# Strength Evaluation of Concrete by Partial Replacement of Coarse Aggregate and Fine Aggregate Instead of Crushed Tiles and Granite Powder in Different Curing Conditions

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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 Granite powder were replaced in place of fine aggregate by 10%, 20%, 30% without changing the mix design. M30 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 slump test and Compressive strength test, Ultrasonic pulse velocity test for different concrete mixes with different percentages of waste crushed and granite powder after 7,28 and 90 days in different curing conditions like normal water curing and accelerated curing tank.

***Key words:*** Granite Powder, Crushed Tiles, Ultrasonic Pulse Velocity Test

## I. Introduction

Generally in design of concrete mix, cement, fine aggregates and coarse aggregates are using from a long years back. These three materials only play a crucial role in designing of a particular grade of concrete. But now a days there is a scarcity in aggregates. So, some new materials which are very near to our surroundings and some type of materials have to be introduce for replacing the fine aggregates, coarse aggregates and as well as cement to get the same strength as that these basic materials can give.

In the present study we have to replace the 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.

## II. Experimental Porgramme

### A. Cement:

Ordinary Portland cement, 53 grade shall be manufactured by intimately mixing together calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this standard. No material shall be added after burning, other than gypsum (natural mineral or chemical, see Note), water, performance improver(s), and not more than a total of 1.0 percent of air-entraining agents or other agents including coloring agents, which have proved not to be harmful.

| S.NO | Properties | Test Values | Standard Values (IS) |
|---|---|---|---|
| 1 | Specific gravity | 3.12 | |
| 2 | Fineness (%) | 2.6 | < 10 |
| 3 | Initial setting time (min) | 148 | >30 |
| 4 | Final setting time(min) | 235 | <600 |

Table 1: Physical Properties of Cement

### B. Fine Aggregate:

Well graded river sand passing through 4.75 mm was used as fine aggregate. It consists of natural sand or, subject to approval, other inert materials with similar characteristics, or combinations having hard, strong, durable particles.

- Specific gravity of fine aggregate-2.6
- Fineness modulus of fine aggregate-2.42

### C. Coarse Aggregate:

Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slag’s, expanded clays and shale’s (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this Materials substantially retained on the No. 4 sieve, shall be classified as coarse aggregate.

- Specific gravity for 20mm size = 2.4
- Specific gravity for 10mm size=2.68
- Fineness modulus of coarse aggregate-8.25

### D. Granite Powder:

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.

- The specific gravity of granite powder = 2.53
- The fineness modulus = 2.4 with a particle size less than 90 μm.

 

### *E. Crushed Tiles:*

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% and 40% individually and along with replacement of fine aggregate with granite powder also

- The specific gravity of granite powder = 2.78
- The fineness modulus = 3.12

## III. MIX DESIGN AND TEST RESULTS

Design grade of concrete: M30 (as per IS:10262-2009 and IS 456-2000)

Mix proportions cement: Fine aggregate: Coarse aggregate-1:2.01:3.28

| S. No | Mix Code | Cement (kg) | Fine aggregate (%) | | Coarse aggregate (%) | |
|---|---|---|---|---|---|---|
| | | | Sand (kg) | Granite powder (kg) | Coarse aggregate (kg) | Crushed tiles (kg) |
| 1 | A0(0,0) | 360 | 723 | 0 | 1181 | 0 |
| 2 | A1(10,10) | 360 | 650.7 | 72.3 | 1062.9 | 118.1 |
| 3 | A2(10,20) | 360 | 650.7 | 72.3 | 944.8 | 236.2 |
| 4 | A3(10,30) | 360 | 650.7 | 72.3 | 826.7 | 354.3 |
| 5 | A4(20,10) | 360 | 578.4 | 144.6 | 1062.9 | 118.1 |
| 6 | A5(20,20) | 360 | 578.4 | 144.6 | 944.8 | 236.2 |
| 7 | A6(20,30) | 360 | 578.4 | 144.6 | 826.7 | 354.3 |
| 8 | A7(30,10) | 360 | 506.1 | 216.9 | 1062.9 | 118.1 |
| 9 | A8(30,20) | 360 | 506.1 | 216.9 | 944.8 | 236.2 |
| 10 | A9(30,30) | 360 | 506.1 | 216.9 | 826.7 | 354.3 |

Table 2: Mix Proportions for 1m3 of concrete for different mix proportions

### *A. Slump Test:*

Slump test is used to determine the workability of fresh concrete. The slump test result is a measure of the behaviour of a self-compacted inverted cone of concrete under the action of gravity. It is a measure of the concrete's workability or the dampness of concrete. Slump test as per IS: 1199 – 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod.

| | | |
|---|---|---|
| 1 | A0(0,0) | 107 |
| 2 | A1(10,10) | 102 |
| 3 | A2(10,20) | 97.4 |
| 4 | A3(10,30) | 95.2 |
| 5 | A4(20,10) | 100.5 |
| 6 | A5(20,20) | 97.7 |
| 7 | A6(20,30) | 91.8 |
| 8 | A7(30,10) | 93.6 |
| 9 | A8(30,20) | 94.9 |
| 10 | A9(30,30) | 90.3 |

Table 3: Slump cone Test Results in mm

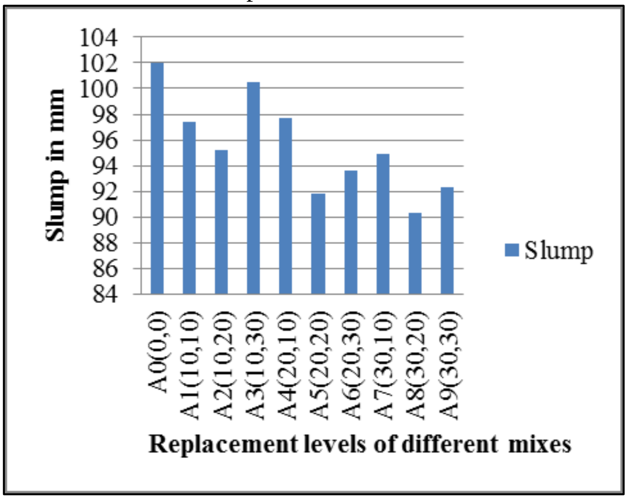


Fig. 1: slump test results

### *B. Concrete Curing:*

Concrete must be properly cured to improve its optimum mechanical properties. To avoid Evaporation water from the unhydrated concrete, the specimens were immediately covered with wet gunny sack after molded. The specimens were removed from the moulds after 1 day; moisture cured in water tank.

#### *1) Normal water curing:*

This is by far the best method of curing as it satisfies all the requirements of curing, namely, promotion of hydration, elimination of shrinkage and absorption of the heat of hydration. For example, the precast concrete items are normally immersed in curing tanks for certain duration.

#### *2) Accelerated curing tank:*

Compressive strength of test specimens cured by accelerated curing methods. This Standard lays down the method of making, curing and testing in compression concrete specimens cured by two accelerated methods namely warm – water method and boiling-water method. In this present study used accelerated curing by boiling water method according to IS: 9013-1978.

Fig. 2: Accelerated curing tank

 

### *C. Compressive Strength Test:*

The compressive strength of cube was obtained, at a loading rate of 2.5kN/s at the age of 7, 28 and 90 days on 3000kN machine. The average compressive strength of three specimens was considered for each age.

| Mix type | 7 Days | | 28 days | | 90 days | |
|---|---|---|---|---|---|---|
| | NWC | ACT | NWC | ACT | NWC | ACT |
| A0(0,0) | 27.79 | 22.23 | 40.98 | 32.78 | 45.49 | 36.39 |
| A1(10,10) | 27.92 | 22.37 | 41.17 | 32.93 | 45.69 | 36.56 |
| A2(10,20) | 28.63 | 22.94 | 41.42 | 33.15 | 45.97 | 36.73 |
| A3(10,30) | 29.14 | 23.31 | 42.16 | 33.72 | 46.95 | 37.56 |
| A4(20,10) | 29.44 | 23.58 | 42.64 | 34.11 | 47.36 | 37.81 |
| A5(20,20) | 29.62 | 23.69 | 43.34 | 34.67 | 48.13 | 38.57 |
| A6(20,30) | 30.14 | 24.11 | 44.26 | 35.40 | 49.15 | 39.32 |
| A7(30,10) | 29.71 | 23.84 | 43.96 | 35.16 | 48.75 | 39.13 |
| A8(30,20) | 29.76 | 23.86 | 42.86 | 34.28 | 47.56 | 38.17 |
| A9(30,30) | 29.83 | 23.92 | 42.76 | 34.21 | 47.47 | 37.97 |

Table 4: Compressive strength of concrete in Mpa

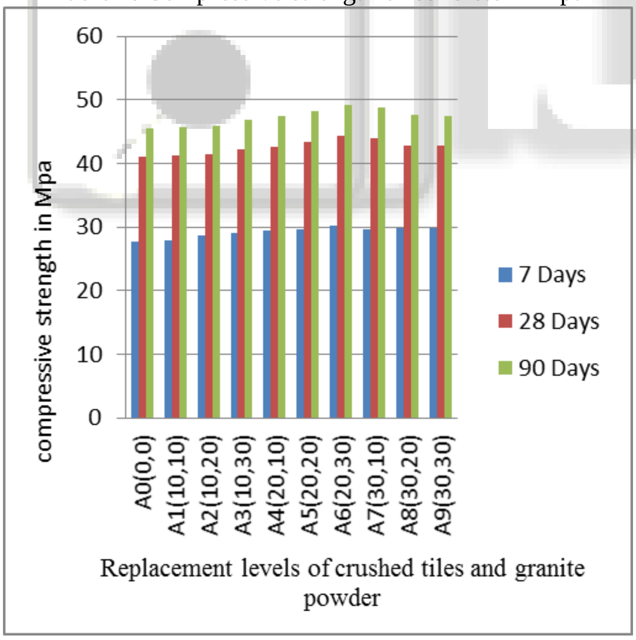


Fig. 3: Compressive strength of concrete In Normal Water Curing

From the Fig it has been observed that the compressive Strength is increases by replacing the materials of Granite powder and crushed tiles at a Percentage of up to A6 (20, 30) and the strength is decreases.

The maximum percentage of replacement of Granite powder and crushed tiles instead of Fine aggregate and Coarse aggregate is 20% and 30%.

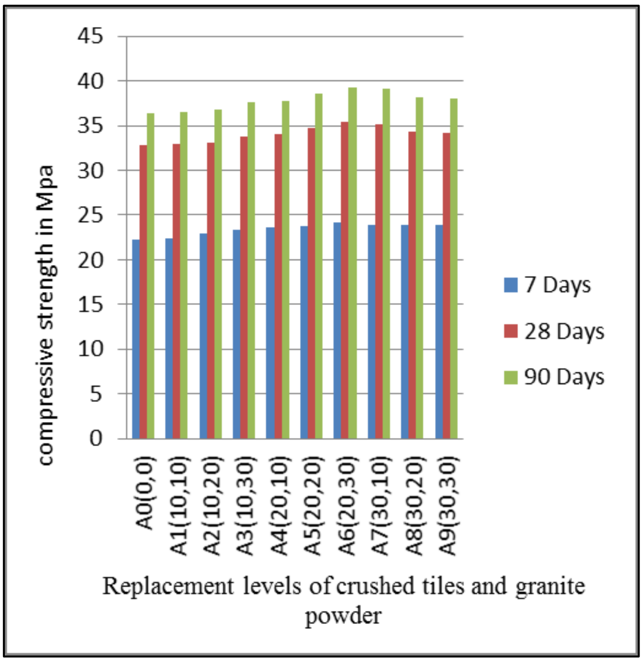


Fig. 4: Compressive strength of concrete In Accelerated Curing Tank.

From the Fig it has been observed that the compressive Strength is increases by replacing the materials of Granite powder and crushed tiles at a Percentage of up to A6 (20, 30) and the strength is decreases.

The maximum percentage of replacement of Granite powder and crushed tiles instead of Fine aggregate and Coarse aggregate is 20% and 30%.

From Fig 3&4 it has been observed that for control mix of M30, the compressive strength is maximum for NWC and then by ACT. The reason behind it is, in the case of NWC sufficient amount of water is available for the curing process & also for the formation of C-S-H gels. In case of ACT, C-S-H gels formation is irrational and incomplete than compared to NWC.

### *D. Split Tensile Strength Test:*

The split tensile strength of cylinder was obtained, at a loading rate of 2.5kN/s at the age of 7 and 28 days on 3000kN machine. The split tensile strength was also tested on the same machine at the age of 7, 28 and 90 days.

| Mix type | 7 Days | | 28 Days | | 90 Days | |
|---|---|---|---|---|---|---|
| | NWC | ACT | NWC | ACT | NWC | ACT |
| A0(0,0) | 2.69 | 2.15 | 3.92 | 3.13 | 4.23 | 3.38 |
| A1(10,10) | 2.72 | 2.17 | 4.13 | 3.28 | 4.32 | 3.45 |
| A2(10,20) | 2.81 | 2.24 | 4.18 | 3.3 | 4.37 | 3.49 |
| A3(10,30) | 2.86 | 2.28 | 4.21 | 3.32 | 4.45 | 3.52 |
| A4(20,10) | 2.91 | 2.32 | 4.22 | 3.35 | 4.47 | 3.57 |
| A5(20,20) | 2.96 | 2.36 | 4.33 | 3.46 | 4.53 | 3.62 |
| A6(20,30) | 3.15 | 2.52 | 4.42 | 3.53 | 4.95 | 3.96 |
| A7(30,10) | 2.67 | 2.13 | 4.24 | 3.39 | 4.25 | 3.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| A8(30,20) | 2.57 | 2.05 | 4.19 | 3.35 | 4.18 | 3.34 |
| A9(30,30) | 2.43 | 1.94 | 4.13 | 3.28 | 4.12 | 3.29 |

Table 5: Split Tensile strength of concrete in Mpa

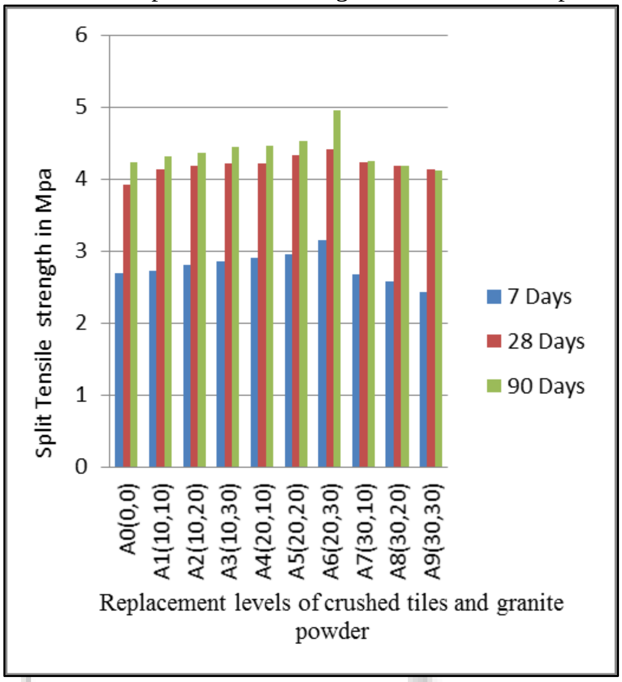


Fig. 5: Split Tensile strength of concrete In Normal Water Curing

From the Fig it has been observed that the Split Tensile Strength is increases by replacing the materials of Granite powder and crushed tiles at a Percentage of up to A6 (20, 30) and the strength is decreases.

The maximum percentage of replacement of Granite powder and crushed tiles instead of Fine aggregate and Coarse aggregate is 20% and 30%

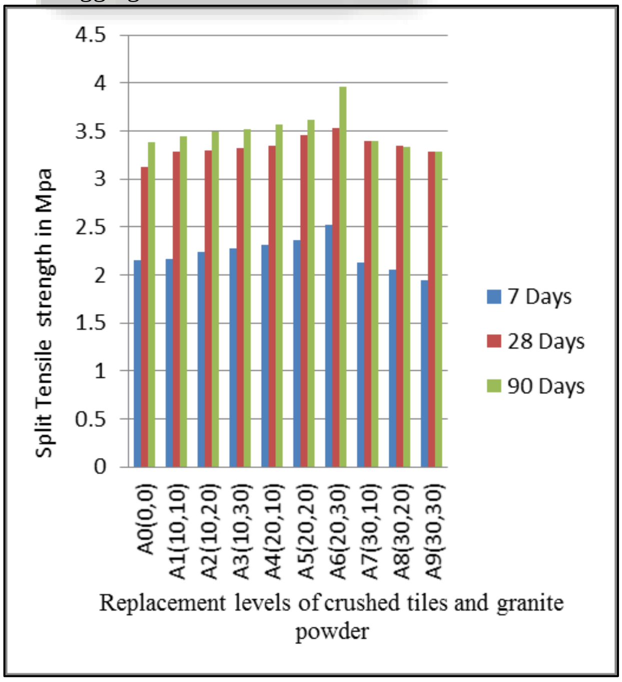


Fig. 6: Split Tensile strength of concrete In Accelerated Curing Tank

From the Fig it has been observed that the Split Tensile Strength is increases by replacing the materials of Granite powder and crushed tiles at a Percentage of up to A6 (20, 30) and the strength is decreases.

The maximum percentage of replacement of Granite powder and crushed tiles instead of Fine aggregate and Coarse aggregate is 20% and 30%

From Fig 5&6 it has been observed that for control mix of M30, the Split Tensile strength is maximum for NWC and then by ACT. The reason behind it is, in the case of NWC sufficient amount of water is available for the curing process & also for the formation of C-S-H gels. In case of ACT, C-S-H gels formation is irrational and incomplete than compared to NWC.

## IV. Conclusion

1) In Normal Water Curing condition for 7 days, 28 days and 90 days A6 (20, 30) is giving 8.456% and 8.004% and 8.046% more compressive strength when compared to control concert for M30 grade.
2) In Accelerated Curing tank condition for 7 days, 28 days and 90 days A6 (20, 30) is giving 8.457% and 7.993% and 8.052% more compressive strength when compared to control concert for M30 grade.
3) For control mix of M30, it is observed that the compressive strength is maximum for NWC and then followed by ACT in decreasing order.
4) In Normal Water Curing condition for 7 days, 28 days and 90 days A6 (20, 30) is giving 17.1% and 12.75% and 17.02% more Split Tensile strength when compared to control concert for M30 grade.
5) In Accelerated Curing tank condition for 7 days, 28 days and 90 days A6 (20, 30) is giving 17.2% and 12.77% and 17.15% more compressive strength when compared to control concert for M30 grade.
6) For control mix of M30, it is observed that the Split Tensile strength is maximum for NWC and then followed by ACT in decreasing order.

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