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AN EXPERIMENTAL INVESTIGATION ON THE STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH STONE DUST AND FINE AGGREGATE WITH CRUSHED FINE AGGREGATE

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Abstract - *In the present study Stone Dust is used as partial replacement of cement by weight at varying percentages i.e.10%, 20%, 30% respectively. Crushed fine aggregate is used as replacement of fine aggregate by weight at varying percentages i.e. 25%, 50%, 75% & 100% respectively. The combined influence of Stone Dust and Crushed fine aggregate on Compressive Strength, Split Tensile Strength and Flexural Strength of M20 grade of concrete is investigated. The test results of concrete prepared using different combinations of Stone Dust and Crushed fine aggregate are compared with that of controlled concrete. A considerable increase in compressive strength, split tensile strength and flexural strength of concrete by using Stone Dust and Crushed fine aggregate is observed compared to control concrete. The maximum strength characteristics of concrete are obtained at 20% replacement of cement with Stone Dust and 50% replacement of fine aggregate with Crushed fine aggregate.*

Key Words: **Stone Dust, Crushed fine aggregate, quarry dust, Flexural Strength, concrete.**

1.INTRODUCTION

Cement is the most active component of concrete usually has the greatest unit cost, its selection and proper use are important in obtaining economical concrete and also concrete of desired properties. The use of large quantity of cement results in increasing C emissions and as a consequence of the green house effect. One of the methods to reduce the cement content in concrete mixes is the use of pozzolanic materials. Stone Dust (stone dust passing through 90micron sieve which contains 93% SiO2) is a supplementary cementitious material with pozzolanic characteristics. It makes concrete more durable and eco-friendly. Stone Dust is added in the hydration process, it reacts with the free lime to form additional calcium silicate hydrate (CSH) material, thereby making the concrete stronger and more durable.

1.1 CRUSHED FINE AGGREGATE

Crushed fine aggregate is a waste material obtains from crusher plants during the process of making of coarse aggregate of different sizes; about 175 million ton Crushed fine aggregate is produced every year, which is discarded as waste. Crushed fine aggregate refers generally to undersized materials typically finer than 4.75mm from crushing plants. They receive no further processing and are generally considered as of no economic value thus accumulated as unwanted waste. The proportions of fines vary according to the rock material used on the crushing process.

1.2 Merits of Crushed fine aggregate as a Fine Aggregate

Crushed fine aggregate reduces the cost of construction. Helps to reduce the impact of the environment by consuming the material generally considered as a waste product. Stone crusher dust can be used in concrete without significant difference in strength and workability compared to concrete with natural sand. The Crushed fine aggregate has potential as fine aggregate in concrete structures with reduction in the cost of construction of concrete by about 20% compared to conventional concrete. Crushed fine aggregate provides stronger bond with cement.

2. Applications of Crushed fine aggregate in processing

In India, Crushed fine aggregate is used to produce concrete blocks. It is mixed with chalk and gypsum to produce blocks. The used of Crushed fine aggregate in producing concrete blocks is also applied in South Africa. Crushed fine aggregate is also used to produce tiles. Application of Crushed fine aggregate in landscaping and recreational The United States of America, Australia and New Zealand has applied the use of Crushed fine aggregate for landscaping. For recreational use, Crushed fine aggregate is used for walkways.

3. OBJECTIVES

The objectives of the present research work are to study the

a. Effect of Stone Dust on the compressive strength, split tensile strength and flexural strength.

b. Effect of combined application of Stone Dust and Crushed fine aggregate on compressive strength, split tensile strength and flexural strength.

c. Comparison of the test results of Conventional Concrete with combined application of Stone Dust as partial replacement of cement and Crushed fine aggregate as replacement of fine aggregate.

4. SCOPE

The scope of project work is

1. Preliminary laboratory tests on cement, fine aggregate and coarse aggregate.
2. Mix design and proportioning of ingredients of Concrete mix.
3. Content of the Stone Dust used as 10%, 20% and 30% of the Cement.
4. Combined application of SD20%+CFA25%, SD20%+CFA50%, SD20%+CFA75%, SD20%+CFA 100%.

5. Materials

5.1 Cement

In the present investigation Ultratech Ordinary Portland Cement (OPC) of 53 grade confirming to IS: 12269-1987 specifications was used. All the tests are carried out in accordance with procedures described in IS: 4031-1985. Tests were conducted for the determination of physical properties of the cement. The physical properties of the cement as obtained from the manufactures are presented in the Table -1.

Table -1: Physical properties of cement

S.No	Property	RESULTS (%)
1.	Fineness	2.5%
2.	Specific gravity	3.12
3.	Normal Consistency Setting time(min) a) Initial b) Final	 95 min 240 min

5.2 Stone Dust

The Stone dust used in the investigation is obtained from the quarry at Chandragiri near Tirupati Andhra Pradesh. Stone Dust is obtained by sieving stone dust through 90 micron sieve. X-ray diffraction method (XRD) is conducted on stone dust it shows that it contains 93% SiO2. Reference XRD, it is ensured that due to the presence of SiO2, stone dust posses pozzolanic property. This SiO2 reacts with calcium hydroxide and forms calcium-silicate-hydrate gel which enhances strength properties of concrete.

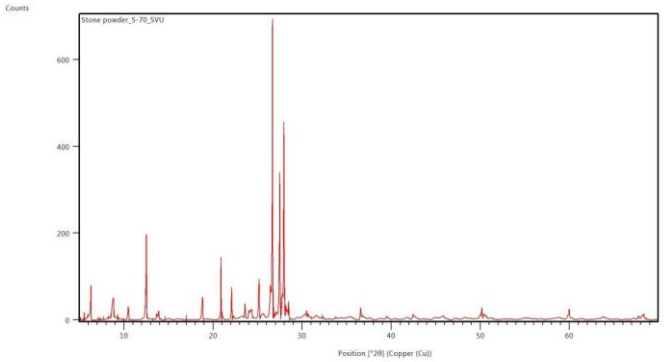

Chart -1: XRD(X-ray diffraction method)

5.3 FINE AGGREGATE

The locally available natural sand is procured and is found to be conformed to grading zone-II of IS 383-1970. Various tests have been carried out as per the procedure given in IS 383-1970 from them it is found that,

- Specific Gravity of Fine Aggregate is 2.56
- Fineness Modulus of Fine Aggregate is 2.6

The particle size distribution of sand was determined and the results are tabulated in Table-2.

Fig -1: Apparatus of sieve analysis of Fine Aggregate

Table -2: Sieve Analysis of Fine Aggregate

Sieve Size	Wei-ght Retained (gm)	Cumul-ative % retained	% passing	Zone specifications As per 383-1970 % Passing			
				I	II	III	IV
4.75 mm	5	0.5	99.5	90-100	90-100	90-100	95-100
2.36 mm	45	5	95	60-95	75-100	85-100	95-100
1.18 mm	130	18	82	82	30-70	55-90	75-100

600 µ	360	54	46	46	15-34	35-59	60-79
300 µ	350	89	11	11	5-20	8-30	12-40
150 µ	50	94	6	6	0-10	0-10	0-10

5.4 Natural coarse aggregate

Machine crushed granite aggregate conforming to IS 383-1970 consisting 20mm and below maximum size of aggregates has been obtained from the local quarry. It has been tested for physical and mechanical properties such as Specific Gravity, Water Absorption and Sieve Analysis and the results are as follows:

1. Specific Gravity of Coarse Aggregate is 2.67
2. Water Absorption of Coarse Aggregate is 0.4%
3. Fineness Modulus of Coarse Aggregate is 6.52

The particle size distribution of Coarse Aggregate was determined and the results are tabulated in Table-3.

Table-3 Sieve Analysis of Natural Coarse Aggregate

Sieve size	Weight retained	% Weight retained	Cumulative % retained	% Weight passing
80	0	0	0	100
40	0	0	0	100
20	2576	2.576	51.52	48.5
10	2389	2.389	99.3	0.7
4.75	35	0.035	100	0
2.36	0	0	100	0
1.18	0	0	100	0

5.5 Crushed fine aggregate

The Crushed fine aggregate is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. Crushed fine aggregate is collected from local stone crushing units of Chandragiri near, Tirupati, Andhra Pradesh. The properties of Crushed fine aggregate are shown in Table 4, the sieve analysis of Crushed fine aggregate is shown in Table 5 and also the grading curve of Crushed fine aggregate is shown in Fig 2

Table-4 Properties of Fine Aggregate (Crushed fine aggregate)

S.No	Property	Values
1	Specific Gravity	2.55
2	Fineness Modulus	3.15
3	Grading of Crushed fine aggregate	Zone – I

Fig-2 Crushed fine aggregate used for replacement of fine aggregate

Table-4 Sieve Analysis of Fine Aggregate

Sieve Size	Weight Retained (gm)	Cumulative % retained	% passing	Zone specifications As per 383-1970 % Passing			
				I	II	III	IV
4.75 mm	0	0	100	90-100	90-100	90-100	95-100
2.36 mm	186	18.6	81.4	60-95	75-100	85-100	95-100
1.18 mm	341	52.7	47.3	82	30-70	55-90	75-100
600 µ	174	70.1	29.9	46	15-34	35-59	60-79
300 µ	121	82.2	17.8	11	5-20	8-30	12-40
150 µ	98	92	8	6	0-10	0-10	0-10

5.6 WATER

As per IS 456:2000[25], water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salt, sugar, organic materials or other substances that may be deleterious to concrete or steel . If these are present can adversely affect the strength of concrete Potable water is generally considered satisfactory for mixing and curing of concrete. The PH value of water shall not less than 6. In my experimental investigation the water available in laboratory is used and all parameters are within permissible limits only. Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit of the concrete surface. The presence of tannic add or iron compounds are objectionable.

6. MIX DESIGN PROCEDURE

As per IS: 10262-2009[27] mix design for M 20 grade concrete

A-I STIPULATIONS FOR PROPORTIONONG

a)Grade designation : M20
b)Type of cement : OPC 53 Grade
c)Maximum nominal size of aggregate : 20mm
d)Minimum content of cement : 300 kg/m3
e)Maximum water- cement ratio : 0.55
f)Workability : 75mm(slump)
g)Exposure condition : Moderate
h)Method of concrete placing : ----
i)Degree of supervision : Good
j)Type of aggregate : Crushed angular aggregate
k)Maximum cement content : 450 kg/m3
l)Chemical admixture type : Nil

A-II TEST DATA FOR DETAILS

a) Cement used : OPC 53 grade confirming to IS: 12269
b)Specific gravity of cement : 3.12
c)Chemical admixture : NIL
d)Specific gravity of:
1)Coarse aggregate : 2.67
2)Fine aggregate : 2.56
e)Water absorption:
1)Coarse aggregate : 0.4 percent
2)Fine aggregate : 1.0 percent
f)Free (surface) moisture:
1)Coarse aggregate : Nil (absorbed moisture also nil)
2)Fine aggregate : Nil
g)Sieve analysis:
1)Coarse aggregate : Conforming to Table 4 of IS :383
2)Fine aggregate : Conforming to grading Zone II of Table

A-III TARGET STRENGTH FOR MIX PROPORTIONING

fck1 = fck + 1.65 S
Where, fck1 = target average compressive strength at 28 days,
fck = characteristic compressive strength at 28days,
S = standard deviation.
From Table 1, standard deviation, s=4 N/mm2
Therefore, Target mean strength = 20 + 1.65 × 4
= 26.6 N/mm2

A-IV SELECTION OF WATER-CEMENT RATIO

From Table 5 of IS 456, Maximum water cement ratio =0.55.
Based on experience, adopt water-cement ratio as 0.5.
0.5 < 0.55, hence O.K.

A-V & VI SELECTION OF WATER CONTENT & CEMENT CONTENT

Considering cement content as 340 kg/m3
From Table 5 of IS 456, minimum cement content for moderate exposure condition = 300 kg/m3
340 kg/m3 > 300 kg/m3, hence, OK.
From Table 2, Maximum water content =186 litre (for 50 mm slump range) for 20 mm aggregate
Estimated water content for 75mm slump = 0.5 x 340 =170 litre <186 litre(Maximum water content)
Hence, the arrived water content = 170 liters.

A-VII PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

From Table 3 (IS 10262:2009), volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (Zone II) for water – cement ratio of 0.55 = 0.62.
For water cement ratio of 0.45 = 0.63.
Therefore, volume of coarse aggregate = 0.64.
Volume of fine aggregate content = 1-0.64 = 0.36

A -VIII MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows:
Volume of Concrete = 1m3
Volume of Cement =Mass of cement x 1/sp.gravity of cement x 1000
= 0.109 m3
Volume of Water = Mass of water x 1/sp.gravity of water x 1000
= 0.17 m3
Mass of Coarse Aggregate = [volume of aggregates × volume of coarse aggregate × specific gravity of coarse aggregate × 1000]
= 0.701 × 0.64 × 2.67 × 1000
= 1198 Kg
Mass of Fine Aggregate = [volume of aggregates × volume of fine aggregate × specific gravity of fine aggregate × 1000]
= 0.701 × 0.36 × 2.56 × 1000
= 646 Kg

A-9 MIX PROPRTIONS

Cement = 340 kg/m3
Water = 170 kg/m3
Fine aggregate = 646 kg/m3
Coarse aggregate = 1198 kg/m3
Chemical admixture = Nil
Water-cement ratio = 0.5

Table-5 Ingredients of M20 Grade of Concrete used for Different Types of Mixes

S.No	Cement (%)	Stoned ust (%)	Crushed fine aggregate (%)	Water (lit)	Cement (kg)	Stone Dust (kg)	Fine Aggregate (kg)	Crushed fine aggregate (kg)	Coarse Aggregate (kg)
1	100	0	0	170	340	0	646	0	1198
2	90	10	0	170	306	34	0	710	1198
3	80	20	0	170	272	68	0	426	1198
4	70	30	0	170	238	102	0	213	1198
5	80	20	25	170	272	68	484.5	161.5	1198
6	80	20	50	170	272	68	323	323	1198
7	80	20	75	170	272	68	161.5	484.5	1198
8	80	20	100	170	272	68	0	646	1198

7 COMPRESSIVE STRENGTH OF CONCRETE

Table-6 Compressive Strength results of Control Concrete mix at different age

S.No	Age (days)	Compressive Strength (MPa)
1	3	13.2
2	7	21.6
3	28	26.8
4	56	30
5	90	32.03

Table-7Split Tensile Strength of M20 Grade Concrete

Concrete Mix	Stone Dust (%)	Crushed fine aggregate (%)	Split Tensile Strength(MPa)
Control Mix	0	0	3.2
M-1	10	0	3.26
M-2	20	0	3.335
M-3	30	0	3.1
M-4	20	25	3.38
M-5	20	50	3.46
M-6	20	75	3.08
M-7	20	100	2.77

Table-8Flexural Strength of M20 Grade Concrete

Concrete Mix	Stone Dust (%)	Crushed fine aggregate (%)	Flexure Strength(Mpa) For 28 Days
Control Mix	0	0	3.5
M-1	10	0	3.56
M-2	20	0	3.62
M-3	30	0	3.41
M-4	20	25	3.7
M-5	20	50	3.835
M-6	20	75	3.39
M-7	20	100	3.17

8. CONCLUSIONS

8.1Compressive Strength

1. The Compressive Strength at 28 days for M 20 design mix controlled concrete is obtained as 26.8 MPa.
2. The Compressive Strength at 28 days for 20% Stone Dust replacement in OPC is observed as 28.44 MPa.
3. Further the compressive strength at 28 days for 20% Stone Dust replacement in OPC and 50% replacement of Crushed fine aggregate in Fine Aggregate is observed as 29.87MPa. The compressive strength increases at SD 20% and CFA 50% by 11.4% compared to control concrete.

8.2 Split Tensile Strength

1. The Split Tensile Strength at 28 days for the M 20 design mix controlled concrete is obtained as 3.2 MPa.
2. The Split Tensile Strength at 28 days for 20% Stone Dust replacement in OPC is observed as 3.335 MPa.
3. The Split Tensile Strength at 28 days for 20% Stone Dust replacement in OPC and 50% replacement of Crushed fine aggregate in Fine Aggregate is observed as 3.46MPa.

8.3 Flexure Strength

1. The Flexure Strength at 28 days for the M 20 design mix controlled concrete is obtained as 3.5 MPa.
2. The Flexure Strength at 28 days for 20% Stone Dust replacement in OPC is observed as 3.62 MPa.
3. The Flexure Strength at 28 days for 20% Stone Dust replacement in OPC and 50% replacement of Crushed fine aggregate in Fine Aggregate is observed as 3.835MPa.

9. SCOPE FOR FUTURE WORK

The work can be extended for:

- The tests on Durability, Elastic modulus, Shrinkage properties of concrete. The impact resistance of the concrete can be also determined.

- Study on properties of concrete at various percentages of Stone Dust with combinations of different percentages of the other admixtures.

REFERENCES

1. Ankit Nileshchandra Patel, Jayeshkumar Pitroda "Stone Waste: Effective Replacement of Cement for Establishing Green Concrete" international Journal of Innovative Technology and Exploring Engineering ISSN: 2278-3075, Volume-2, Issue-5, and April-2013

2. Abdullah Anwar, Juned Ahmad, Meraj Ahmad, Khan Sabih, Ahmad Syed , Aqeel Ahmad "Study Of Compressive Strength Of Concrete By Partial Replacement Of Cement With Marble Dust Powder" International Journal on Mechanical Engineering and Robotics (IJMER) ISSN (Print) : 2321-5747, Volume-2, Issue-3,2014

3. Amitkumar D. Raval, Indrajit N. Patel, Jayeshkumar Pitroda "Eco-Efficient Concretes: Use Of Ceramic Powder As A Partial Replacement Of Cement" International Journal of Innovative Technology and Exploring Engineering ISSN: 2278-3075, Volume-3, Issue-2, and July-2013

4. Venkata Sairam Kumar N, Dr. B. Panduranga Rao, Krishna Sai M.L.N examined that the experimental studies on partial replacement of cement with crushed fine aggregate. International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974.

5. Tasnia Hoque, Muhammad Harunur Rashid, MD. Rokon Hasan in 2013 examined the Influence of Stone Dust as Partially Replacing Material of Cement and Sand on some Mechanical Properties of Mortar. International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 02, No. 02, April 2013. IJASGE 020203