Experimental Study on Concrete With Partial Replacement of Granite Dust And Waste Cuddapah Stone As Fine And Coarse Aggregates

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Abstract- *Concrete is a major building material which is extremely versatile and used for all types of structures. Due to the rapid growth in construction activity, the consumption of concrete is increasing every year. This results in excessive extraction of natural aggregates. The use of these materials is being constrained by urbanization, zoning regulations, increased cost and environmental concern. Thus, it is becoming inevitable to use alternative materials for aggregates in concrete which include recycled aggregates, crushed rock powder etc. The present project report summarizes the strength behavior of partial replacement of fine aggregate in concrete by cuddapah stones and cement by granite dust.*

It is well known that produce Portland cement consumes more natural resources and at the same time releases a large volume of CO2 into atmosphere and causes greenhouse effect. In order to decrease the production we are replacing cement with granite dust in different proportions. Geographically the Tadipatri, Anantapur (Dist), Andhra Pradesh (state) is much potential to layered stone (Kadapa slab).In this study cuddapah stones were partially replaced as coarse aggregates in 20%, 40% and 60%, the fine aggregate is partially replaced by granite dust in 10%, 15% and 20% respectively are casted and tested for 7 and 28 days. Concrete is made for M30 mix and hardened concrete properties are evaluated by workability test, compressive strength and spilt tensile test.

I. INTRODUCTION

Concrete is a mixture of cement, aggregate and water. The most commonly used fine aggregate is sand derived from river banks.

The high consumption of raw materials by the construction sector, results in chronic shortage of building materials and the associated environmental damage. In the last decade, construction industry has been conducted various researches on the utilization of waste products in concrete in order to reduce the utilization of natural resources. In this content, coarse aggregate has been replaced by waste cuddapah stone. Crushed cuddapah stone aggregate are more suitable for production of high strength concrete compared to natural gravel and sand.

It is the reliable partial replacement for granite stone in Cuddapah stone, Impact environment impact and also its availability of sand properties. By using waste Cuddapah stone and mixing with different type's ratio and percentage of waste Cuddapah stone, the comparison of it results and analysis can be made whether it is suitable for construction material. It is great practice significance to developing new product for civil engineering works.

River sand is one of the principal components of concrete. The cost of river sand is increasing due to the high demand on the construction industry. So we are using M-sand as fine aggregate .In this case we are using granite dust as partial replacement for fine aggregate. The selection of ratio must be alone properly by considering the result of the quality of concrete. The source of material added and proportion of the material according to IS 10262-1984.

The primary investigation is to make use of waste cuddapah stone as partial replacement of coarse aggregate and granite dust as partial replacement of fine aggregate in concrete. Compression test were performed on waste cuddapah stone by replacing 20%, 40%, & 60% and granite dust by replacing 10%, 15%,& 20% of fine aggregate test results were compared.

In project work ratio concrete is 1:1.45:2.51 both conventional and replaced concrete of 3 different proportions considered. The testing of this study is based on the sources of material added and proportion of the material according to Indian standard 10262-1984.

1.1 Waste Cuddapah Stone:

Mainly in the places of Kadapa, Yerraguntla, Mydukuretc. The mostly available stone is cuddapah stone. Localized use this stone as Flooring for the Houses, Footpaths, and Garden areas etc… When they get it from the quarry, it is generally in irregular shape which they used to transform it into a proper shape for efficient use. In this process there is a lot of waste comes out from the polishing shop. Wastes are cuddapah Stone Powder and cuddapah stone chips.

Geographically the Tadipatri, Anantapur (District), Andhra Pradesh (State) is much potential to layered stone (Kadapa slab). The layered stone is utilizing for roof and floor works. During processing of finished product, waste is generating and this waste is dumping in and around the town (Tadipatri). The paper presents the feasibility of utilization of stone waste for construction works. The primary lab tests showed the potentiality of waste for construction.

Cuddapah slab wastes are normally big to be put into a crushing machine. They were broken into small pieces of about 100– 150 mm sizes by a hammer. These small pieces are then put into a jaw crusher to get the required 20 mm to 12.5 mm size after sieved.

1.2 Manufactured Sand:

Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not readily available; it is transported from a long distance. Those resources are also exhausting very rapidly. So it is a need of the time to find some substitute to natural river sand.

The artificial sand produced by proper machines can be a better substitute to river sand. The sand must be of proper gradation (it should have particles from 150 microns to 4.75 mm in proper proportion).

1.3 Granite Dust:

Inhalation of granite powder fine particles is a health hazard and is a cause of lungs diseases especially for people living near granite mills. In this present work, granite powder is used as partial replacement of sand in concrete in different percentage and the associated compressive strength, flexural, and splitting tensile strengths of concrete have been evaluated. By doing so, natural resources of sand can be preserved and the health hazards of these industrial wastes are minimized.

Recycling of granite dust will prevent these wastes from ending up in landfills and provides affordable, eco-friendly, solid stone for various uses. Recycled tiles made from recycled glass or wastes from mines or factories have been used for floors, countertops, and walls

The specific gravity of granite powder was 2.53 and the fineness modulus was approximately 2.4 with a particle size less than 90 μm.

1.4 SCOPE OF THE STUDY:

This work is mainly focusing on to find the effect of Cuddapah stone and granite dust on the properties of concrete mixture by partial replacement of coarse and fine aggregates. The use of waste materials saves resources and dumping spaces, and helps to maintain clean environment. To reduce the overall cost of construction.

Waste disposal is an important issue in the present time and utilization of industrial waste like quarry dust, rock dust in concrete making studied to investigate the improvement in the properties of concrete and presenting their use as an alternative material.

We can prevent health hazards caused due to powder waste exposed to atmosphere.

1.5 SUMMARY:

One of the major challenges of our present society is the protection of environment and natural resources. Due to growing of structures, cement and natural aggregate availability is relatively reduced. Some of the imported elements in this respect are the reduction of the consumption of energy and natural raw materials. These topics are getting considerable attention under sustainable development nowadays. In recent past good attempts have been made for the successful utilization of various industrial by-products in concrete.

II. LITERATURE REVIEW

Nanda, R. P., Das, A. K. and Moharana, N.C(2010) Stone crusher dust as a fine aggregate in Concrete for paving blocks. International journal of civil and structural engineering.

G Murali, K R Jayavelu, et al (2012)., Experimental investigation on concrete with partial replacement of coarse aggregate, International Journal of Engineering Research and Applications, Natural aggregate had been replaced with the waste cuddapah stone in four different percentages namely 10, 20, 30 &40 %. A comparison was made between the specimens of partially replaced coarse aggregate and the same set of specimens admixed with supaflo. Test results indicated that the replacement of coarse aggregate by 30% had attained a good strength in the two cases mentioned.

N.VenkataRamana (2013), "A technical feasibility approach to utilize the stone waste for construction works", International Journal of Innovative Research in Science, Engineering and Technology, studied a technical feasibility approach to utilize the stone waste for construction works. Utilization of the black stone powder waste as partial replacement of cement and fine aggregate so as to keep the environment green. The disposal problem can be eradicated up to some extent. Properties of black stone wastes are tested and results were found.

M. C. Nataraja and Lelin Das(2014), "A study on the strength properties of paver blocks made from unconventional materials", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), studied the strength properties of paver blocks such as compressive strength, split tensile strength, bending strength and water absorption by replacing coarse aggregate wih crushed granite, cuddapah and broken paver. The coarse aggregates used in this study are crushed granite, cuddapah and old paver block aggregate whose specific gravity are 2.58, 2.44 and 2.60 respectively.

Adanagouda, Mahesh and Dr.H.M.Somasekharaiah(2015). An Experimental Study On Properties of the Concrete for Replacement of Sand by Stone Waste for Different Types of Cement with Chemical Admixture. International Journal of Civil Engineering and Technology.

Cement: The most available Portland pozzalona cement of 53-grade was used for the investigation. Cement was bought from the same source throughout the research work.Portland Pozzolana Cement, "Product of Future," is prepared by a fully-automated, dry manufacturing process using state of the art technology under strict quality assurance at all stages of manufacturing with the help of the "ROBOTIC (POLAB)" system. PPC is manufactured by inter-grinding well-burnt OPC Clinker with gypsum and pozzolanic materials like power-station fly ash or siliceous earths.

Coarse aggregate: Coarse aggregate is defined as rock particles with diameter more than 4.75 mm, usually called gravels. Commonly-used coarse aggregates in concrete are gravels and pebbles. Hard broken granite stones were used as a coarse aggregate in concrete. Size of the coarse aggregate used in investigation was 20mm.

Waste Cuddapah stone:

There is an interest mounting up to the handling of waste materials as different aggregates and significant research was performed on the use of many different materials as aggregate substitute such as waste Cuddapah and other industrial wastes. We bought this stone near tadipatri surrounding area. In this study 20mm size of aggregate is used.

Table 3.1 Chemical properties of waste stone aggregate

SL. NO	PROPERTY	VALUES
1	Silica(SiO_2)	22.35%
2	Calcium Oxide (CaO)	38.91%
3	Magnesium Oxide(MgO)	2.75%
3	Ferric Oxide(Fe_2O_3)	1.30%
5	Alumina(Al_2O_3)	2.80%
6	Loss on Ignition(LOI)	30.52%

Fine aggregate (M-sand): As fine aggregate we used the manufactured sand. Manufactured sand is produced from hard granite stone by crushing.

The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm.Grading of sand is zone-II as per IS 383.

Specific gravity of cement (IS 2720:PART-3)

$$S_g = \frac{W2 - W1}{(W2 - W1) - (W3 - W4) \times 0.79}$$

$$= \frac{100-56}{(131-56)-(161-10)} = 3.15$$

The Specific Gravity Of Cement Is Given By= 3.15

Determination Of Fineness Of Cement (Is: 4031-Part-1)

Percentage fineness of cement= $\frac{\text{weight of residue retained}}{\text{weight of cement taken}} \times 100$

$$= \frac{6}{100} \times 100$$

=6%

Fineness of Cement =6%

Determination of Normal Consistency of Cement Calculation:

S NO	Weight of cement	Water content	Time (min)	Normal consistency b/a*100
1	300	90	4	30%
2	300	96	4	32%
3	300	102	4	34%

Water content = 30/100*300 = 90
Normal consistency of cement = 30%

Determination of Initial and Final Setting Time of Cement:

Weight of cement = 300gm
Water required = P*0.85 = 30*0.85
= 75.5ml
Time in minutes = 34min
Height of penetration = 5mm
Initial setting time = 30 min
Final setting time = 600 min

Coarse Aggregate and Waste Cuddapah Stone Aggregate:
Specific Gravity and Water Absorption of Coarse Aggregate and Cuddapah Stone Aggregate (IS: 383-1970):
Observations of waste Cuddapah stone:

- Weight of saturated aggregate suspended in water with basket = $\mathbf{W_1 g = 0.500}$
- Wt of basket suspended in water = $\mathbf{W_2\, g = 1.625}$
- Weight of saturated surface dry aggregate in air = $\mathbf{W_3}$g = 0.525
- Weight of oven dry aggregate = $\mathbf{W_4\, g = 0.470}$
- Weight of saturated aggregate in water = $\mathbf{W_1 - W_2\, g}$
- Weight of water equal to the volume of the aggregate = $\mathbf{W_3 - (W_1 - W_2) g}$

Specific gravity = $\mathbf{W_3 / (W_3 - (W_1 - W_2))}$
Water Absorption = $\mathbf{((W_3 - W_4) / W_4) \times 100}$
Specific Gravity of Coarse Aggregate = 2.63
Specific Gravity of Cuddapah Stone = 2.54
Water Absorption of Coarse Aggregate = 0.2%
Water Absorption of Cuddapah Stone =1.9%

Crushing value of Coarse Aggregate and Cuddapah stone aggregate.

Calculation of Aggregate Crushing Value:

The ratio of weight of fines formed to the weight of total sample in each test shall be expressed as a percentage, the result being recorded to the first decimal place.

Aggregate crushing value = (W2 x 100) / (W1-W)

Calculations of coarse aggregate:

W2 =Weight of fraction passing through the appropriate 2.36mm sieve= 0.548kg

W1-W =Weight of surface dry sample = 2.542kg

Calculations of waste cuddapah stone:

W2 =Weight of fraction passing through the appropriate 2.36mm sieve= 0.749kg
W1-W =Weight of surface dry sample = 2.970kg
The aggregate crushing value of coarse aggregate = 21.53
The aggregate crushing value of cuddapah stone = 25.21

Impact Value of coarse aggregate and cuddapah stone aggregate: Calculations of coarse aggregate:

Total weight of dry sample (W_1 gm) = 390gm
Weight of portion passing 2.36 mm sieve (W_2 gm) = 46.2gm
Aggregate Impact Value (percent) = $W_2 / W_1 \times 100$

Calculations of waste cuddapah stone:

Total weight of dry sample (W_1 gm) = 375gm
Weight of portion passing 2.36 mm sieve (W_2 gm) = 58.3gm
Aggregate Impact Value (percent) = $W_2 / W_1 \times 100$
Aggregate impact value of coarse aggregate = 11.8%
Aggregate Impact Value of cuddapah stone =15.3%

Flakiness and Elongation Index of Waste Cuddapah Stone

Total Weight Of Aggregates Taken = 1150 Kg
Total Weight Of Aggregates Passing Through Thickness Gauge = 0.308gm
Total Weight Of Aggregates In Each Fraction Retained On Length Gauge = 0.177gm

$$\text{Flakiness index} = \frac{\text{Wt Of Agg In Each Fraction Passing Thickness Gauge}}{\text{Total Weight Of Aggregates Taken}}$$

$$\text{Elongation index} = \frac{\text{Wt Of Agg In Each Fraction Retained On Length Gauge}}{\text{total weight of aggregates taken}}$$

- Flakiness index = 26.78%
- Elongation index = 15.39%

Fine Aggregate (M-Sand):

Specific gravity and water absorption of fine aggregate (M-sand) using pycnometer (IS:383-1970)
Weight of sample taken = 500gm
Weight of saturated & surface dry aggregate (C) = 508gm
Weight of pycnometer+ sample+ water (A) = 1845gm
Weight of pycnometer + water (B) = 1532gm
Weight of oven dry sample (D) = 496.7 gm

- Specific gravity = **D** / (**C**– (**A**– **B**))
- Apparent specific gravity = **C**/ (**D**– (**A**– **B**))
- Water Absorption = **(C** – **D) / D) X 100**

Specific Gravity Of M-Sand = 2.547
Water Absorption = 2.27%

Fineness Modulus of Fine Aggregate (IS: 383-1970)

Fineness modulus of fine aggregate = 4.06

III. METHODS FOR TESTING STRENGTH OF CONCRETE: IS -516:1959

Mix Design Procedure for M30 Grade Concrete:
Design stipulations:

- Characteristic compressive strength of required in the field at 28 days=30N/sq.mm
- Maximum size of aggregates= 20mm
- Degree of quality control= good
- Type of exposure= severe

Test Data:

1. Specific gravity of cement = 3.15
2. Specific gravity of fine aggregate = 2.547
3. Specific gravity of coarse aggregate = 2.630

Step 1: Target mean strength:

Fck = fck + 1.65$\times S$

S.NO	Is Sieve(mm)	Weight Retained Each Sieve (gm)	Cumulative weight retained (gm)	Percentage cumulative weight (%)	Percentage fines
1	4.75	10	10	1	99
2	2.36	50	60	6	94
3	600	450	510	51	49
4	300	180	690	69	31
5	150	135	825	82.5	17.5
6	90	140	965	96.5	3.5
7	pan	35	100	100	0

Fck = target mean compressive strength
fck = characteristic compressive strength
S = standard deviation
= 30+ 1.65*5 (as per Is code 10262, tab
= 38.25 N/sq.mm

Step 2 : Selection Of Water Cement Ratio:

Water cement ratio for target mean strength of 38.25 N/sq.mm is 0.45(from Is code 10262,3.1 fig 1)

Step 3: selection of water content:

From IS code 10262, table 4, for 20mm aggregate &Zone-II sand
Water = 197.16 lit\

Step 4: determination of cement content:

Water cement ratio = 0.45
Cement content = 197.16/0.45 = 438.13 kg/cu.m(severe exposure)
For W/C = 0.45,V_{ca} = 0.63,V_{fa} = 0.37
Volume of concrete = 1 cu.m
Volume of cement = $\frac{438.13}{3.15*1000}$ = 0.139 cu.m
Volume of water = 0.197 cu.m
Volume of all in aggregate = 1-(0.197-0.139)
= 0.644 cu.m
Mass of CA = 0.63*0.644*263*1000
= 1064.04 Kg/cu.m
Mass of FA = 0.37*0.644*2.547*1000
= 606.90Kg/cu.m

MIX PROPORTIONS:

Cement = 438.13 Kg/cu.m
Water = 197.16 lit/cu.m
Fine aggregate = 606.900Kg/cu.m
Coarse aggregate = 1067.05 Kg/cu.m
W/C = 0.45

IV. TESTS FOR CONCRETE

4.1 Compressive Strength of Concrete:

Preparation of Concrete Cube Specimen:

The proportion and material for making these test specimens are from the same concrete used in the field.Specimen6 cubes of 15 cm size Mix. M30.

Mixing of Concrete for Cube Test

Mix the concrete either by hand or in a laboratory batch mixer

Hand Mixing

1. Mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color
2. Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch
3. Add water and mix it until the concrete appears to be homogeneous and of the desired consistency

Sampling of Cubes for Test

1. Clean the mounds and apply oil
2. Fill the concrete in the molds in layers approximately 5 cm thick
3. Compact each layer with not less than 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end)
4. Level the top surface and smoothen it with a trowel

Curing of Cubes

The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

Precautions for Tests

The water for curing should be tested every 7 days and 28 days the temperature of water must be at 27+-2oC.

Procedure for concrete cube test

1. Remove the specimen from water after specified curing time and wipe out excess water from the surface.
2. Take the dimension of the specimen to the nearest 0.2m
3. Clean the bearing surface of the testing machine
4. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
5. Align the specimen centrally on the base plate of the machine.
6. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
7. Apply the load gradually without shock and continuously at the rate of 140 kg/cm^2/minute till the specimen fails
8. Record the maximum load and note any unusual features in the type of failure.

5.1 Compressive Strength and Split Tensile Strength of M30 Grade Of Conventional Concrete and Waste Cuddapah Stone Concrete.

The Compressive Strength Of M30 Grade Of Conventional Concrete And Waste Cuddapah Stone Concrete For 7 And 28 Days Values Can Be Given In Table Below.

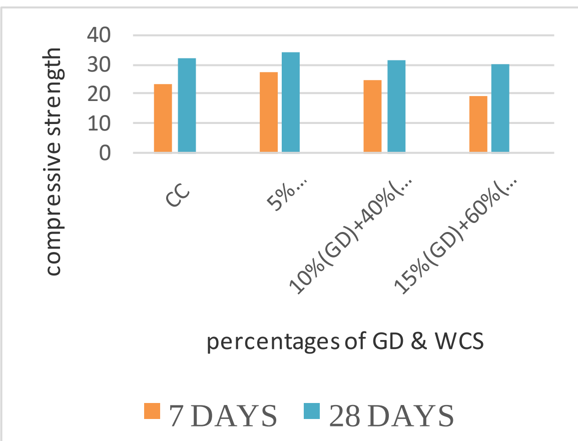
TABLE 5.1 compressive strength of M30 for 7 days:

mix	Weight (Kg)	Load (KN)	Strength (N/sq.mm)
CONVENTIONAL CONCRETE	7.54	435	23.5 (61%)
5%GD+20%WCS	7.65	650	27.61 (72%)
10%+40%(GD+WCS)	7.92	600	25.33 (66%)
15%+60%(GD+WCS)	7.83	495	19.33 (50%)

TABLE 5.2 compressive strength of M30 for 28 days:

mix	Weight (Kg)	Load (Kn)	Strength (N/sq.mm)
CONVENTIONAL CONCRETE	8.025	940	32.53
5%GD+20%WCS	8.220	690	34.81
10%+40%(GD+WCS)	8.120	720	31.83
15%+60%(GD+WCS)	7.900	625	24.82

GRAPH 1:Compressive Strength of M30 grade concrete cubes for 7 days and 28 days:



5.2 Split Tensile Strength of M30 Grade of Conventional Concrete and Waste Cuddapah Stone Concrete.

The split tensile strength of M30 grade of conventional concrete and waste cuddapah stone concrete for 7 and 28 days values can be given in table below.

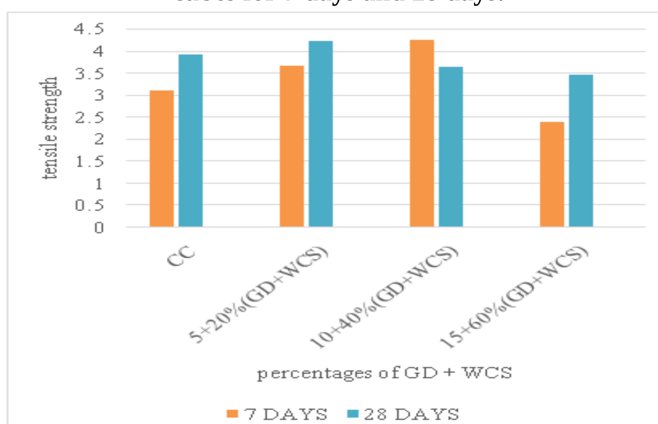
TABLE 6.1 compressive strength of M30 for 7 days:

mix	Weight(Kg)	Load(KN)	Strength (N/sq.mm)
CONVENTIONAL CONCRETE	12.23	310	3.11
5%GD+20%WCS	12.41	260	3.67
10%+40%(GD+WCS)	12.54	300	4.24
15%+60%(GD+WCS)	12.370	170	2.40

TABLE 6.2 compressive strength of M30 for 28 days:

mix	Weight (Kg)	Load (KN)	Strength (N/sq.mm)
CONVENTIONAL CONCRETE	12.635	310	32.53
5%GD+20%WCS	12.685	325	34.81
10%+40%(GD+WCS)	12.245	265	31.85
15%+60%(GD+WCS)	12.435	270	24.82

GRAPH 2: compressive strength of M30 grade concrete cubes for 7 days and 28 days:



VI. SCOPE

In The Present Work The Experimental Study Was Done On Testing Of KFB Manufactured With Kadappa Waste. Based On Limited Experimental Investigations Concerning The Compressive Strength Of Bricks, The Following Results Were Observed Regarding The Replacement Of Cement And Quarry Dust By Kadappa Waste. Kadappa Waste Is Waste Material Obtain From Sizing And Polishing Units Which Is Available In Ample Quantity. Kadappa Waste Is Economical Material As Compare To Other Material Use For Manufacturing Of Brick. Kadappa Waste Has High Impact Value. Kadappa Waste Reduces The

Quantity Of Fly Ash Use In Brick And It Also Gives High Compressive Strength.

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