International Journal of Advanced Technology in Engineering and Science
Vol. No.6, Issue No. 05, May 2018
www.ijates.com
ijates
ISSN 2348 - 7550

Partial Replacement of Fine Aggregate with Kota Stone Dust & Fly ash in Cement Mortar

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ABSTRACT

Stones are used for purposes like flooring and cladding etc. as a building material since the ancient times. This industry generates both stone slurry and solid waste by sawing and polishing processes. Aim of this paper is to study the effect on partially replacement of sand with Kota stone and fly ash in cement mortar. The main variable taken into consideration is the percentage of Kota stone dust and fly ash as partial replacement of sand content in cement mortar. Disposing the waste material in the environment can cause pollution. That is why the reuse of waste material has been considered important for balancing environment. Waste material can be used in production of new products or can be used as admixtures or substitutes by which efficient use of resources can be done and the environment can be protected from solid waste deposits. Fly ash is also a solid waste produced in thermal industries in the process of power generation. This research work give a description about the feasibility of using the Kota Stone dust and fly ash in mortar production with partially replacement of Sand. This study contains Standard Consistency test, Initial Setting Time test, Particle Size Distribution with Sieve Analysis, Specific Gravity of Sand, and water absorption test of sand showing properties of material and Compressive Strength Test of Cement Mortar with different proportions with standard water content, partial replacement of sand and one 0% cement mortar samples also prepared for help in easy comparison of data with graphical representation.

Keywords: *Cement, Fine Aggregate, Fly Ash, Kota Stone Dust etc.*

1. INTRODUCTION

Cement Mortar is most widely used important construction material as it is hard to make structures without it and used in civil engineering industry because of its adhesiveness, durability, quick setting and cheapness. The mortar industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problems are among the solid wastes generated by industry. Kota is a city rich in Kota stone

and also produce electricity by coal combustion in Kota Super Thermal Power Plant. Coal is a major source of fuel for production of electricity in this process large quantity of fly ash gets produced and becomes available as a by-product of coal-based power stations. Similarly 20-30% of Kota stone turns into dust in the process of cutting and polishing which is about 2.50 to 3.00 lakh MT per year, by this every year tons of Kota stone dust left undisposed & it is surely a calcareous material which shows a possibility of enhancement in strength. Since river sand is prohibited for construction by government, black-marketing of sand started with an increase in 5 to 7 times of previous actual cost with decrease in quality which makes overall project costs much more expensive and it also reduced construction sites especially of small contractors. So this study aims for a solution of this problem with the reuse of fly ash and Kota stone dust in cement mortar with various proportions to make project more economical and ecofriendly. The proportions of replacing fine particles of sands i.e. 90 mic – 500 mic are 5%, 10%, 15%, 20% & 0% of fly ash as well as Kota stone dust at the ages of 3, 7, 21, 28 days and a comparison is done of both types of samples in compressive strength.

2. LITERATURE REVIEW

A.Sathesh Kanna, G.Sangara Pitchai Raj, performed compressive strength with concluding M15 mix gave greater, M 5 mix gave lower compressive strength & split tensile strength test with M 15 mix gave greater, M20 results lower split tensile strength.

B.Senthil, **S.Selvarani**, **M.Saranya**, **D.Suganya** reported that 30% replacement of fine aggregate by industrial waste give maximum result in strength and quality aspects than the conventional concrete and prepared the concrete containing 10, 20, 30, 40, 50% waste of quarry dust, and granite slurry with sand compared to the total quantity of normal concrete with studied in terms of their properties both in fresh and in hardened states.

Chandraprabha Sahu reported that the inclusion of Marble powder the strength of concrete gradually increases up to a certain limit but then gradually decreases with Partial Replacement of Cement with Marble Dust Powder and tested at 3, 7, 28 days with taking five types of fly ash cement bricks specimens. In first three types sand percentage is taken as 30%, while the percentages of cement and fly ash have been changed by 5%. And in others percentage of fly ash is taken 60% with cement and sand having variation in their percentage by weight of the brick.

Lokesh Kumar, **Gautam Bhadoriya** concluded compressive strength of 7^{th} days cube is maximum for concrete mix M3 with addition of 25% fly ash as compared to other diverse concrete mixes & Increase in water cement ratio with addition of 25% fly ash.

3. EXPERIMENTAL MATERIAL & PROPERTIES

3.1. Material

- Cement: The ordinary Portland cement confirming to IS 4031 of 33 grade was used for the specimen preparation.

- Fine aggregate is used for experimental investigation and confirming to IS: 650 –1991. Standard Sand equal to 600 gm is used in this experimental work which has the particle size 2 mm to 1 mm = 200 gm, 1 mm to 500 mic = 200 gm, 500 mic to 90 mic = 200 gm.
- Water: Fresh Ground Water of pH 7.4 for Hydration of cement to form binding matrix between particles which hardens with time, workability of cement. Water required = (P/4 + 3) Percentage of combined mass of cement and sand. Where P is the consistency of cement as per IS: 4031 (Part 4) 1988.
- Kota Stone Dust: Fine particle remains of Kota Stone from Sawing, polishing, etc.
- Fly Ash: Fine Solid Waste or combustion remains of Bituminous coal used for power generation in Kota Super Thermal Power Plant.

3.2. Material Properties:

- Cement – 33 Grade
  - Fineness modulus -3%
  - Consistency -32.66%
  - Initial setting time-32 mins
- Fine Aggregate
  - Specific Gravity = 2.64
  - Water Absorption = 0.80%
- Kota Stone Dust
  - Specific Gravity = 2.63
  - Water absorption = 2.9%
  - Particle Size = 90 mic – 500 mic

Table 1: Chemical Composition of Kota stone dust

Component	Content (%)
Calcium oxide	37.30%
Magnesium oxide	4.13%
Sodium oxide	1.21%
Potassium oxide	0.40%
Aluminium oxide	1.37%
Ferrous oxide	0.86%
Titanium oxide	0.05%
Silica	24.90%
LOI	31.94%

- Fly Ash

Table 2: Composition of Fly Ash

Component (%)	Bituminous Coal
SiO_2	20-60
Al_2O_3	5-35
Fe_2O_3	10-40
CaO	1-12
LOI	0-15

4. RESULT & DISCUSSION

4.1. Compressive Strength Test:

In compressive strength test, 3 cubes of each type are casted in size of 7.06 mm * 7.06 mm * 7.06 mm mould and the samples are prepared with proportions of 0%, 5%, 10%, 15%, 20% by w/w of sand. Cubes are tested at the age of 3, 7, 21 & 28 days the methodology is adopted for sample preparation is from IS 4031 (Part 6) 1988.

4.2. Experiment Result:

Compressive strength test results are calculated for 3, 7, 21, 28 days. The following graph are the resultants which shows the variation of compressive strength at different percentages of fly ash and Kota Stone dust by weight of cement at different testing age.

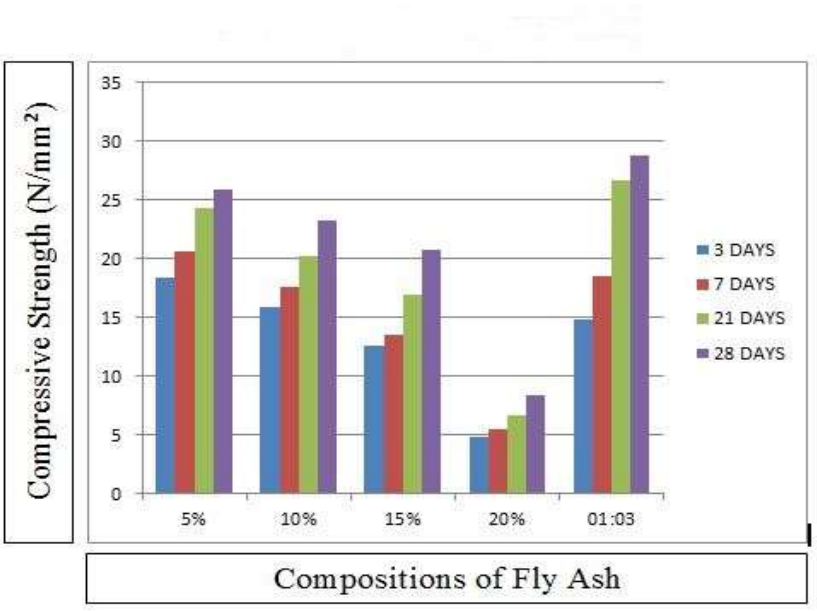

Fig. 1. Graph of Compressive Strength of different compositions of Fly ash

28 days			
S.No.	**Compositions**	**CTM Readings (KN)**	**Compressive Strength (N/mm²)**
01	1:3	141.66	28.78
02	05% FA	127.66	25.93
03	10% FA	114	23.26
04	15% FA	102.33	20.82
05	20% FA	41	8.36
06	05% KSD	121.66	24.70
07	10% KSD	127.66	25.93
08	15% KSD	135.66	27.56
09	20% KSD	147	30
21 DAYS			
10	1:3	131	26.73
11	05% FA	119.66	24.29
12	10% FA	99	20.20
13	15% FA	83	16.93
14	20% FA	33.33	6.74
15	05% KSD	113	23.06
16	10% KSD	120.33	24.49
17	15% KSD	131.66	26.74
18	20% KSD	139.33	28.37
7 DAYS			
19	1:3	91.66	18.58
20	05% FA	101	20.61
21	10% FA	86	17.55
22	15% FA	66.66	13.48
23	20% FA	27.66	5.32
24	05% KSD	102.33	20.82
25	10% KSD	112.66	22.87
26	15% KSD	119.33	24.29
27	20% KSD	131.66	26.74
3 DAYS			
28	1:3	73.33	14.90
29	05% FA	90.33	18.37
30	10% FA	78.33	15.92
31	15% FA	62.66	12.66

32	20% FA	24.33	4.90
33	05% KSD	93.33	18.98
34	10% KSD	101.66	20.62
35	15% KSD	110.33	22.45
36	20% KSD	123.66	4.70

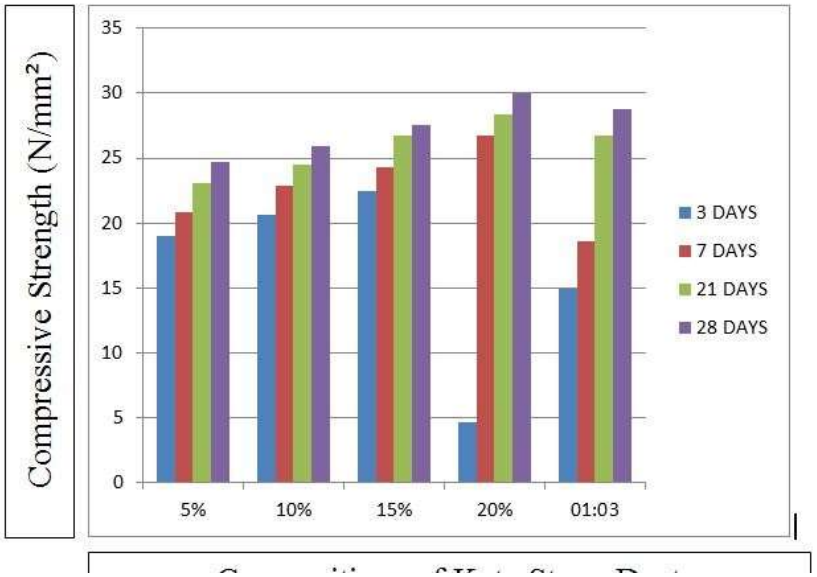

Fig. 2. Graph of Compressive Strength of different compositions of Kota Stone Dust

Table 3. Compressive strength with Compositions

V. CONCLUSION

From the above Kota Stone Dust mixed specimens showed positive result in compressive strength with early strength & reduced permeability. This early strength is due to enhanced ratio of CaO content in cement due to mixing Kota stone dust. Whereas water content was not sufficient for bonding matrix formation and hydration of cement. More economy can be achieved with the use of admixtures like plasticizer which will help in increasing workability and provide sufficient water for hydration in fly ash mixed specimens.

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