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Evaluation of non-conventional concrete by Self-Curing method

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ABSTRACT

Conservation of natural resources and preservation of environment is the essence of any development. The problem arising from continuous technological and industrial development is the disposal of waste material. The main focus of this research is the strength assessment of Non- Conventional Concrete by self-curing method. Extensive research is currently going on to evaluate the introduction of recycled waste materials in concrete.

We introduced the waste materials as useful ingredients in concrete namely Ceramic Wastes (C.W) as partial replacement of coarse aggregate respectively. Cubes were casted and tested for compressive strength, flexural test and split tensile test after a curing period of 7 and 28 days by immersion method.

Keywords: Ceramic Waste, Compressive strength, Tensile strength, Flexural strength.

INTRODUCTION

Concrete is the most consumed material. Production of concrete relies to a large extend on the availability of cement, sand and coarse aggregate, the cost of which have astronomically over the past few years. The negative consequences for increasing the demand for the concrete including depreciation of aggregate deposit. Most damaging are the enormous amount of energy is required to produce the Portland cement as well as large quantity of co2 released during this process. Concrete made with Portland cement with certain characteristic it is relatively strong in comparison and weal in tension and tends to be brittle. So we need to reduce the environmental stress to make construction sustainable, has necessitate research into the use of alternative materials, especially locally available one used in concrete production. So here we introduce the ceramic waste can be transformed into useful coarse aggregate the properties of ceramic waste coarse aggregate are well within the range of values of the concrete making aggregate and also use inorganic industrial residual product in making concrete will lead to sustainable concrete design and greener environment.

MATERIALS USED

Materials used and its Properties

Cement

The Cement used in this study was Ordinary Portland cement (OPC) which is the most important type of cement. OPC cement of 53grade of cement use in this experimental work. Conforming to IS: 12269-1987 is used in this project and the weight of each cement bag was 50kg.The property of cement is shown in Table 1.

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Table 1: Properties of Cement

Physical Properties	Value observed in investigation	Standard value for OPC
Specific gravity	3.15	-
Initial setting time (minutes)	25min	> 30min
Final setting time (minutes)	390min	< 600 min

Fine Aggregate

Fine aggregate are termed as "filler" which fills the voids in concrete. M-sand was used as Fine aggregate with fineness modulus of 2.77 and it should passing through IS Sieve 4.75mm. It should have fineness modulus 2.50- 3.50 and silt content should not be more than 4.The properties of Fine aggregate are shown below in Table 2.

Table 2: Properties of Fine Aggregate

S.No	Property	Value
1	Specific gravity	2.53
2	Grading Zone	II (IS 383- 1970)
3	Fineness modulus	2.50 (2.50-3.50)
4	Sieve analysis	4.75 mm

Coarse Aggregate

The coarse aggregate are the blue granite stone of which particles greater than 4.75mm they should be hard, strong, dense, durable and clean. It should be conical shape. Flaky pieces should be avoided. It creates much better bond between cement paste and the Aggregates.The fraction of aggregate is used in this experimental work passed in 20mm sieve and retained in 12.5mm IS sieve conforming to IS: 383-1970. The properties of Coarse aggregate are shown below in Table 3.

Table 3: Properties of Coarse Aggregate

S.No	Property	Value
1	Sieve analysis	6.99 mm
2	Specific gravity	2.69
3	Water absorption	0.70%

Super Plasticizers

Super plastizers are known as high range water reducers are chemical admixtures used where well dispersed particle suspension is required. Polyethylene glycol-400 is used as self-curing agent. It is condensation polymer of ethylene oxide and water with general formula H(OCH2CH2)n OH.one common feature of PEG appears to be water soluble in nature. The aim of this project is prepare the self-curing concrete of grade M20 with PEG-400 in the range 1% as addition by weight of the cement in mix.

Table 4: physical and chemical Properties of PEG-400

S.No	Characteristics	Test value
1	Appearance	Clear liquid
2	Solubility	Soluble in water
3	Odour	Mild odur
4	Molecular weight	400

Ceramic Waste

Ceramic waste can be transformed into useful coarse aggerete. The properties of ceramic waste coarse aggregate are not significantly different from those of conventional concrete. The use of ceramic waste coarse aggregate concrete has increased because it has various advantages over other cementitious material. It has been estimated that about 30% of daily waste in ceramic industry goes to waste. This waste is not recycled in any form at present. However the ceramic waste is durable, hard, and highly resistant to biological, chemical and physical degradation forces. The use of inorganic industrial residual product in making concrete will lead to sustainable concrete design and greener environment.

Table 5: Properties of Ceramic waste

S.No	Property	Value
1	Specific gravity	2.25
2	Sieve analysis	6.99 mm
3	Crushing value	25.00%
4	Impact value	20.00%
5	Shape	Flaky

Table 6: Quantity of material

S.No	Description	Value	Kg/Lit
1	Total quantity of cement	40	Kg
2	Total quantity of coarse aggregate	93.81	Kg
3	Total quantity of fine aggregate	65	Kg
4	Total quantity of water	15	Lit
5	Total quantity of ceramic waste	37.05	Kg
6	Total quantity of super plasticiser	1	Lit

IVESTIGATION

Workability of fresh concrete

Influence of ceramic waste content on the workability of fresh concrete. The slump test was used to measure workability as a function of ceramic waste content for constant w/c ratio, the effect of ceramic waste content on the slump. The slump value seems to decrease with higher percentage of limestone filler content, this result is related to the relatively high water absorption capability which is attributed mainly to the large specific surface of ceramic waste.

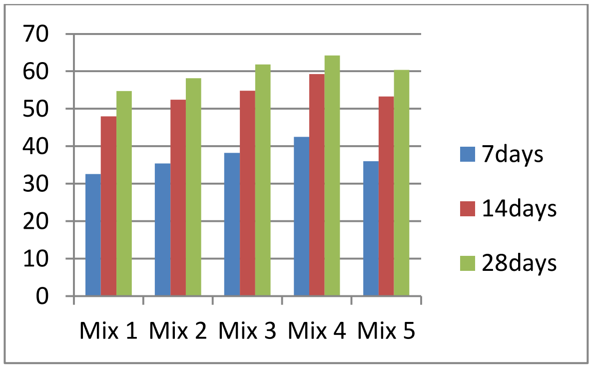
Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform and partly because most of the desirable properties of concrete are qualitatively related to its compressive strength. The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7, 14 and 21days. The mould and its base rigidly clamped together so as to reduce leakages during casting. The sides of the mould and base plates were oiled before casting to prevent bonding between the mould and concrete. The cube was then stored for 24 hours undisturbed.

The testing of cube under compression was shown in figure

Table 7: Test results for compression strength

Mix	Compression Strength N/mm^2		
	7days	**14days**	**28days**
Mix 1 (0%)	8.23	12.42	19.30
Mix 2 (20%)	8.75	12.58	19.40
Mix 3 (30%)	8.80	13.80	18.78
Mix 4 (40%)	9.17	13.28	19.4
Mix 5 (50%)	9.05	14.25	19.00



Graph 1: Compression strength Test

Split Tensile Strength Test

For tensile strength test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. In this test three cylinders were tested and their average value was reported. The split tension test was conducted by using digital compression machine having 2000 KN capacity.

Split tensile strength was calculated as follows:
Spilt Tensile strength (MPa) = 2P / π DL
Where, P = Failure Load (kN)
D = Diameter of Specimen (150 mm)

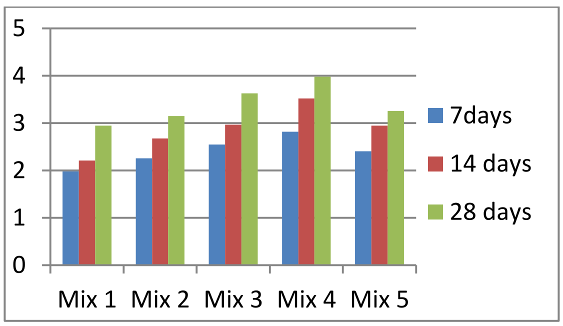
L = Length of Specimen (300 mm)

Test Results of splitting tensile strength for M_{20}grade of concrete shown in table 7.

Three cylinder specimens were casted in each percentage, in order to find the average value of split tensile strength. These cylinder specimens were left for 28days curing in a curing tank for conventional concrete and non-conventional concrete can be cured in ecofriendly manner. After the course of curing, the specimens were ready for testing. All the cylinders were tested. From the split tensile strength test, it has been clear that the F.A percentage of 20% (M3) has greatest strength than others. The addition of F.A increased up to 14% strength, whereas more addition of F.A decreased the strength of the cylinders.

Table 8: Test results for Split Tensile strength test

Mix	**Split Tensile Strength Test N/mm^2**		
	7days	**14days**	**28days**
Mix 1(0%)	2.24	2.39	2.95
Mix 2 (20%)	1.90	2.40	3.15
Mix 3(30%)	2.10	3.10	3.63
Mix 4(40%)	2.20	3.52	3.98
Mix 5(50%)	1.86	2.95	3.26



Graph 2: Split Tensile Strength Test

Flexural strength test

For Flexural strength test, specimen of 150 mm X 200 mm X 1500 mm was casted. A beam specimen is placed in the ultimate testing machine of 2000kN capacity for testing. Rollers are placed at a centre to centre distance of the beam specimen. The load is increased until the specimen fails and the maximum load applied to the specimen during the test is recorded.

The Flexural strength is calculated by using the formula

$$\sigma = P\, l / bh_2$$

Where,

P = load in Newton shown in dial gauge

l = length of rectangular prism in mm i.e. 1500 mm

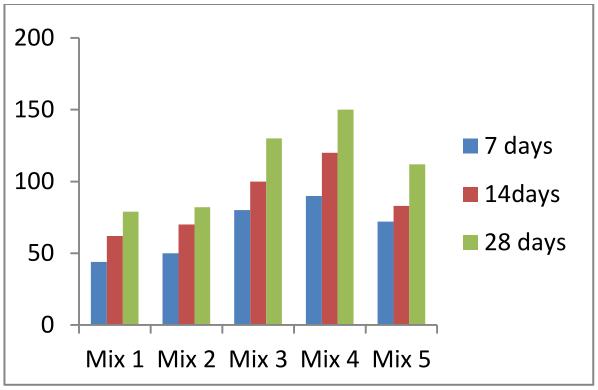
b = breadth of rectangular prism i.e. 150 mm

h = height of rectangular prism i.e. 200 mm.

Test Results of flexural strength for M_{60} grade of concrete is shown in table 9.

Table 9: Test results for Flexural strength test

Mix	**Flexural Strength Test N/mm^2**		
	7days	**14days**	**28days**
Mix 1(0%)	1.5	2.4	2.38
Mix 2(20%)	1.9	3.04	3.45
Mix 3(30%)	2.3	3.68	3.89
Mix 4(40%)	2.45	2.62	2.78
Mix 5(50%)	1.85	1.98	2.21



Graph 3: Flexural strength test

CONCLUSIONS

In summary of the above investigations, the following conclusions are made from the experimental results on ceramic waste and self-curing agent PEG-400 indicated following:

- Concrete on 40% replacement of coarse aggregate by ceramic waste aggregate gives the optimum strength and hence it's become more economical without compromising concrete strength than the controlled concrete.
- Also reducing the unit weight of concrete by 3%
- Cost of concrete is reduced by 9.92%
- It is the possible alternative solution of disposal of ceramic waste.
- For the experimental investigation, it is clearly showed that compressive and split tensile strength of self-curing concrete is greater when compared to concrete by immersion curing.

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