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An Experimental study on properties of Fly ash aggregate pellets Comparing with Natural Aggregate

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***Abstract*—** In this paper a detailed study on the properties of Light weight artificial aggregates is carried out, these aggregates were made out by geo-polymerization. In the current scenario, the disposal problem of industrial by-products like fly ash has become an environmental issue due to the pollution caused. Further, shortage of land to fill these materials also adds up to this issue. Fly-ash is mainly used for the dumping purpose or as a fine aggregate. On the other side, shortage of natural aggregates in the growing infrastructure industry, creates problem of depleting natural resources which builds the need for artificial aggregates. In this project we aimed to develop a technique for producing an aggregate with the fly-ash and use it in the replacement of normal coarse aggregate. Consequently, the production of artificial aggregates solves two problems, conserves environment from pollution and prevents natural resource from depletion, thereby giving way tosustainable development. Artificial aggregates are prepared by pelletization process. The properties of artificial aggregate were compared with natural aggregate it found that the artificial aggregate results in light weight then compared to natural aggregate and it poses higher mechanical property than natural aggregate.

Keywords—light weight aggregate; geopolymerization; pellitization;Natural aggregate; properties (key words)

I. INTRODUCTION

Aggregate are materials that have a vast application in several industries. Many industries are dependent on natural resources to gain their aggregate. Thus, the manufacture of light weight artificial aggregate is developed in order to avoid exhausting of natural resources. Nowadays one of the major issues that needs to be a concern is to minimize and recycling waste materials from industry. The waste materials from industry can be used in producing lightweight aggregate for the construction industry. The lightweight aggregate also has an application on geotechnical fill, insulation products, soil engineering, hydroculture, drainage, roof gardens and filter Lightweight aggregate can be produced either from natural rock or manufacture. The typical properties that important for lightweight aggregate are the weight, strength, thermal and acoustical, high fire resistance toughness and depending on the application other properties such as water absorption shrinkage, bonding with cement, elastic properties and abrasion resistance are also considered.

II. LITERATURE REVIEW

Ravisankar et al., made a work onartificial fly ash aggregate concrete, artificial fly ash aggregates were used in concrete and its effect on strength of concrete was studied. **Darwin et al.**, has worked on Effect of Paste-AggregateBond Strength on Behavior of Concrete, The resulting concrete was compared to concrete containing uncoated control aggregate for strength, stiffness, and type and amount of 1micro cracking. **Tareq s al-attar**,has made a study on A quantitative evaluation of bond strength between coarse aggregate and cement mortar in concrete. It was concluded that the values of bond to splitting tensile strength ratio could be considered as an indication to weather the failure of concrete is occurred due to bond lose or because the stresses at the interface zone had exceeded the tensile strength. **Krishna kumar S et al.,** has worked on "Bond strength of concrete containing crushed concrete aggregate (CCA)"The variation of bond strength with respect to that of control concrete was found to be minimal for M25 grade concrete containing CCA.
Manikandan et al., suggested that the durability properties of concrete made with fly ash aggregate cured by different methods and found that sintered aggregates have more strength compared to cold bonded aggregates. **Priyadarshiny et al**., have noticed that the fly ash aggregates produced by normal curing showed comparable studies with the aggregates produced with other methods of curing, when the experimental study on cold bonded fly ash

aggregates with number of days of curing period is increased.

II. MATERIALS AND ITS PROPERTIES

A. Cement:

Cement is used in this project is Portland Pozzolana Cement (P.P.C.) according to IS 1489(PART1):199. Table 1 gives the composition of chemical compound of fly ash and cement.

Table 1: Chemical components of Cement and Fly-ash

	CaO	**S_iO_2**	**Al_2O_3**	**Fe_2O_3**	**Na_2O**	**K_2O**	**MgO**
Cement	63.5	20.3	2.2	1.8	0.45	0.35	1.1
Fly-ash	1.3	54.41	30.8	8.44	1	1.98	1.53

B. Fly-ash class C:

Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash hardens and gets stronger over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulphate (SO_4) contents are generally higher in Class C fly ashes.

IV. METHODS OF PREPARATION OF FLY-ASH AGGREGATES

A. Alkaline solution (geo polymer)

Geo polymer solution was use to alternative binding material for water lime ratio in artificial aggregate production. Geo polymer solution is nothing but mixing of two chemical with proper ratio. The chemical which were used to prepare geo polymer are sodium hydroxide and sodium silicate. The sodium hydroxide flakes are taken by volume of molar ratio and dissolved indistilled water to make a solution. The sodium silicate solution was available in the market. Sodium silicate and sodium hydroxide was added in ratio of 1:2.5 and then it is mixed thoroughly. It is kept for about 24 hours to make geo polymer solution. The solution was turn into liquid gel state after 24 hoursthen it was directly used in the aggregate production.

B. Preparation of Flyash Aggregate

A 1kg of flyash is taken and 250ml of alkaline solution is added in concrete mixer and allow it to rotate for 10 mins which is the optimum revolution. Fig 1 shows fly ash aggregate.

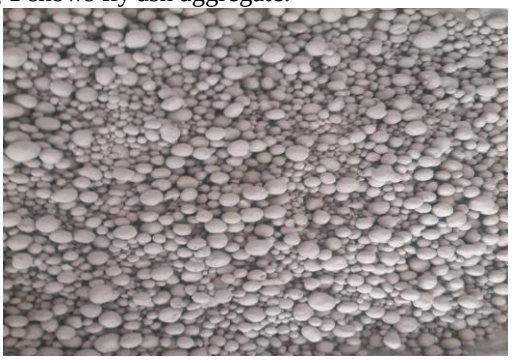

Fig 1 Fly ash Light weight aggregate

C. *Hardening Of Fly-Ash Aggregate:*

The flyash aggregate is hardened by allowing it for dry curing for an optimum cuing period of 14 days

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V. STUDY ON PROPERTIES OF LIGHTWEIGHTFLY-ASH AGGREGATE

Crushing value, Impact value test were performed as per IS 2386 Part-4; and Bulk density, Specific Gravity Test were performed as per IS 2386 Part-3 is concerned. The properties of Fly-ash aggregate and Coarse aggregate were listed as below.

Table 2 Test performed on coarse aggregate and Fly-ash aggregate.

Description NA/AA	**100/0**	**80/20**	**60/40**	**50/50**	**40/60**	**20/80**	**0/100**
Specific Gravity	2.8	2.714	3.01	2.44	2.47	2.52	2.86
Bulk density	1646.6	1564.5	1534.6	1687.7	1564.58	1627.8	1138
Fineness modulus	2.53	2.44	2.26	2.23	2.22	2.23	3.77
Crushing value	18	15	16	17.3	17.9	20	21
Impact value	25	12.75	12.5	12.5	12.5	12.5	17.5

VI. RESULT AND DISCUSSION:

A. Crushing strength:

Crushing strength of a coarse aggregate is depend on the load taking capacity of the coarse aggregate due to constant or increases in loading. The difference in crushing strength of aggregate is shown in the Fig 2.

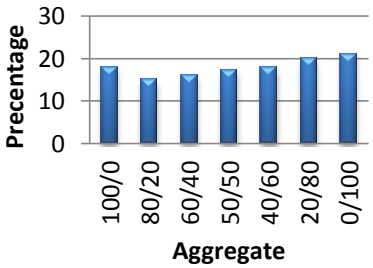

Fig 2 Comparison of Crushing strength

The crushing value of artificial aggregate with respect to natural aggregate combination is shown in Fig 2. It clearly shows that the crushing value of light weight fly ash aggregate is similar to the natural aggregate. The crushing of artificial aggregate is less than 45%, it shows the suitability of light weight aggregate in construction.

B. Impact value:

Impact value of a coarse aggregate is depending upon the certain loading on the coarse aggregate. The difference in the impact value of the aggregate in various ratios is shown in Fig 3.

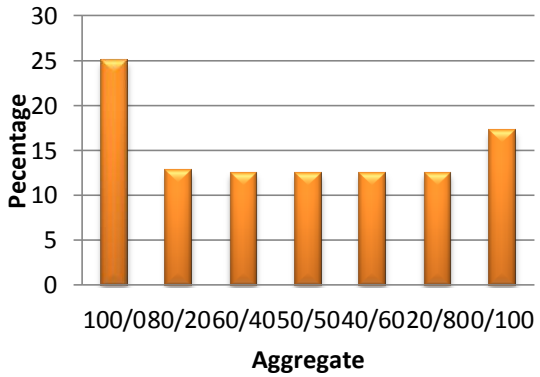

Fig 3 Comparison of impact values

The light weight aggregate has the maximum impact value of about 18% which is 30% lesser than the natural aggregate that of about 25%. Impact value from the Fig3 it is observed that the impact value of all the proportion is satisfying the usage of aggregate in building construction.

C. Bulk density:

Bulk density of a coarse aggregate is the ratio of weight of the aggregate mass inside the container to the volume of the container that is bulkdensity helps us to know packing of the aggregate.

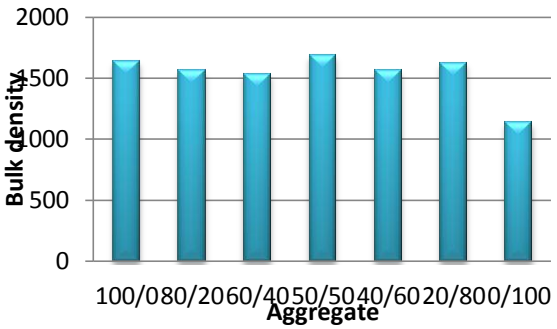

Fig 4 Bulk density of fully compacted aggregate

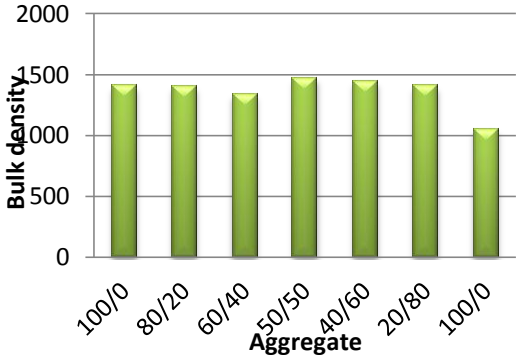

Fig 5 Bulk density of partially compacted aggregate

From the Fig 4 it is observed that the bulk density of natural aggregate is 1646.6 kg/m^3 and the bulk density of artificial aggregate is observed that 1138 kg/m^3 which is 40% lower than the natural aggregate. It shows that the artificial aggregate is lighter in weight. By usage of artificial aggregate in concrete it will resultsin lower density of concrete without changes in concrete properties.

D. Fineness modulus

It is an index number which gives an idea about the coarseness or fineness of aggregate. It is found by adopting the procedure which is specified in IS: 2386 (Part 4)-1963.

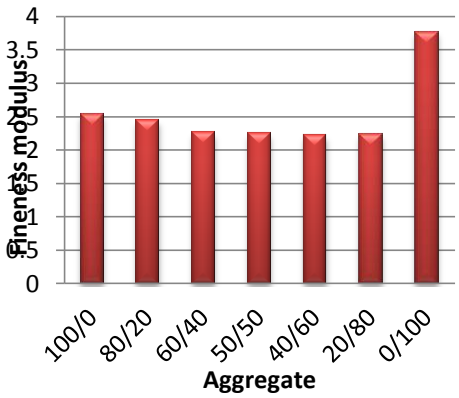

Fig 6 Comparison of fineness modulus

From the Fig 6 it is observed that the fineness modulus of natural aggregate is 2.5 and the fineness modulus of artificial aggregate is observed that 3.7 which is 30% higher than the natural aggregate.

CONCLUSION

From the study following conclusion were made,

- Compared various properties of aggregate, flyash aggregate has got a positive result and nearly same property of conventional aggregate.
- The impact value of Geopolymer aggregate value is less is 30% which result that the aggregate is suitable for concrete works.
- Artificial aggregate absorbs more water content than natural aggregate, so it may affect the workability of concrete butcontrolled by addition of granite powder while making aggregate.
- It found that the density of aggregate which is formed by geopolymer process is lesser than compared to natural aggregates.

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