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Research paper

Experimental Investigation on Fly Ash and GGBS Based Geopolymer Concrete Incorporate Black Marble Waste Aggregate

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Abstract

In show development area usage of common assets is expanded, this cases to decrease in accessible natural assets. Then again high volume of creation has produced a lot of waste materials which have antagonistic effect on the environment. Natural coarse aggregate is one of the material used in concrete, it causes a shortage in future and causes environmental damage. Several studies have been carried out to reduce the utilization of natural coarse aggregate (NCA) in concrete. There is need to supplementary material like demolished concrete waste aggregate, recycle aggregate, marble and granite aggregates, which are by-products from stone industries. In this experimental work, black marble waste aggregate (BMWA) was used as coarse aggregate at different replacement levels (0%, 50% and 100%) in geopolymer concrete (GPC). The compressive quality of GPC mixes was determined after 28 days of curing and then compared with GPC using natural coarse aggregate.

Keywords*: Natural Coarse Aggregate, Black marble waste aggregate, GGBS, Fly ash, and ambient room temperature.*

1. Introduction

Aggregate is the major ingredient in concrete nearly it occupies 70 % to 80 % of concrete volume. Aggregate is a non-sustainable natural resources, utilization of the natural resources is expanding day by day. Meanwhile the production of cement also releases large amount of Co_2 to the atmosphere that essentially adds to ozone harming substances outflows[1]. In this connection geopolymer Concrete is comes out for alternative to OPC it is a sustainable material produces by utilisation of industrial by-products like fly ash Silica fume, rice-husk ash, metakaolin and ground granulated blast furnace slag (GGBS) [2-3]. Therefore GPC is alternative for OPC, there is a need to replace Natural coarse aggregate in OPC as well as GPC, and many thinks about have been done to decrease the utilization of conventional aggregate to protect natural resources. These include the utilization of waste aggregate in concrete that is black marble waste aggregate, these are by-products from marble and granite stone industries. Preeti Tiwari et. al. [4] shown an tentative effort on behaviour of concrete by moderately substituting coarse aggregate with granite tiles waste and fine aggregate with quartz sand stone powder. They recommended that 20% of replacement of natural coarse aggregate with polished granite. H.Hebhoubet. al. [5] studied the possibilities of using marble wastes as a substitute rather than natural aggregate in concrete manufacture. In their investigation they confirmed that the substitution of natural aggregate by waste marble total up to 75% of any plan is gainful for the concrete obstruction.

G.Murali, et. al. [6] directed a trial examination on concrete with different waste stone as aggregate. They used rock stone concrete (GSC), recycled aggregate concrete (RAC) and shabath stone concrete (SSC) in concrete specimens as replacement on natural coarse aggregate (NCA). The results showed that strength of GSC better performance than NCA and SSC, they concluded Granite stone can be utilized as a coarse aggregate in construction industries relies on the waste stone accessibility. D.Gopinath, et. al [7] examined the mechanical properties of concrete with ceramic waste aggregate. The outcomes demonstrated that the mechanical properties of concrete specimens produced by utilizing the ceramic waste were imperceptibly higher than that by stone aggregate concrete. N.Venkata Ramana [8] conducted experimental work on compressive strength of concrete using marble stone waste aggregate with crimpled steel filaments. The outcomes demonstrated that the level of marble stone waste aggregate substance expanded in the blend the strength are diminished with consolidation of steel strands, the strength are upgraded. Subba Reddy Singam, et.al. [9] considered the utilization of black marble waste aggregate (BMWA) concrete. The exploratory outcomes demonstrated that, workability of BMWA is expanded when contrasted and Natural coarse aggregate (NCA) and they inferred that the utilization of dark stone marble squander is advantageous for concrete works up to 75 % replacement of black stone marble waste and with 2 % fiber. N.Venkata Ramana, et.al [10] exhibited the specialized possibility way to deal with use of stone waste for construction works.

2. Experimental Study

The present investigation is aimed to determine influence the replacement of natural coarse aggregate with black marble waste aggregate in different proportions (100NCA:0BMWA; 50NCA:50BMWA; 0NCA:100BMWA) to find the compressive strength of GPC with varying percentage of class F fly ash (FA) and GGBS (0FA:100GGBS; 50FA:50GGBS; 0FA:100GGS) next 28 days of water preserving ambient room temperature curing.

3. Materials

3.1 Fly ash and GGBS

A low Calcium Fly Ash (FA) and Ground Granulated Blast Furnace Slag (GGBFS) are obtained from Rayalaseema Thermal Power Plant (RTPP), Muddanur, Kadapa District, A.P India and GGBS obtained from B.N Chemicals Produttur, Kadapa District, AP respectively. The physical & chemical assets as shown in Table 1

Table 1: Physical and Chemical Properties of Flash and GGBS

Particulars	Class F fly ash	GGBS
Chemical composition		
% Silica(SiO2)	65.6	30.61
% Alumina(Al2O3)	28.0	16.24
% Iron Oxide(Fe2O3)	3.0	0.584
% Lime(CaO)	1.0	34.48
% Magnesia(MgO)	1.0	6.79
% Titanium Oxide (TiO2)	0.5	-
% Sulphur Trioxide (SO3)	0.2	1.85
Loss on Ignition	0.29	2.1
Physical properties		
Specific gravity	2.12	2.94
Fineness (m^2/Kg)	360	400

3.2 Coarse and Fine Aggregate

Natural Coarse Aggregate (NCA) available from local crusher having of combination of 20 mm and 10 mm of sizes. Black Marble Waste Aggregate (BMWA) are dumped from marble processing industries (dumping yard) as shown in figure 1 Tadipatri Anantapur District and crushed to 20 mm and 10 mm nominal sizes. Locally accessible stream sand was utilized as a Fine Aggregate. The physical properties of NCA and BMWA are shown in Table 2. Aggregates are shown in Figure 2

3.3 Alkaline Liquids

A blend of sodium silicate (Na_2SiO_3) and sodium hydroxide of chosen concentration was ready by blending 97-98% pure NaOH pellets was kept constant (10M) for all mixes. These solutions are purchased from Fusion chemicals limited & products Hyderabad.

Table 2: Physical Properties of Natural Coarse Aggregate and Black marble waste Aggregate

Physical Properties	Natural Coarse Aggregate (NCA)	Black Marble Waste Aggregate (BMWA)
Specific Gravity	2.68	3.51
Fineness Modulus	3.64	2.77
Bulk Density		
Loose State	14.28 Kn/m^3	12.48 Kn/m^3
Compacted State	16.62 Kn/m^3	14.86 Kn/m^3
Impact Value	14.40%	13.20%
Water Absorption	0.42%	0.50%

Fig. 1: Black Marble Waste Aggregate dumped in road side

Fig. 2: Showing 20 mm Size of Natural Coarse Aggregate and Black Marble Waste Aggregate

4. Mix Design

In light of the past research on GPC, (Hardjito and Rangan 2005) [13] the following extents were decided for the constituents of the mixes. In the design of geopolymer concrete mix, coarse and fine aggregates add up to together were taken as 77% of entire mix by mass. Fine total aggregate was taken as 30 % of the aggregate totals. The density of geopolymer concrete is taken like that of OPC as 2400 Kg/m3. Molarity of sodium hydroxide arrangement was kept at 10M. The details of mix design and its extent for different blends of GPC are appeared in Table 3.

Table 3: Details of GPC Mixes

Materials		Mix 1 FA100:GGBS0			Mix 2 FA0:GGBS100			Mix 3 FA50:GGBS50		
Natural Coarse Aggregate (NCA)	20 mm	905.52	-	452.76	905.52	-	452.76	905.52	-	452.76
	10 mm	388.08	-	194.04	388.08	-	194.04	388.08	-	194.04
Black Marble Waste Aggregate (BMWA)	20 mm	-	905.52	452.76	-	905.52	452.76	-	905.52	452.76
	10 mm	-	388.08	194.76	-	388.08	194.76	-	388.08	194.76
Fine Aggregate		554.4	554.4	554.4	554.4	554.4	554.4	554.4	554.4	554.4
Fly Ash		408.9	408.9	408.9	0	0	0	204.45	204.45	204.45
GGBS		0	0	0	408.9	408.9	408.9	204.45	204.45	204.45
Sodium Silicate Solution		102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2	102.2
Sodium Hydroxide		40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Extra Water		60	60	60	60	60	60	60	60	60
Super Plasticizer		2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86

5. Test Setup and Testing

The experimental studies the characteristic compressive strength of geopolymer concrete incorporating Black Marble Waste Aggregate, to produce geopolymer concrete fly ash and GGBS utilized as a binders, sodium hydroxide and sodium silicate were used as alkaline activators. Replacement of Natural Coarse Aggregate with Black Marble Waste Aggregate in different percentages (0%,50% and 100%). Total 54 specimens are casted in that for each mix having 18 cubes, 9 cubes for water curing and 9 cubes are at ambient temperature for 28 days of duration as shown in Figure 3.

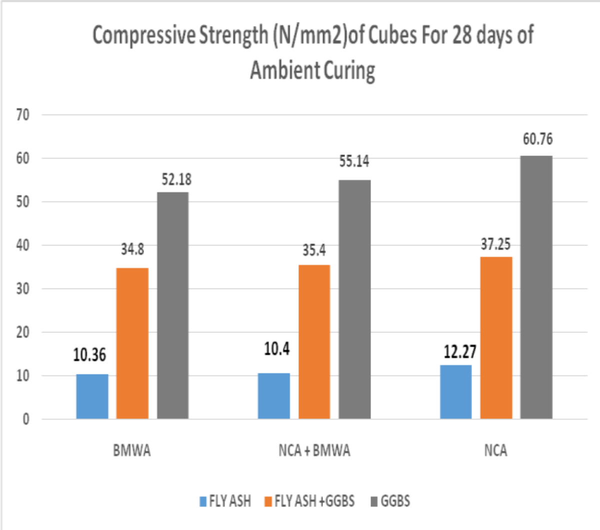
Fig. 3: Specimens are in water cured and at room temperature

6. Compressive Strength

Table 4 shows the compressive strength of geopolymer concrete with three mixes (FA100:GGBS0, FA0:GGBS100& FA50:GGBS50) replacement of NCA in percentages of BMWA (0%, 50%and 100%) at ambient curing of 28 days.
Table 5 shows the compressive strength of geopolymer concrete with three mixes (FA100:GGBS0, FA0:GGBS100& FA50:GGBS50) replacement of NCA in percentages of BMWA (0%, 50% and 100%) in water curing for 28 days.

Table 3: Compressive Strength of GPC after 28 days of ambient temperature curing

% of Aggregate	Mix1 (Only Fly Ash)	Mix2 (Only GGBS)	Mix3 (FlyAsh+GGBS)
BMWA	10.36	52.18	34.8
NCA+BMWA	10.4	55.17	35.4
NCA	12.27	60.76	37.25

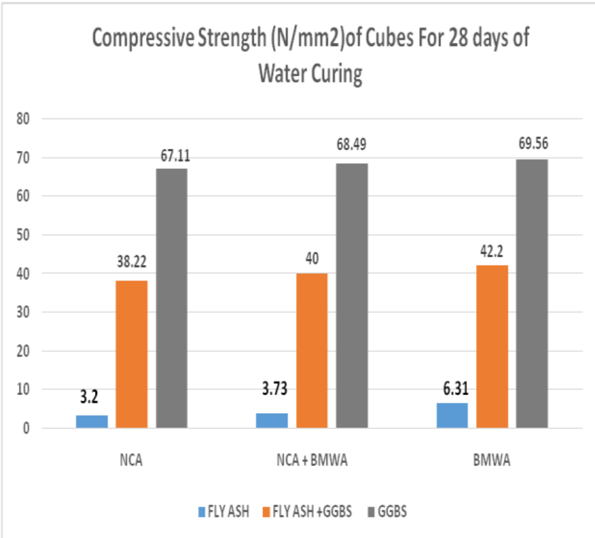


Graph 1: Showing Compressive strength of GPC in ambient curing

Table 4: Compressive Strength of GPC after 28 days of water curing

% of Aggregate	Mix1 (Only Fly Ash)	Mix2 (Only GGBS)	Mix3 (Fly Ash+GGBS)
NCA	3.2	67.11	38.22
NCA+BMWA	3.73	68.49	40
BMWA	6.31	69.49	42.20

Graph 2. Showing Compressive strength of GPC in water curing



7. Conclusions

1. Increment in percentage substitution of fly ash with GGBS causes increments in compressive strength of concrete from 10.36 Mpa to 52.18 Mpa, when GPC with BMWA specimens at ambient temperature for 28 days.

2. Increment in percentage substitution of fly ash with GGBS causes increments in compressive strength of concrete from 6.31 Mpa to 69.56 Mpa, when GPC with BMWA specimens are water cured for 28 days.
3. In compressive strength point of view it is concluded 100% substitution of Fly ash with GGBS &100% replacement of NCA with BMWA, specimens are in water cured gives more strength when compared to specimens are at ambient temperature.
4. In water curing the compressive strength is more when GPC with Natural Coarse Aggregate, where as in Ambient curing compressive strength is more in Black Marble Waste Aggregate. Curing affects the properties of concrete.

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