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Behaviour of Pervious Concrete by Replacement of Coarse Aggregate with Ceramic Waste

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Abstract - *Pervious concrete is a open graded structure with interconnected voids through which rain and storm water is allowed to travel into groundwater. It is usually prepared with small gravel as coarse aggregate in its composition. It contains little or no sand. Pervious concrete is used in pavement for parking lots. In this method , it is proposed to replace the regular coarse aggregates by crushed ceramic waste. Low cost of concrete is due to reuse of waste ceramics materials. Further, land pollution is prevented as the ceramic wastes are utilized as raw material for pervious concrete preparation .In the recent study, Ceramic tile waste were used in concrete as a replacement for coarse aggregate with M20 grade concrete were used. The concrete moulds were casted and tested for Compressive Strength after a curing period of 3, 7 & 28 days. The results indicate that, the maximum compressive strength is obtained for the 50% replacement of ceramic tile aggregate with natural coarse aggregate*

Key Words: *Ceramic Waste Aggregate (CWA), Compressive strength ,conventional coarse aggregate ,Setting time, Sieve analysis, Specific gravity, Water absorption. , Water-cement ratio.*

1. INTRODUCTION

Concretes are mixtures of cement, aggregate and water. Addition of coarse aggregate to cement paste increases the strength of the concrete. The coarse aggregate added influences the properties and applications of the concrete. Pervious concrete is a type of concrete with high porosity (17–25%).The high porosity in pervious concrete is attained by a highly inter connected void content. The pervious concrete has little or no fine aggregate and has just enough cement paste to coat the coarse aggregate particles (10–20mm) while preserving the interconnectivity of the voids. It is used for concrete pavement applications which allow water from precipitation and other sources to pass through, there by reducing the water stagnation , surplus water from a site and recharging ground water levels. Pervious concrete is widely used in parking areas, pedestrian walkway, green houses. It is important application for workable construction. Rapid industrial development causes serious problems all over the world such as exhaustion of coarse aggregates and creates vast amount of waste material from construction and pulling down activities. One of the ways to reduce this problem is to make use 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 70% .The ceramic materials contribute the highest percentage of wastes within the construction and demolition wastes about 50%. Ceramic waste is strong, hard and highly resistant to Biological, Chemical and Physical ruin forces. Ceramic waste aggregate are hard having considered value of specific gravity, rough surface on one side and smooth on other side, are lighter in weight than conventional coarse aggregates. Using ceramic tiles as aggregate in concrete not only will be cost effective but also will be good from pollution free point of view. The following section gives a brief explanation and some of the important relevant studies that were carried out to the considered work Studied on the utilization of waste materials in concrete production which is helpful to achieve the goal of sustainable construction. This study intends to use of Ceramic tile waste aggregate having 20mm 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 important effect on M20 and M25 Mixes. But beyond that, strength started decreasing gradually with the increase in the proportion of tile aggregate in concrete. Studied by replacing crushed tile as a coarse aggregate in concrete with partial replacement of coarse aggregate. The fresh concrete and hardened concrete tests were carried out. The strength and unit weight of ceramic waste aggregate concrete were decreased compared to control concrete. Captivation and capillarity coefficients were increased compared to the control concrete.

In this tentative world, the reuse of solid wastes and aggregates from construction and demolition waste is showing a potential application in construction and as alternative to primary and natural aggregates.

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2. DESCRIPTION OF MATERIALS

2.1 Cement

Cement is a powdery material which is mixed with water to act as a binding medium. The components used for manufacturing cement are calcium carbonate, silica, iron ore and alumina .These components are obtained from limestone rock, chalk, clayey schist or clay. The density of Cement is 2.8g/cm^3.There are 3 main grades of Ordinary Portland cement. Of the three, Ordinary Portland cement of grade 53 confirming to IS:12269 is used for various works. IS 4031 part 1 & 2 specifies the physical test to be conducted on cement.

2.2 Fine Aggregate

Sand ranging between 4.47mm and 0.150mm size is termed as fine aggregate .It is commonly used for making concrete, mortar and plaster. Some of the impurities present in sand are Clay, Silica, mica and organic matter .If the impurities are present beyond the permissible limit, the strength of mortar and concrete made from sand is reduced. A maximum of 8% silt and 2 to 3 % mica are permitted in sand. IS 2386-1963, Part 1 to 8 specifies the test to be conducted on aggregate

2.3 Coarse Aggregates

Materials that are greater than 4.75mm sieve size are termed as coarse aggregate .It's maximum size can be upto 63mm.The requirements of coarse aggregate is mentioned in IS 383 and IS 2386.Water used for construction should not have Ph below 6.The W/C ratio should be between 0.25 and 0.50. IS 3025 (in 56 parts) refers to the test on water and waste water.

2.4 Ceramic tile Aggregate

Ceramic waste are the waste that are produced during dressing and polishing work. The ceramic waste such as tiles are collected and broken into fragments .The size of ceramic waste ranging between 20mm and 12mm sieve size is selected.

Fig-1: Snapshot of Pervious Concrete

Table -1: Physical properties of cement

SL.NO	TEST	RESULTS
1	Specific gravity	3.14
2	Setting time of cement Initial setting time Setting time of cement	28 Min 280 Min

Table -2: Physical properties of fine aggregates

SL.NO	TEST	RESULT
1	Fineness modulus	2.45
2	Maximum size	2.35mm
3	Specific gravity	2.56
4	Water absorption	1%

Table -3: Physical properties of coarse aggregates

SL.NO	TEST	RESULTS
1	Fineness modulus	2.26
2	Maximum size	20mm
3	Specific gravity	2.6
4	Water absorption	0.7%

Table -4: Physical properties of ceramic tile aggregates

SL.NO	TEST	RESULTS
1	Specific gravity	2.22
2	Impact value	25%
3	Water absorption	13.4%

3. EXPERIMENTAL PROCEDURE

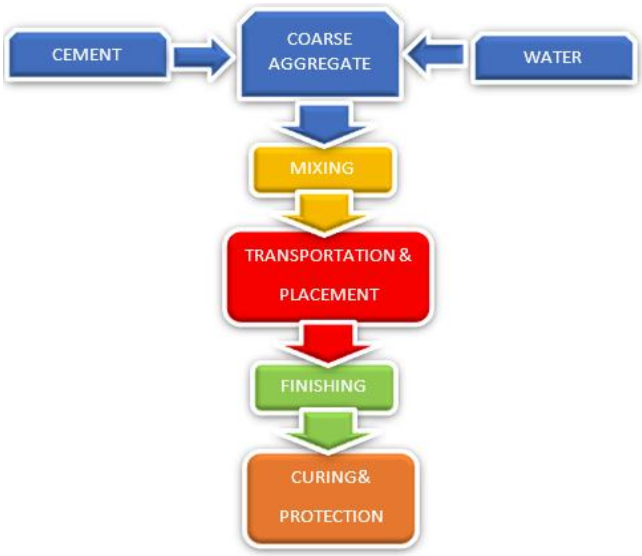

Chart-1: Process involved

This Chart .1 indicates the flowchart of the whole process which consists of selection of materials such as cement, fine aggregate, coarse aggregate and ceramic waste aggregate. Concrete is prepared for M20 mix designed for conventional concrete. Ceramic waste aggregate is used as partial replacement with coarse aggregate. Materials are mixed by considering the proportions as per the mix design. The cube mould of dimension 150x150x150 mm in 3 layers in which each layer of height 50mm. In each layer compaction is done by using tamping rod/vibrator table. Moulds are prepared for different proportions as per the design IS: 10262 – 2009. The moulds are cured for 3, 7 & 28 days under no dry condition until they are tested. The concrete cube specimens are tested at the age of 3, 7 & 28 days of curing period. Concrete cubes are placed on compression test machine & 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.

3.1 Mix proportion

The mix proportion refers to the process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing.

Table-5: Mix proportion

RATIO	CERAMIC WASTE	CA	CEMENT
2:0:1	2	0	1
3:0:1	3	0	1
1.5:0.5:1	1.5	0.5	1
2:0:0.5	2	0	0.5
2:0:1 (< 16mm)	2	0	1

4. RESULTS AND DISCUSSION

Compressive strength for different ratio of ceramic waste aggregate used for M20 grade .This result section shows the compressive strength of the conventional concrete and ceramic waste aggregate concrete and also the comparison of their 28th day strength.

Table - 6: Test results of M20 grade concrete with replacement of CWA with coarse aggregate for 3, 7 and 28 days

COMPOSITION CERAMIC & CA:CEMENT	7TH DAY (N/ mm²)	14TH DAY (N/ mm²)	28TH DAY (N/ mm²)
2:1 (100%replacememt of CA by ceramic waste)	12.32	15.62	17.77
2:0.5 (100%replacememt of CA by ceramic waste)	4.77	5.62	6.80
2:1 (75% of ceramic waste and 25% of coarse aggregate)	9.66	15.6	24.44
3:1 (120% replacement of CA by ceramic waste)	5.33	7.83	8.88
2:1 (100%replacememt of CA by ceramic waste of <16 mm)	7.85	9.87	10.23

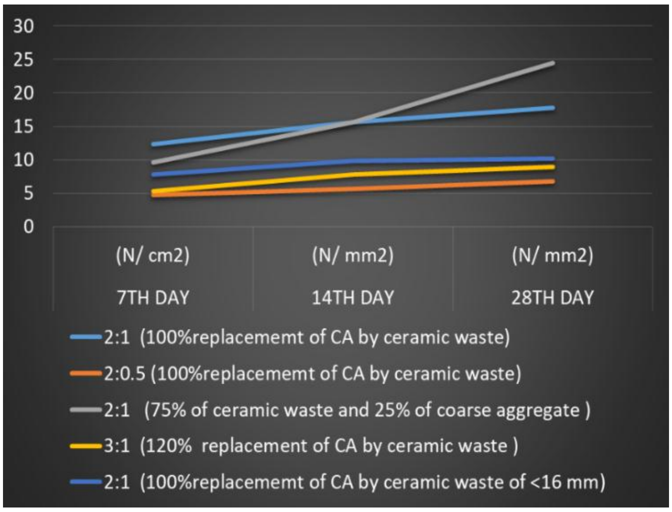

Chart-2: M20 concrete grade with replacement of CWA and their compressive strength at 3,7 and 28 days

Table-7: Test results of M20 grade concrete with replacement of CWA with coarse aggregate for 3, 7 and 28 days

COMPOSITION CA & CERAMIC:CEMENT	7TH DAY (N/ mm²)	14TH DAY (N/ mm²)	28TH DAY (N/ mm²)
2:1 (100% coarse aggregate)	17.77	19.58	21.88
2:0.5 (100% coarse aggregate)	8.88	10.55	12.58
2:1 (75% CA and 25 % ceramic waste)	13.33	20.44	22.85
3:1 (120% coarse aggregate)	4.53	5.33	7.11
2:1 (100% coarse aggregate of size <16mm)	9.55	15.46	17.82

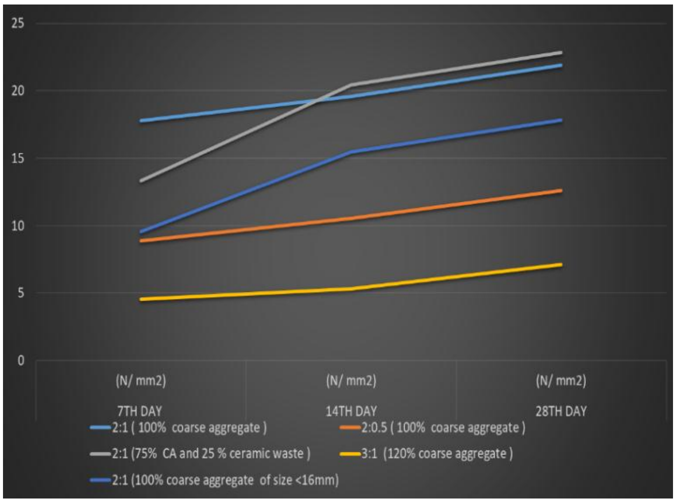

Chart-3: M20 concrete grade with replacement of conventional concrete and their compressive strength at 3,7 and 28 days.

Two different charts are been made for the compressive strength results of conventional concrete and ceramic waste concrete.

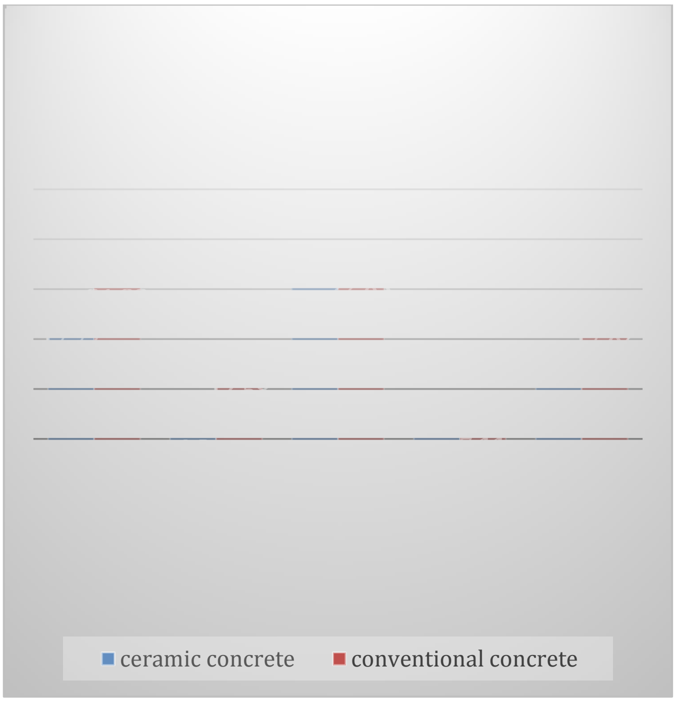

Chart-4: Shows the 28th day test comparison between ceramic waste concrete and conventional or normal coarse aggregate

5. CONCLUSIONS

Based on the experimental investigation and research, the following results have been derived

- Pervious concrete has been made, by modifying the body formulations of the conventional pervious concrete.
- The coarse aggregate (10-20mm size) is partially replaced by same sized ceramic waste which is obtained from crushing the tiles <ehich have comparative strength as compared with conventional aggregates.
- Three samples of five different composition were prepared to study the properties. Among the five different compositions, the one which satisfies porosity, compressive strength is the composition which contains 2 parts by volume of ceramic waste and 1 part by volume of cement and required amount of water.
- It is also found to be cheaper than conventional concrete by 10% for 1m3 work.
- We expect that this proposed strategy can be used in various applications where the pervious concrete is particularly used and it is suitable for the applications such as parking areas, pavements, tree grates in side walks, and the like.

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] Bentz, D.P., and Martys, N.S., "A Stokes Permeability Solver for Three-DimensionalPorousMedia,"NISTIR7416, U.S. Department of Commerce, 2007

[5] Haselbach, L.M., and Freeman, R.M., "Vertical Porosity Distributions in Pervious Concrete Pavement," ACIMaterialsJournal,103(6),452-458,2006.

[6] Utilization of ceramic waste in ceramic, Ceramic International, Volume 26, Issue 5, 16 June 2000, Pages 485-493, Sakarya University, Arts and Sciences Faculty,

[7] Chemistry Department, Serdivan, Sakarya 54180, Turkey.

[8] Waste management in sanitary ware, Waste management and Research, Volume 9, Issue 4, August

1991, Pages 239-258, Stormgade20, 1555,Copenhagen V, Denmark.

[9] Tennis,P.D,Leming,M.L;andAkers,D.J,PerviousConcretePavements,Portland cement Association, Ready Mixed Concrete Association, Silver Spring, Maryland, 2004,25pages.

[10] Schaefer, V.R .,Wang , K ., Suleiman , M.T. and Kevern, J.T.," Mix Design Development for Pervious Concrete in Cold Weather Climates , " Final Report , National Concrete Pavement Technology Center, Feb.2006.

[11] Montes, F., and Haselbach , L., "Measuring Hydraulic Conductivity on Pervious Concrete," Environmental Engineering Science, 23 (6), 960-969,2006.

[12] Neithalath , N., Weiss ,J ., and Olek ,J., "Characterizing Enhanced Porosity Concrete Using Electrical Impedance to Predict Acoustic and Hydraulic Performance," Cement and Concrete Research,36(11),2074-2085,2006.

[13] Utilization of ceramic waste in ceramic, Ceramic International, Volume26, Issue 5, 16 June 2000, Pages 485-493, Sakarya University,

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