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AN EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTH OF NAGALOOTI WASTE STONE AGGREGATE CONCRETE

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ABSTRACT: Concrete production by replacing conventional CA and FA with crushed waste Nagalooty stone as CA and FA (Other than granite – OTG) and also replacing cement with fly ash up to 30% in traditional concrete of M25 grade in 20 combinations of mix proportions in different percentages. The main aim and objective behind the research is to reduce the production cost of cement concrete and also to clear landfills by utilizing abundantly available waste stones in Nagalooty in Nandikotkur near Kurnool and also to reduce sand usage in concrete keeping in view of ground water table and environmental conditions. For finding the fresh properties, slump cone test was carried and for finding hardened properties, Compressive strength test was conducted to determine the cube compressive strength. In this experiment natural aggregates are replaced by Nagalooti waste stone aggregates in proportion of 0,25,50,75,100% and also cement is replaced with flyash by 0,10,20,30%.

Key words: Nagalooti Waste stone aggregates, Natural aggregate, concrete and flyash.

I.INTRODUCTION

Concrete is the most common construction material used in building industry. Cement is a basic component of concrete used for building and all civil engineering constructions. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on the environment. The cost of natural resources are also increased, and also forced to focus on recovery, reuse of natural resources by finding other alternatives. Presently large amounts of stone waste are generated in layered stone processing Quarries/Plants in Nagalooty near Nandikotkur in Kurnool District, A.P. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.. During processing of the finished product, lot of waste stone is generating in irregular shape and these waste stones are dumping on both sides of roads and also keeping abundant stocks near quarries. It creates lot of landfills and disposal will become problem in these areas. Since long back some of the habitants are using these waste stones as (CA) in Concrete for laying of Roof slabs also, keeping in view of "O" initial cost and easy available in the eastern part of Kurnool District.

II. LITERATURE REVIEW

G. Murali et al.[1]studied the effects of shabad (a variety of Kadapa) stone and the chemical Admixture (supaflo) on concrete by replacing with 10,20,30,40% and conclusion arrived that30% replacement of Coarse aggregate has attained good strength in both cases. N. VenkataRamana.[2]has given a scope of thinking to utilize the KADAPA WASTE stone powder for civil engineering construction works by partial replacement of cement and sand and also to clear the land fills to some extent. V. RameshBabu et al.[3]studied the effect of Bethamcherla Marble stone on concrete by replacing in the range of0,25,50,75,100% and results found that compressive strength is gradually decreased at all levels of replacement with Bethamcherla marble stone. Dr. A. Vijaya Kumar et al.[4]studied the effect of quarry dust in concrete by replacing with natural sand in 25,50,75 and 100% and concluded that 50% quarry dust replacement with sand found optimum strength in concrete. Prof. Jayesh Kumar Pitroda et al. [5] has made study on feasibility of using thermal industry waste in concrete production with partial replacement of cement range of 0,10,20,30 and 40%in M25, M40 grade concrete and concludes that percentage of cement reduction, decreases the strength of concrete and also reducing the cost of concrete. Tasnia Hoque et al. [6] studied effect of sand replacement by stone dust on the properties of normal strength with varying water cement ratio. This study discloses that 25% stone dust replaced with sand can increase the strength of mortar, where as cement replacement decreases the strength of mortar. Ankit Nilesh Chandra Patel et.al. [7]studied the impact of replacement of cement with waste stone dust in 0,10,20,30,40 and 50% and results found that 20% replacement of cement with stone dust provides maximum compressive strength comparing with other percentage combinations. Y. Yeshvanth Kumar et al. [8] this study focuses the rational performance of concrete by normal sand and crushed stone and concrete by stone powder and stone chips. From the laboratory study it can be concluded that stone powder is well appropriate for medium graded concrete for better performance in terms of strength and economy over normal sand. Omar M. Omar et al. [9] studied the influence of sand replacement with lime stone waste and marble powder on concrete and concluded that rate of strength gain is decreased, as the percentage of lime stone waste replaced more than 50% in cement content.

III. EXPERIMENTAL PROGRAMME

In this experimental programme casting and testing of concrete cubes (150 X150X150)mm cast, by replacing the natural aggregate with nagalooti waste stone aggregates in proportion of 0,25,50,75,100% and also replacement of cement with fly ash by 0,10,20 and 30%.

IV. MATERIALS

Materials utilized on production of concrete and their properties are explained below.

A. Cement:

In this research work ULTRATECH cement of OPC 53 grade was used for all concrete mixes. The cement is of uniform colour i.e., grey with a light greenish shade and free from any lumps. Various tests conducted on the cement and found that Specific Gravity of Cement is 3.1,Initial and final setting time found that 48 minutes and 240 minutes respectively. Normal Consistency is 35% and Fineness percentage is 4%.

B. Fly Ash:

Fly ash is a by-product obtained during the combustion of coal in Thermal Power Plants. In the present study, Low calcium (Class F) fly ash obtained from Raichur Thermal Power Plant, Karnataka, INDIA. The physical properties of fly ash ie., Specific Gravity is 2.20, Surface area is 300-400 sqm/kg.

C. Natural Aggregate (HBG metal) (Coarse Aggregate) :

This crushed Hard Broken Granite metal used as coarse aggregate procured from Ulindakonda quarry near Kurnool Town of AP. To get reasonable good grading of aggregate 60-65% passing through 20mm sieve and retained at 12.50 mm sieve and Specific Gravity of aggregate observed as 2.97 and Fineness Modulus is 3.54 as given in table 1.

D. River Sand (Fine Aggregate):

River Sand is used as Fine aggregate collected from Thungabhadra River. Specific gravity of river sand found as 2.84 and Fineness Modulus is 3.12 as given in table 1.

E. Nagalooty Waste Stone Material (CA & FA) :

Nagalooti is a village near Nandikotkur in Kurnool District, in which layered stone called Nagalooty waste stone is being used for roofing, flooring and also for foundations and walling. The physical properties of fine and coarse aggregates are viz., Specific Gravity and Fineness Modulus of CA are 3.06, 3.34 and for FA is 2.73 and 2.97 respectively.

F. Objective of Research :

Major objective of this research is to test the behavior of these waste stone as CA & FA in cement concrete and to find out in which combination these material can be utilized in manufacturing of concrete and also to propose the different applications of these crushed Nagalooty waste stone to use as coarse aggregate and fine Aggregate in different Mix combinations in concrete.

G. Mix proportions:

The concrete mix is designed as per IS 10262 – 2009. Concrete is produced by replacing the coarse aggregate with Nagalooty waste stone, fine aggregate with Nagalooty waste stone dust in different mix combinations and cement with fly ash upto some extent for M25 Grade Concrete, with the water cement ratio of 0.48. The details of the mix proportion are given in the table 1.

Table 1: **Mix Proportion of M25 grade concrete**

Unit of Batch	Cement(kg/m^3)	FA(Kg)	CA(Kg)	Water(kg/m^3)
		River Sand	HBG Metal	
Cubic meter content	399	724	1262	192
Ratio of ingredients	1	1.81	3.16	0.48

Table 2: Mechanical Properties of Coarse Aggregate & Fine Aggregate

S.No	Mechanical Properties	Coarse Aggregate		Fine Aggregate	
		Natural HBG Metal	Nagalooty Waste Stone Metal	River Sand	Nagalooty Waste Sand Dust
1	Impact Value	26.52%	18.08%	-	-
2	Crushing Strength	25.95%	16.47%	-	-
3	Water absorption	0.05%	0.15%	-	-
4	Bulking of FA	-	-	3%	4%
5	Water Content	-	-	27.78%	23.81%

H. Mixing, Casting and curing:

Cubes are cast in 20 different combinations of mixes as per design mix. For each combination, 9 Cubes with size 150mm X150mm X150 mm were cast, for 7, 28, & 60 days of curing. The samples are demoulded after 24 hrs from casting and kept in a water tank for curing.

I. Compressive Strength:

Compressive strength test was conducted by using standard Universal Testing Machine by applying uniform load until cube fails and ultimate load and strength of the cubes are found.

V. ANALYSIS OF RESULTS OBTAINED

The results obtained of compressive strength of cubes are presented in Tables 3,4,5,6. The values mentioned are the average compressive strength of cubes of 3 specimens for each mix combination. Based on the results obtained for different mix combinations were named from M1 to M20, strength was analyzed with Natural Aggregate concrete M1 V/S other Mix Combination Concrete from M2 to M20 Mix combinations.

Compressive Strength of cubes are cast with normal aggregate i.e., 20 mm HBG metal, River sand and Cement mixed as per Design Mix for M25 grade concrete designated as M1 Mix. Similarly other different Mix Proportions are designated as M2 to M20 Mix as clearly mentioned in the tables.

Table 3: Compressive Strength values of Cubes (M1 to M5 mix)

Mix Designations and different proportions							Average Compressive Strength (MPa)			Percentage of strength decreased with respect to Natural Mix Concrete (M1 Mix)		
Mix Designation	Cement	Fly Ash	HBG Metal (CA)	NWS Metal (CA)	Sand (FA)	NWS Dust (FA)	7 Days	28 Days	60 Days	In 7 Days	In 28 Days	In 60 Days
M1	100	0	100	0	100	0	29.96	44.42	46.95	-	-	-
M2	100	0	75	25	75	25	26.02	43.27	45.75	13.15	2.58	2.55
M3	100	0	50	50	50	50	25.86	40.72	42.64	13.68	8.33	9.18
M4	100	0	25	75	25	75	25.62	39.38	41.72	14.48	11.34	11.35
M5	100	0	0	100	0	100	24.06	38.78	40.85	19.7	12.7	13

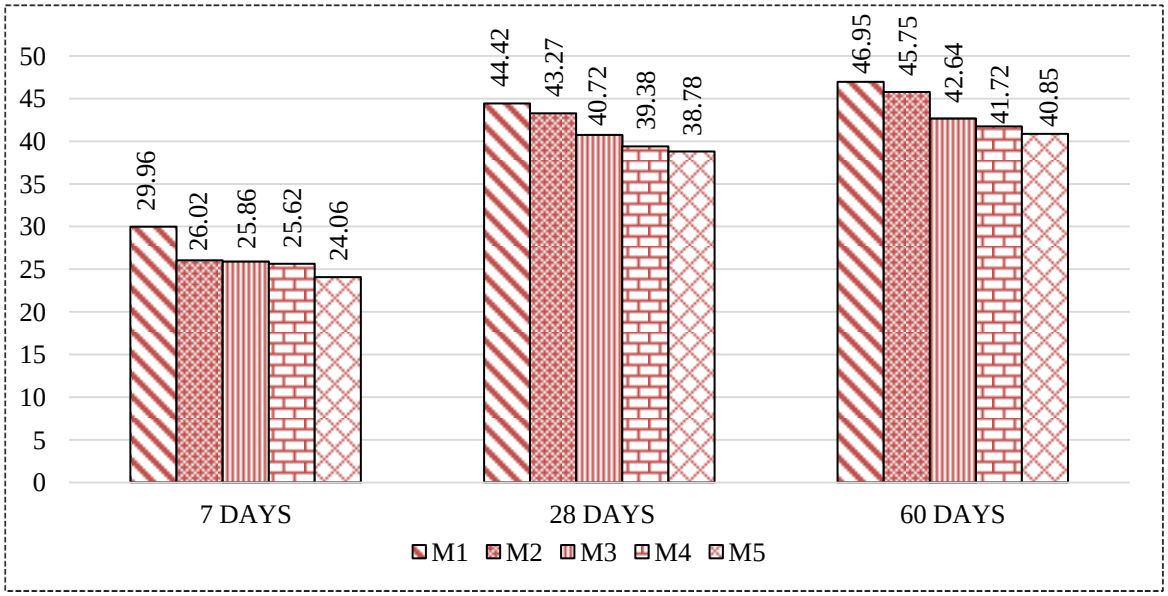

Fig.1: Tabular Analysis of results found for the mixes M1 to M5 with M5 mix

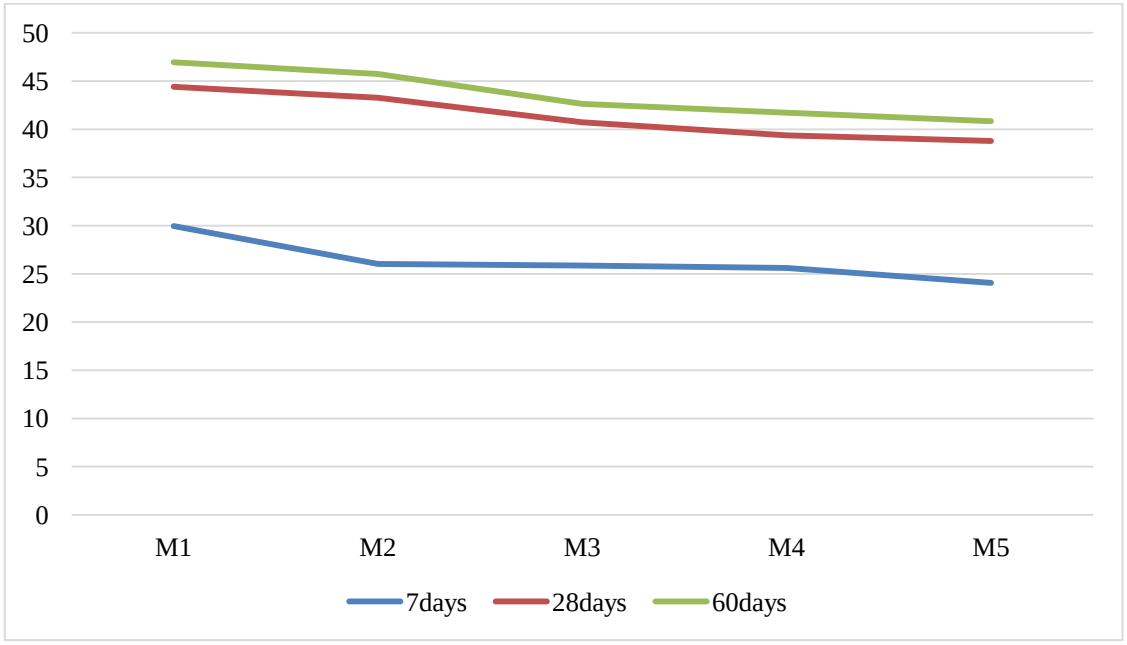

Fig 2: Graphical Analysis of results found for the mixes M6 to M1 with M5 mix

From Table-3 it is observed that the compressive strength results for M1 mix (base mix), 7 days Compressive strength is found as 29.96 MPa where as for other mix combinations it is found as M2–26.02, M3-25.86, M4-25.62 and M5-24.06MPa which is lesser than M1 Mix respectively. As observed from the above results, percentage of compressive strength is decreased in 7 days, on M2, M3, M4, M5 mix combinations with respect to M1 mix are found by13.15%, 13.68%, 14.48%, 19.70% respectively. Similarly for M1 mix 28 days compressive strength was found as 44.42 MPa where as for other mix combinations it is found as M2-43.27, M3-40.72, M439.38, M5-38.78MParespectively.As observed from the above results, percentage of compressive strength is decreased in 28 days on M2, M3, M4, M5 mix combinations with respect to M1 mix are found by2.58%, 8.33%, 11.34%, 12.70% which is lesser than M1 mix respectively. In the same manner M1 mix 60 days compressive strength was found as 46.95 MPa where as for other mix combinations it is found as M2-45.75, M3-42.64, M4-41.72, and M5-40.85MPawhich is lesser than M1 mix respectively as shown in Fig.1 & 2.

As observed from the above results, percentage compressive of strength decreased in 60 days on M2,M3,M4,M5 mix combinations with respect to M1 mix are found by2.55%, 9.18%, 11.35%, 13.00% respectively.

Table 4: Compressive Strength values of Cubes (M6-M10)

Mix Designations and different proportions							Average Compressive Strength			Percentage of strength decreased with respect to natural Mix Concrete (M1 Mix)		
Mix Designation	Cement	Fly Ash	HBG Metal (CA)	NWS Metal (CA)	Sand (FA)	NWS Dust (FA)	7 Days	28 Days	60 Days	7 Days	28 Days	60 Days
M6	90	10	100	0	100	0	24.20	43.03	45.26	19.22	3.13	3.6
M7	90	10	75	25	75	25	23.40	41.16	43.50	21.89	7.34	7.35
M8	90	10	50	50	50	50	22.80	38.07	41.50	23.89	14.29	11.6
M9	90	10	25	75	25	75	22.65	36.36	39.64	24.4	18.14	15.57
M10	90	10	0	100	0	100	21.21	35.10	38.14	29.2	20\.98	18.76

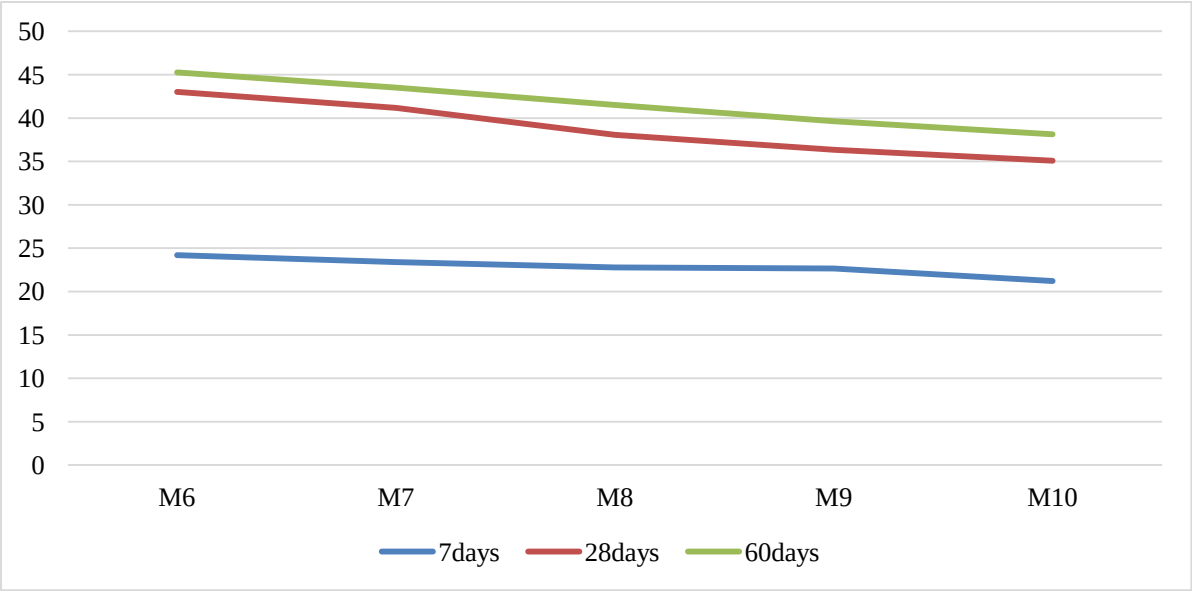

Fig 3: Tabular Analysis of results found for the mixes M6 to M10 with M1 mix

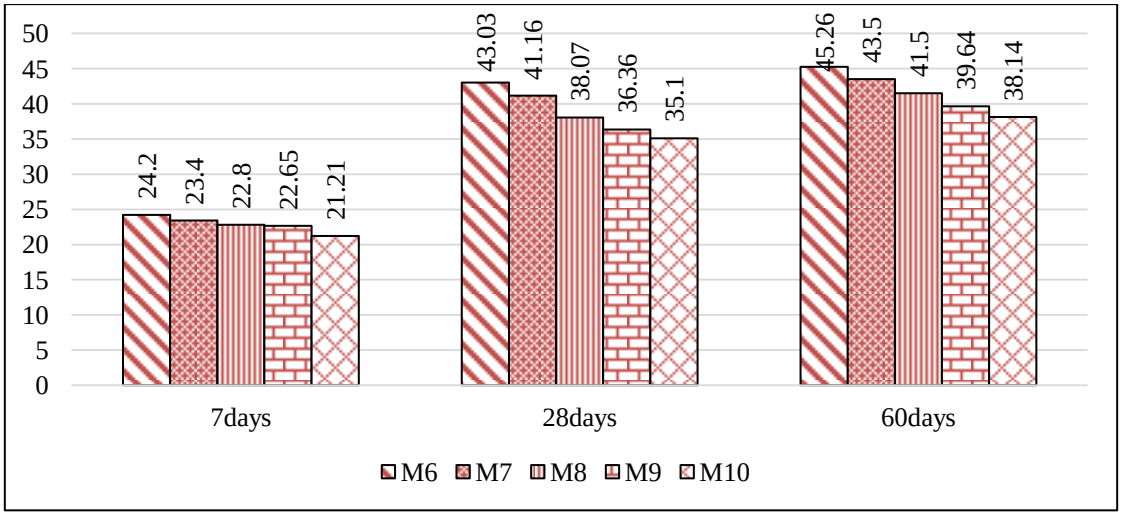

Fig 4: Graphical Analysis of results found for the mixes M6 to M10 with M1 mix

From Table-4 it is observed that compressive strength results for M1 mix (base mix), 7 days Compressive strength is found as 29.96 MPa whereas, for other mix combinations it is found as M6-24.20, M7-23.40 ,M8-22.80 , M9-22.65 and M10-21.21MPawhich is lesser than M1 mix respectively..As observed from the above results, percentage of compressive

strength decreased in 7 days on M6, M7, M8, M9, M10 mix combinations with respect to M1 mix are found by 19.33%, 21.89%, 23.89%, 24.40%, 29.20% respectively. Similarly for M1 mix 28 days compressive strength is found as 44.42 MPa where as for other mix combinations it is found as M6-43.03, M7-41.16, M8-38.07,M9-36.36 and M10-35.10 MPa which is lesser than M1 mix respectively. As observed from the above results, percentage strength of compressive strength is decreased in 28 days on M6,M7,M8, M9, M10 mix combinations with respect to M1 mix are found by 3.13%,7.34%,11.60%,15.57%,18.76% respectively. In the same manner M1 mix 60 days compressive strength was found as 46.95MPa, where as for other mix combinations it is found as M6-45.26, M7-43.50, M8-41.50, M9-39.64 and M10-38.14 MPa which is lesser than M1 mix respectively as shown in fig 3 & 4.
As observed from the above results, percentage of compressive strength decreased in 60 days onM6,M7,M8, M9, M10 mix combinations with respect to M1 mix are found by 3.60%, 7.35%, 11.60%, 15.57% and 18.76% respectively.

Table 5: Compressive Strength values of Cubes (M11-M15)

Mix Designations and different proportions							Average Compressive Strength			Percentage of strength decreased with respect to natural Mix Concrete (M1 Mix)		
Mix Designation	Cement	Fly Ash	HBG Metal (CA)	NWS Metal (CA)	Sand (FA)	NWS Dust (FA)	7 Days	28 Days	60 Days	7 Days	28 Days	60 Days
M11	80	20	100	0	100	0	22.98	36.60	38.50	23.29	17.6	18
M12	80	20	75	25	75	25	21.60	35.52	37.60	27.9	20.03	19.91
M13	80	20	50	50	50	50	20.24	33.76	35.49	32.44	24	24.4
M14	80	20	25	75	25	75	19.46	31.24	33.11	35.04	29.67	29.47
M15	80	20	0	100	0	100	19.10	30.95	32.95	36.24	30.32	29.81

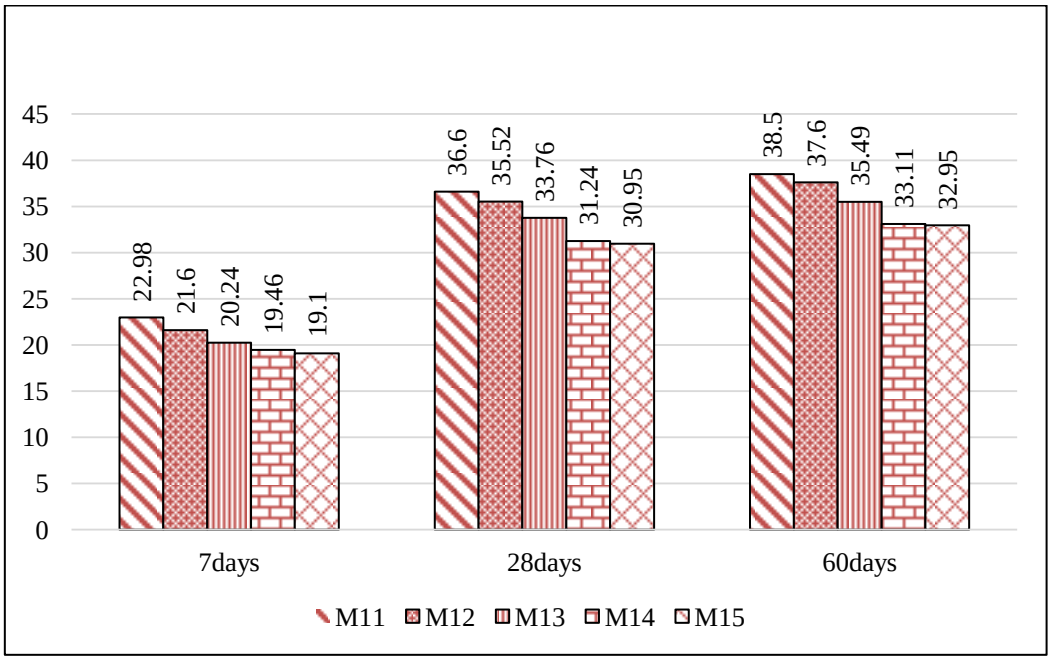

Fig 5: Tabular Analysis of results found for the mixes M11 to M15 with M1 mix

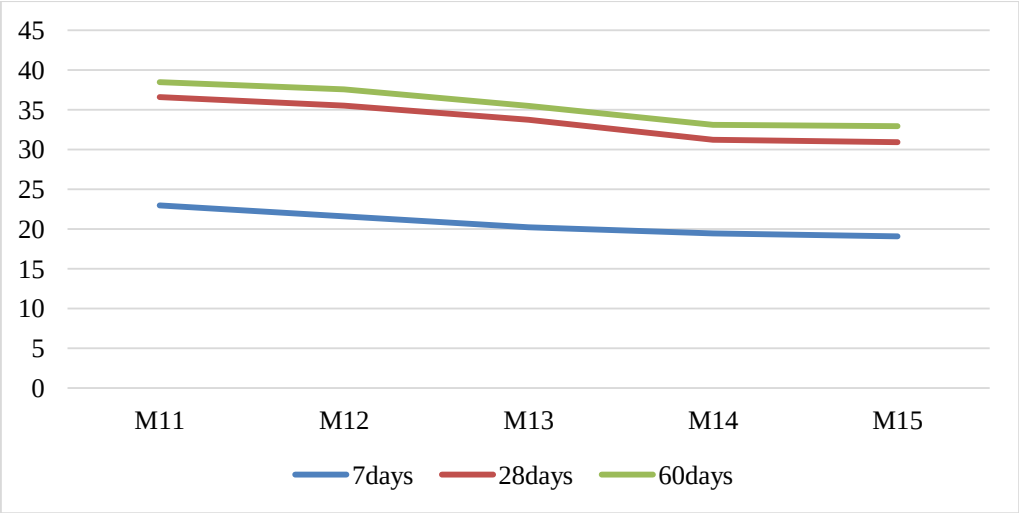

Fig 6: Graphical Analysis of results found for the mixes M11 to M15 with M1 mix

From Table 5 it is observed that the compressive strength results for M1 mix(base mix), 7 days Compressive strength is found as 29.96 MPa where as for other mix combinations are found as M11-22.98, M12-21.60,M13-20.24, M14-19.46and M15-19.10 MPa respectively which is lesser than M1 mix.

As observed from the above results, percentage of compressive strength is decreased in 7 days on M11,M12,M13, M14, M15 mix combinations with respect to M1 mix are found by 23.29%,27.90%,32.44%,35.04% , 36.24% respectively. Similarly for M1 mix 28 days compressive strength was found as 44.42 MPa where as for other mix combinations it is found as M11-36.60, M12-35.52, M13-33.76,M14-31.24 and M15-30.95MPa respectively. As observed from the above results, percentage of compressive strength is decreased in 28 days on M11,M12,M13, M14, M15 mix combinations with respect to M1 mix are found by17.60%,20.03%,24.00%, 29.67%, 30.32% respectively. In the same manner M1 mix 60 days compressive strength was found as 46.95MPa where as for other mix combinations it is found as M11-38.50,M12-37.60,M13-35.49, M14-33.11 and M15-32.95MPa respectively as shown in fig. 5 & 6.

As observed from the above results, percentage of compressive strength is decreased in 60 days onM11, M12, M13, M14, M15 mix combinations with respect to M1 mix are found by 18.00%,19.91%,24.40%,29.47%,29.81% respectively

Table 6: Compressive Strength values of Cubes (M16-M17)

Mix Designations and different proportions							Average Compressive Strength			Percentage of strength decreased with respect to natural Mix Concrete (M1 Mix)		
Mix Designation	Cement	Fly Ash	HBG Metal (CA)	NWS Metal (CA)	Sand (FA)	NWS Dust (FA)	7 Days	28 Days	60 Days	7 Days	28 Days	60 Days
M16	70	30	100	0	100	0	19.75	31.52	33.67	34.07	29.04	28.28
M17	70	30	75	25	75	25	18.50	30.95	32.56	38.25	30.32	30.65
M18	70	30	50	50	50	50	17.96	30.52	32.05	40	31.29	31.73
M19	70	30	25	75	25	75	17.65	29.58	31.06	41.08	33.4	33.84
M20	70	30	0	100	0	100	17.25	27.65	29.30	42.42	37.75	37.59

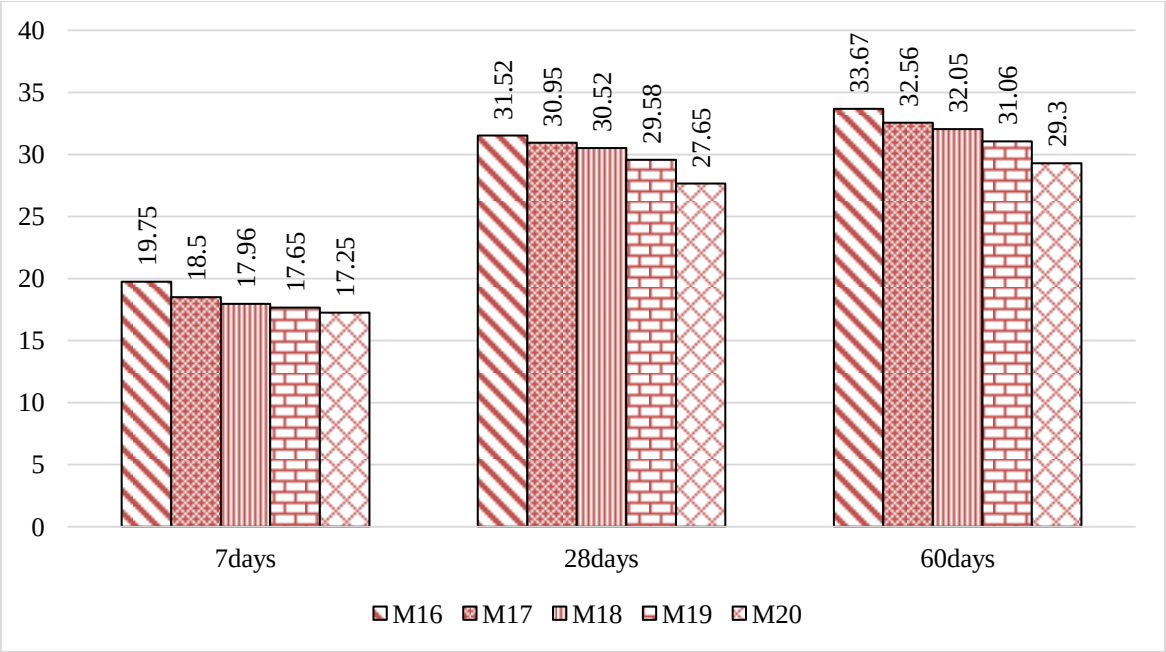

Fig 7: Tabular Analysis of results found for the mixes M16to M20 with M1 mix

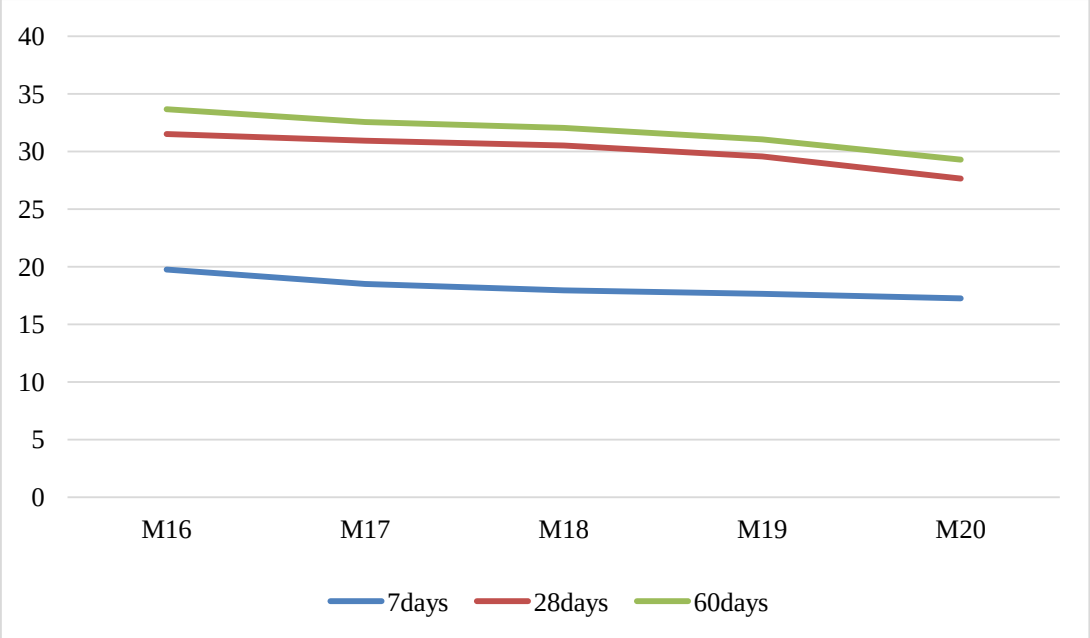

Fig 8: Graphical Analysis of results found for the mixes M16to M20 with M1 mix

From Table 6 it is observed that the compressive strength results for M1 mix, 7 days Compressive strength is found as 29.96 MPa where as for other mix combinations it is found as M16-19.75, M17-18.50,M18-17.96,M19-17.65 and M20-17.25MParespectively which is lesser than M1 mix.

As observed from the above results, percentage of compressive strength is decreased in 7 days on M16,M17,M18,M19, M20 mix combinations with respect to M1 mix are found by34.07%,38.25%,40.00%,41.08 and 42.42% respectively. Similarly for M1 mix 28 days compressive strength was found as 44.42 MPa, where as for other mix combinations it is found as M16-31.52,M17-30.95, M18-30.52,M19-29.58, M20-27.65MPa respectively. As observed from the above results, percentage of compressive strength is decreased in 28 days on M16,M17,M18,M19, M20 mix combinations with respect to M1 mix are found by 29.04%,30.65%,31.73%,33.84% and 37.59% respectively.

In the same manner M1 mix 60 days compressive strength was found as 46.95MPa where as for other mix combinations it is found as M16-33.67,M17-32.56,M18-32.05, M19-31.06 and M20-29.30 MPa respectively as shown in fig. 7 & 8.

As observed from the above results, percentage of compressive strength is decreased in 60 days compressive strength on M16, M17, M18, M19, M20 mix combinations with respect to M1 mix are found by28.28%,30.65%,31.73%,33.84%, 37.59% respectively.

Casting and testing of cubes:


VI. CONCLUSIONS & APPLICATIONS:

1. As the crushing strength and impact value of Nagalooti waste stone which is found lesser than natural HBG metal, hence compressive strength of cubes are gradually decreased with increase in percentage of Nagalooti waste stone aggregate.
2. It is also observed that as the percentage of Nagalooti waste stone material is increased, workability is reduced, as the water absorption is found more inNagalooti waste stone material than conventional material.
3. Though other 19mix combinations are found little less compressive strength than M1 Mix(base mix), but all other mix combinations, has got compressive strength more than the Characteristic strength of M25 Grade Concrete.
4. Finally it can be concluded that Nagalooti waste stone can be used for both FA & CA for construction of single storied buildings where limited live loads are applying on buildings, duly taking proper care on sieving & grading of raw materials except heavy traffic roads, bridges and culverts.
5. As there is no initial cost for waste stones in Nagalooti near Kurnool, nearby habitations are benefiting cost savings around 20%-30% are observed comparing with Traditional/Natural Mix concrete in these areas.

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