

# **Experimental Investigation on Mechanical Properties of Normal Concrete Using Stone Crusher Waste and Fly Ash with Estimated Cost**

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**ABSTRACT:** Now a day's using sand as an fine aggregate is becoming over exploiting due to heavy constructions. Due to this scarcity of sand occurs for the future generation. So in this we are interested to study on replacement of sand with stone crusher waste at various replacements levels. Also it is well known that produce Portland cement consumes more natural resources and at the same time releases a large volume off CO<sub>2</sub> into the atmosphere and causes green house effect. In order to decrease cement production we are replacing cement with fly ash in different proportions. Along with these cement is also replaced by Kadapa stone powder. In this experimental work 20%, 40% and 60% of fly ash used in replacement of Ordinary Portland cement and for each these mixes 50%, 75% and 100% stone crusher waste is used as fine aggregate. For all these mixes 5% (by weight of cement) of Kadapa stone powder is used. Due to the time constraint, as a part of experimental work standard size cubes, cylinders and beams were cast and tested to evaluate only the 28 days Compressive, Split tensile and Flexural strengths of the above concrete mixes were found.

**KEYWORDS:** Fly ash, Stone crusher waste as fine aggregates, Kadapa stone powder, Compressive strength, Flexural strength, Split tensile strength..

## **I. INTRODUCTION**

Concrete is the most important construction material for civil engineering. Concrete is one of the most durable material. It provides superior fire resistance compared with wooden construction and gain strength over time. Structures made of concrete can have along service life. Sand is used as fine aggregate in mortars and concrete. Natural river sand is the most preferred choice as a fine aggregate material. River sand is a product of natural weathering of rocks over a period of millions of years. It is mined from the river beds and sand mining has disastrous environmental consequences. River sand is becoming a scarce commodity and hence exploring alternatives to it has become eminent. This reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute materials to sand as fine aggregate in the production of concrete. Quarry dust, a by-product from the crushing process during quarrying activities is one of such materials. Granite fines or rock dust is a by-product obtained during crushing of granite rock and is also called quarry dust. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete.

Fly ash is a by-product of the combustion of pulverized coal in electric power generating plants. It is the most widely used supplementary cementitious material in concrete. It is used in more than 50% of ready mix concrete. The properties of fly ash can greatly affect the properties for both fresh concrete and hardened concrete. Many countries have their own national standards and specifications regulating the use of fly ash in concrete. In the United states, ASTM C 618, "Standard specifications for coal Fly Ash and Raw or Calcined Natural Pozzolana for use in concrete," is the common specification to assess the suitability of fly ash and pozzolana for use in concrete. The standards test

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methods related to this specification are contained in ASTM C 311 , “Standard test method for sampling and testing Fly Ash or natural Pozzolanas for Use in Portland-Cement concrete.”

By using waste materials of concrete in the construction purpose like Highways, Air ports, Dams, Bridges, Nuclear plants etc.

## Stone powder

In Kadapa district, there are number of stone polishing industries and huge quantities of fine powder from the grinding of rough Kadapa stones during the process of polishing the stones to convert them into polishing stone suitable for laying of flooring and other such works, is generated. This powder is finer than cement. At present this powder is not used for constructive use. Kadapa stone powder obtained from grinding of stones in an inert material. As the powder is finer than the cement, this can be used as filler in concrete.

## II. LITERATURE REVIEW

Abdullah Anwar et al. [1] studied the Compressive Strength of Concrete by Partial Replacement of Cement with High Volume Fly Ash and mixtures containing 10%, 20%, 30% and 40%. When the percentage of replacement is increased the water/ binder ratio gets reduced, hereby, increasing the compressive strength. And also observing that the compressive strength of concrete having more than 40% replacement of cement by fly ash suffers adverse effects though water/ binder ratio is gradually lost weight. The compressive strength of the concrete mix with 40% replacement with fly ash was lesser than the conventional concrete at 28 days.

Balamurugan and Perumal [2] studied the behaviour of concrete by replacing sand by quarry dust. Then the strength of the concrete will be varied. when replacing sand by quarry dust from 0% to 100% in steps of 10% . M 20 and M 25 grades of concrete are taken for taking the slump of 60 mm. Then we have to find out the maximum compressive strength, split tensile strength and flexural strength are obtained only at 50% replacement. So, they concluded that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand at 50% replacement with additional strength than control concrete.

Chandana Sukesh et al. [3] carried out investigation on partial replacement of sand with quarry dust in concrete. The replacement of sand with quarry dust is 55% to 75% in case of compressive strength. The further increasing the percentage of replacement can be made useful by adding the fly ash along with the quarry dust so that 100% replacement of sand can be achieved. They concluded that the partial replacement of sand with quarry dust shows an improvement in the compressive strength of the concrete.

Felixkala and Partheeban [4] Using granite powder as Replacement of sand along with partial replacement of cement with fly ash, silica fume and blast furnace slag etc. They concluded that granite powder is of partial replacement to sand had beneficial effect on the mechanical properties such as compressive strength, split tensile strength and modulus of elasticity. And then also the values of drying and plastic shrinkage of concrete are less than those of ordinary concrete specimens.

Jayesh kumar Pitroda et al. [5] The partial replacement of cement with fly ash in design mix concrete. The use of fly ash in concrete formulations as a supplementary cementitious material was tested as an alternative to traditional concrete. The cement has been replaced by fly ash accordingly in the range of 0%, 10%, 20%, 30% and 40% by weight of cement for M25 and M40 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split tensile strengths with the conventional concrete. They concluded that the test results for compressive strength up to 28 days.

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### III. DESIGN METHODOLOGY

#### MIX DESIGN PROCEDURE FOR M<sub>20</sub> CONCRETE:

Grade of designation = M<sub>20</sub>  
Type of cement = OPC (53 grade conforming to IS 12269-1987)  
Size of aggregate = 20 mm

#### TEST DATA FOR MATERIALS :

Cement = OPC (53 Grade)  
Specific gravity of cement = 3.16  
Specific gravity of sand = 2.61  
Specific gravity of coarse aggregate = 2.70  
Specific gravity of stone crusher waste = 2.68  
Specific gravity of kadapa slab powder = 2.75  
Water / cement = 0.50

1 . Target mean strength  $f(t) = f_{ck} + k_s$   
 $= 20 + 1.65 \cdot 4$   
 $= 26.6 \text{ N/mm}^2$

Standard deviation (s) = 4.0

2 . water / cement = 0.50

Exposure condition = Good

3. Maximum water content for 20mm agg = 186 liters ( for slump 25 to 50mm)

w/c = 0.50

Cement = water/ 0.50

= 186 / 0.50

= 372 kg/m<sup>3</sup>

4. Proportion of volume of coarse aggregate and fine aggregate

Volume of coarse aggregate = 0.62

Volume of fine aggregate = 1-0.62 = 0.38

#### MIX CALCULATIONS :

The mix calculation per unit volume of concrete

A. Volume of concrete = 1 cubic meter

B. Volume of cement = weight / specific gravity of cement \* 1000  
 $= 372 / 3.16 * 1000 = 0.117 \text{ m}^3$

C. Volume of water = 186 / 1000 = 0.186 m<sup>3</sup>

D. Volume of all in aggregate = [ A- (B+c)]  
 $= [1 - (0.117 + 0.186)]$   
0.697 m

E. Mass of fine aggregate/ sand = D \* Volume of sand \* specific gravity of sand \* 1000  
 $= 0.697 * 0.38 * 2.61 * 1000$   
 $= 691.3 \text{ kg/m}^3$

F. Mass of coarse aggregate = D \* Volume of coarse aggregate \* specific gravity of Coarse aggregate \* 1000  
 $= 0.697 * 2.70 * 0.62 * 1000$   
 $= 1166.77 \text{ kg/m}^3$

#### Mix calculations :

1. Volume of concrete = 1 m<sup>3</sup>
2. Volume of cement = 372 kg/m<sup>3</sup>
3. Volume of fine aggregate = 691 kg/m<sup>3</sup>
4. Volume of coarse aggregate = 1170 kg/m<sup>3</sup>

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5. Volume of water = 186 liters  
6. Water/ cement = 0.50

M<sub>20</sub> grade ratio = 1: 1.5: 3

Proportions of concrete mix details In this experimental work as per IS 10262 : 2009, for M20 grade concrete the proportions for 1cu.m of conventional concrete :

Cement	Fine aggregate	Coarse Aggregate	Water/cement ratio
1	1.85	3.14	0.50

In this experimental work finding the tests that are to be conducted for various proportions of concrete are:

- Cubes for Compressive strength
- Cylinders for Split tensile strength
- Beams for Flexural strength

## IV. RESULTS AND DISCUSSION

Table 1 : Increases / Decreases in % of compressive strength.

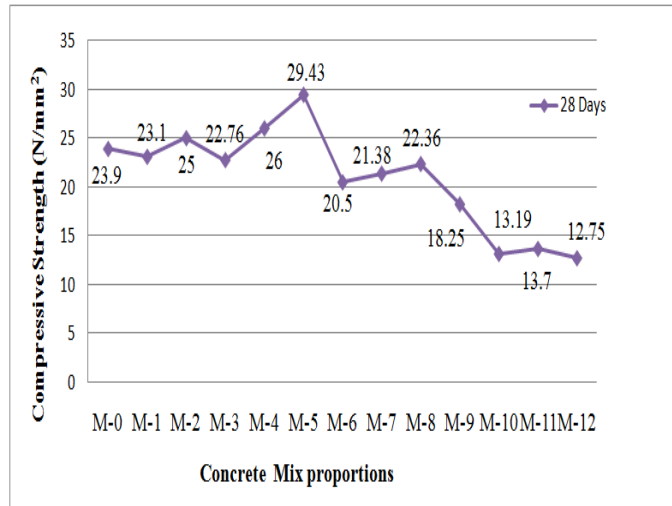
S no	Mix designation	Normal concrete for M <sub>20</sub> concrete	Avg Compressive strength values @ 28 Days	% of Increases/ decreases strength
1	M-0	26.6	23.9	-10.15
2	M-1	26.6	23.1	-13.15
3	M-2	26.6	25	-6
4	M-3	26.6	22.76	-14.4
5	M-4	26.6	26	-2.25
6	M-5	26.6	29.43	+10.64
7	M-6	26.6	20.5	-23.0
8	M-7	26.6	21.38	-19.62
9	M-8	26.6	22.36	-16
10	M-9	26.6	18.25	-31.39
11	M-10	26.6	13.19	-50.41
12	M-11	26.6	13.7	-48.50
13	M-12	26.6	12.75	-52.06

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Graph - 1: showing variation of compressive strength for different mix proportions at 28 days.

Table.2 Increases / Decreases in % of Split tensile strength

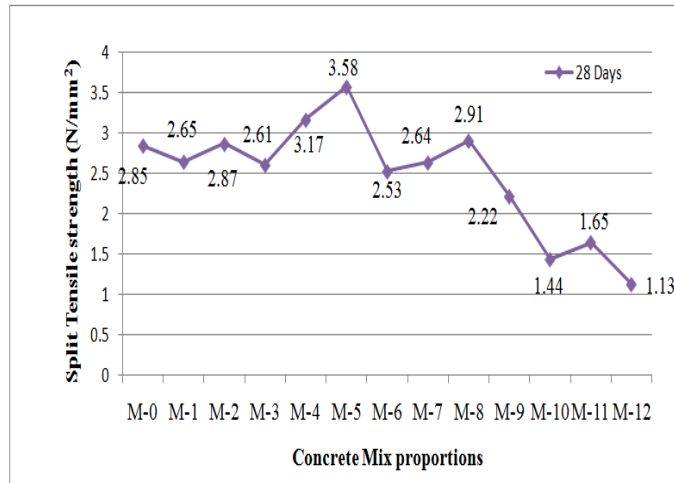
S no	Mix designation	Normal concrete	Avg Split tensile strength values @ 28 Days	% of Increase/Decrease in strengths
1	M-0	2.87	2.85	-0.70
2	M-1	2.87	2.65	-19.5
3	M-2	2.87	2.87	0
4	M-3	2.87	2.61	-9.05
5	M-4	2.87	3.17	+10.45
6	M-5	2.87	3.58	+24.74
7	M-6	2.87	2.53	-11.8
8	M-7	2.87	2.64	-8.01
9	M-8	2.87	2.91	+1.40
10	M-9	2.87	2.22	-22.6
11	M-10	2.87	1.44	-49.8
12	M-11	2.87	1.65	-42.5
13	M-12	2.87	1.13	-60.6

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Graph - 2 showing variation of Split tensile strength for different mix proportions at 28 days.

Table.3 Increases / Decreases in % of Flexural strength

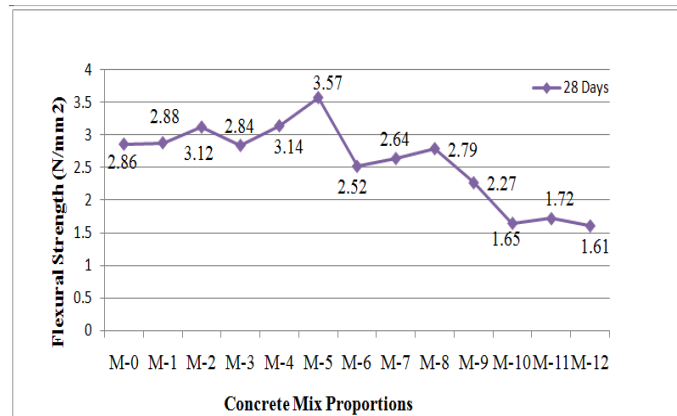
S no	Mix designation	Normal concrete	Avg Flexural strength values @ 28 Days	% of Increase/Decrease in strength
1	M-0	3.12	2.86	-8.33
2	M-1	3.12	2.88	-7.70
3	M-2	3.12	3.12	0
4	M-3	3.12	2.84	-9
5	M-4	3.12	3.14	+0.64
6	M-5	3.12	3.57	+14.42
7	M-6	3.12	2.52	-19.23
8	M-7	3.12	2.64	-15.4
9	M-8	3.12	2.79	-10.57
10	M-9	3.12	2.27	-27.24
11	M-10	3.12	1.65	-47.11
12	M-11	3.12	1.72	-44.87
13	M-12	3.12	1.61	-48.40

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Graph - 3: showing variation of Flexural strength for different mix proportions at 28 days.

Table .4 Percentage increases in strengths

Sno	Mechanical properties of concrete	Normal concrete	M-5 (20% Fly ash + 75% Stone Crusher Waste ) in concrete.	% Increases in strengths
1	Compressive strength (N/mm <sup>2</sup> )	26.6	29.43	11%
2	Split tensile strength (N/mm <sup>2</sup> )	2.87	3.58	25%
3	Flexural Strength (N/mm <sup>2</sup> )	3.12	3.57	14%

Table 6 Estimation of cost for 1 cu.m of concrete mix.

Materials	Normal concrete			Concrete mix M-5		
	Quantity (kg)	Rate/kg (Rs)	Cost (Rs)	Quantity (Kg)	Rate/ Kg (Rs)	Cost (Rs)
1.Cement (OPC 53 Grade)	372	7.2	2678.4	(75%) 279	7.2	2008.8
2.Flyash	----	----	----	(20%) 74.4	1.0	74.4
3.Kadapa slab powder	----	----	----	(5%) 18.6	5.0	93
4.Fine Aggregate a.sand	691	0.5	345.5	(25%) 172.75	0.5	86.37
b.Stone Crusher waste	-----	-----	-----	(75%) 518.25	0.15	77.74
5.coarse aggregate	1170	1.00	1170	1170	1.00	1170
<b>Total Cost</b>			<b>4195.00</b>			<b>3510.00 / -</b>
			/-			

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## V. CONCLUSION

The most commonly used grade of concrete M20 is examined for their mechanical properties. Based on the results obtained from this study, the following conclusions seems to be valid:

- From the investigation it can be concluded that stone crusher waste can be effectively be used in the production of concrete.
- Compressive strength of M-5 concrete is marginally 18% higher compared to that of conventional concrete.
- Split tensile strength of M-5 concrete is marginally 25% higher compared to that of conventional concrete.
- Flexural strength of M-5 concrete is marginally 15% higher compared to that of conventional concrete.
- From the investigation it can be concluded that using M-5 concrete, the cost for one cubic metre is 19% lesser compared to that of conventional concrete.

## REFERENCES

1. Abdullah Anwar, Sabih Ahmad, Syed Aqeel Ahmad, Juned Ahmad and Syed Mohd. Ashraf Husain (2014), "Study of Compressive Strength of Concrete by Partial Replacement of Cement with High Volume Fly Ash", International Journal of Current Engineering and Technology, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, Vol.4, No.6, December 2014, pp. 4162-4166.
2. Balamurugan .G and Dr. Perumal .P (2013), "Behaviour of concrete on the use of Quarry dust to replace sand – an Experimental study", IRACST – Engineering Science and Technology: An International Journal (ESTIJ),ISSN: 2250-3498, Vol. 3, No. 6, December 2013, pp.776-781.
3. Chandana Suresh, Katakam Bala Krishna, Sri Lakshmi .P, Sai Teja and Kanakambara Rao .S (2013), "Partial Replacement of Sand with Quarry Dust in Concrete", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Vol. 2, Issue-6, May 2013, pp. 254-258.
4. Felixkala .T and Partheeban .P (2010), "Granite Powder Concrete", Indian Journal of Science and Technology, ISSN: 0974- 6846, Volume 3, no. 3, March 2010, pp. 311-317.
5. Jayeshkumar Pitroda, Dr. Zala .L.B, Dr. Umrigar .F.S (2012), "Experimental investigations on partial Replacement of cement with fly ash in design mix concrete", International Journal of Advanced Engineering Technology, E-ISSN 0976-3945, IJAET/Vol.III/ Issue IV, October-December 2012, pp. 126-129.
6. Rama Raju .M.V, Vivek .K.V, Dr. Siva Shankar Reddy .T and Srinivas Reddy .P (2011), " Study of Properties of SCC using Quarry Dust and Fly Ash", International Journal of Engineering Sciences Research-IJESR, ISSN: 2230-8504; e-ISSN-2230-8512, Vol 02, Issue 04;August-September 2011, pp. 323-332.