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Research Article

EXPERIMENTAL STUDY FOR THE USE OF CERAMIC WASTE AS PARTIAL REPLACEMENT OF COARSE AGGREGATE IN CONCRETE

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ABSTRACT

Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like ceramic tile and granite powder came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic tile waste is not only occurring from the demolition of structures but also from the manufacturing unit.

Studies show that about 20-30% of material prepared in the tile manufacturing plants are transforming into waste. This waste material should have to be reused in order to deal with the limited resource of natural aggregate and to reduce the construction wastes. Crushed waste ceramic tiles, crushed waste ceramic tile powder and Granite powder are used as a replacement to the coarse aggregates and fine aggregate. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20%, 30%, 40%. The mix design for different types of mixes were prepared by replacing the coarse aggregates and fine aggregate at different percentages of crushed tiles. Experimental investigations like workability, Compressive strength test, Split tensile strength test for different concrete mixes with different percentages of waste crushed floor tiles at 7 and 28 days curing period has done.

INTRODUCTION

Generally the Concrete is a material having high compressive strength than to tensile strength. As it has lower tensile stress it is generally reinforced with some materials that are strong in tension like steel. The elastic behavior of concrete at low stress levels is relatively constant but at higher stress levels start decreasing as matrix cracking develops. Concrete has a low coefficient of thermal expansion and its maturity leads to shrinkage. Due to the shrinkage and tension, all concrete structures crack to some extent. Concrete prone to creep when it is subjected to long-duration forces. For the applications various tests be performed to ensure the properties of concrete correspond to the specifications. Different strengths of concrete are attained by different mixes of concrete ingredients, which are measured in psi or Mpa. Different strengths of concrete are used for different purposes of constructions. If the concrete must be light weight a very low-strength concrete may be used. The Lightweight concrete is achieved by the addition of lightweight aggregates, air or foam, the side effect is that the strength of concrete will get reduced. In the present construction world, the solid waste is increasing day by day from the demolitions of constructions. There is a huge usage of ceramic tiles in the present constructions is going on and it is increasing in day by day construction field. Ceramic products are part of the essential construction materials used in most buildings. Some common manufactured ceramics include wall tiles, floor tiles, sanitary ware, household ceramics and technical ceramics. 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. Indian tiles production is 100 million ton per year in the ceramic industry, about 15%-30% waste material generated from the total production. 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 so, we selected these waste tiles as a replacement material to the basic natural aggregate to reuse them and to decrease the solid waste produced from demolitions of construction.

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There are some researchers are also going on solid waste from construction to reuse them again in the construction to reduce the solid waste and to preserve the natural basic aggregates. These researches promotes to use the recycled aggregates in the concrete mix and they got good result when adding some extent percentages of recycled aggregates in place of natural coarse aggregate.

Objective of the study

1. To find out the mix proportion of ceramic waste floor tiles to coarse aggregate for M20 grade of concrete mix.
2. To find out the compressive and split tensile strength of the concrete which is made by waste ceramic floor tiles.

Material used

In this project make the M20 grade of concrete. Main material we use in this project is-

1. Fine aggregate
2. Coarse aggregate
3. Cement
4. Ceramic Waste (Floor Tiles)

Properties of the material used

Fine aggregate

We did all test for knowing the physical properties of the fine aggregate we use in this project- Sieve analysis

S.No.	Is Sieve	Weight Retained [gm]	Cumulative Weight Retained [gm]	Cumulative % Weight Retained	% Finer
1	10mm	6	6	.6	99.4
2	4.75mm	25	31	3.1	96.9
3	2.36mm	164	195	19.5	80.5
4	1.18mm	292	487	48.7	51.3
5	600mic	170	657	65.7	34.3
6	300mic	192	849	84.9	15.1
7	150mic	122	971	97.1	2.9
8	pan	29	1000	100	0

Physical properties of fine aggregate

Physical Properties	Observed Table
Grading zone	1
Fineness modulus	3.8
Specific gravity	2.56
Water absorption	0.95

Coarse Aggregate

For the high strength of concrete we use 20mm size coarse aggregate for M20 grade of concrete. The sieve analysis was carried out conforming to IS-383(1970) are tabulated below-

Sieve analysis

S.no	Is Sieve (mm)	Weight Retained	Cumulative Weight Retained	Cumulative % Weight Retained	Percent Finer
1	20	221	221	2.4	97.6
2	16	2426	2647	52.94	47.06
3	12.5	1022	3669	73.38	26.62
4	10	1046	4715	94.30	5.7
5	6.3	163	4878	97.56	2.44
6	PAN	122	5000	100	0

Different Properties

Description	Test result
Specific gravity	2.9
Water absorption	0.15%
Nominal size	20mm

Cement

Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions. We make some test for the cement before use and following are the results which is found in test:-

Properties	Find value
Normal consistency	0.34
Initial setting time	31min
Final setting time	600min
Compressive strength	33

EXPERIMENTAL RESULT& DISCUSSION

This chapter deals with the various mix proportions adopted in carrying out the experiments and experimental results obtained with respect to their workability, compressive strength, split tensile strength, flexural strength and durability test.

Different types of mixes were prepared by changing the percentage of replacement of coarse aggregates with crushed tiles. Total 5 types of mixes are prepared along with conventional mixes. The coarse aggregates are replaced by 10%, 20%, 30%, 40% of crushed tiles along with the coarse aggregate. The details of mix designations are as follows:

We did, all the test in this experimental study for M20 grade of concrete in which we partially replace coarse aggregate with waste floor tiles. Firstly we did all the testing for compression test value @7days. And following are the arrangement of mix prepared-

Mix Proportion

S.No.	Mix	Cement %	Coarse Aggregate %	Crushed Tiles %	Fine Aggregate
1	M1	100	100	0	100
2	M2	100	90	10	100
3	M3	100	80	20	100
4	M4	100	70	30	100
5	M5	100	60	40	100

Compressive Strength

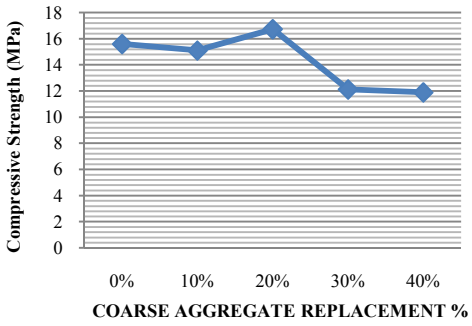
Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 15cm x 15cm x 15cm cube with proper compaction, after 24 hrs place the specimen in water for curing.

Compressive Strength = (LOAD / AREA) in N/sq.mm

TEST RESULT @ 7 DAYS

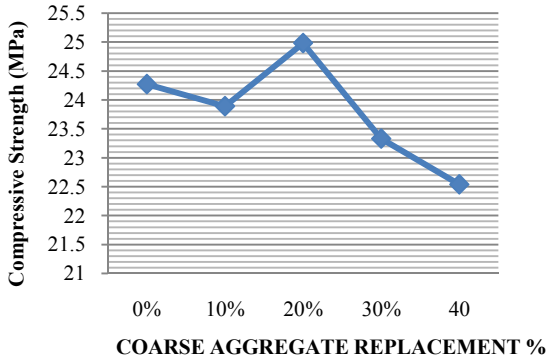
S.NO.	MIX	Compressive Strength (MPa)	AVG. Compressive Strength (MPa)
1	M1	14.2 16.9 15.7	15.6
2	M2	16.8 14.8 13.7 16.7	15.1

3	M3	17.2 17.3	16.73
4	M4	11.2 12.7 12.6	12.13
5	M5	12.0 11.7 12.0	11.9



Test Result @ 28 Days

S.no.	MIX	Compressive Strength (MPa)	AVG. Compressive Strength (MPa)
1	M1	23.89 24.44 24.48	24.27
2	M2	23.99 23.56 24.10	23.89
3	M3	24.95 24.86 25.10	24.98
4	M4	23.22 23.85 22.94	23.33
5	M5	22.36 22.39 22.89	22.54

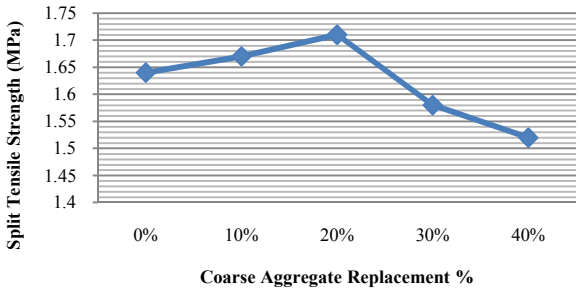


Split Tensile Strength

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 15 cm x 30 cm cylinder with proper compaction, after 24 hrs place the specimen in water for curing.

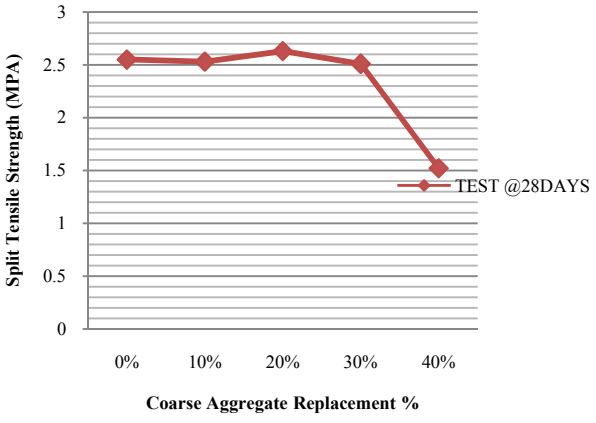
Test result @7 days

S.NO.	MIX	Split Tensile Strength (MPa)	Avg. Split Tensile Strength (MPa)
1	M1	1.67 1.61 1.66	1.64
2	M2	1.69 1.65	1.67
3	M3	1.68 1.70 1.71 1.73	1.71
4	M4	1.55 1.59 1.62	1.58
5	M5	1.55 1.49 1.52	1.52



Test Result @ 28 Days

S.no.	Mix	Split Tensile Strength (MPa)	AVG. Split Tensile Strength (MPa)
1	M1	2.55 2.52 2.59	2.55
2	M2	2.62 2.52 2.53	2.53
3	M3	2.61 2.66 2.64	2.63
4	M4	2.49 2.47 2.51	2.51
5	M5	2.44 2.43 2.48	2.48



CONCLUSION

The basic objective of the study is to prepare a concrete much more stable and durable than the conventional by replacing coarse aggregates. Mix designs for all the replacements of materials has done and a total of 60 specimens (30 cubes, 30 cylinders) are prepared and tested in the aspect of strength calculation and also comparisons has done.

Following are the some conclusion which are found from the above experimental study which is important for us and which are given as follows-

1. There is a vast scope of research in the recycled aggregate usage in concrete especially ceramic tile wastes in the future.
2. from the above experimental result we can easily see that for M25 grade of concrete the 20% replacement of coarse aggregate from floor tiles gives us the maximum target mean compressive strength and split tensile strength for the M25 grade of concrete.
3. A combination of different tiles (based on their usage) in different proportions in concrete and their effects on concrete properties like strength, workability etc can be determined.
4. A study on properties of concrete made with combination of recycled aggregate and tile aggregate in different proportions can be investigated to enhance the concrete properties and also to reduce the pollution or waste generation from construction industry.

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