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STUDY ON EFFECT OF CERAMIC WASTE TILES ON STRUCTURAL BEHAVIOR OF M40 CONCRETE WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE

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Abstract:

In the design of concrete mix, cement, fine aggregates and coarse aggregates are using for a past long period of time, that involve essential role in designing of a particular grade of concrete. But now a days there is a lack in coarse aggregates So, some of alternate new materials which are choose based on locally available of low cost materials are introduce for partial replacing of coarse aggregates to obtain same strength as that of the basic materials. In this research work the analysis of partial replacement of coarse aggregate with 0%, 5%, 10% and 25% of broken tiles wastes with maximum size of 20mm used in the production of M40 a water-cement ratio of 0.45 is used. Experimentally analysis is conducted on fresh concrete for workability and hardened concrete tests conducted like a compression test and also to evaluate the concrete strength, at different stages of curing time periods of 7 and 28 days. From the results obtain that shows the water-cement ratio improves the workability of the concrete, with the addition of ceramic wastes broken tiles materials upto 25%, this concluded that partial replacement of ceramic tiles waste despite performance in concrete decreases with increasing of replacement of ceramic wastes broken tiles materials.

Keywords: M40 concrete, waste floor tiles, compressive strength, flexural behavior.

INTRODUCTION

1.1 GENERAL

Concrete is a composite material composed with fine, coarse aggregate, cement and water that hardens (cures) over time. Concrete is the one most useful substance in the world next to water and its used for the building materials. The usage of the concrete is more than ton for ton, is twice that of steel, wood, plastics, and aluminium combined materials. When aggregate is mixed with the cement and water, the mixture forms as fluid slurry that is easily poured and moulded into shape of structure. The cement reacts with the water through to hardens concrete over several hours to form a hard matrix that binds the materials together into a durable stone like material that has many uses. In the concrete admixture is added to increasing the strength of concrete and also lack of building materials. From this research focuses on ceramic waste tiles as partially replacement with coarse aggregate to the prevention of environmental pollution and considers the elements of sustainable and cost saving construction projects, especially alternate material usage. However, many of the construction industry waste that contributes largely of solid waste, which is not undergoing the recycle, process yet. Besides whatever the conditions might be, concrete is expected to provide satisfactory performance for the wholeness of their service life with very little care.

1.2 OBJECTIVES OF THE STUDY

1. To determine the maximum load carrying capacity of reinforced concrete beam before its fails in flexure behaviours of M40 grade.
2. To analysis and predict the deflection of the RC beam under various load condition
3. To analysis development of cracks in RC beam under particular loads.
4. To analysis the flexural behaviour of RC beam replacement of partially ceramic waste tile
5. To compare the compressive strength of the broken tiles waste concrete with conventional concrete M40.

2. Methodology:

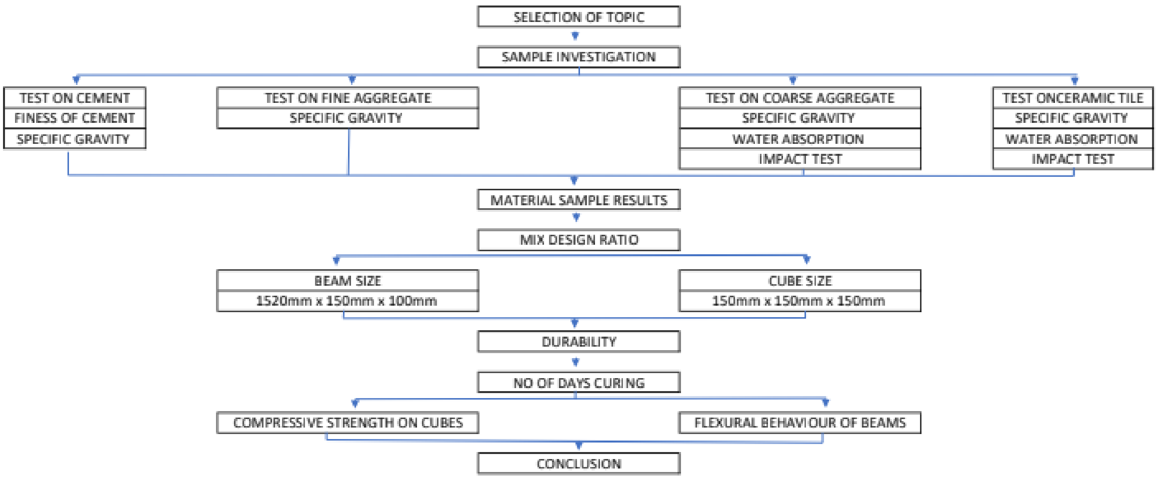

Figure 2.1 Methodology Flow chart

Figure 2.1 Organize the steps in sequential order is involved about this project considering logical flow from start to finish. In this project start from preliminary sample test to conclusion of the study.

3. 0 preliminary testing on samples.

From the Table 3.1represent the preliminary test results value for the given samples cement, fine aggregate, coarse aggregate and broken tiles. Base on the values mix design ratio is calculate to analysis fresh concrete and hard concrete. The specific gravity of cement is a fundamental property that influences various aspects of concrete production and construction, from the result value is 3.15 within permissible limits, for the coarse aggregate and fine aggregate specific gravity value within the permissible limits. For the broken tiles specific gravity value are calculated for 0% to 40%.

MATERIAL	PROPERTY	VALUE
CEMENT	Fineness Test	7.01%

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	Specific gravity	3.15
	Normal Consistency Test	31%
	Initial Setting Time	41.2min
FINE AGGREGATE	Specific gravity	2.64
COARSEAGGREGATE	Specific gravity	2.72
	Water-Absorption Test	0.29%
	Impact test	26.44
BROKEN TILES		
SPECIFIC GRAVITY	0% of replacement	2.42
SPECIFIC GRAVITY	5 % of replacement	2.43
SPECIFIC GRAVITY	10 % of replacement	2.43
SPECIFIC GRAVITY	15 % of replacement	2.42
SPECIFIC GRAVITY	20% of replacement	2.44
SPECIFIC GRAVITY	25 % of replacement	2.45
SPECIFIC GRAVITY	30% of replacement	2.43
SPECIFIC GRAVITY	35% of replacement	2.42
SPECIFIC GRAVITY	40 % of replacement	2.41
IMPACT TEST	0 % of replacement	22.44
IMPACT TEST	5 % of replacement	22.44
IMPACT TEST	10 % of replacement	22.45
IMPACT TEST	15 % of replacement	22.35
IMPACT TEST	20% of replacement	22.26
IMPACT TEST	25 % of replacement	22.36
IMPACT TEST	30 % of replacement	22.40
IMPACT TEST	35 % of replacement	22.33
IMPACT TEST	40 % of replacement	22.31

3. 1 Fresh concrete.

Fresh concrete tests are achieved to guarantee the quality and workability of the concrete earlier it sets. slump Test, one of the main method to test measures of the consistency and workability of concrete by observing the slump cone-shaped sample when it's subjected to gentle compaction figure 3.1.

figure 3.1slump cone.

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3. 1 Harden concrete:

Hardened concrete denotes to concrete that has felt the setting and curing process, becoming solid and rigid. Once concrete has cured, it transitions from its plastic, workable state to a hardened state, gaining strength and durability over time. Harden concrete is typically used in various construction applications such as foundations, columns, beams, slabs, pavements, and structures.

figure 3.2 Concrete mixing

figure 3.3 Concrete cubes casting

figure 3.4 Concrete cubes curing

figure 3.5 Concrete cubes testing

figure 3.2 shows that concrete mixing is the process of combining cement, water, fine aggregates, coarse aggregate (partially replacement of tiles) to create a uniform mixture that can be poured and moulded into shapes size of 150mm x 150mm figure 3.3. The quality of the concrete is curing in the water for the no of days' figure 3.4. final concrete structure testing for strength and durability after curing 7days 14days 28 days in figure 3.5.

Table -3.2 Compressive Strength Concrete

Broken Creamic Tiles	Compressive Strength Concrete (N/mm^2)		
	7 days	14 days	28 days
0 % of replacement	26.240	36.030	46.350
5 % of replacement	26.720	36.378	46.637
10 % of replacement	26.960	36.610	46.817
15 % of replacement	28.200	37.074	47.177
20% of replacement	28.440	37.306	47.357
25 % of replacement	26.240	36.039	46.350

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30% of replacement	26.210	36.030	46.320
35% of replacement	26.230	36.00	46.050
40 % of replacement	25.120	35.378	45.637

In the table 3.2 compressive strength of concrete cube (150 X 150 mm) are tested and the are value presented. From above the table represents the maximum and minimum value of the strength and durability concrete cube base on the percentage from (0 % of replacement to 40 % of replacement) of replacement of coarse aggregate with the broken tiles.

3.2 SPECIFICATIONS FOR PROPORTIONING

1. Grade designation: M40
2. Type of cement: OPC 53 Grade conforming IS 12269
3. Maximum nominal size of aggregate: 20mm
4. Minimum cement content: 320 kg/m^3 (IS 456:2000)
5. Maximum water-cement ratio: 0.45 (Table 5 of IS 456:2000)
6. Workability: 100-120mm slump
7. Exposure condition: Moderate (For Reinforced Concrete)
8. Method of concrete placing: Pumping
9. Degree of supervision: Good
10. Type of aggregate: Crushed Angular Aggregates
11. Maximum cement content: 360 kg/m^3

3.3 DESIGN OF BEAM

Dead Load = Self Weight = 1 kN

Live Load = 5 kN + 1 kN Self Weight **as per IS875 Part – 2 – Pg 11**

Live Load = 6 kN

b = 100 mm h = 150 mm l = 1520 mm d = l/d
l /d = 20 **as per IS456 – Pg 37 (2000) Clause 23.2.1**

l /d = 20 = 1520/20 = d d = 1520/20
d = 76 mm

Take it as 100mm

d = effective depth d '= effective cover

D = d+d' = over all depth d' = 50mm cover block D = d+d' = 100+50

D = 150mm

l = 1520mm = Clear Span

Effective Span = Clear Span + Effective Depth Effective

Span = Center to Center of Clear

Condition 1 as per IS456 (2000) – Pg 34 Clause 22.2

Clear Span = 0.10 + 1.52

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Clear Span = 1.62

Condition 2 as per IS456 (2000) – Pg 34 Clause 22.2

Effective Span = 150/2 + 1.52 + 150/2

Effective Span = 1.67 m

b = 100 mm d = 100 mm d '= 50 mm D = 150 mm l = 1.67 m

Beam is a structural portion that primarily attacks loads applied perpendicular to its longitudinal axis. Beams are frequently used to support loads over spans, transferring them to provisions such as columns, walls, or other structural members. They piece a key role in the stability and integrity of various structures, including buildings, bridges, and mechanical systems. based on the standard calculation based beam design as in figure 3.6

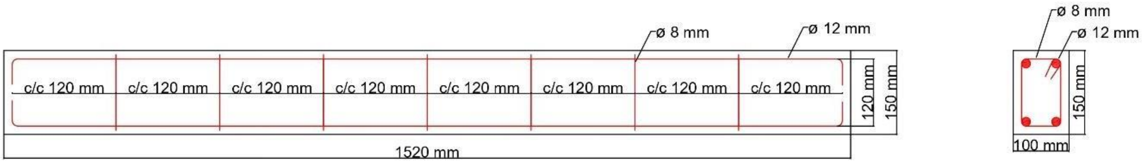

figure 3.6 Design of beam

Beam curing raises to the course of providing precise surroundings to inspire the hydration and strength progress of concrete beams subsequently they have been cast figure3.7. Curing is vital for safeguarding the chosen properties and durability of concrete structures, plus beams. Proper curing services preclude drying shrinkage, cracking, and surface defects, while sponsoring hydration and the formation of strong, durable concrete figure 3.8. Flexural strength is the maximum winding stress that a beam can withstand before failure occurs figure 3.9. It depends on factors such as the material properties, beam geometry, and support conditions Flexural strength test on Beam value are presented in the Table 3.3.

figure 3.7 beam casting

figure 3.8 beam curing

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Figure 3.9 Flexural Strength Test on Beam

Table – 3.3 Flexural Strength Test on Beam kN/m^2

Waste Ceramic Tiles Replacement on Coarse Aggregate.	Flexural Strength Test on Beam kN/m^2
	28 days
Replacement of 0%	50.15
Replacement 5%	53.41
Replacement of 15%	54.31
Replacement of 25%	54.23
Replacement of 35%	52.22

3.4 STAAD PRO ANALYSIS OF BEAM

The structural analysis of the beams using STAAD Pro. The software applies mathematical models and numerical methods to calculate the internal forces, bending moments, shear forces, deflections, and other structural responses of the beams under the specified loads and support conditions Fig 3.10 Table for Displacement of Beam. Fig 3.11 Graph for Displacement of Beam. Fig 3.12 Table for Reaction of Beam Fig 3.13 Graph for Reaction of Beam. Fig 3.14 Table for Beam Result. Fig 3.15 Graph for Beam Results

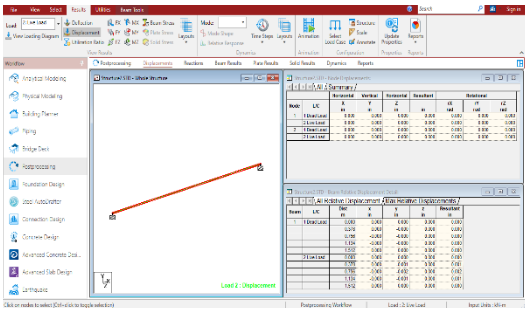

Fig 3.10 Table for Displacement of Beam

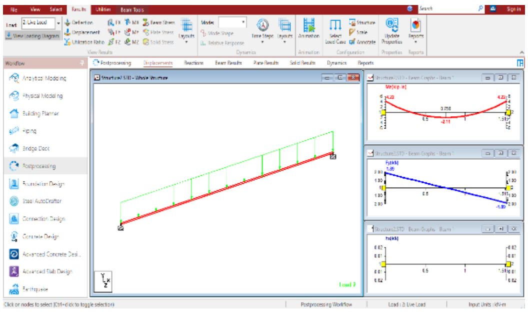

Fig 3.11 Graph for Displacement of Beam

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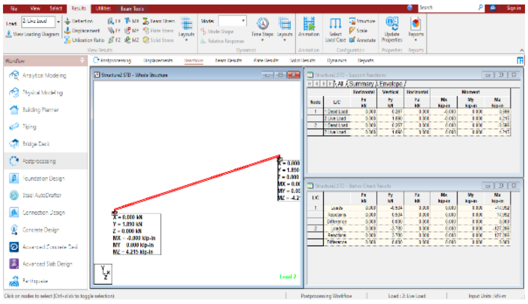

Fig 3.12 Table for Reaction of Beam

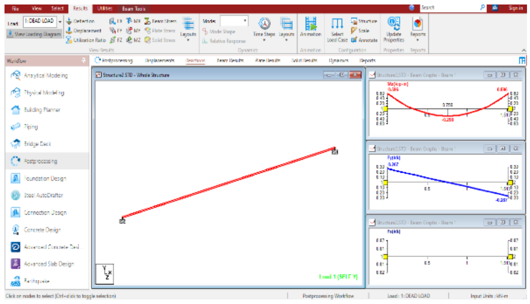

Fig 3.13 Graph for Reaction of Beam

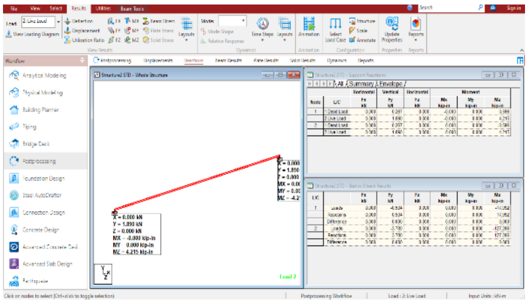

Fig 3.14 Table for Beam Results

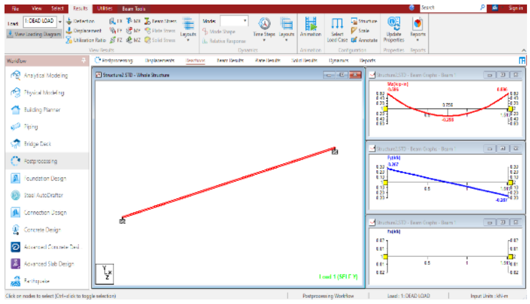

Fig 3.15 Graph for Beam Results

CONCLUSION

The performance of concrete made with recycled ceramic waste tiles from the various industrial, replacing with natural coarse aggregates and to find out strength of concrete. So their required to find of basic preliminary test to carryout for the materials testing like fine aggregate, coarse aggregate, ceramic tile & cement with using the standard equipment's and as per standard code, from the preliminary test result value are within the limits as per the norms. Next stage to known the durability of the concrete by the experiment method like compression test to be analysis, by casting with standard mould as per specific in the code. For the concrete mixture M40 grade is used, fine aggregate, broken waste ceramic tiles with partial replacement of coarse aggregate range from 0% to 30% with maximum size of 20mm of aggregate and water-cement ratio of 0.45. After casting the concrete sample is to be soaked in water for 28 days to increases the strength of concrete. Concrete samples are tested at age of 7 days and 28days the test report obtain that concrete level on compressive strength increasing upto the 30 % by adding of partially replacement of broken tiles waste. Next stage to analysis of the beam structure for the same design mix ratio and partially replacement of broken tile waste with the coarse aggregate. Beam is a structural slice that primarily spasms loads applied perpendicular to its longitudinal axis. Flexural strength is the maximum curving stress that a beam can withstand before failure occurs from the results beams can be to with stand upto maximum at stage of 15% partially replacement of broken waste tile with coarse aggregate is 53.41 kN/m^2 and minimum value at using partially replacement of broken waste tile with coarse aggregate is 30%.from the analysis of flexural strength behaviour of beams upto 30% adding partially replacement of broken waste tile is can withstand before failure.

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