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STUDY ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATES WITH CERAMIC TILES AND FINE AGGREGATES WITH CERAMIC TILES AND REBUTTED TYRE WASTE

V.VENKATA PRAVEEN KUMAR[1], N.AVINASH KUMAR REDDY[2]

[1]*(PG Student, Annamacharya Institute of technology and sciences)*

[2]*(Assistant Professor, Research Guide,Annamacharya Institute of Technology and Science)*

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 rebutted tyre waste came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20%, 30%, 40% and 50%. In this present investigation the fine aggregate is replaced with two different type of materials i.e rebutted tyre waste and ceramic tiles powder. Among which the rebutted tyre waste dosage is kept constant by 10% weight to the fine aggregate replacement. And the ceramic tiles powder is partially replaced by fine aggregates in proportion of 10%,20%,30%,40% and 50%. M25 grade of concrete was designed and tested. The mix design for different types of mixes were prepared by replacing the coarse aggregates and fine aggregate at different percentages of crushed tiles and rebutted tyre waste. It has been observed that the workability increases with increase in the percentage of replacement of rebutted tyre waste and crushed tiles increases. The optimum presence of coarse aggregates that can be replaced by crushed tiles and fine aggregates by ceramic tiles powder and rebutted tyre is30%.

2. INTRODUCTION

2.1 CONSTRUCTION WASTE IN INDIA:

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. Waste tiles and rebutted tyre powder were collected from the surroundings. 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.

2.2 TILE AGGREGATECONCRETE:

Crushed tiles are replaced in place of coarse aggregate and rebutted tyre powder in place of fine aggregate by the percentage of 10%. The fine and coarse aggregates were replaced individually by these crushed tiles and rebutted tyre 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 rebutted tyre 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.

2.3 ENVIRONMENTAL AND ECONOMIC BENEFITS OF TILE AGGREGATE CONCRETE:

The usage of tile aggregate as replacement to coarse aggregate in concrete has the benefits in the aspects of cost and reduction of pollution from construction industry. The cost of concrete manufacturing will reduce considerably over conventional concrete by including tile aggregate and rebutted tyre powder since it is readily available at very low cost and there-by reducing the construction pollution or effective usage of construction waste.

3. LITERATURE REVIEW

3.1 P. Rajalakshmi (2016):

Use of ceramic waste will ensure an effective measure in maintaining environment and improving properties of concrete. The replacement of aggregates in concrete by ceramic wastes will have major environmental benefits. In ceramic industry about 30% production goes as waste. The ceramic waste aggregate is hard and durable material than the conventional coarse aggregate. It has good thermal resistance. The durability properties of ceramic waste aggregate are also good. This research studied the fine aggregate replacement by ceramic tiles fine aggregate accordingly in the range of 10% and coarse aggregate accordingly in the range of 30%, 60%,100% by weight of M-30 grade concrete. This paper recommends that waste ceramic tiles can be used as an alternate construction material to coarse and fine aggregate in concrete irrespective of the conventional concrete, it has good strength properties i.e., 10% CFA and 60% CCA being the maximumstrength.

3.2 ParminderSingh and Dr. Rakesh Kumar Singla (2015): A research paper on utilization of ceramic waste tiles from industries. A partial replacement to coarse aggregate has been studied. Three different grades of concrete has been prepared and tested. The results are not appropriate with the conventional but considering the strength properties, it is advisable to use ceramic tile aggregate in concrete. It is finally concluded that, about 20% of ceramic tile usage in M20 grade of concrete ispreferable.

4. MATERIALSUSED

4.1 CEMENT:

Ordinary Portland Cement of 53 Grade of brand name Ultra Tech Company, available in the local market was used for the investigation. 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. The cement thus procured was tested for physical requirements in accordance with IS: 169-1989 and for chemical requirement in accordance IS: 4032-1988.

4.2 FINEAGGREGATES:

River sand locally available in the market was used in the investigation. The aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity in accordance with IS: 2386-1963.The sand was surface dried before use.

4.3 COARSEAGGREGATES:

Crushed aggregates of less than 12.5mm size produced from local crushing plants were used. The aggregate exclusively passing through 12.5mm sieve size and retained on 10mm sieve is selected. The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS:2386-1963.

4.4 WATER:

Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about $3/10^{th}$ of its weight of water. It is practically proved that minimum water-cement ratio 0.35 is required for conventional concrete. Water participates in chemical reaction with cement and cement paste is formed and binds with coarse aggregate and fine aggregates. If water content exceeds permissible limits it may cause bleeding. If less water is used, the required workability is not achieved. Potable water fit for drinking is required to be used in the concrete and it should have pH value ranges between 6 to 9.

4.5 CERAMIC TILEAGGREGATE:

Broken tiles were collected from the solid waste of ceramic manufacturing unit and from demolished building. The waste tiles were crushed into small pieces by manually and by using crusher. The required size of crushed tile aggregate was separated to use them as partial replacement to the natural coarse aggregate. The tile waste which is lesser than 4.75 mm size was neglected. The crushed tile aggregate passing through 16.5mm sieve and retained on 12mm sieve are used. Crushed tiles were partially replaced in place of coarse aggregate by the percentages of 10%, 20% and 30%, 40% and 50% individually and along with replacement of fine aggregate with granite powder also.

Figure 4.1: Ceramic Tile Aggregate Sample

4.6 CERAMIC TILE-FINEAGGREGATE:

The tile aggregate after crushing results in some material which is finer in size. This material is also included in concrete as replacement to fine aggregate since it is also a waste and similar to that of sand. The aggregate which passes through the 4.75mm sieve is used as a partial replacement to fine aggregate of 10% in combination with the coarse aggregate replacement.

Figure 4.2: Ceramic Tiles Powder

4.7 REBUTTEDTYRE:

The scarcity and availability at reasonable rates of sand and aggregates are now giving anxiety to the construction industry. In India out of 36 tyres manufactures the tyre recyclers are about 20, the major player's number only about four or five. . Over years, deforestation and extraction of natural aggregates from river beds, lakes and other water bodies have resulted in huge environmental problems. The best way to overcome this problem is to find alternate aggregates for construction in place of conventional natural aggregates. The rubber aggregates from discarded tyre rubber in sizes 20-10 mm, 10-4.7 5mm and 4.75 mm down can be partially replaced natural aggregates in cement concrete construction.

Figure 4.3: Rebutted Tyre Waste Powder

5. CONCRETE MIX DESIGN (AS PER IS:10262-2009)

5.1 MIX DESIGN FOR M25 GRADE CONCRETE:

Characteristic compressive strength required in the field at 28 days: 20Mpa

a) The mean strength , $f^1_{ck} = f_{ck} + ks$

=25+(1.65x4)

= 31.6 Mpa

b) For OPC, adopting a water-cement ratio of0.44

c) Form table 2 of IS: 10262-2009, maximum water content for 20 mm aggregates is 186liters.

Adopting a water content of 170 liters

d) Water-cement ratio=0.44

Cement Content,C = $\frac{170}{0.44}$ =380kg/m^3

From IS: 456-2000, the minimum cement content is 300 kg/m^{3}for severe exposure.

Hence O.K.

e) From table 3 of IS:10262-2009, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate(Zone III) for water-cement ratio of 0.50 =0.64 %

In the present case water-cement ratio is 0.44. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. Thus, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.44 =0.652.

Volume of Fine Aggregates = 1- volume of C.A.

= 1- 0.652 = 0.348%

f) Volume of cement = $\frac{380}{3.14} \times \frac{1}{1000}$ =0.121%

Volume of water = $\frac{170}{1} \times \frac{1}{1000}$ = 0.17%

Volume of all in aggregates = 1- volume of (cement + water) = 1- (0.121+0.17) = 0.71 %

Mass of Coarse aggregate (C.A.) = e x Vol. of C.A. x Sp. gravity of C.A. x 1000

= 0.71x0.652x2.9x1000

= 1342.46 kg/m^3

Mass of Fine aggregate (F.A.) = e x Vol. of F.A. x Sp. gravity of F.A. x 1000

= 0.71x0.348x2.59 = 639.9 kg/m^3

g) Mix proportions:

C :FA :CA:WATER

380 :639.9 :1342.46:170

h) Site Corrections:

Water Absorption of C.A.= 1342.46x $\frac{0.15}{100}$=2kg/m^3

Moisture content of F.A.= 639.9 x $\frac{1}{100}$= 6.39kg

Weight of C.A. =1342.46-2

= 1340.46 kg/m^{3}Weight of F.A. =639.9-6.4

= 633.5 kg/m^3 Adjusted water content =170-2+6.4

= 174.4liters

i) Final quantities of materials after corrections/adjustments according to thesite:

Cement= 380kg/m^3

Fine aggregates = 633.5 kg/m^3 Coarse aggregates = 1340.46kg/m^{3}Water= 174.4kg/m^3

Final Mix Proportions:

C:FA :CA: WATER

380 :633.5:1340.46:174.4

1:1.667 : 3.52 :0.45

For NFA 80%+CTFA 10%+RTW10% and NCA 90%+CTA 10%

Aggregates:

Mix Proportions:

C : NFA : CTFA : RTW : NCA : CTA : WATER

380 : 506.8 : 63.35 :63.35: 1206.4 : 134 : 174.4

1 : 1.33 : 0.16 : 0.16 : 3.17 : 0.352 : 0.45

For NFA 70%+CTFA 20%+RTW10% and NCA 80%+CTA 20%

Aggregates:

Mix Proportions:

C : NFA : CTFA : RTW : NCA : CTA : WATER

380 : 443.4 : 126.7 : 63.3 : 1072 .46 : 268 : 174.4

1 : 1.16 : 0.33 : 0.16 : 2.82 : 0.705 : 0.45

For NFA 70%+CTFA 20%+RTW10% and NCA 70%+CTA 30% Aggregates:

Mix Proportions:

C : NFA : CTFA : RTW : NCA : CTA : WATER

380 : 380.1 : 190.0 : 63.35 : 938.33 : 402.1 : 174.4

1 : 1.01 : 0.50 : 0.16 : 2.46 : 1.05 : 0.45

For NFA 60%+CTFA 30%+RTW10% and NCA 60%+CTA 40% Aggregates:

Mix Proportions:

C : NFA : CTFA : RTW : NCA : CTA : WATER

380 : 316.6 : 253.4 : 63.35 : 804.36 : 536.1 : 174.4

1 : 0.83 : 0.66 : 0.16 : 2.11 : 1.410 : 0.45

For NFA 50%+CTFA 40%+RTW10% and NCA 50%+CTA 50% Aggregates:

Mix Proportions:

C : NFA : CTA : RTW : NCA : CTA : WATER

380 : 253.4 : 316.75 : 63.35 : 670.23 : 670.23 : 174.4

1 : 0.66 : 0.83 : 0.16 : 1.76 : 1.76 : 0.45

6. EXPERIMENTALDETAILS:

Different types of mixes were prepared by changing the percentage of replacement of coarse and fine aggregates with crushed tiles, crushed tile powder and rebutted tyre powder. Total 14 types of mixes are prepared along with conventional mixes. The coarse aggregates are replaced by 10%, 20%, 30%, 40% and 50% of crushed tiles and the fine aggregate is replaced by 10% of both crushed tile powder and rebutted tyre powder individually but along with the coarse aggregate. The details of mix designations are asfollows

Table 6: Details of aggregate replacement for mix codes

S.no	Mixcode	cement (%)	CA (%)	Fine aggregate(%)		
				Sand	Crushed tile powder	Rebutted tyre powder
1	M0	100	100	100	0	0
2	M1	100	90	80	10	10
3	M3	100	80	70	20	10
4	M4	100	70	60	30	10
5	M5	100	60	50	40	10
6	M6	100	50	40	50	10

6.1 WORKABILITY:

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product.

Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete.

6.2 DETERMINATION OF WORKABILITY BY SLUMP-CONETEST:

To find the workability of concrete thoroughly mix cement, sand And coarse aggregate according to designed mix proportions to form a homogenous mix of concrete.

Equipments Required for Concrete Slump Test:

Mould for slump test, non porous base plate, measuring scale, temping rod. The mould for the test is in the form of the frustum of a cone having height 30 cm, bottom diameter 20 cm and top diameter 10 cm. The tamping rod is of steel 16 mm diameter and 60cm long and rounded at one end.

- Clean the internal surface of the mould and apply oil.
- Place the mould on a smooth horizontal non- porous base plate.
- Fill the mould with the prepared concrete mix in 3 approximately equal layers.
- Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
- Remove the excess concrete and level the surface with at rowel.
- Clean away the mortar or water leaked out between the mould and the base plate.
- Raise the mould from the concrete immediately and slowly in vertical direction.
- Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

Figure6.1: Concrete Slump Test Procedure

When the slump test is carried out, following are the shape of the concrete slump that can be observed:

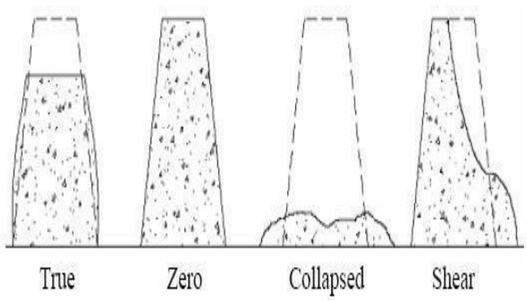

Figure6.2: Types of Concrete Slump Test Results

- **True Slump** – True slump is the only slump that can be measured in the test. The measurement is taken between the top of the cone and the top of the concrete after the cone has been removed as shown infigure-1.
- **Zero Slump** – Zero slump is the indication of very low water-cement ratio, which results in dry mixes. These type of concrete is generally used for road construction.
- **Collapsed Slump** – This is an indication that the water-cement ratio is too high, i.e. concrete mix is too wet or it is a high workability mix, for which a slump test is not appropriate.
- **Shear Slump** – The shear slump indicates that the result is incomplete, and concrete to be retested.

6.2 COMPRESSIVE STRENGTH PROCEDURE:

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.

- Take away the specimen from water when such as natural process time and wipe out excess water from the surface.
- Take the dimension of the specimen to the closest0.2m
- Clean the bearing surface of the testing machine
- Place the specimen within the machine in such a fashion that the load shall be applied to the other sides of the cube forged.
- Align the specimen centrally on the bottom plate of the machine.
- Rotate the movable portion gently by hand so it touches the highest surface of the specimen.
- Apply the load step by step while not shock and incessantly at the speed of 140kg/cm^2/minute until the specimen fails
- Record the utmost load and note any uncommon options within the form of failure.

COMPRESSIVE STRENGTH = (LOAD / AREA) in N/sq.mm

Figure 6.3: Compression testing of Cube Specimen

6.3 SPLIT TUBE TENSILE STRENGTH PROCEDURE:

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 10 cm x 30 cm cylinder with proper compaction, after 24 hrs place the specimen in water for curing.

- Take the wet specimen from water when seven days of natural process
- Wipe out water from the surface of specimen
- Draw diametrical lines on the 2 ends of the specimen to make sure that they're on a similar axial place.
- Note the weight and dimension of the specimen.
- Set the compression testing machine for the specified vary.
- Keep are plywood strip on the lower plate and place the specimen.
- Align the specimen so the lines marked on the ends square measure vertical and targeted over very cheap plate.
- Place the other plywood strip above the specimen.
- Bring down the upper plate to touch the plywood strip.
- Apply the load incessantly while not shock at a rate of roughly 14-21kg/cm^2/minute (Which corresponds to a complete load of 9900kg/minute to14850kg/minute)

- Note the breaking load(P)

The splitting tensile strength is calculated using the formula= $\frac{2P}{\pi LD}$

Where, P = applied load

D = diameter of the specimen L = length of the specimen

Figure6.4: Split tensile testing machine

6.4 FLEXURAL STRENGTHTEST:

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 10x10x50cm prism with proper compaction, after 24 hrs place the specimen in water forcuring.

- Remove the specimens from water after specified curing time and wipe out excess from thesurface.
- Leave the specimen in the atmosphere from 24hours beforetesting.
- The specimen is then placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mould, along the two lines spaced 20.0cm a part. The axis of the specimen is carefully aligned with the axis of loading devices.
- The load is then applied without shock and increasing continuously at a rate of 400kg/min.
- Since a < 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cmspecimen.

The Flexural strength or the modulus of rupture is calculated using the formula: = $\frac{3Pa}{bd^2}$

Where,

P=load applied at failure b=Width of specimen d=Depth of the specimen

a= the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen

Figure 6.5: Flexural Testing of Beam Specimen

7. TESTRESULTS

7.1 Slump Cone Test:. The test was conducted for fresh concrete prepared before the moulding process. A total of 14 concrete mixes are prepared at different times. Workability Results obtained from slump cone test for M25 grade of concrete is shown in table 7.1

Table 7.1: Test results from slump cone test for workability in mm

S.No	Mix designation	CA Replacement %(CA+ CTA)	FA Replacement %(CTFA +RTW)	Workability (mm)
				M25
1	M0	100+0	0+0	62
2	M1	90+10	10+10	65
3	M2	80+20	20+10	68
4	M3	70+30	30+10	73
5	M4	60+40	40+10	78
6	M5	50+50	50+10	81

The workability from the slump cone test is in increasing manner as the mix proportion replacement increasing. The work ability range of concrete increasing as mentioned while being in medium range overall.

7.2 Compressive strength:

Table7.2: Compressive strength results of M25 grade of concrete for 7, 24 and 28 days

S.no	Mi x Designation	CA Replacement %(CA+CTA)	FA Replacement %(CTF A+RTW)	Compressive strength of M25 grade inN/mm^2		
				7 days	14 days	28 days
1	M0	100+0	0+0	20.57	28.54	33.18
2	M1	90+10	10+10	24.09	31.39	36.5
3	M2	80+20	20+10	26.27	32.8	37.5
4	M3	70+30	30+10	27.05	37.53	39.14
5	M4	60+40	40+10	23.96	31.77	37.16
6	M5	50+50	50+10	22.22	28.83	34.18

A total of 42 cubes of size 150 x 150 x 150mm were casted and tested for 7 days, 14 days and 28 days testing each of 13 specimens after conducting the workability tests. The results are tabulated above.

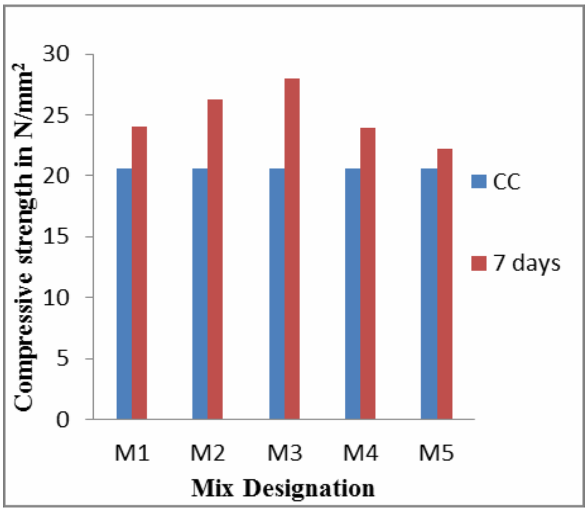

Figure 7.1: Comparison of Compressive strength of M25 at 7 days

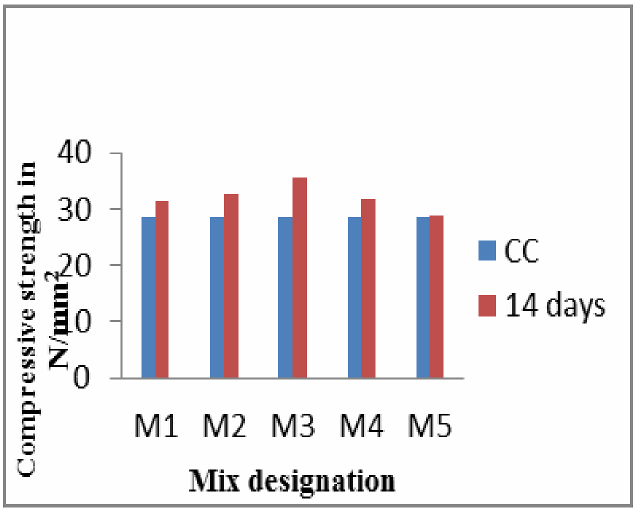

Figure 7.2: Compressive strength of M25 concrete at 14days

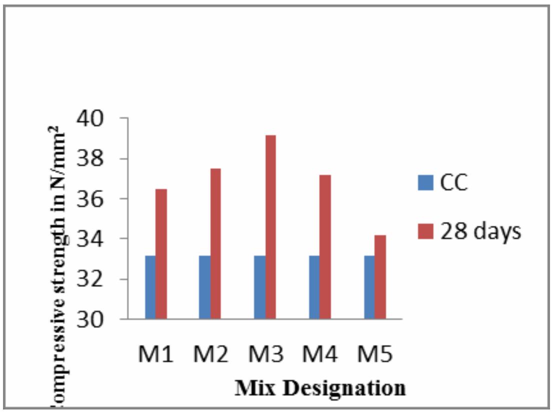

Figure 7.3: Compressive strength of M25 concrete at 28days

The results obtained from compression testing gives comprehensive outcome of the project as the replacement the replacement of tile aggregates produces a concrete with suitable properties as conventional

7.3 Split Tensilestrength:

The split tensile strength obtained by testing the cylindrical specimen for M25 grade of concrete to all the mixes designed for various replacements are given below:

S. No	Mix Designation	CA replacement %(CA +CTA)	Aggregate Replacements %(CTA+RTW)	Split Tensile Strength of M25 grade in N/mm²		
				7 days	14days	28 days
1	M0	100+0	0+0	1.67	2.18	2.56
2	M1	90+10	10+10	1.67	2.19	2.61
3	M2	80+20	20+10	1.69	2.24	2.615
4	M3	70+30	30+10	1.71	2.26	2.65
5	M4	60+40	40+10	1.69	2.21	2.59
6	M5	50+50	50+10	1.67	2.16	2.52

Table 7.3: Split Tensile Strength Results For M25 Grade Of Concrete

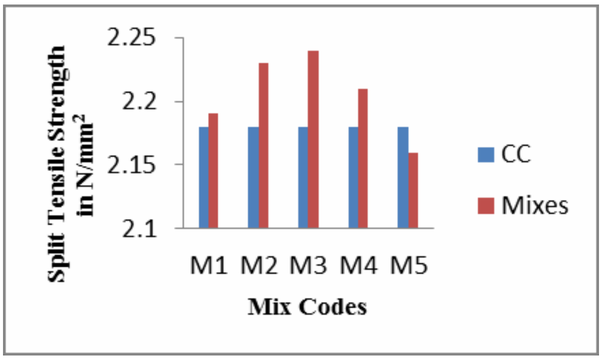

Figure 7.4: Split tensile strength of M25 concrete at14days

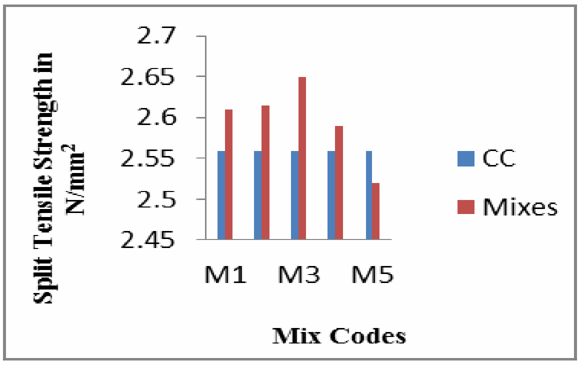

Figure 7.5: Split tensile strength of M25 concrete at 28days

The strength i.e., the tensile strength, from the results is clearly in an increment way compared to the conventional concrete at all the curing ages of 7days, 14 days and 28 days. The replacement of aggregates by various proportions has positive effect on the strength of the concrete.

7.4 Flexural Strength:

The flexural test was conducted for M3 mix only since it has the highest compressive and split tensile strength to compare it with conventional i.e.,M0. A Total of 2 beams were casted and tested as follows

Table 7.4: Flexural test results for 7, 14 and 28 days

S.No	Grade of concrete	Mix Code	Flexural Strength in N/mm^2		
			7 days	14 days	@ 28 days
1	M25	M0	3.25	4.75	5.3
3	M25	M3	3.19	4.81	5.33

8. RESULTS ANDDISCUSSIONS

8.1 Slump Cone Test:

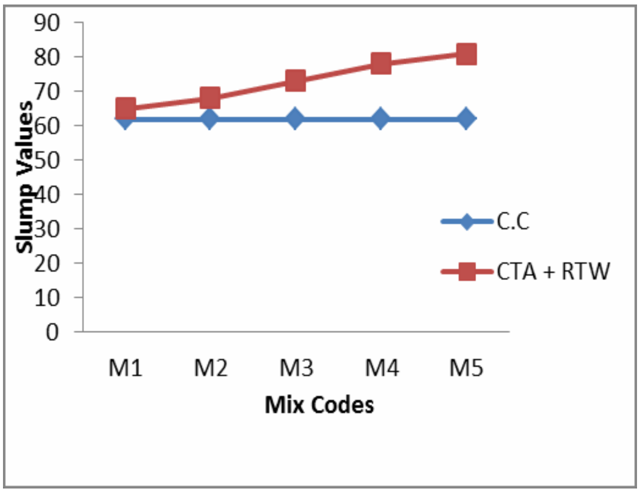

Figure 8.1: Comparison of workability for different mixes of M25 Grade

From the results it is observed that the workability is increased by an amount of 4.8%, 9.6%, 17.7%, 25.8%, 30.6%, 1.6%, 8%,14.5%, 22.5%, 16.1%, 27.4%, 38.7% and 64.5% for M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12, M13 mixes respectively over conventional M25 concrete grade(M0).

8.2 Compressive strength

The Compressive strength of concrete varies as 17.11%, 27.7%, 36.36%, 16.4%, 8.02%,6.85%, 13.8%, 28.82%, -2.72%, 2.33%, 19.59%, 36.6% and3.64%forM1,M2,M3,M4,M5,M6,M7,M8, M9, M10, M11, M12 and M13 compared with the conventional concrete after 7days of curing.

The Compressive strength of concrete varies as 9.99%, 14.92%, 31.49%, 11.31%, 1.19%, 1.61%, 10.72%, 20.53%, -6.62%, 0.3%,17.65%, 34.54% and -1.57% for M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12 and M13 Compared with the conventional concrete after 14days of curing.

The Compressive strength of concrete varies as 10%, 19.04%, 30%, 11.99%, 3.01%, 5.99%, 11.99%, 19.04%, 0.8%, 3.97%,19.04%, 27%and1.98%forM1,M2,M3,M4,M5,M6,M7, M8, M9, M10, M11, M12 and M13 compared with the conventional concrete after 28days of curing.

On comparing the strengths of all mixes, M3, M8 and M12 has the highest i.e., 30% replacement of coarse aggregate. The addition of rebutted tyre powder has positive effect on strength while improving the workability also.

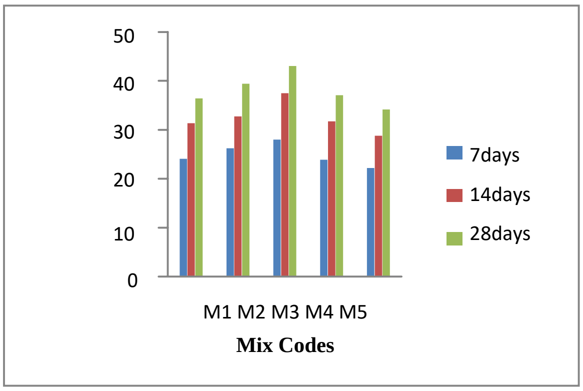

Figure 8.2: Strength comparison at 7, 14 and 28 days for M25 concrete

8.3 SPLIT TENSILESTRENGTH:

The split tensile strength of concrete varies as0%,1.2%,2.4%,1.2%,0%,1.2%,1.2%,1.8%, -1.2%, 0.59%, 2.4%, 3.0% and 1.2% for M1,M2,M3,M4,zM5,M6,M7,M8,M9,M10,M11,M12,M13

compared with the conventional concrete after 7days of curing.The split tensile strength of concrete varies as 0.46%, 2.7%, 4.6%, 1.4%, -2.7%, 0%, 1.37%, 2.3%, 0.46%, 0.92%,1.37%,2.75% and 0.92% for M1,M2,M3,M4,M5,M6,M7, M8,M9,M10,M11,M12,M13

compared with the conventional concrete after 14days of curing. The split tensile strength of concrete varies as 1.95%, 5%, 7%, 1.18%, -1.6%, 0.39%, 1.9%, 3.1%, -2.3%, 0.78%, 3.5%, 3.9% and 2.3% for M1,M2,M3,M4,M5,M6,M7, M8,M9,M 10,M11,M12,M13

compared with the conventional concrete after 28days of curing.

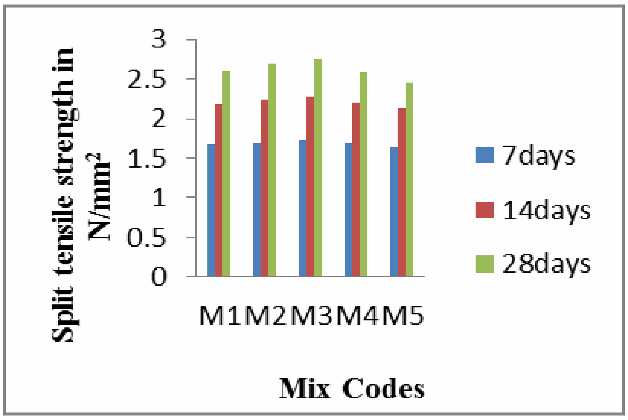

Figure 8.3: Split tensile strength for M25 concrete mixes

8.4 Flexural Test:

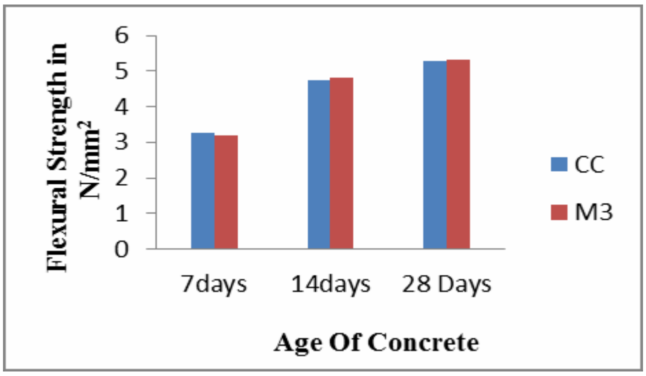

Figure 8.4: Flexural strength comparison M25 grades for M3 mix with conventional

The flexural test is conducted for the mix, which has maximum compressive strength and split tensile strength i.e., M3 (30% of CCA) and the results are plotted above.

The strength gaining of beam is linearly increasing. The strength variation for three grades is in increasing manner. The flexural strength of conventional varies as 12.6%, 1.8% and 3.32% of increment at 7, 14 and 28 days respectively for M3 mix. The 7days strength gain is quite same for three grades but after 14 days M25 has the rapid growth of strength. Even though we are not comparing with the conventional concrete but the attainment of strength for issatisfactory.

9. SUMMARY ANDCONCLUSIONS

9.1 General:

The basic objective of the study is to prepare a concrete much more stable and durable than the conventional by replacing aggregates both coarse and fine. Mix designs for all the replacements of materials has done and a total of 90 specimens (42 cubes, 42 cylinders, 6 beams) are prepared and tested in the aspect of strength calculation and also comparisons has done

9.2 Conclusions:

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

- Workability of concrete increases with the increase in tile aggregate replacement. The workability is further increased with the addition of rebutted tyre powder which acts as admixture due to its chemical properties.

- The properties of concrete increased linearly with the increase inceramic aggregate up to 30% replacement later it is decreased linearly.

- M3 mix of concrete produced a better concrete in terms of compressive strength, split tensile strength and flexural strength than the other mixes. But the mixes up to 50% of ceramic coarse aggregate can be used.

- The usage of ceramic fine aggregate has some effect on the properties of concrete in decrement The manner.

- Rebutted tyre powder using as fine aggregate has more influence on the concrete than the ceramic fine because of chemical composition it is made of and works as admixture.

- The addition of rebutted tyre powder along with the ceramic coarse aggregate improves the mechanical properties of concrete slightly since mineral and chemical properties are of rebutted tyre.

FUTURE SCOPE OF WORK

There is a vast scope of research in the recycled aggregate usage in concrete especially ceramic tile wastes in the future. The possible research investigations that can be done are mentioned below:

- The usage of marble floor tiles can be studied as it is similar to that of tile waste generation and also it is quite hard compared to the natural crushed stones using in conventional concrete.

- The usage of rebutted tyre waste in concrete as an admixture to improve the workability of concrete and the strength parameters can also be studied at various percentages.

- A further investigation on the use of rebutted tyre powder alone as a replacement tofine aggregate can be carried out the possibility of using such waste generation from industries.

- The mechanical properties of concrete with marble aggregate (waste) either from manufacturing units or from construction demolition can be investigated to improve the properties like permeability; resistance to sound can also bestudied.

- Ceramic tile aggregate in high strength concrete can be studied further to check the possibility of its use in high rise buildings.

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