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Partial Replacement of Coarse aggregate by Crushed Tiles and Fine aggregate by Granite Powder to improve the Concrete Properties

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Abstract: *Due to the day by day innovations and development in construction field, the use of natural aggregates is very high and at the same time production of solid wastes from the demolitions of constructions is also very high. Because of these reasons the reuse of demolished constructional wastes and granite powder came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates. Crushed waste tiles and Granite powder are used as a replacement to the coarse aggregates and fine aggregate. The combustion of waste crushed tiles were replaced in place of coarse aggregates by 10%, 20%, 30% and 40% and Granite powder were replaced in place of fine aggregate by 10%, 20%, 30% and 40% without changing the mix design. M25 grade of concrete was designed to prepare the conventional mix. Without changing the mix design different types of mixes were prepared by replacing the coarse aggregates and fine aggregate at different percentages of crushed tiles and granite powder. Experimental investigation like Compressive strength test, Split tensile strength test, Flexural strength test, Water absorption test and Bond strength test for different concrete mixes with different percentages of waste crushed and granite powder after 7, 14 and 28 days curing period.Variations in the workability for these different mixes were studied and observed that, increase in the percentage of replacement of granite powder and crushed tiles.*
Keywords*: Bond Strength, Crushed tiles, Compressive strength, Flexural strength, Granite powder,Split Tensile strength. Water absorption.*

I. Introduction

In the present construction world, the solid waste is increasing day by day from the demolitions of constructions. 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. 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. 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. Waste tiles and granite powder were collected from the surroundings. Crushed tiles are replaced in place of coarse aggregate and granite powder in place of fine aggregate by the percentage of 10% and 20% and 30%. The fine and coarse aggregates were replaced individually by these crushed tiles and granite powder and also in combinations that is replacement of coarse and fine aggregates at a time in single mix.

For analyzing the suitability of these crushed waste tiles and granite powder in the concrete mix, workability test was conducted for different mixes having different percentages of these materials. Slump cone test is used for performing workability tests on fresh concrete. And compressive strength test is also conducted for 3, 7 and 28 days curing periods by casting cubes to analyze the strength variation by different percentage of this waste materials. In the present study to understand the behavior and performance of ceramic solid waste in concrete. The waste crushed tiles are used to partially replace coarse aggregate by 10%, 20% and 30%. Granite powder is also used partial replace fine aggregate by 10%, 20% and 30%.

Aruna D [1] The Author mentioned in this study is utilization and to ascertain the suitability of tile aggregate as partial replacement to coarse aggregate in normal pervious and blended concretes. The utility of partial replacement of tile waste as aggregates along with partially replacing OPC by fly ash is also addressed in the work. The strength performance of these concretes (Tiled waste based, tiled waste based pervious, and tile & fly ash based blended concretes) with conventional concretes is studied.

Vignesh.S1 [2] This paper recommends that waste seashells can be used as an alternate construction material to coarse aggregate in concrete. In their experimental study, seashells are partially replaced in place of coarse aggregate by 10%, 20%, and 30% without affecting the design strength. The compressive strength of the concrete with different percentages of seashells is tested and the values at 30% replacement is 20 N/mm^2 and 25 N/mm^2 at 7 days and 28 days respectively.

II. Work On Materials

2.1 Material tested

1) Cement

Table 1: Properties of Cement

S.No.	Description	Test Result / Specifications
1	Grade used	53
2	Fineness of the cement	93%
3	Consistency	28%
4	Initial setting time	60min
5	Final setting time	240min
6	Specific gravity	3.19

2) Fine Aggregate

Table 2: Properties of Fine Aggregate

S.No	Description	Test Result
1	Sand zone	Zone- III
2	Specific gravity	2.59
3	Water absorption	5%
4	Bulk density of fine aggregate (poured density) = 1385.16 kg/m³. Bulk density of fine aggregate (tapped density)	1385.16kg/m^3 1606.23 kg/m^3

3) Coarse Aggregate

Table 3: Properties of Coarse Aggregate

S.No	Description	Test Results
1	Nominal size used	20mm
2	Specific gravity	2.9
3	Impact value	10.5
4	Water absorption	0.15%
5	Sieve analysis	20mm
6	Aggregate crushing value	20.19%
7	Bulk density of coarse aggregate (Poured density) Bulk density of coarse aggregate (Tapped density)	1687.31kg/m^3 1935.3 kg/m^3

4) Replacement of coarse aggregate:

Broken tiles were collected from the solid waste of ceramic manufacturing unit. Crushed them into small pieces by manually and by using crusher. And separated the coarse material to use them as partial replacement to the natural course aggregate. Separated the tile waste which is lesser than 4.75 mm. Crushed tiles were partially replaced in place of coarse aggregate by the percentages of 10%, 20% and 30% individually and along with replacement of fine aggregate with granite powder also.

Figure 1. Manual crushing of waste tiles

Table 4: Properties of Crushed tiles and Granite Powder

S.No	Description	Test Results
1	Impact value of crushed tiles	12.5%
2	Specific gravity of crushed tiles	2.39
3	Specific gravity of granite powder	2.9
4	Water absorption of crushed tiles	0.19%
5	Water absorption of granite powder	0.10%

5) **Replacement to Fine aggregate:**

From Industry granite powder will be collect; 4.75 mm passed materials was separated to use it as a partial replacement to the fine aggregate. Granite powder was partially replaced in place of fine aggregate by the percentages of 10%, 20% and30% individually and along with replacement of coarse aggregate with crushed tiles also.

Figure 2. Granite powder

2.2 Mix Design

All the concrete mixes in the project are prepared as per IS: 10262-2009.This standard was first prepared in the year 1982 and later revised in the year 2009.This Indian standard was adopted by the Bureau of Indian standards, after the draft finalized by the cement and the concrete sectional committee has been approved by the civil engineering division council.

III. Manfacturing Process

3.1 Experimental Test

Different types of mixes were prepared by changing the percentage of replacement of coarse and fine aggregates with crushed tiles and granite powder. Total 11 types of mixes are prepared along with conventional mix. 10%, 20%, 30% and 40% of both coarse and fine aggregates are replaced by using crushed waste tile and granite powder individually. And also replacement of both coarse and fine aggregates is done at a time by changing the percentages of 10%, 20%, 30% and 40%. The details of mix designations are as follows.

Table 5: Combinations

S.No	Mix Code	Cement (%)	Fine aggregate (%)		Coarse aggregate (%)	
			Sand	Granite powder	Coarse aggregate	Crushed tiles

1	A0	100	100	0	100	0
2	A1	100	90	10	90	10
3	A2	100	90	10	80	20
4	A3	100	90	10	70	30
5	A4	100	80	20	90	10
6	A5	100	80	20	80	20
7	A6	100	80	20	70	30
8	A7	100	70	30	90	10
9	A8	100	70	30	80	20
10	A9	100	70	30	70	30
11	A10	100	60	40	60	40

B. Demoulding and curing

- Demoulding was done after 1 day.
- Cubes are placed in water sump to allow the cubes for 7, 14 and 28 days curing period

.**Figure 3** Curing period

3.1.1 Compressive strength

Compressive strength test was conducted on concrete cubes of size 150 x 150 x 150 mm cast from concrete of each series, to check quality by obtaining the 7-days and 28-days compressive strength. The maximum compressive load on the specimen was recorded as the load at which the specimen failed to take any further increase in the load. The average of three samples was taken as the representative value of compressive strength. The compressive strength was calculated by dividing the maximum compressive load by the cross-sectional area of the cube specimen.

f_c= Failure load/ Cross sectional area

Figure 4 Testing of Cube Specimens

3.1.2 Split tensile strength

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs.

Splitting Tensile Strength shall be calculated by using the formula:

$$f_{ct} = \frac{2P}{\pi l d}$$

P = maximum load in Newtons applied to the specimen,
L = length of the specimen in mm,
D = cross sectional dimension of the specimen in mm.

Figure 5 Testing of Cylindrical Specimens

3.1.3 Flexural Strength

The flexural strength may be expressed as the modulus of rupture f_b, which, if "a" equals the distance between the line of fracture and the nearer support, measured on the centre line of tensile side of the specimen, shall be calculated to the nearest 0.5kg/sq.cm as follows:

$$f_b = \frac{pl}{bd^2}$$

Where
b=measured width in cm of the specimen
d=measured depth in cm of the specimen.
l= length in cm of the span in which the specimen was supported and
p=maximum load in kg applied to the specimen.

Figure 6 Testing of Prism Specimens

3.1.4 Water Absorption Test

The concrete blocks after casting were immersed in water for 28 days curing. They were then weighted and this weight was noted as the wet weight of the concrete block. These specimens were then oven dried at the temperature 1100 ^{0}C until the mass became constant and again weighed. This weight was noted as the dry weight of the concrete block.

% Water Absorption = [(WW – DW) / DW] x 100

Where, WW = Wet Weight of concrete block,

DW = Dry Weight of concrete block.

3.1.5 Bond strength

- A hollow hydraulic machine with maximum loading capacity of 30 ton was needed to perform cement bond tests
- The load was applied with a rate of 2KN/sec and distributed on the specimen surface by a square plate with size of 20cm and a hole at the centre.
- Bond stress is calculated as average stress between the reinforcing bar and the surrounding concrete along the embedded length of the bar.
- For uniform bond ,the bond stress S can be expressed as:

$S = P_{max}/(\Pi * L * D)$

Where P_{max} = Maximum load applied

L = length of the specimen

D= diameter of the specimen

Figure 7 Bond strength Testing Machine

Concrete samples were prepared and cured in the laboratory, and are tested, to evaluate the concrete fresh and harden properties like compressive strength, Split tensile strength, flexural strength requirements, Durability Test and Bond strength. The different tests were conducted in the laboratories as shown in below.

3.2 Engineering properties of Concrete

3.2.1 Compressive Strength Test

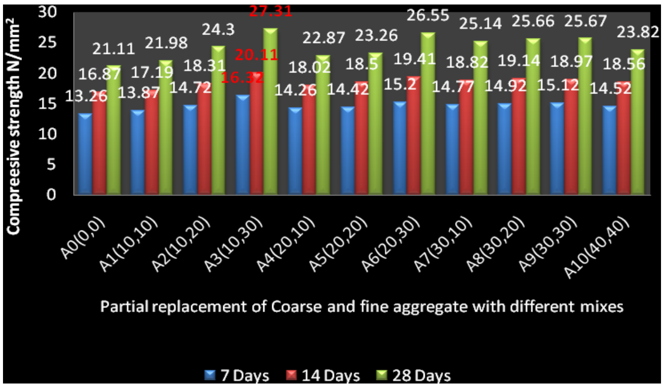

Figure 8 Compressive strength values at 7, 14 and 28 Days

3.2.2 Split Tensile Strength Test

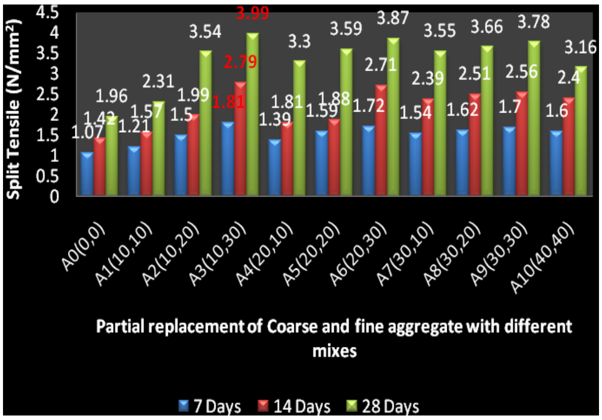

Figure 9 Split tensile strength values at 7, 14 and 28 Days

3.2.3 Flexural Strength Test

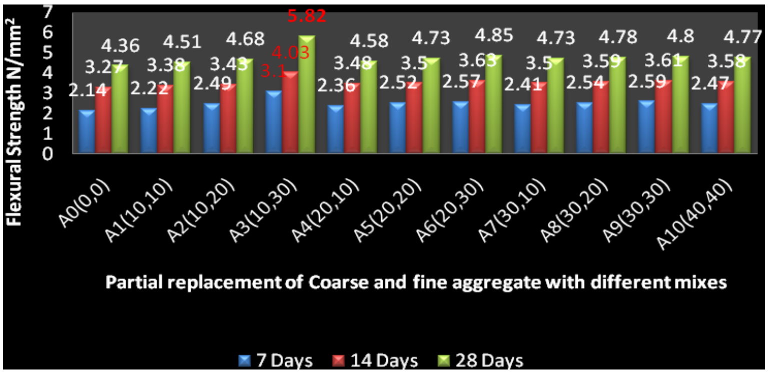

Figure 10 Flexural strength values at 7,14 and 28 Days

3.2.4Water Absorption Test

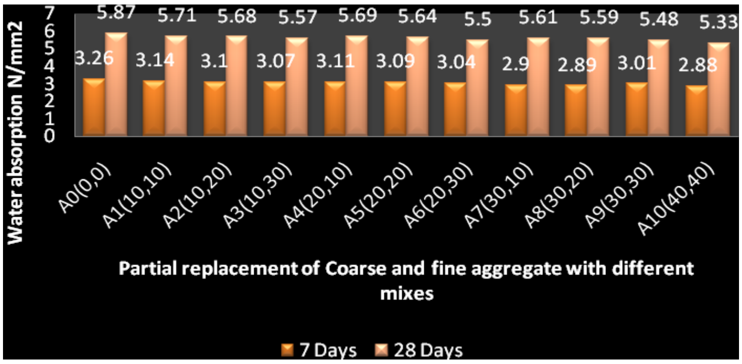

Figure 11 Water absorption values at 7 and 28 Days

3.2.4 Bond Strength on Concrete:

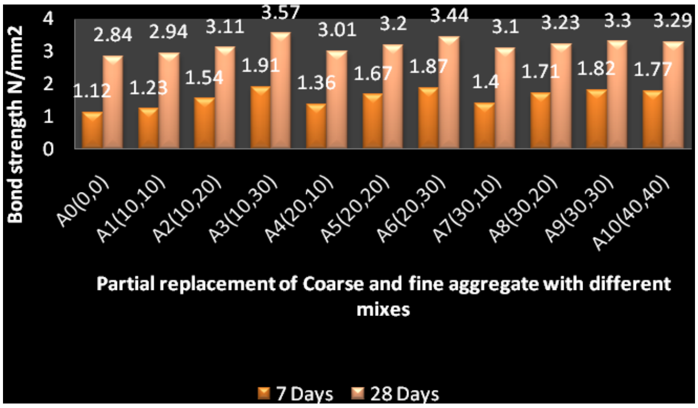

Figure 12 Bond strength at 7 and 28 days

III. Conclusion

After completion of total experimental methodology, from the above investigations and from the test results some variations observed in workability and in compressive strengths of different concrete mixes having different percentages of replacing materials (Crushed tiles in place of coarse aggregate and granite powder in place of fine aggregate) as mentioned below.

1. After performing workability test observed that, when increasing percentage of granite powder and crushed tile pieces in concrete leads to the increase in workability of the concrete.
2. Granite powder is behaving like admixtures, which are used to produce RMC mix.
3. It is observed that the compressive strength of the concrete increases to 4.60%, 11.01%, 23.07%, 7.54%, 8.74%, 14.63%, 11.38%, 12.51%, 14.02% and 9.50% when Course and fine aggregates mixes increases from A1,A2,A3,A4,A5,A6,A7,A8,A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 7 days.
4. It is observed that the compressive strength of the concrete increases to 4.12%, 15.11%, 29.36%, 8.33%, 10.18%, 25.76%, 19.09%, 21.55%, 21.60% and 12.83% when Course and Fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 28 days.
5. It is observed that split tensile strength of the concrete increases to 13.08%, 40.18%, 69.15%, 29.90%, 48.59%, 60.74%, 43.92%, 51.40%, 58.87% and 49.53% when Course and fine aggregates mixes increases from A1,A2,A3,A4,A5,A6,A7,A8,A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 7 days.
6. It is observed that split tensile strength of the concrete increases to 17.85%, 80.01%, 98.57%, 68.36%, 83.16%, 97.44%, 81.12%, 86.73%, 92.87 %and 61.22% when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 28 days
7. It is observed that flexural strength of the concrete increases to 13.08%, 40.18%, 69.15%, 29.90%, 48.59%, 60.74%, 43.92%, 51.40%, 58.87% and 49.53% when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 7 days.
8. It is observed that flexural strength of the concrete increases to 3.44%, 7.33%, 33.48%, 5.04%, 8.48%, 11.23%, 8.48%, 9.63%, 10.09% and 9.40% when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 28 days.
9. It is observed that Water absorption of the concrete decreases to 3.68%, 4.90%, 6.74%, 4.6%, 5.21%,7.36%, 11.00%, 11.34%, 11.96% and 16.25%when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 7 days.
10. It is observed that Water absorption of the concrete decreases to 2.12%, 3.23%, 6.47%, 3.06%, 3.91%, 5.11%,4.42%, 4.77%, 6.30% and 6.98% when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 28 days.
11. It is observed that Bond Strength of the concrete increases to 9.82%, 37.5%, 70.53%, 21.42%, 49.1%, 66.96%, 25.00%, 52.6%, 62.5% and 58.03% when Course and fine aggregates mixes increases from A1,

A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 7 days.

12. It is observed that Bond Strength of the concrete increases to 3.52%, 9.5%, 25.7%, 5.98%, 12.67%, 21.12%, 9.15%, 13.73%, 13.93% and 15.84% when Course and fine aggregates mixes increases from A1, A2, A3, A4, A5, A6, A7, A8, A9 and A10 for CTM and UTM when it is compared with conventional concrete A0 at 28 days.
13. For 10% of granite powder and 30% crushed tiles are replaced in place of fine aggregates and coarse aggregate i.e., A3 sample, there is a increment in compressive strength, split tension strength, flexural strength and bond strength when compare to the conventional concrete strength results after 7 and 28 days curing period.

References

[1] *CONCRETE TECHNOLOGY" Theory and practice, A text book by M.S.Shetty, 2005.*

[2] *A.A Ramezanianpour, P.pourbiek, M.Mahdikhani, and F.Moodi. "Mechanical properties and durability of concrete containing rice husk ash as supplementary cementing material" International journal of civil Engineering. Vol. 7. 2, june 2009, june 2010.*

[3] *Alireza Nirshid,, suraya Abdul Rashid,Farah Nora A.Aziz, Mohamad Amran Mohd Salleh. "Contribution of Rice husk ash to the properties of mortar and concrete A Review" journal of American science: 2010.*

[4] *Moayad N A1-Khalaf and Yousif," Use of rise husk ash in concrete" , the International journal of cement composites and Lightweight concrete, Vol. 6, November 4 ,1984.*

[5] *Muhammad Soaid Ismail and A.M. Waliuddin, " Effect of rice husk ash on high strength concrete", Construction and Building Material,Vol. 10.No. 7,1996, 521-526.*

[6] *Gemma Rodriguez de Sensale, " Syrength development of concrete with Rice-husk ash",Cement & Concrete Composition , Vol. 28, 2006, 158-160.*

[7] *Dr.Suji D, Poovendran S, Prabhakar P "Experimental Study on Partial Replacement of Waste Foundry Sand in Flexible Pavements" in IJCSER, 2015.*

[8] *Lejumol.T.U "Experimental study on Sulphate Attack in Granite Powder concrete with GGBFS" in IJCSER, 2015.*

[9] *Krishna Kumar S "Experimental Study on Concrete using Waste Marble Power and Quarry Dust as Partial Replacement of Cement and Fine Aggregate" in IJCSER,2015.*

[10] *P.Rajalakshmi, Dr.D.Suji "Studies on Strength Characteristics on Utilization of Waste Ceramic Tiles a Aggregate in Concrete" in IJCSER, 2015.*

[11] *Kshitija Nadgouda"Coconut Fibre Reinforced Concrete" in Proceedings of Thirteenth IRF International Conference, 14th September 2014, Chennai, India, ISBN: 978-93-84209-51-3.*

[12] *Indrajt Patel, C D Modherav , " Study Effect Of Polyester Fibers On Engineering Properties Of High Volume Fly Ash Concrete" in Journal of engineering research and studies,2011.*

[13] *Alireza Nirshid, suraya Abdul Rashid, Farah Nora A.Aziz, Mohamad Amran Mohd Salleh. "Contribution of Rice husk ash to the properties of mortar and concrete A Review" journal of American science: 2010.*

[14] *Moayad N A1-Khalaf and Yousif," Use of rise husk ash in concrete" , the International journal of cement composites and Lightweight concrete, Vol. 6, November 4 ,1984.*

[15] *Muhammad Soaid Ismail and A.M. Waliuddin, "Effect of rice husk ash on high strength concrete", Construction and Building Material, Vol. 10.No. 7, 1996, 521-526.*

IS Codes

[16] IS 10262–2009 : Indian Standard "Guidelines for concrete mix design proportioning" – code of practice

[17] IS 456 – 2000: Indian Standard "Plain and reinforced concrete" – code of practice

[18] IS 13311 part 1 – 1992 : Method of Non – destructive testing of concrete, part1: Ultrasonic pulse velocity

[19] IS 383 – 1970: Indian Standard "Specification for coarse and fine aggregates from naturals sources for concrete"