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Investigation on Partial Replacement of Coarse Aggregate with Ceramic Waste and Addition of Steel Fiber in Concrete

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Abstract: ***Housing industry is consuming the planet's resources at a really rapid rate, because the industry is growing at an increasing speed to satisfy the stress of the economy, it's consumption requirements are becoming bigger, expensive and putting tons of stress on the environment waste disposed in landfills and isn't recycled. Even a little portion of it recycled may cause considerable deduction within the effects. Fiber in concrete is usually wont to control the plastic shrinkage, dry shrinkage cracking and permeability. In recent times steel fiber ferroconcrete has become more frequent substitute for steel ferroconcrete because the lastingness and flexural strength of concrete is increased thanks to addition of steel fiber in concrete. In this project, we are proposing to use used or broken ceramic tiles as a partial replacement to the coarse aggregate which forms the majority of the concrete, and addition of steel fiber for extra reinforcement to concrete. Ceramic waste isn't only from the development industry it's also coming from the manufacturing sector. These ceramic waste materials are almost non-recyclable and are very inert to environmental elements. These will meet the conditions of aggregate in strength, durability and inertness. They're also of lower density and good insulation material. For this project ceramic waste which varying sizes are going to be partially replaced in situ of coarse aggregate by 5%, 10% and 15% and addition of fifty of steel fiber by weight of cement for a mixture of M25 grade concrete. all types of experimental investigations are going to be done on the concrete and therefore the variations in compression strength, lastingness, flexural strength of the concrete are going to be noted and a report are going to be submitted.***
Keywords: Concrete, Ceramic waste, Steel fiber, compressive strength, split tensile strength, flexural strength

I. INTRODUCTION

Concrete is a mixture of fine, coarse aggregate bonded with fluid cement (cement paste) that hardens with time. Most often inside the past a lime-based cement binder, like lime putty, but now and again with other hydraulic cements, kind of calcium aluminates cement or with cement to shape cement concrete. When mixture is mixed with dry cement and water, the combination forms fluid suspension that's while not problems poured and wrought into form. The cement reacts with the water to form a tough compound that binds the aggregates together right into a stone-like difficult cloth that has many uses.

The technology of using concrete was adopted earlier on large-scale by the traditional Romans, and thus the foremost important a component of concrete technology was highly utilized within the empire. The Colosseum in

Rome changed into built largely of concrete and as a consequence the dome of the pantheon is that the World's largest unreinforced concrete structure. After the collapse of empire inside the mid-18th century, the generation become re-pioneered due to the fact the use of concrete has come to be rare. Today, the widely used simulated material is concrete in terms of tonnage.

II. LITERATURE REVIEW

B. Topçu and M. Canbaz (2010): The number of tile waste produced is enough to be used as an alternative to coarse aggregate in concrete. The utilization of ceramic tile waste features a positive effect on environment and within the cost aspects too. By the employment of tile combination, the self weight of concrete is reduced concerning 4% that makes the structure economical. Returning to the strength side, the tile combination replacement options a negative impact on each the compressive and split strength of concrete. However this paper studied most replacements of tile waste which can be any divided into smaller percentages and should be utilized in concrete with fascinating properties Falah A. Almottiri (2011): The study is conducted on the structural behavior of steel fibers reinforced ash concrete under the compression also as flexure. It had been determined that the employment of steel fiber in ash containing concrete improved its structural properties like flexural strength. sweetening of flexural strength and

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compressive strength obtained by increasing the proportion of ash up to 30% additionally as by adding 1% of steel fiber in concrete. Vikrant S. Vairagade and Kavita S. Kene (2012): The review study was administered for the introduction of steel fibers to get steel fiber ferroconcrete in sustainable and long-lasting concrete structures. The study found that the workability are often capable the concrete by introducing the super plasticizer without affecting the opposite properties.

III. EXPERIMENTAL METHODOLOGY

The methodology of research includes the collection of required materials i.e. cement, sand, coarse aggregates, broken ceramic tiles, steel fiber and super plasticizers from the various sources and determining the properties of all the materials gathered. Designing the concrete mix proportions for replacement and addition of materials and preparation of the concrete mix, molding and curing. The testing of concrete includes Slump cone test for determining workability of concrete in fresh state and compressive strength, split tensile test and flexural test for determining the strength of concrete in hardened state. The coarse aggregates are replaced by 5%, 10% and 15% of crushed tiles.

TABLE 1: Properties of cement

Sl.No	Characteristics	Values
1.	Fineness of cement	6%
2.	Normal consistency	30%
3.	Initial setting time	35 min
4.	Final setting time	220 min
5.	Specific gravity	3.04

TABLE 2: Properties of fine aggregate

Sl.No	Characteristics	Values
1.	Specific gravity	2.65
2.	Sieve analysis	2.75
3.	Bulking of sand	11.11%

TABLE 3: Properties of coarse aggregate

Sl.No	Characteristics	Values
1.	Specific gravity	2.75
2.	Sieve analysis	8.64
3.	Elongation index	9%
4.	Flakiness index	7%

TABLE 4: Properties of ceramic waste

Sl.No	Characteristics	Values
1.	Specific gravity	1.67
2.	Impact value	6.24%
3.	Abrasion	1.56%
4.	Attrition	1.83%

TABLE 5: Properties of steel fibre

Sl.No	Characteristics	Values
1.	Diameter	1.6mm
2.	Length of fibre	130mm
3.	Average aspect ratio	80
4.	Specific gravity	7.15

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IV. PREPARATION AND TESTINGOF SPECIMEN

There is a huge usage of ceramic tiles in the present constructions are going on and it is increasing in day by day construction field. Products made of ceramic are one of the main and important construction materials used in buildings. They are mostly produced using natural materials that contain high content of clay minerals. However, despite the ornamental benefits of ceramics, its wastes among others cause a lot of nuisance to the environment. And also in other side waste tile is also producing from demolished wastes from construction. Tiles production in Indian in the ceramic industry is 100 million ton per year; total waste material generated from the production is about 15% - 30%. The ceramic waste cannot be recycled into any form at present, but the ceramic waste is is tough, sturdy and extremely proof against all degradation forces thus, we tend to designated ceramic waste tiles as a material to replace the basic natural aggregate to recycle them and to decrease the ceramic waste produced from construction. Steel fiber is used in concrete for reinforcement and to increase the tensile strength of concrete.

Various sizes of broken ceramic waste are used as coarse aggregate and steel fiber is used as reinforcement. Workability is calculated by slump cone and compaction factor test to concrete. Cubes of 100mm x 100mm for compressive strength test, cylinders of 150mm x 300mm for split tensile test, beams of 500mm x 100mm x 100mm for flexural strength test where casted and cured. Five concrete mixes where prepared with different percentages of ceramic waste and 5% of steel fiber. Prepared specimens where tested as per IS: 516: 1959 for compressive strength, split tensile strength and flexural strength. Based on the results obtained from the tests optimum mix of concrete is arrived.

V. MIX DESIGN

TABLE 6: Mix design

S.No.	Material	Quantity(kg/m^3)	Proportion
1.	Cement	438.13	1
2.	Fine aggregate	643.20	1.46
3.	Coarse aggregate	1136.52	2.594
4.	Water	197.16	0.45
5.	Super plasticizer	0.438	0.1

VI. RESULTS AND DISCUSSION

A. Compression Strength Of Cubes

A total of 24 cubes of size 100 x 100 x 100mm were casted and tested for 7 days and 28 days testing of 6 specimens for each percentage after conducting the workability tests. C represents ceramic waste and S represents steel fiber in specimen designation. The results are tabulated below:

TABLE 7: Compressive strength on cubes for 7 days

Sl.No	Specimen Designation	Compressive Strength in N/mm^2
1	CS_0	17.63
2	CS_5	22.47
3	CS_{10}	24.26
4	CS_{15}	23.18

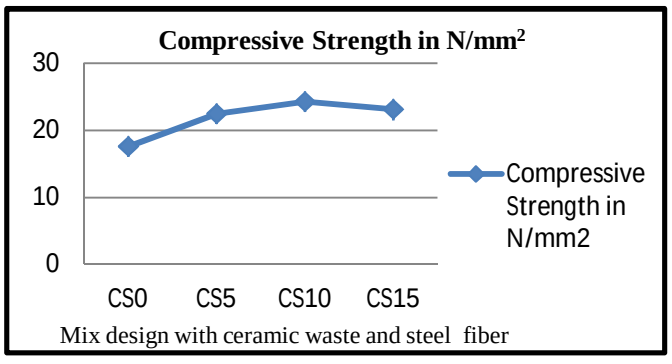


Fig 1: Compressive strength for 7 days

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TABLE 8: Compressive strength on cubes for 28 days

Sl.No	Specimen Designation	Compressive Strength in N/mm^2
1	CS_0	26.36
2	CS_5	34.68
3	CS_{10}	37.23
4	CS_{15}	36.49

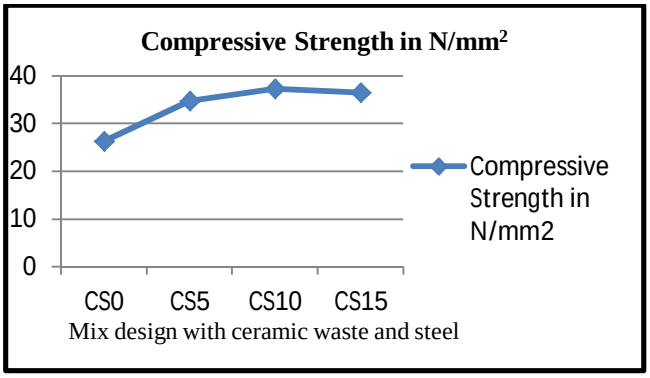


Fig 2: Compressive strength for 28 days

B. Split Tensile Test

A total of 16 cylinders of size 300mm x 150mm were casted and tested for 7 days and 28 days testing of 4 specimens for each percentage after conducting the workability tests. C represents ceramic waste and S represents steel fiber in specimen designation. The results are tabulated below:

Table 9: Split tensile strength on cylinders for 7 days

Sl.No	Specimen Designation	Split Tensile Strength in N/mm^2
1	CS_0	2.93
2	CS_5	3.31
3	CS_{10}	3.44
4	CS_{15}	3.37

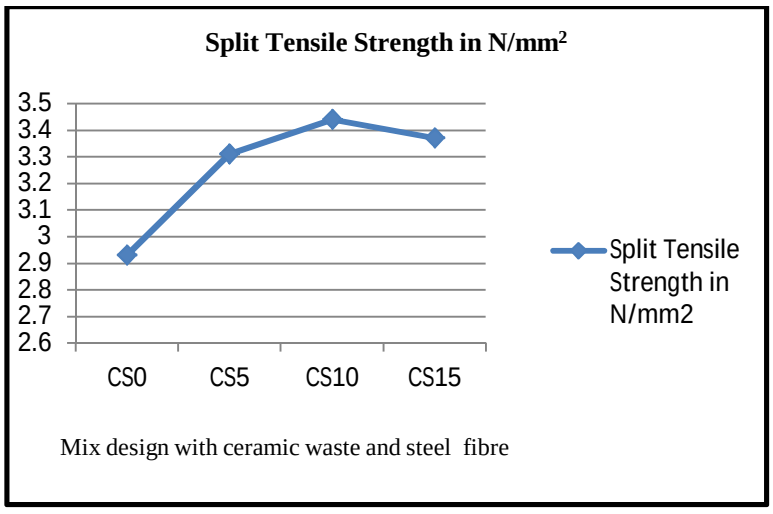


Fig 3: Split tensile strength for 7 days

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TABLE 10: Split tensile strength on cylinders for 28 days

Sl.No	Specimen Designation	Split Tensile Strength in N/mm^2
1	CS_0	3.59
2	CS_5	4.12
3	CS_{10}	4.27
4	CS_{15}	4.22

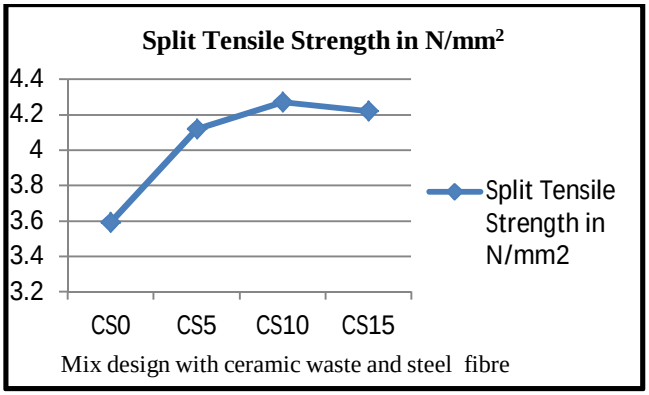


Fig 4: Split tensile strength for 28 days

C. Flexural Strength Test

A total of 16 beams of size 500mm x 100mm x 100mm were casted and tested for 7 days and 28 days testing of 4 specimens for each percentage after conducting the workability tests. C represents ceramic waste and S represents steel fiber in specimen designation. The results are tabulated below:

TABLE 11: Flexural strength on beams for 7 days

Sl.No	Specimen Designation	Flexureal Strength in N/mm^2
1	CS_0	2.36
2	CS_5	6.84
3	CS_{10}	9.15
4	CS_{15}	8.52

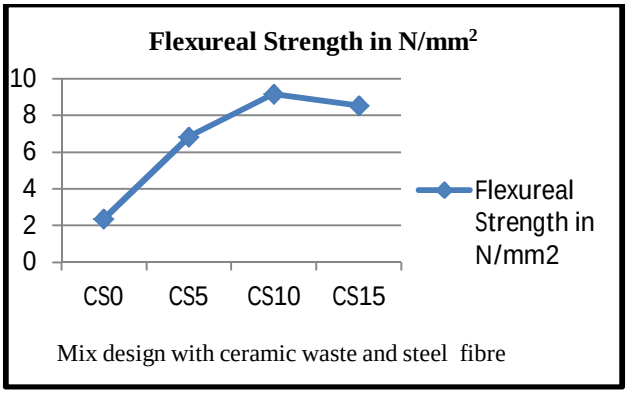


Fig 5: Flexural strength for 7 days

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TABLE 12: Flexural strength on beams for 28 days

Sl.No	Specimen Designation	Flexural Strength in N/mm^2
1	CS_0	3.96
2	CS_5	7.52
3	CS_{10}	10.49
4	CS_{15}	9.37

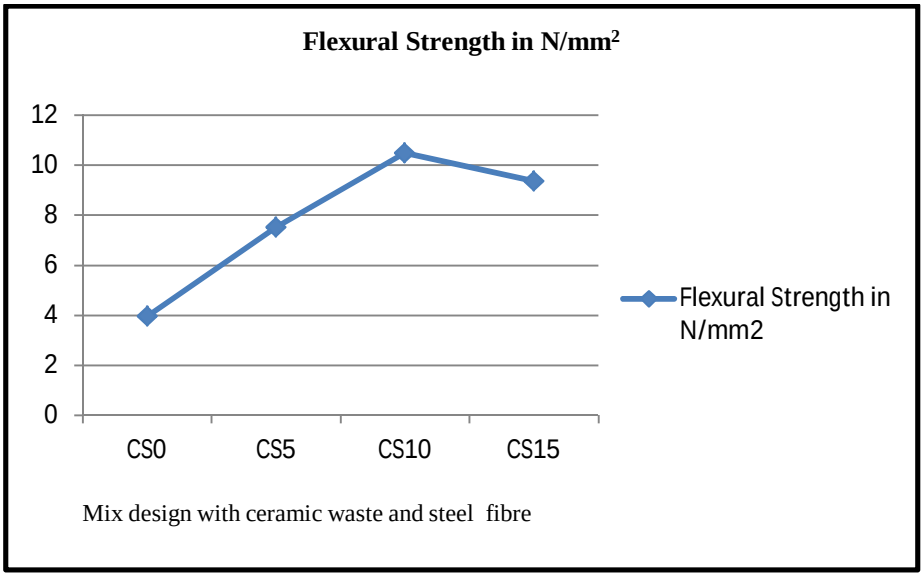


Fig 6: Flexural strength for 28 days

VII. CONCLUSSION

The following conclusions are made based on the experimental investigations on compressive strength, split tensile strength and flexural strength considering the environmental aspects also:

A. With increase in the aggregate replacement, the workability of concrete increases.
B. The properties of concrete increased linearly with the increase in ceramic aggregate up to 10% replacement later it is decreased linearly.
C. CS_{10} mix of concrete produced a better concrete in terms of compressive strength, split tensile strength and flexural strength than the other mixes.
D. The addition of steel fiber along with the ceramic coarse aggregate improves the mechanical properties of concrete since the steel fiber improves the tensile strength of concrete.
E. There is no negative effect on the properties of concrete by using of ceramic waste.
F. The use of ceramic waste and steel fiber in concrete is an effective measure in reducing the cost of concrete, increasing its strength and keeping the environment clean by maintaining waste management and reducing the use of raw materials

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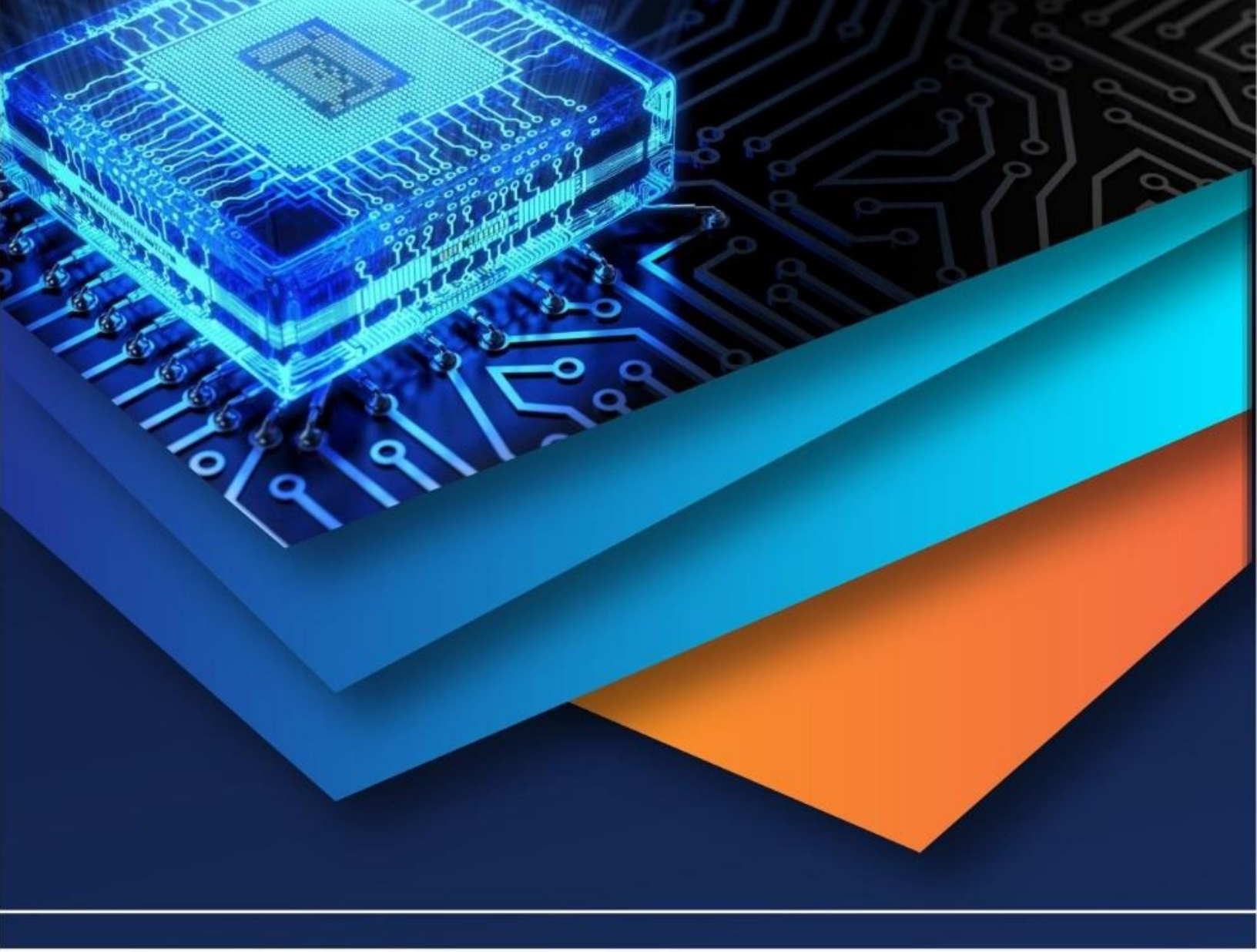
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