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AN EXPERIMENTAL STUDY ON CERAMIC WASTE AGGREGATE AND CRUSHED SAND AS AN PARTIAL REPLACEMENT FOR COARSE AGGREGATE AND NATURAL SAND IN CONCRETE

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Abstract - *The main objective of this study is to examine the mechanical properties of concrete by using ceramic coarse aggregate and crushed sand (Manufactured sand).The aggregate was replaced by ceramic aggregate in the proportion of 0%, 10%, 20% and 30%. Based on the experimental results the replacement by 20% ceramic aggregate exhibited the highest strength. By based on results ceramic aggregate in the proportion 20% is taken optimum value. The natural sand was replaced by Crushed Sand in the proportion of 0%, 20%, 40%, 60% and 80%. A series of experiments were conducted in M40 grade concrete to study the compressive strength, flexural strength and splitting tensile strength. Water cement ratio is 0.40 and super plasticizer is1% by the weight of cement. Based on the experimental results the replacement by 20% ceramic aggregate and 60% Crushed Sand exhibited the highest compressive strength.*

Key Words: Ceramic aggregate, crushed sand, Mechanical properties.

1. INTRODUCTION

The strength of the concrete composite is based on the strength of different constituents used in the preparation of concrete. The use of secondary materials, such as recycled aggregates, might not create a major source of aggregate but if secondary materials were used in demanding situations, the quantity of natural aggregate but if secondary materials were used in demanding situations, the quantity of natural aggregate required by construction Industry would be reduced. The use of secondary materials may not completely remove the Problem of the resulting shorting of aggregate but it could alleviate it.

Concrete is a mixture of cement, fine aggregates, coarse aggregate and water with or without admixtures. Since the development in the construction sector, there has been a rapid depletion of natural resources mainly river sand. The use of crushed stone fine aggregate as substitute for natural sand was studied and it was concluded that there was significant increase in strength and durability properties with crushed sand. The crushed stone waste as fine aggregate in concrete leads to increase in compressive strength, flexural strength and split tensile strength. But the workability of concrete decreased with higher percentage of stone dust as this can be increased with the addition of super plasticizer.

2. MATERIAL PROPERTIES

2.1CEMENT

Cement used in experimental work was Ordinary Portland cement (Rasi gold) of 53 Grade. Cement used was fresh, of uniform colour, free from any lumps and foreign matter and from the same batch. As per IS: 12269 have been procured and following tests have been carried out according IS: 8112-1989. Experimental results are tabulated in Table 1 and compared the results with IS specification.

Table – 1: Properties of cement

S.NO	Property	Value	IS Standards
1.	Normal consistency	32%	33-35%
2.	Fineness of cement (weight of residue on 90 μ sieve)	6.5%	<10%
3.	Setting times		
	Initial setting time (Minutes)	105 Minutes	≥ 30 minutes
	Final setting time (Minutes)	300 Minutes	≤ 600 Minutes
4.	Specific Gravity	3.15	3.1-3.2
5.	Compressive strength		
	3 Days	29.39 Mpa	27 Mpa
	7 Days	43 Mpa	-
	28 Days	53.62 Mpa	53 Mpa

2.2 FINE AGGREGATE

The natural available river sand conforming to grading as zone-II of table3.4 according to the IS: 383-1970 has been used as Fine aggregate for the experimentation. It is clean, inert and free from organic matter, silt and clay.

Table – 2: Properties of Fine Aggregate

S.NO	Property	Value	Range of values AS PER IS:383-1970
1.	Specific gravity	2.58	2.5-2.8
2.	Fineness modulus	2.6	2.2-2.6
3.	Grading	ZONE- II	I-IV

2.3 CRUSHED SAND

Crushed stone sand is manufactured sand (M sand), which is better in terms of quality and fulfils the requirements of suitable material for use in concrete**.** The manufactured sand as fine aggregate in concrete slightly increases the compressive strength.

Table – 3: Physical Properties of crushed sand

S.NO	Property	Value
1.	Specific gravity	2.64
2.	Fineness modulus	2.83
3.	Grading	ZONE- II

2.4 CERAMIC WASTE AGGREGATE

The properties of ceramic aggregate such as specific gravity, water absorption, impact value, crushing value, abrasion value are determined and the results are tabulated in table 5.Comparison is made between ceramic aggregate and coarse aggregate and tabulated in table 6.

Table – 4: Physical properties of ceramic aggregate

S .No	Property	Value
1	Specific gravity	2.48
2	Water absorption in %	0.17
3	Impact value in %	22
4	Crushing value in %	20
5	Abrasion value in %	18

2.5 COARSE AGGREGATE

For the usage of this aggregate into concrete, it is necessary to determine the specific gravity, water absorption, and bulk density. Accordingly, tests have been carried out as per the procedure given in IS: 2386(part-III)-1963 and the results are tabulated in table 5.

Table – 5: Physical properties of coarse aggregate

S .No	Property	Value
1	Specific Gravity	2.72
2	Bulk density (kg/m3) i. Loose ii. Compacted	 1224 1418
3	Water absorption in%	0.10

2.6 WATER

Locally available bore well water is used for the experimentation and curing purpose. The water is free from any contamination, substance and other organic matter.

- Portable water from laboratory taps was used for concrete production.
- Water from same source was used for curing.
- PH value not less than 6 as per IS 456-2000

3. TEST RESULTS

3.1 COMPRESSIVE STRENGTH

In order to study the behavior of ceramic waste aggregate and crushed sand concrete produced with waste ceramic coarse aggregate by replacing the natural coarse aggregate and crushed sand by replacing the natural river sand design mix is prepared for M40 grade. Samples are casted by replacing natural coarse aggregate with waste ceramic aggregate as 10, 20 &30%. 20% of ceramic aggregate is optimum taken samples are casted replacing natural river sand with crushed sand as 20%, 40%, 60% and 80%. The compressive strength of concrete specimens for 3days, 7 days and 28 days was tested and the results are tabulated in table 6.

Table – 6: Compressive strength of ceramic aggregate and crushed sand concrete for 3,7 and 28 Days

S.NO	% of ceramic	% of crushed sand	Compressive strength at 3 days (Mpa)	Compressive strength at 7 days (Mpa)	Compressive strength at 28 days (Mpa)
1	0	0	24.6	35.5	49.0
2	10	0	25.2	36.5	50.5
3	20	0	26.4	38	51.5
4	30	0	22.8	35.5	47.5
5	20	20	24.0	35	44.5
6	20	40	25.8	36.5	48.5
7	20	60	26.4	38.5	53
8	20	80	23.6	34.5	43.5

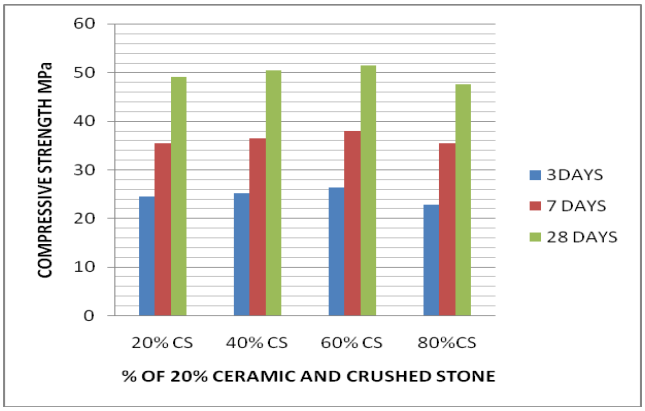

Chart - 1: Compressive strengths of 20 % of ceramic aggregate optimum and %0f crushed dust.

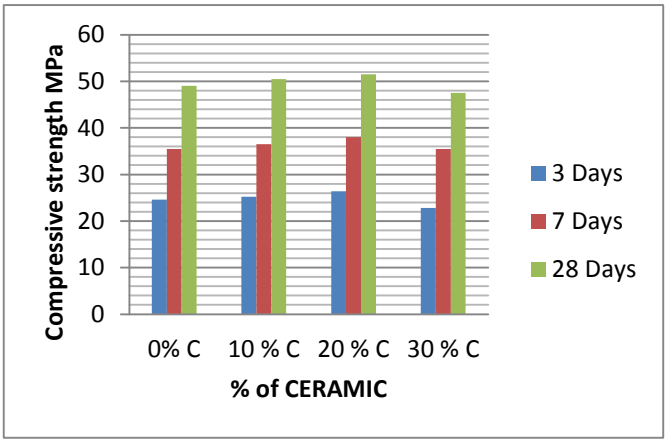

Chart -2: Compressive strengths of % of ceramic aggregate

3.2 SPLIT TENSILE STRENGTH

Samples are casted by replacing natural coarse aggregate with waste ceramic aggregate as 10, 20 &30%. 20% of ceramic aggregate is optimum taken samples are casted replacing natural river sand with crushed sand as 20%, 40%, 60% and 80%. The split tensile strength of concrete specimens for 3days, 7 days and 28 days was tested and the results are tabulated in table 7.

Table - 7split tensile strength of ceramic aggregate and crushed sand concrete for 3,7 and 28Days

S.NO	% of ceramic	% of crushed sand	Split tensile strength at 3 days(Mpa)	Split tensile strength at 7 days(Mpa)	Split tensile strength at 28 days(Mpa)
1	0	0	1.59	2.42	2.80
2	10	0	1.60	2.43	2.86
3	20	0	1.61	2.46	2.99
4	30	0	1.590	2.44	2.96
5	20	20	1.62	2.51	2.97
6	20	40	1.66	2.57	3.02
7	20	60	1.72	2.63	3.24
8	20	80	1.68	2.48	3.05

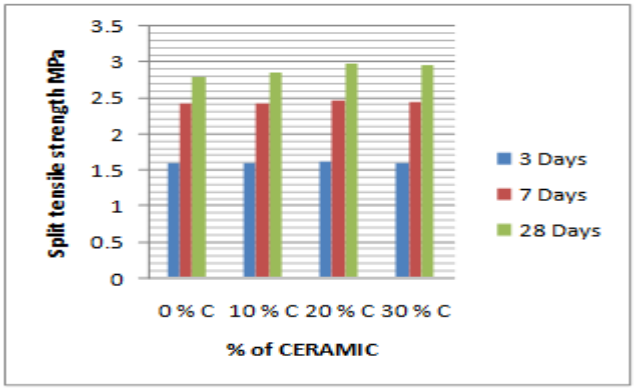

Chart – 3: Split tensile strength % of ceramic aggregate

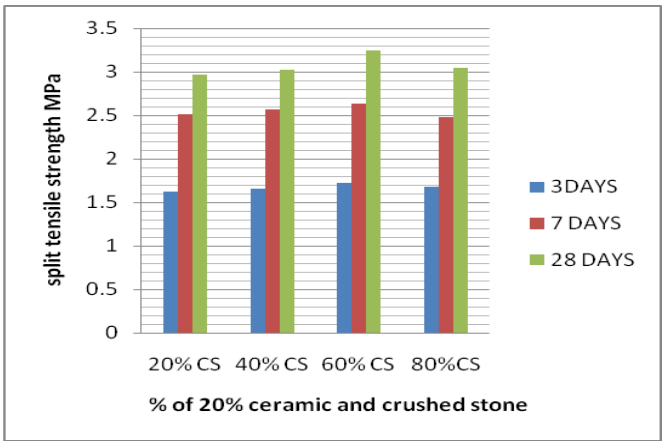

Chart - 4: Split tensile strength of 20% of ceramic aggregate optimum and % of crushed sand.

4. CONCLUSION

This study deals with M40 Concrete with ceramic aggregate and Crushed Sand used as substitute material to course aggregate and natural sand. The concrete mix was designed to attain the strength of 46.5 N/mm2. In compression testing all the specimens reached more than 46.5N/mm2. Thus it is proved that ceramic aggregate and crushed sand can also partial replacement for course aggregate and fine aggregate in concrete. Based on the experimental results it is evident that the optimum percentage of ceramic aggregate is 20% and crushed sand is 60% partial replacement in concrete.

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