ISSN: 2096-3246
Volume 54, Issue 02, November, 2022

PROPERTIES OF NATURAL AND ALKALI ACTIVATED COARSE AGGREGATE

Naveena M.P.[1] ,G Narayana. [2]

[1] Research Scholar ,SJC Institute of Technology./Asst.Professor KSSEM, Visvesvaraya Technological Univerisity., Belagvi ,Karnataka , India[1]

[2] Professor & Head, Department of Civil Engineering, SJC Institute of Technology

ABSTRACT

Present experiment study focused on manufacturing and properties of Alkali Activated Coarse Aggregate (AACA) by method of pelletization. The manufacturing of AACA using Ground Granulated Blast Furnace slag (GGBS) and alkali activator solution. The sodium hydroxide and sodium silicate were alkali activator solutions. The concentration of sodium hydroxide maintained as six molarity and ratio of sodium silicate to sodium hydroxide was 2.5.AACA were manufactured using drum mixer by maintain a 45 degree angle and speed of the mixer was 20 rpm for 2.5,3,3.5,4 and 4.5 minutes. It is observed that the speed of mixer is also affects the properties of aggregate, especially loose bulk density and absorption of water. Specific gravity of AACA is between 2.6 -2.7, which is similar to Natural Aggregate. From SEM image show that the packing density for NA is higher to AACA may be the reason of low water absorption of NA

Keywords: Alkali, molarity, GGBS, Pelletization

1. INTRODUCTION

GGBS is a solid by product from the steel making process that possess cementitious property. It is a popular supplementary cementitious material/admixture used to improve the characteristics of concrete [1]. The utilization of GGBS has not only restricted for making concrete it can be used for manufacturing mortar and masonry blocks. Geopolymer has well developed and relatively new material in construction industry to replace traditional cement. Production of geopolymer needs base materials which are more prominent presence of alumina and silica such as fly ash and GGBS [2].The geopolymerization is the high alkali binder family[3].The activation of GGBS involves activation of silicate and calcium by mild alkali material to produce CSH gel through geopolymeric reaction process as similar to ordinary Portland cement concrete[4].The application of geopolymer has also extended to making durable roads, grout, mortar of geopolymer solid and hollow blocks and paver blocks[5].An investigation has revealed that,compressive strength of concrete does not improve if GGBS is more than 55% of the total binder[6]. The mechanical properties of concrete depend on water content, GGBS and curing period[7].The strength of concrete mix with GGBS depends on age and percentage replacement of GGBS[8].GGBS specimen developed maximum strength at the age of 28 and 90 days [9].Concrete with GGBS has been proved to be economical and ecofriendly material [10]. Production of concrete is increasing with time. Traditional cement is in demand to produce many cementitious materials along with aggregates. However, there is a restriction to the exploitation of natural aggregate, Hence, it is necessary to develop alternative aggregates[11,12].Fly ash can be used as source material for production of geopolymer sand to replace the natural river sand in mortar [13]. The metallurgical industry has effectively used palletization process for the

lightweight aggregate production.

Many researchers has worked on production of aggregate which is lesser in density, and observed that cost of production of those aggregates is higher than the natural aggregate. [14]. Many researchers reported that the raw materials like fly ash, iron ore tailings and Car fluff can be used in making aggregates [15].Sustainable structural concrete were produced using replacement of natural fine and coarse aggregateby sintered fly ash aggregate. It is observed that the aggregate properties of depends on the typeof dosage and binder [16].

Many researchers has carried out a research initiate on production of alternative greener material to cement, fine aggregate as activated slag. Current research focused on various activators is sodium aluminate, sodium carbonate and lime [17].The use of AAS as binder in concrete for sustainable development in concrete indirectly reduces the exploration of natural resources. There is a limited study on Alkali Activated using GGBS as a source material to produce the aggregate [18].In this paper, manufacturing process and characteristics of Alkali Activated coarse aggregate is reported.

2 Preparation of Alkali Activated Coarse Aggregate (AACA)

The preparation of coarse aggregate involves the mixing of source material GGBS with alkaline solution in the mixer. The 45 degrees angle of rotation of drum mixer is maintained. The drum mixer has speed of 20 rpm for 2.5, 3, 3.5, 4 and 4.5 minutes respectively. Physical Appearance of AACA in Fig.1.

Fig. 1.Manufactured Alkali Activated Coarse aggregate

3 Results and Discussions

The physical and chemical properties of manufactured AACA carried out as per IS 2386 -1(1963) as shown in Tables 1 and 2. The physical properties of AACA observed that as increase in speed of mixer the water absorption is also increase. The shape of the particle is spherical hence, the flakiness and elongation index has not performed. The crushing and Impact strength is higher than natural aggregate however confirms the IS requirements may suitable for road work. Abrasion value is more than natural aggregate and not confirming with Indian standards. The sieve analysis was carried out for speed of mixer at 20 rpm for 2.5, 3, 3.5, 4 and 4.5 minutes as shown in Fig. 2(a),(b),(c),(d) and

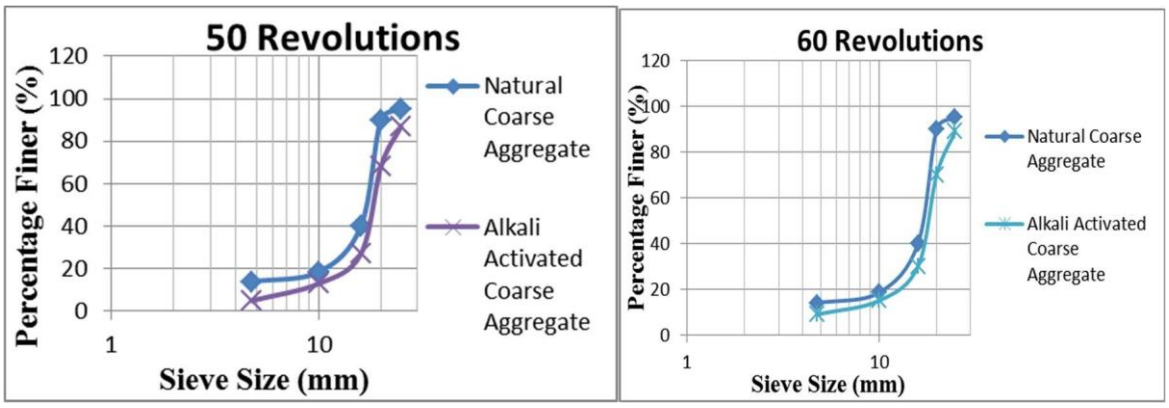
(e). The particle size distribution indicates that AACA prepared at 20 rpm for 2.5 minute and 3 minute shows similar to natural coarse aggregates. The fineness modulus of prepared aggregate in the range 6.5-7. SEM image of AACA is shown in Fig.3.The alkali activated coarse aggregates are less densely packed as compared to natural aggregate.

Table 1. The Physical analysis of AACA

Sl. No	Properties	Values				
		50 Rev	60 Rev	70 Rev	80 Rev	90 Rev
1	Fineness Modulus	6.5	6.7	6.72	6.9	7.1
2	Specific Gravity	2.6	2.65	2.67	2.7	2.7
3	Water Absorption (%)	2.89	3.25	3.97	4.10	4.52
4	Bulk Density (kg/m^3)	1391	1422	1467	1480	1496
5	Aggregate Crushing Value (%)	25.8	27.2	28.5	29.4	30
6	Aggregate Impact Value (%)	18.21	21.54	22.2	23.5	26.2
7	Aggregate Abrasion Value (%)	83.8	86.2	88	88.2	85

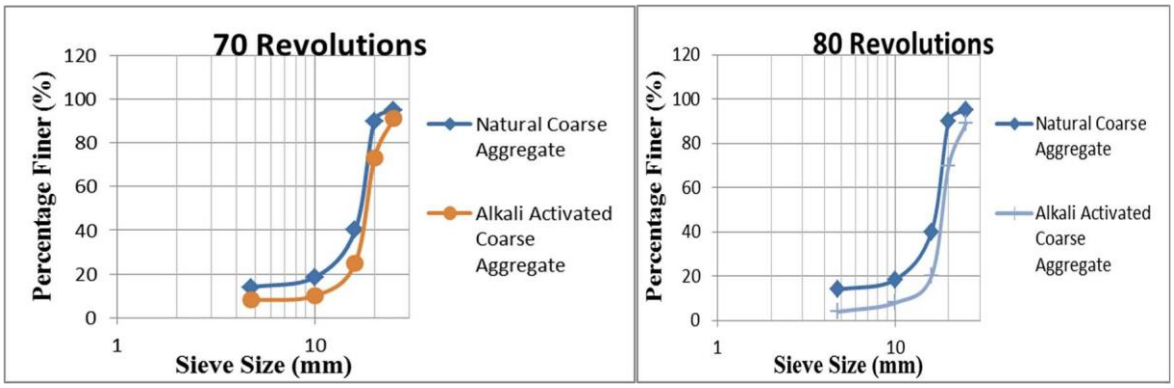
Table 2. The Chemical analysis of AACA

Sl.No	Properties	Values
1	Silica (%)	25.31
2	Alumina (%)	7.01
3	Calcium oxide (%)	31.94



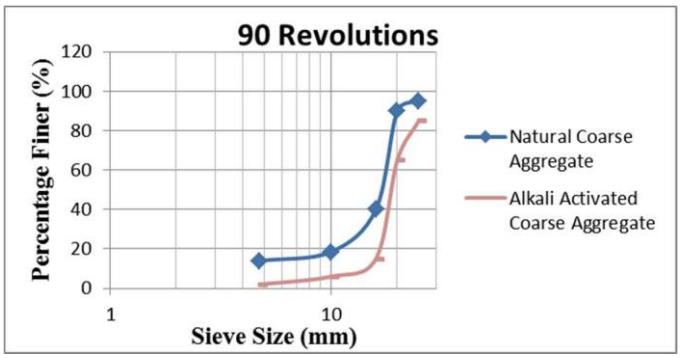
(a) (b)

ISSN: 2096-3246
Volume 54, Issue 02, November, 2022



(c)

(d)



(e)

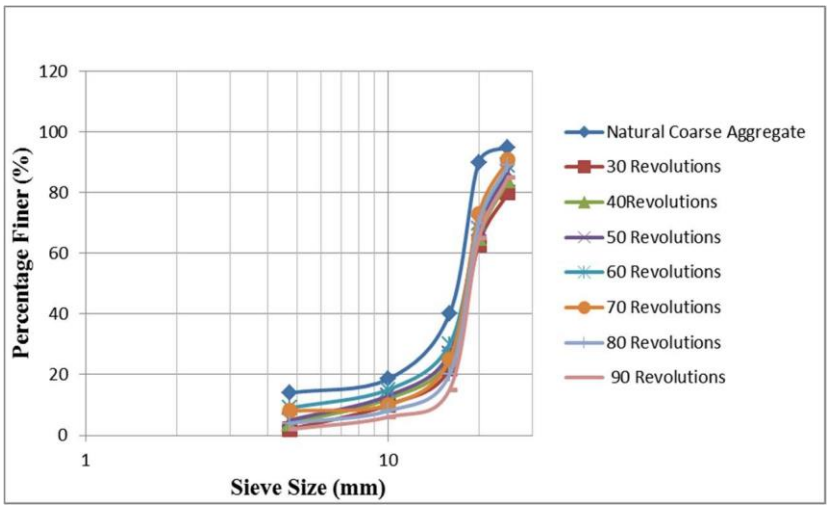
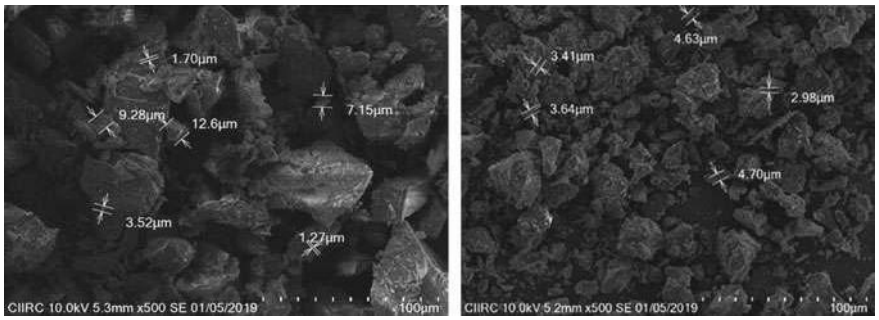


Fig.2. Gradation curve for Natural Aggregate and Alkali activated Coarse Aggregate for different rpm of mixer

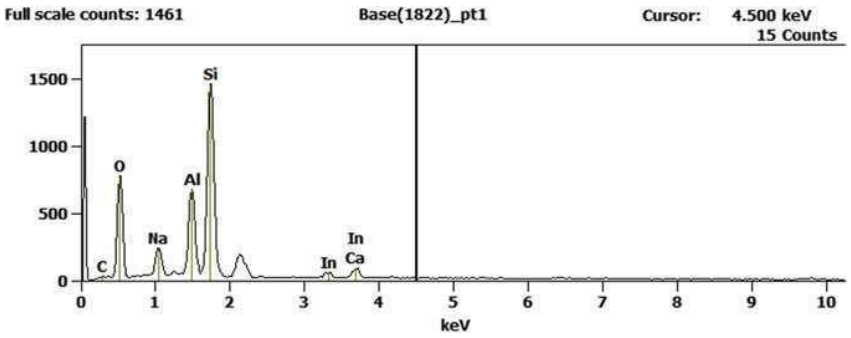


(a) (b)

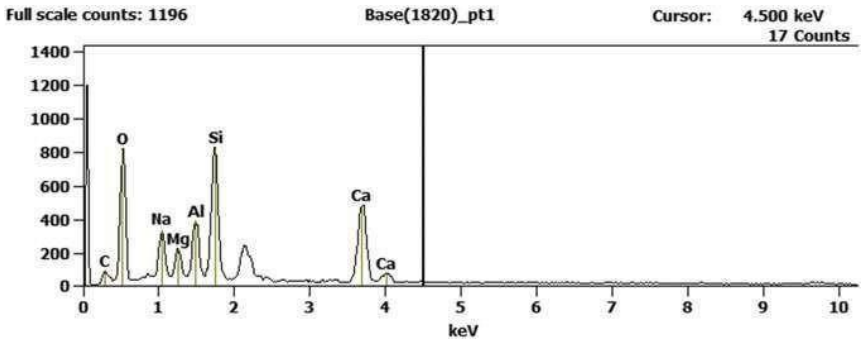
Fig.3. SEM Image (a)Natural Aggregate (b)Alkali Activated Coarse aggregates

3.1 Energy Dispersive Spectroscopy (EDS)

The Energy Dispersive Spectroscopy is one of the qualitative analysis of materials. The EDS has carried out for both Natural and Alkali Activated Aggregate. The results obtained that Alumina and Silica presence, which has a significance of improvement in the strength of aggregate [19] in case of both Natural, and Alkali Activated Aggregate.



(a)



(b)

Fig.4. EDS Image (a) Natural Aggregate (b) Alkali Activated Coarse aggregates

4. Conclusions

Properties of AACA is depends on speed and number of revolutions of mixer. The specific gravity in the range of 2.6-2.7 similar to NA. The particle size distribution indicates that the Alkali Activated

coarse aggregates prepared at 50 and 60 rpm shows similar like Natural Coarse aggregates. It can be observed from the SEM figure the alkali activated coarse aggregates are less densely packed as compared to Natural aggregate. It can conclude that the developed AACA can be used for Preparing the concrete by partial replacement of natural aggregate.

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