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# Study on Strength Properties of Concrete with Waste Kadappa Stones

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***Abstract***

*Recently, technologies are developing in the field of building materials, specifically for manufacturing of concrete and those concretes are mixes with a combination of different materials. Cement, fine aggregate, coarse aggregate and water are important constitutes of concrete that are obtained naturally. So we can replace new materials instead of natural sources such as M Sand, fly ash, Metakaolin, etc. In this research, coarse aggregates are partially replaced with 20%, 30%, 40% and 50% of Kadappa stones and the concrete mixes are formed based on the Indian Standard specifications. Fresh and hardened concrete properties are evaluated by workability test, compressive strength and split tensile test with a fixed water cement ratio 0.5. By using Kadappa stones, we can achieve 16.70% of extra compressive strength in M20 Concrete.*

***Keywords:*** *Kadappa Stones, Workability, Mix Design, Compressive Strength*

## INTRODUCTION

Nowadays, a large amount of waste is produced every year throughout the world, and some of the waste materials are useful to create another product. A research was undertaken to understand safe and economic disposal of waste materials and ways to use some waste materials to save natural resources, reduce dumping spaces, and maintain a clean environment. The current concrete construction practice is consuming enormous quantities of stone, sand, drinking water and also two billion tons of Portland cement every year, which releases greenhouse gases leading to global warming. Construction wastes are recycled in various countries with the help of a recycle plant. However, such a plant does not solve the problem permanently. Utilizing different waste materials such as rubber tyre, e-waste, coconut shell, blast furnace slag, waste plastic and demolished concrete constituents as a replacement of natural resources offers a permanent solution. In general, we cannot replace the whole basic material as a concrete, but we can replace different materials to certain limits only [1]. Currently, huge amounts of solid wastes are obtained from manufacturing units and demolished constructions. Some researchers are working on converting locally available solid wastes as partial replacements. The waste materials partially replaced in construction industries include crushed plastic, coconut shells, over burnt bricks, M – sand, glass powder, stone dust, coconut shell ash , waste tires, slag, fly ash produced from industries, broken glass pieces, rice husk ash, waste tiles, waste marbles etc. [1] India produced large amounts of raw stone material and this sector is quite developed and vibrant in the South India, as well as in Rajasthan and Gujarat, with many dedicated entrepreneurs. India also has an indigenous resource of machinery and tool manufacturers which cater well to the demands of this sector. The concrete consists of cement, fine aggregates and coarse aggregates. All these elements play a crucial role in designing of a particular grade in concrete. But nowadays, there is a scarcity of aggregates due to natural and man-made activities. New materials available locally can be used for reducing cost by replacing the fine aggregates, coarse aggregates as well as cement while the construction strength remain the same. So, without changing mix design procedure, we have to search for different materials to reduce the quantity of natural materials in the concrete mix. In developing countries, use of cheaper materials without loss of performance is crucial to economic growth.

## MATERIALS

### *Coarse Aggregate:*

Kadappa black stone are quite impervious and hard which is used in place of natural coarse aggregate in the range of 20%, 30%, 40% and 50%. The specific gravity, impact and water adsorption test was carried out on both natural and kadapaa stone aggregates. In total, three trial tests are carried as per Bureau of Indian Standard (BIS) and corresponding results mentioned in table 1.

*Table 1 Physical Properties of Natural and Kadappa Stone Aggregate*

| Physical properties | Coarse aggregate | Kadappa aggregate |
|---|---|---|
| Sieve analysis | Nominal size 20 mm | Nominal size 20 mm |
| Specific gravity | 2.6 | 2.7 |
| Impact | 12% | 15% |
| Water adsorption | 0.8% | 2.02 |

***Fine Aggregate:***

Sand was obtained from the river bed and its properties are tested as per IS 383: 1970. 100% of river sand passes through 4.75 mm sieve which comes under the zone –II category. Specific gravity of sand is 2.6.

***Cement:***

In concrete, cement is a material that binds coarse aggregate and fine aggregate with addition of water. Manufacturing involves intimately grinding Portland cement clinker and fly ash with addition of gypsum or calcium sulphate or by intimately and uniformly blending OPC with fine fly ash. The fly ash constituent shall not be less than 15 percent and not exceed 30 percent by mass of Portland Pozzolana Cement. Portland Pozzolana cement was used in this study and the properties of Fineness modulus, setting time and specific gravity tests are carried and the corresponding results are mentioned in table 2.

***Water:***

The usual pH range of water is between 6.5 and 8.5. If the same is less than 6, it is not preferred for construction because deterioration occurs due to acid content. Normal drinking water is used.

**MIX DESIGN PROPORTIONING**

M20 grade of Conventional concrete mix design is developed with different trials as per Indian Standard. Conventional concrete mix design modified by using kadappa stone in the proportion of 20%, 30%, 40% and 50% instead of natural coarse aggregate and the mixes are summarized in table 3.

***Table 2: Properties of Portland Pozzolana Cement***

| **Physical properties** | **Results** |
|---|---|
| Specific gravity | 3.15 |
| Fineness Modulus | 2.85 |
| Initial Setting Time | 40 min. |
| Final Setting Time | 320 min. |
| Grade of Cement | PPC |

***Table 3 Concrete Mix Proportioning***

| **Materials** | **Quantity** |
|---|---|
| Cement | 383 kg/m3 |
| Coarse aggregate | 1187 kg/m3 |
| Fine aggregate | 546 kg/m3 |
| W/C ratio | 0.50 |

## RESULTS AND DISCUSSION

### *Fresh Concrete Properties*

Slump cone test was carried out for concrete to study the workability of concrete with partial replacement of Kadappa stones. Compactor factor test was also carried out for the concrete as per Indian Standard specification. True slump values are obtained from slump cone test. Its results are summarized in table 4.

### *Casting*

As per the derived mix design ratio, three types of Specimen need to be casted. They are listed below as follows:

*1. Cube mould (150 x 150x 150 mm)*
*2. Cylinder mould (150 x 300 mm)*

The mould was removed to allow curing in 7 and 28 days respectively. The compressive strength is found out for concrete which was replaced with kaddapa stone in the proportion of 20%, 30%, 40%, and 50%. This was to be partial replacement of coarse aggregate.

*Table 4 Workability Properties of both Conventional and Partial Replacement Concrete*

| Concrete Mix | W/C Ratio | Slump Value | Compaction Factor |
|---|---|---|---|
| M20 | 0.5 | 142 | 0.87 |
| 20% of Kadappa stones | 0.5 | 139 | 0.93 |
| 30% of Kadappa stones | 0.5 | 136 | 0.92 |
| 40% of Kadappa stones | 0.5 | 132 | 0.92 |
| 50% of Kadappa stones | 0.5 | 128 | 0.90 |

*Table 5 Compressive Strength of Cubes and Cylinders for M20 Concrete after 28 Days*

| Concrete | Specimens | | | | | |
|---|---|---|---|---|---|---|
| | Cubes | | | Cylinder | | |
| Conventional concrete | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ |
| | 20.53 | 21.20 | 21.37 | 23.48 | 23. 85 | 23.92 |
| Partial replacement of kadappa stone | | | | | | |
| 20% | $B_1$ | $B_2$ | $B_3$ | $B_4$ | $B_5$ | $B_6$ |
| | 19.71 | 21.4 | 23.2 | 21.06 | 21.56 | 22.48 |
| 30% | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ |
| | 23.53 | 20.36 | 23.32 | 23.61 | 23.73 | 24.01 |
| 40% | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ |
| | 25.85 | 23.54 | 25.71 | 25.27 | 25.23 | 25.31 |
| 50% | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ |
| | 25.16 | 24.47 | 24.5 | 23.42 | 23.98 | 24.26 |

***Tests on Hardened Concrete***

Hardened concrete properties are evaluated by compressive and split tensile strength in laboratories. In total, 30 numbers of cubes and cylinders are tested in compressive testing machine and the results of tests are mentioned in Table 5. Split tensile strength is also calculated for 7 Days of curing concrete and 28 days of curing concrete. 30 numbers of cylinders are tested in 40 tons' capacity of compression testing machine. The results are shown in table 6.

*Table 6: Split tensile strength of concrete after 7 and 28 days*

| Concrete | Split tensile strength in N/mm$^2$ | | | | | |
|---|---|---|---|---|---|---|
| | 28 days | | | 7 days | | |
| Conventional concrete | 4.20 | 4.50 | 4.20 | 2.80 | 3.00 | 2.80 |
| Partial replacement of kadappa stone | | | | | | |
| 20% | 2.55 | 3.33 | 2.25 | 1.70 | 2.22 | 1.50 |
| 30% | 3.33 | 2.25 | 3.33 | 2.22 | 1.55 | 2.22 |
| 40% | 4.34 | 4.33 | 4.21 | 2.66 | 2.22 | 2.66 |
| 50% | 3.00 | 3.33 | 3.33 | 2.00 | 2.22 | 2.22 |

*Fig1. Testing of concrete cube specimens in compression testing machine*

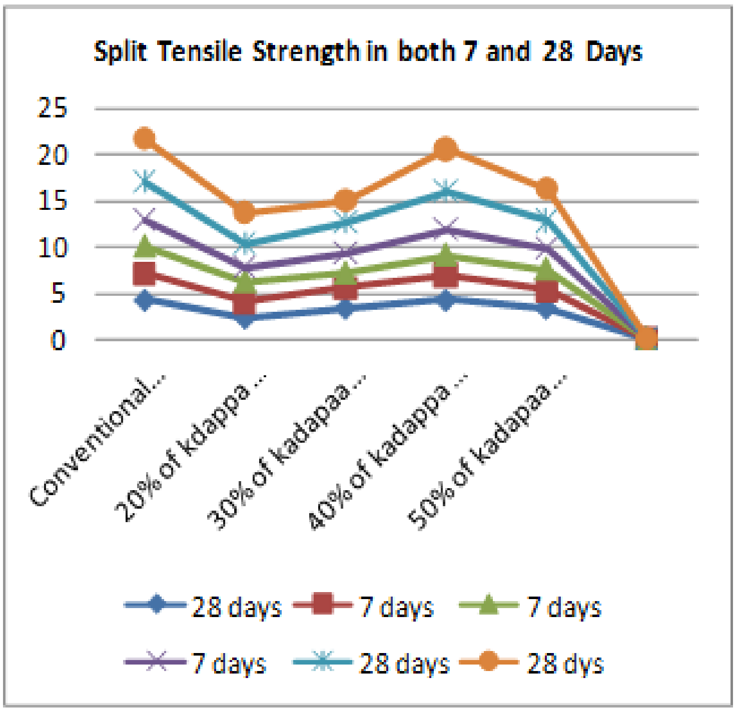


***Fig. 2: Comparisons of Split Tensile Strength after 7 and 28 days of curing concrete***

Compared to conventional concrete, 40 % partial replacement of kadapa stones give maximum compressive strength, which is 25.71N/mm2 after 28 days. The strength of replaced concrete range is 19.71- 25.71 N/mm2. 40 % of coarse aggregate replaced by Kadapaa stones obtains maximum split tensile strength 4.34 N/mm2 and minimum 2 N/mm2. Figure 2 shows the split tensile strength after 7 and 28 days of concrete curing.

## CONCLUSION

Based on the results obtained from the experiment the following conclusions are drawn:

The maximum compressive strength of concrete can be achieved by using 40% Kaddapa stone in the mix was found to be adaptable. Compared to conventional concrete, the compressive strength of 40% kadappa stone replaced coarse aggregate concrete was gradually increased up to 16.70% and its split tensile strength value was 4.34. From the above results, it was clear that the strength decreased when 30% of coarse aggregate was replaced. Hence, replacement of coarse aggregate with 40% kaddapa stone achieved excellent strength. Effect on compression with 30% replacement of aggregate has been found to be similar to conventional concrete. However, replacement of aggregates with up to 40% of concrete increases compressive strength significantly when compared with 30% replacement of coarse aggregate. Using Kaddapa stones as paver aggregate is most suitable for building paver blocks. This method can also be used in heavy weight concrete as it gives better strength than natural aggregate.

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