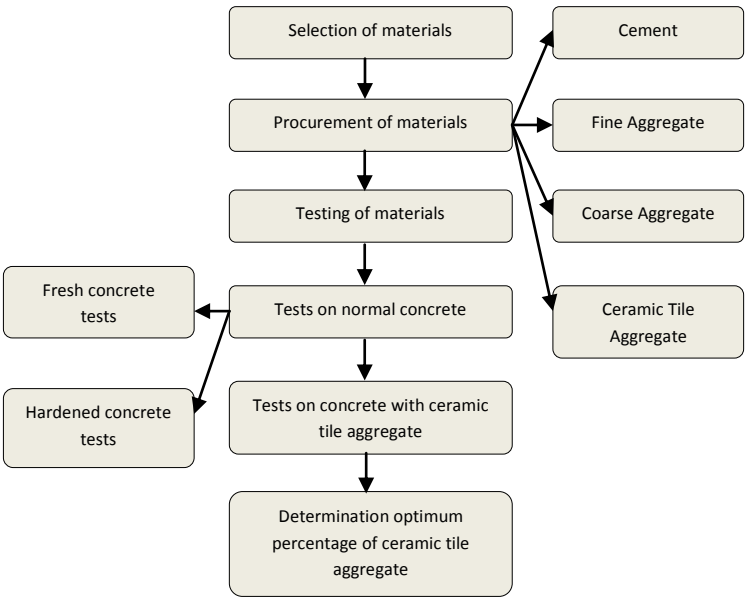


Figure – 3.1: Hierarchy of processes involved

Fig (3.1) indicates the flowchart of the whole process which consists of selection of materials such as cement, fine aggregate, coarse aggregate and ceramic tile aggregate. Concrete is prepared for M20 mix designed for plain concrete. Ceramic tile aggregate is used as partial replacement with coarse aggregate. Materials are mixed by considering the proportions as per the mix design. The mould of dimension 150x150x150 mm in 03 layers in which each layer of height approximately 50mm. In each layer compaction is done by using tamping rod/shake table. Moulds are prepared for different proportions as per the design **IS: 10262 – 2009**. The moulds are cured for 03, 07 & 28 days under no dry condition until they are tested.

The concrete cube specimens are tested at the age of 03, 07 & 28 days of curing period. Concrete cubes are placed on compression test rig & the maximum load applied to the cube, at which the resistance of the specimen to the increasing load breaks & no greater load can be sustained is recorded. Similarly split tensile tests are carried out on the concrete cube specimens in a tensile test rig and the values are recorded.

3.1 MIX PROPORTION

Table -3.1: Mix proportion of samples

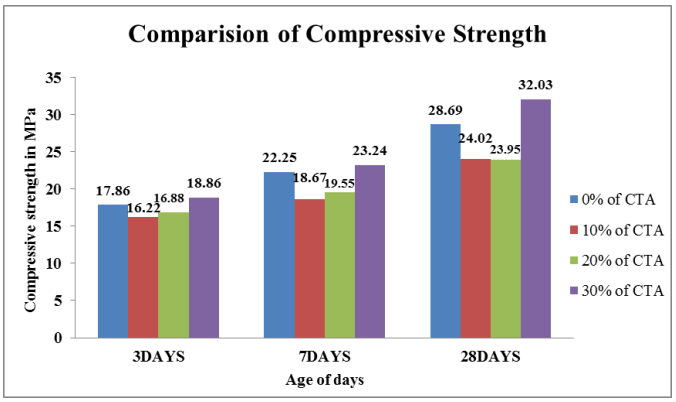
% Replacement of CTA	W/C Ratio	Cement Content (kg/m³)	Water (kg/m³)	Fine Aggregate (kg/m³)	Coarse Aggregate (kg/m³)	Ceramic Tile Aggregate (kg/m³)
0%	0.5	383.2	205.53	721.99	1099.66	NA
10%		383.2	220.79	721.99	989.7	94.7
20%		383.2	236.06	721.99	879.73	189.4
30%		383.2	251.33	721.99	769.76	284.1

4. RESULTS

4.1 Compressive strength for different percentage of ceramic tile aggregate used for M20 grade

Table 4.1: Test results of M_{20} grade concrete with 0%,10%, 20% and 30% replacement of CTA with coarse aggregate for 3, 7 and 28 days

SL. NO.	% REPLACEMENT OF TILE AGGREGATE	AGE IN DAYS	3 DAYS	7 DAYS	28 DAYS
01	0%	COMPRESSIVE STRENGTH IN MPA	17.86	22.25	28.69
02	10%		16.22	18.67	24.04
03	20%		16.88	19.55	23.95
04	30%		18.86	23.24	32.03

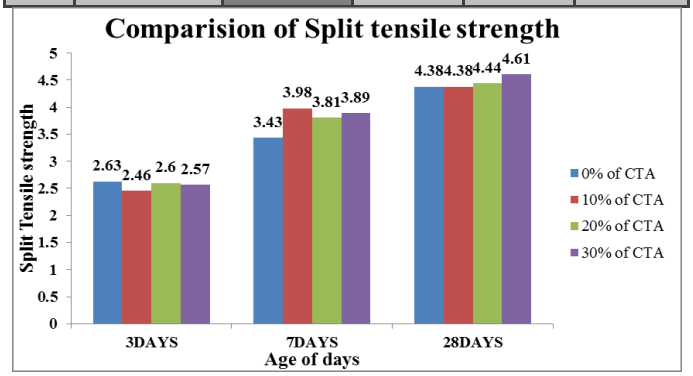


Graph - 4.1: M_{20} concrete grade with 0%, 10%, 20% and 30% replacement of CTA and their compressive strength at 3,7 and 28 days

4.2: Comparison of split tensile strength for 0%, 10%, 20% and 30% replacement of CTA with normal aggregate for 3, 7 and 28 days

Table 4.2: Test results of M_{20} grade concrete with 0%,10%, 20% and 30% replacement of CTA with coarse aggregate for 3, 7 and 28 days

SL. NO.	% REPLACEMENT OF TILE AGGREGATE	AGE IN DAYS	3 DAYS	7 DAYS	28 DAYS
01	0%	SPLIT TENSILE STRENGTH IN MPA	2.63	3.43	4.38
02	10%		2.46	3.98	4.38
03	20%		2.60	3.81	4.44
04	30%		2.57	3.89	4.61



Graph – 4.2: M_{20} concrete grade with 0%, 10%, 20% and 30% replacement of CTA and their tensile strength at 3,7 and 28 days

5. CONCLUSION

Research on the usage of waste construction materials is very important since material waste is gradually increasing with the increase in population and increasing of urban development. The main aim of this investigation was the utilization of tiles collected from the demolished buildings and the wastes obtained from the tile industries. The use of these tile aggregates as partial replacement in coarse aggregate in concrete has positive effect on the environment and obtaining lower costs since the tile aggregates are easy to obtain. Their cost is cheaper than the natural aggregates. The ceramic tile aggregate are partial replaced with coarse aggregate because the tile aggregate are easy to obtain and their cost is cheaper than the natural aggregate.

After completions of all experimental, programs are conducted that ceramic tile aggregate can be used in place of coarse aggregate with certain percentage of replacement, Based on the compression strength test, split tensile strength test. The following are the conclusions obtained after performing the above experiments,

- The maximum compression strength is obtained when 30% of ceramic tile aggregate was replaced with coarse aggregate.
- The maximum split tensile strength is obtained when 30% of Ceramic tile aggregate was replaced with coarse aggregate.
- The compressive strength and split tensile strength for 10% and 20% replacement of CTA is not increased. There is little variation in the strength when compared with normal concrete. The optimum result is obtained for 30% replacement of CTA with coarse aggregate.
- By addition of ceramic tile aggregates into coarse aggregate, proper utilization of ceramic tile waste can be achieved.
- In case of combinations, the compressive strength is increasing for all the cases.

REFERENCES

1. **IS: 456-2000**, Indian Standard "Plain and reinforced concrete"-code of practice.
2. **IS: 10262-2009,** Indian Standards **"**Recommended guidelines for concrete mix design proportioning"-code of practice.
3. **IS: 383-1970,** "Specifications for coarse and fine aggregate from natural source for concrete", (Second revision), Bureau of Indian Standards, New Delhi, India.
4. "Concrete technology" Theory of practice, A text book of M**.S Shetty,** 2005.
5. **Parmindar singh, "**Utilization of waste ceramic tiles as aggregate in concrete" Journal of multidisciplinary engineering science and technology (IJMEST), ISSN: 3159-0040 Vol 2 issue 11, pp 3294-3300.
6. **MD Daniyal, Shakeel Ahmed,"** Application of waste ceramic tile aggregate in concrete",

International Journal of Innovative Research in Science, Engineering and Technology, ISO 3297: 2007, VOL. 4, Issue 12,dec 2015.

7. **I. B. TOPCU and M . CANBIZ,** Utilization of crushed tile as aggregate in concrete" Iranian Journal of Science and Technology, vol 31, no. B5, pp 561-565.
8. **Sudarsana Rao Henchate, Giridhar Valikala, Vaishali .G. Ghospade, "**Influence of water absorption of the ceramic aggregate on strength properties of ceramic aggregate concrete", International Journal of Innovative Research in Science, engineering and Technology, Vol 2, Issue 11.pp 6329-6335**.**
9. **A.MD Mustafa Al Baki, M . N. Nolazian, H . Kamaruin, and G. MD Ruzaidi, "**Potential of recycled ceramic waste as coarse aggregate for concrete", Malaysian Universities Conferences on Engineering and Technology, March 8-10,2008,Malaysia
10. **R. Kamala, B. Krishna Rao, "**Reuse of solid waste from building demolition for the replacement of Natural Aggregate" ,International Journal of Engineering and Advanced Technology, ISSN: 2249-8958, Volume-2, Issue-1, October 2012.

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