NOVATEUR PUBLICATIONS
International Journal Of Research Publications In Engineering And Technology [IJRPET]
ISSN: 2454-7875
VOLUME 2, ISSUE 12, Dec. -2016

OPTIMIZATION OF PARTIAL REPLACEMENT OF NATURAL SAND BY MANUFACTURED SAND WITH METAKAOLIN

D.SATYANARAYANA
P.G Student, Visakha Technical Campus, Narava, Visakhapatnam

D.SATESH
Assistant professor, Visakha Technical Campus, Narava, Visakhapatnam

E.V. RAGHAVA RAO
Professor, H.O.D, Dept of CIVIL Engineering
Visakha Technical Campus, Narava, Visakhapatnam.

ABSTRACT:

Compared with previous centuries Concrete is the mostly used in construction. The concrete is a made up of binding material (Cement and Lime etc.), fine aggregate (River Sand) and coarse aggregate (stone). Large amount of concrete is deploying by construction industry all over the world. Generally Conventional concrete is produced using natural sand from river beds as fine aggregate. Now days the availability of sand is very less, because of more utilization and less availability of sand with suitable concrete mixture aggregates. Diminishing natural assets poses the ecological trouble and thus government limitation on sand excavation resulted in shortage and noteworthy increase in its cost. This project present the exaggeration of fragmentary replacement of the natural sand (Sand stone) by manufactured sand with Met kaolin in Moderate Concrete (IS 10262-2009). Concrete mixes were assessed for compressive strength, flexural strength. The normal Portland cement was partially substituted with & Metakaolin by 5 % to 25 % with variation of 5% and natural sand was replaced with manufactured sand (Basalt Sand) by optimum proportions with variation of every 25%. The results indicated that may be there is a boost in the strength of MC nearly 10% and 20% correspondingly with the boost of manufactured sand percentage, Addition of up to 100% of 25% variation & Met kaolin by 5 % to 25 % with variation of 5% replacement yielded comparable strength with that of the control mix.

KEYWORDS: Moderate Concrete, Basalt Sand, Metakaolin, Compressive Strength, Flexural Strength, Optimum Percentage.

INTRODUCTION:

Concrete is perhaps the majority widely used building material in the world. It is merely next to water as heavily consumed matter and about six billion tones being produced every year. This is because of the availability of large quantity of raw materials available for cement concrete. The huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced using natural sand from river beds as fine aggregate. Diminishing natural assets create the environmental crisis and therefore government limitation on sand mining resulted in shortage and considerable boost in its cost.

Sand is the one of main constituents of concrete making which is about 35% of volume of concrete used in construction industry. Concrete is used for buildings in aggressive environments, marine structures, nuclear structures, tunnels, precast units, etc. Fine element under 600 microns should be at least 30 % to 50% for creating concrete will present superior results. The deep pits dug in river bed, affects the ground water level. Erosion of nearby land is also due to excessive sand lifting. To accomplish the necessity of fine aggregate, various substitute material have to be initiate. Concrete made with crushed stone dust as replacement of natural sand in concrete can attain the same compressive strength, comparable tensile strength, modulus of rupture and lower degree of shrinkage as the control concrete.

Basalt is defined by its mineral content and texture, and physical descriptions without mineralogical context may be unreliable in some circumstances. Basalt is usually grey to black in colour, but rapidly weathers to brown or rust-red due to oxidation of its mafic (iron-rich) minerals into hematite and other iron oxides and hydroxides. Although usually characterized as "dark", basaltic rocks exhibit a wide range of shading due to regional geochemical processes. Due to weathering or high concentrations of plagioclase, some basalts can be quite light-coloured, superficially resembling andesite to untrained eyes. Basalt has a fine-grained mineral texture due to the molten rock cooling too quickly for large mineral crystals to grow; it is often porphyritic, containing larger crystals (phenocrysts) formed prior to the extrusion that brought the magma to the surface, embedded in a finer-grained matrix.

RESEARCH SIGNIFICANCE:

The strength is one of the basic properties of the concrete structures. The conventional methods of mining the sand are not sufficient and hence the shortage of sand is there. Hence the requirement of concrete with better strength is there. Authors have carried out an extensive study to produce the alternatives i.e. Metakaolin and M-sand (Basalt Sand).

EXPERIMENTAL INVESTIGATIONS:

3.1 MATERIALS:

3.1.1 CEMENT: Cement is a binder, a substance that sets and hardens and can bind other materials together. Ordinary Portland cement (OPC) 53 grade conforming to IS 12269-1987 was used.

S.NO	Properties	Values
1	Specific gravity	3.15
2	Initial setting time	47mins
3	Final setting time	521mins
4	Standard consistency	33%

3.1.2 FINE AGGREGATE:

Natural Sand Those particles almost entirely passing through 4.75mm sieve, and predominantly retained on the 75µm sieve are called fine aggregate. The river sand confirming to zone as per IS 383-1987 was used.

S.NO	Properties	Values
1	Specific gravity	2.70
2	Fineness modulus	5.672

M-Sand Crushed sand is used as replacement to the fine aggregate. Crushed sand collected from Annakapalli Quarry Near to Visakhapatnam.

S.NO	Properties	Values
1	Specific gravity	2.73
2	Fineness modulus	4.85

3.1.3 Coarse Aggregate: Coarse aggregates are particles greater than 4.75mm. Crushed angular coarse aggregates confirming to IS 383-1987 was used.

S.NO	Properties	Values
1	Specific gravity	2.72
2	Fineness modulus	3.199

3.1.4 Metakaolin: Metakaolin is Hydroxylated form of the clay mineral Kaolinite , having 50%-55% of SiO_2

Test	Value
Colour	Grey
Shape	Spherical
Specific gravity	1.19

3.1.5 Super plasticizer : In order to improve the workability of high-performance concrete, superplasticizer in the form of Sulphonated Napthalene Polymers complies with IS 9103:1999 and ASTM C 494 type F as a high range water reducing admixture (CONPLAST SP 430) was used. This had 40% active solids in solution. The specific gravity is 1.22.It is a brown liquid instantly dispensable in water.

3.1.6 Water Fresh portable water, which is free from organic substance, was used for mixing the concrete.

3.2 Mix proportions and Mix Details

Grade of Concrete - M_{50}; Mixed proportions – 1:1.9:2.71; Water-Cement ratio-0.45

Mix	Conven-tional Concrete	Modified Mix proportions with MK &MS				
MK (%)	0	5	10	15	20	25
CEMENT (kg)	420.37	399.35	378.33	357.31	336.29	315.27
MK (kg)	0.00	21.01	42.037	63.05	84.07	105.93
M-Sand (%)	0	25	50	75	100	--
N-sand (kg)	779.13	584.3	389.56	194.78	0.00	--
M-Sand (kg)	0.00	194.78	389.56	584.3	779.13	--
C.A (kg)	1101.13					

PERCENTAGE OF SAND REPLACEMENT	SPLIT TENSILE STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
00	4.01	4.30	4.97
25	4.05	4.39	5.07
50	4.16	4.45	5.14
75	4.24	4.51	5.21
100	4.28	4.64	5.36

3.3 Experimental Procedure:

Prepare concrete cubes (150 x 150 x 150 mm), cylinders (150mm dia. 300 mm long) and standard prisms (100 x 100 mm and 500mm) long size to determine compressive strength split tensile and flexural strength of concrete. Three specimens were tested for 7 days & 28 days with each proportion of Metakolian and M-sand replacement. The constitutes were weighed and mixed manually and the specimens compacted by using vibrating machine. The specimens were removed after 24 hours, cured in water for 7days & 28 days and then tested for its compressive strength, split tensile and flexural strength.

RESULTS AND DISCUSSIONS:

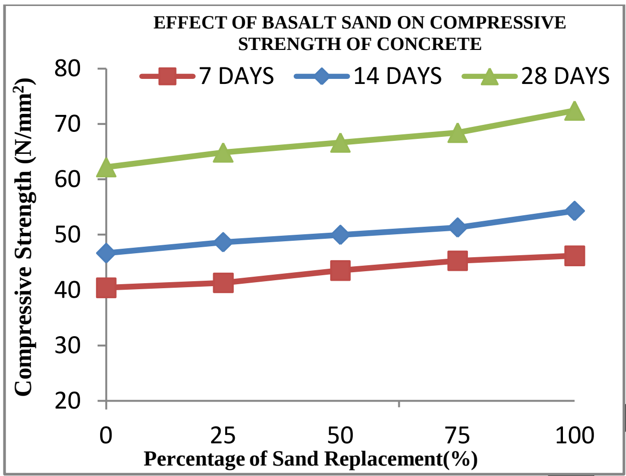
The strength characteristics of the concrete specimens are listed below.

4.1 Strength characteristics of the Concrete specimens while replacing M-Sand to Natural Sand

4.1.1 The Compressive strength of the concrete cubes with Sand Replacement:

Table 4.1 Compressive strength of the concrete cubes

PERCENTAGE OF SAND REPLACEMET	COMPRESSIVE STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	40.44	46.665	62.22
25	41.33	48.66	64.88
50	43.55	49.995	66.66
75	45.33	51.33	68.44
100	46.22	54.33	72.44

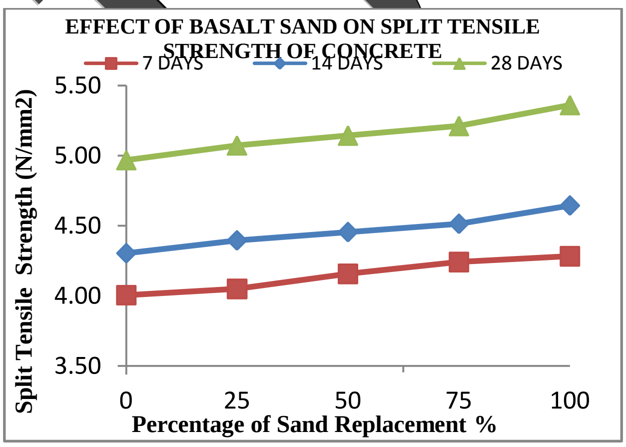


Graph 4.1: Compressive strength of concrete cubes

4.1.2 The Split Tensile Strength of the concrete cubes with Sand Replacement:

Table 4.2 Tensile strength of the concrete cylinders

PERCENTAGE OF SAND REPLACEMENT	SPLIT TENSILE STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	4.01	4.30	4.97
25	4.05	4.39	5.07
50	4.16	4.45	5.14
75	4.24	4.51	5.21
100	4.28	4.64	5.36

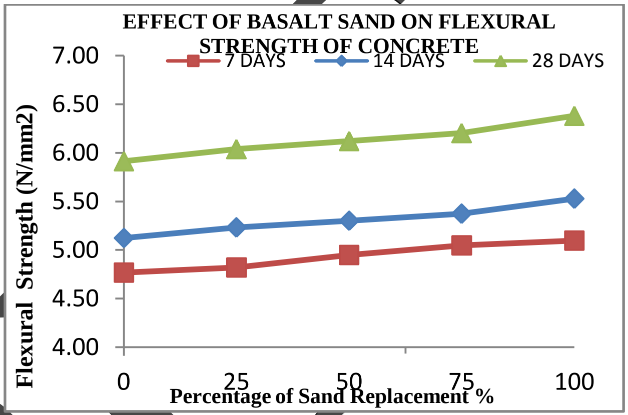


Graph 2: The split tensile strength of the concrete cylinders

4.1.3 The Flexural strength of the concrete cubes with Sand Replacement:

Table 4.3 Flexural strength of the concrete prisms

PERCENTAGE OF SAND REPLACEMENT	FLEXURAL STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	4.77	5.12	5.92
25	4.82	5.23	6.04
50	4.95	5.30	6.12
75	5.05	5.37	6.20
100	5.10	5.53	6.38



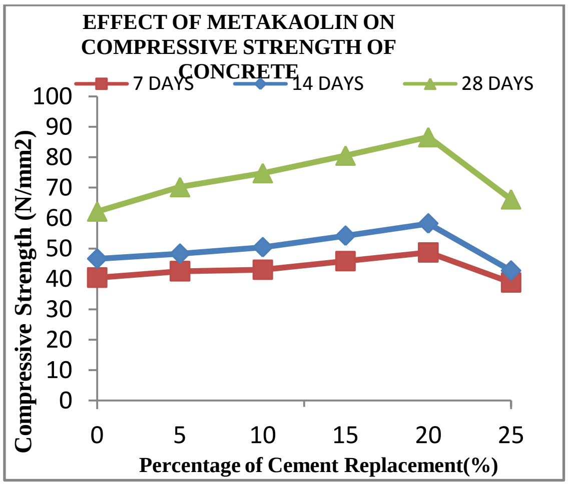
Graph 3: Flexural strength of concrete prisms

4.2 Strength characteristics of the Concrete specimens while replacing Metakaolin to Cement

4.2.1 Compressive Strength of Concrete:

The test was carried out conforming to IS 516-1959 to obtain compressive strength of concrete at the age of 7 and 28 days.

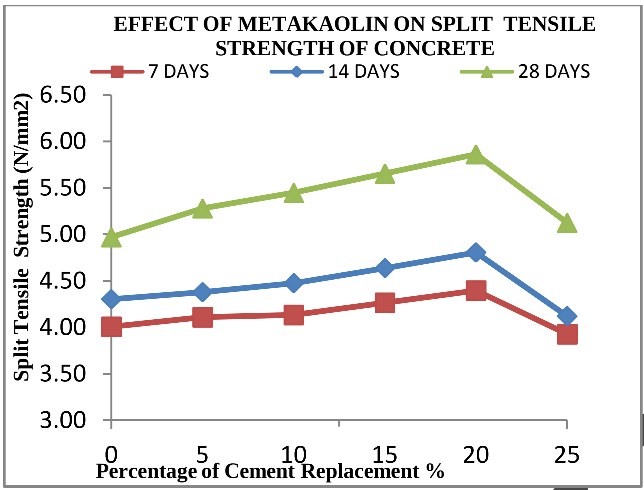
PERCENTAGE OF CEMENT REPLACEMENT	COMPRESSIVE STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	40.44	46.665	62.22
5	42.54	48.3	70.24
10	43.05	50.42	74.82
15	45.83	54.2	80.57
20	48.68	58.22	86.62
25	38.84	42.75	66.22



ISSN: 2454-7875
VOLUME 2, ISSUE 12, Dec. -2016

4.2.2 Split Tensile Strength of Concrete:

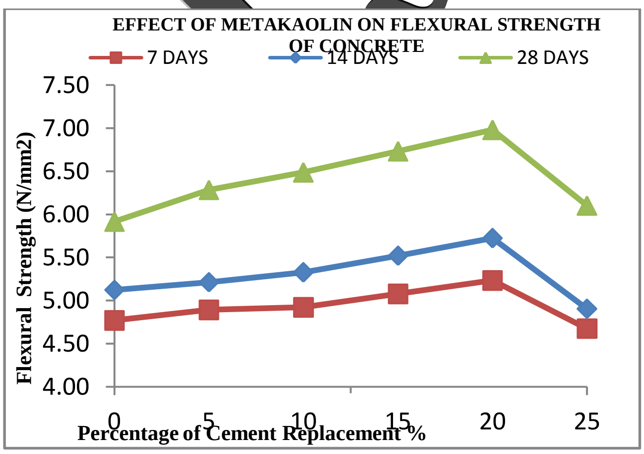
PERCENTAGE OF CEMENT REPLACEMENT	SPLIT TENSILE STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	4.01	4.30	4.97
5	4.11	4.38	5.28
10	4.13	4.47	5.45
15	4.26	4.64	5.65
20	4.40	4.81	5.86
25	3.93	4.12	5.13



4.2.3 Flexural Strength of Concrete:

The test was carried out conforming to IS 516-1959 to obtain Flexural strength of concrete at the age of 7 and 28 days. The specimens are tested on Universal testing Machine (UTM) of Capacity 100T.

PERCENTAGE OF CEMENT REPLACEMENT	FLEXURAL STRENGTH(N/mm2)		
	7 DAYS	14 DAYS	28 DAYS
0	4.77	5.12	5.92
5	4.89	5.21	6.29
10	4.92	5.33	6.49
15	5.08	5.52	6.73
20	5.23	5.72	6.98
25	4.67	4.90	6.10



QUANTITIES:

5.1 For cube size of 150mm X 150 mm X 150 mm is

Volume of cube 0.15 X 0.15 X 0.15 = 0.003375

Cement = 350 X 0.15^3 = 1.181 Kg = 1.82 Kg.

F.A = 698 X 0.15^3 = 2.356 Kg = 2. 36Kg.

C.A = 1218.0 X 0.15^3 = 4.111 Kg = 4.12 Kg.

Water = 140 X 0.15^3 = 0.47 lt

5.2 For cylinder size of 150mm X 300 mm is

Volume of cylinder $\pi R^2 H$

Cement = 350 X π $(0.15/2)^2$ X 0.3 = 1.855 Kg = 1.86 Kg.

F.A = 698 X π $(0.15/2)^2$ X 0.3 = 3.704 Kg = 3.71 Kg.

C.A = 1218.0 X π $(0.15/2)^2$ X 0.3 = 6.457 Kg = 6.46 Kg.

Water = 140 X π $(0.15/2)^2$ X 0.3 = 0.742 Kg = 0.75 kg.

5.3 For cube size of 500 mm X 150 mm X 150 mm is

Volume of cube 0.5 X 0.15 X 0.15 = 0.01125 m^3

Cement = 350 X 0.01125 = 3.9375 Kg = 3.94 Kg.

F.A = 698 X 0.01125 = 7.852 Kg = 7.86Kg.

C.A = 1218.0 X 0.01125 = 13.702 Kg = 13.71 Kg.

Water = 140 X 0.01125 = 1.575 lt = 1.56 lt.

RESULTS AND DISCUSSIONS:

The following conclusions are drawn from this investigation:

- It is seen that the compressive strength and flexure strength of concrete can be enhanced by partial substitution of Metakolien for cement and M-sand for fine aggregate.
- It is proven that, M-Sand can be utilized as limited substitution for the natural sand, the optimum percentage of replacement of natural sand by M-sand is 100%
- The most favorable percentage of Metakolien substitution cement is 20% for receiving highest compressive strength and the maximum Compressive Strength obtained is 86.62 N/mm².
- The Split Tensile Strength increases with the increase in percentage of Metakolien as well as with the increase in percentage of M-sand and the maximum Tensile Strength obtained is 5.86 N/mm².
- The Flexural Strength also increases with the increase in percentage of Metakolien as well as with the increase in percentage of M-sand and the maximum Flexural Strength obtained is 6.98 N/mm².
- The maximum increase in Compressive Strength, Split Tensile Strength, and Flexural Strength is higher than compared to that of the conventional mix at the age of 28 days.
- The percentage of boost in the compressive strength is **24.36%** and the flexure strength is **11.5%** at the age of 28

days by replacing 100% of natural sand with M- Sand and **13.6%** of cement by Metakolien.

- The dwindling sources of natural sand and its high cost could encourage the adoption of M-sand by 50% replacement of natural sand.

REFERENCE:

1) El-Hadj Kadri and Said Kenai., "*Silica Fume on Hydration Heat and compressive strength of High performance Concrete",* ACI material Journal 2009,V.106, pp 107 – 113
2) Faseyemi Victor Ajileye., *"Investigation on Silica fume as partial replacement in concrete*", Global Journal of Researches in Engineering, January 2012. IS 516: 1959 *Methods of Tests For Strength of Concrete.*
3) IS 10262-2009 – *"Concrete Mix Proportioning Guidelines", Bureau of Indian Standard*, New Delhi.
4) IS 10262-1982 – "*Concrete Mix Proportioning Guidelines",* Bureau of Indian Standard, New Delhi.
5) IS 456:2000.*Plain and Reinforced Concrete Code of Practice* (Fourth Revision), Bureau of Indian Standards, New Delhi.
6) IS: 8112-1989. Specification for 53 *Grade ordinary Portland cement.* Bureau of Indian Standards, New Delhi.
7) IS: 383-1970. *Specification for coarse and Fine Aggregates from natural sources for concrete*. Bureau of Indian standards, New Delhi.
8) IS 383-1970 – *"Indian Standard Specification for coarse and fine aggregates from natural sources for concrete, Second Revision"*, Bureau of Indian Standards, New Delhi.
9) Saeed Ahmad and Shahid Mahmood , "*Effects of crushed and Natural Sand on the properties of fresh and Hardened concrete, Our World in Concrete & Structures*, August 2008
10) Sahu A.K. Kumar and Sachan A.K., *"Crushed stone waste as fine aggregate for concrete",* Indian Concrete Journal, January 2003.
11) Sensale GR , *Strength development of concrete with rice husk ash, Cement and Concrete Composites* 2006
12) Shanmugavadivu P.M., Malathy R. "*A comparative study on Mechanical Properties of concrete with Manufactured Sand"* International Journal of Technology World, Oct – Nov 2009
13) T. Shanmugapriya & R. N. Uma "*optimization of partial replacement of m-sand by natural sand in high performance concrete with silica fume*"