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FLY-ASH PELLETS: A REPLACEMENT OF COARSE AGGREGATE

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***Abstract* — Coal which is a very promising material in industry for a growing country like India produces Fly-ash which is creating a great threat to the environment. Fly-ash is mainly used for the dumping purpose or as a fine aggregate. The study is aimed to develop a technique for producing an aggregate with the fly-ash and use it in the in replacement of normal coarse aggregate. The properties of fly-ash were experimentally checked whether it is of type-C or of type-F by chemical analysis of the fly-ash. Batches of fly-ash aggregates were manufactured using cold bonded technique using disc pelletilizer. Based on the crusing value, water absorption and impact value test results of their properties, fly-ash aggregates were selected. Using the fly-ash aggregates prepared from the cold bonded technique, there properties were tested. These pellets will be light in weight having specific gravity (1.63,1.89) less than that of gravel(2.67) and will have high impact value(32.52, 28.54) than that of gravel(20.12). At the same time, they will also address some of the environmental problems such as disposing the industrial waste which is being generated from thermal waste.**

***Index Terms* — Fly-ash aggregate, Fly-ash pellets, Super plasticizer, Cold-bonded technique.**

I. INTRODUCTION

Coal is a very useful material for a developing country like India. In this country for most of the industry (like: thermal power plant, iron industry) coal is burnt a large no. Thus a significant amount of fly-ash is produced in our country and it becomes a threat to our society as fly-ash is injurious to our health. In account to solve this problem fly- ash is now a day using for dumping the low-land and it is also using in making of fly-ash bricks and in a concrete mix with a proper proportion with the fine aggregate. But there is another option is to use the fly-ash aggregate in a replacement of coarse aggregate. The coarse aggregate which is produced with a mix of cement as a binder have a good pozzolanic property and it also help us to solve the environmental problem as well. For green city purpose fly-ash aggregates is also essential as it is produced by recycling of fly-ash coming from industries.[1]

The use of fly-ash by products is very essential now a day as it is environment friendly [2] along with economical. The fly-ash pellets are produced with the help of disc pelletalizer

using cement as a binder in a cold bonded technique. After preparing of the aggregate it needs higher energy in curing process. Though the aggregates are formed as a round shape but it has more pozzolanic property than that of the normal coarse aggregate. Due to have a higher initial cost it is not widely used in India. But there is also a process to make the aggregate with using minimum energy for curing. There are also methods of curing like cold bonding which does not require energy for making those aggregate[3].

II. LITERATURE REVIEW

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 [4].

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 [5].

In conventional concrete, weight of aggregate is one of the parameters to compare with weight of fly ash aggregate. Normally density of concrete with coarse aggregate is in the order of 2200 to 2600 kg/m3. This heavy self-weights of the coarse aggregate make an uneconomical structural material as compared to low self-weight of fly ash aggregate. In order to produce concrete mixture of desired density to suit the required application, the self-weight of structural and non- structural members are to be reduced than the original one. Hence economy will be achieved in the design of supporting structural elements which lead to the development of light weight concrete using fly-ash aggregate. This paper is reviewed on the suitability of using fly ash lightweight aggregate strength properties.[6]

III. MATERIALS AND ITS PROPERTIES

A. Cement:

Cement is used in this project is Portland Pozzolana Cement (P.P.C.) according to
IS 1489(PART1):1991. [7].

	CaO	SiO_2	Al_2O_3	Fe_2O_3	Na_2O	K_2O	MgO	Density(g/cc)
Cement	63.5	20.3	2.2	1.8	0.45	0.35	1.1	2.67
Fly-ash	1.3	54.41	30.84	8.44	1	1.98	1.53	2.1

Table: Chemical components of Cement and Fly-ash

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 (SO4) contents are generally higher in Class C fly ashes.

C. Water:

Portable water was used for making fly-ash pellets.

IV. METHODS OF PREPARATION OF FLY-ASH AGGREGATES:

The desired grain size distribution of an artificial fly-ash aggregate [8] is either crushed or by means of agglomeration process. The pelletization process is used to manufacture of lightweight coarse aggregate; some of the important parameters need to be considered for the efficiency of the production of pellet such as speed of revolution of pelletizer disc, moisture content, and angle of pelletizer disc and duration of pelletization. The different types of pelletizer machine were used to make the pellet such as disc type or pan type, drum type, cone type and mixer type. With disc type pelletizer [9] the pellet size distribution is easier to control. The smaller grains are produced initially and are subsequently increased in particle size by disc type pelletizer. The disc pelletizer size is 0.57m diameter and side depth of the disc as 0.250 m, it is fixed in a flexible frame with adjusting the angle of the disc as 35 to 55° and to control for the rotate disc in vertically manner should varying speed as 35 to 55 rpm.[10] In a cold bonded method is to made the increase the strength of the pellet as to increase the fly ash/cement ratio as 0.2 and above (by weight). In this case study two type of fly- ash cement ratio is used here such as 5:1 and 10:1 to check the strength of aggregate.

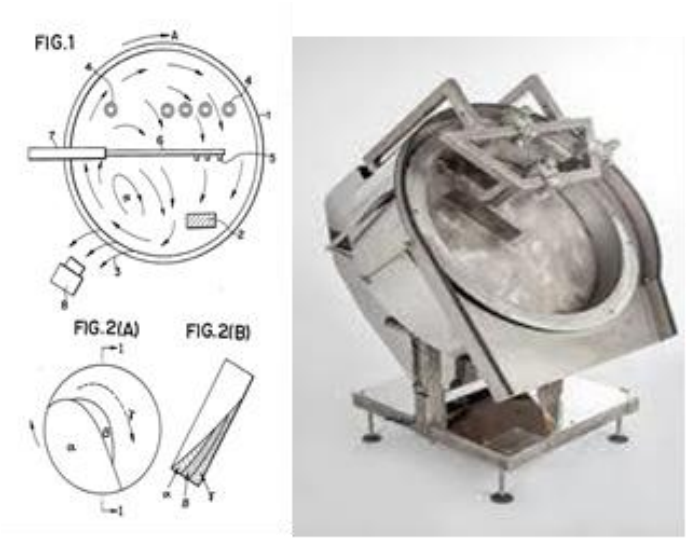


Fig: Pelletization Process; Disc Pelletizer

V. HARDENING OF FLY-ASH AGGREGATE:

The Fly-ash aggregates are porous material so for hardening the pellets we have to use cement as binder material. The hardening of the pellets can be done by following process: cold bonding, sintering, and autoclaving. Cold-bonded fly-ash can be hardened by normal water curing, steam curing, and autoclaving. Among all these 3 process normal water curing is most effective process to increase the strength of the pellets. So to increase the strength of the pellets after removing them from the pelletilizer we have to dry those pellets for one day then put them for curing for 28 days.

Fig: Pellets

Study on properties of Fly-ash aggregate:

Aggregate passing through 12.5 mm sieve and retained 10 mm sieve were used for both for Fly-ash aggregates and coarse aggregate to find the strength of the material. Crushing value, Impact value, Abration value test were performed as per IS 2386 Part-4; and water absorption, Bulk density, Specific Gravity Test were performed as per IS 2386 Part-3 [11]is concerned. The properties of Fly-ash aggregate and Coarse aggregate were listed as below.

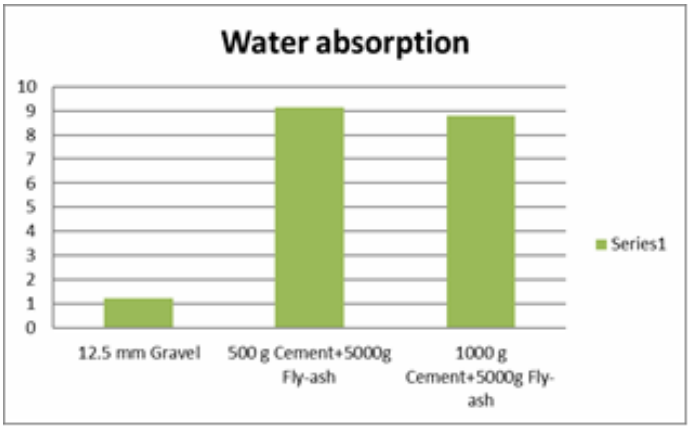
	Units	12.5 mm Gravel	500 g Cement+5000g Fly-ash	1000 g Cement+5000g Fly-ash	Allowable limit	Reference
Water Absorption	%	1.23	9.12	8.78		IS 2386 Part-3
Crushing Strength	%	34.18	26.52	29.69	<45%	IS 2386 Part-4
Impact Value	%	20.12	32.42	28.54	<45%	IS 2386 Part-4
Abration Value	%	3.2	4.78	4.35	<50%	IS 2386 Part-4
Bulk Density	kg/lts	2.72	1.32	1.28		IS 2386 Part-3
Specific Gravity		2.67	1.63	1.89		IS 2386 Part-3
Size	mm	4.75-20	4.75-20	4.75-20		
Shape		Angular	Circular	Circular		

Table: Test performed on coarse aggregate and Fly-ash aggregate

VI. RESULT AND DISCUSSION:

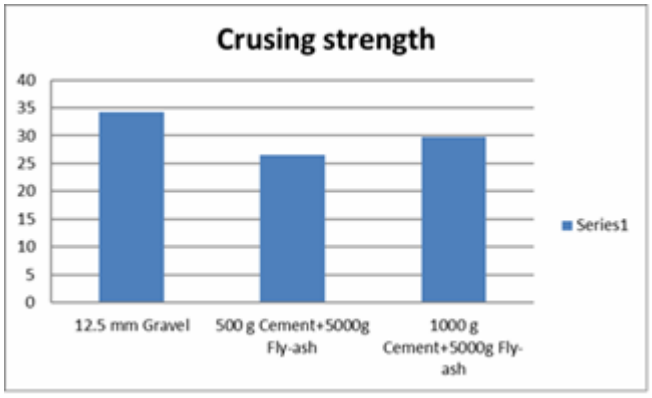
A. Water absorption:

Water absorption of a coarse aggregate is the water absorbed by the dry coarse aggregate due to the voids present inside the aggregate.



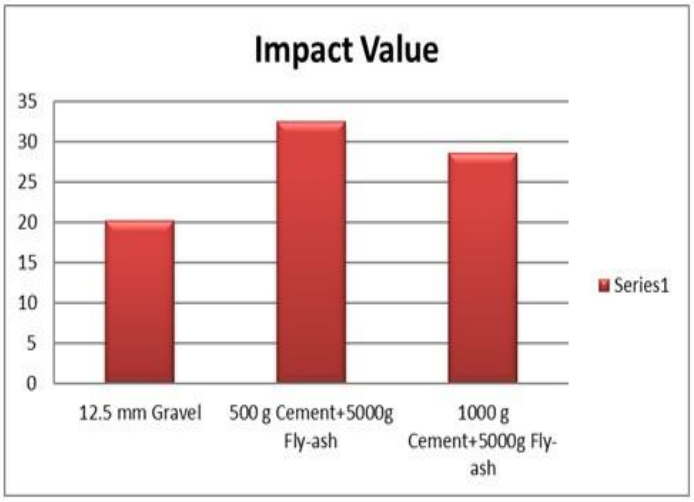
B. Crushing strength:

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 is shown in the graph. The



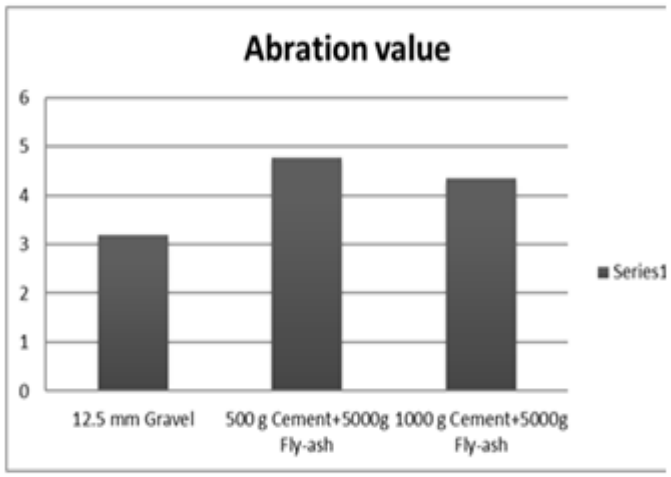
C. Impact value:

Impact value of a coarse aggregate is depending upon the certain loading on the coarse aggregate. The difference is shown in the bar chart.



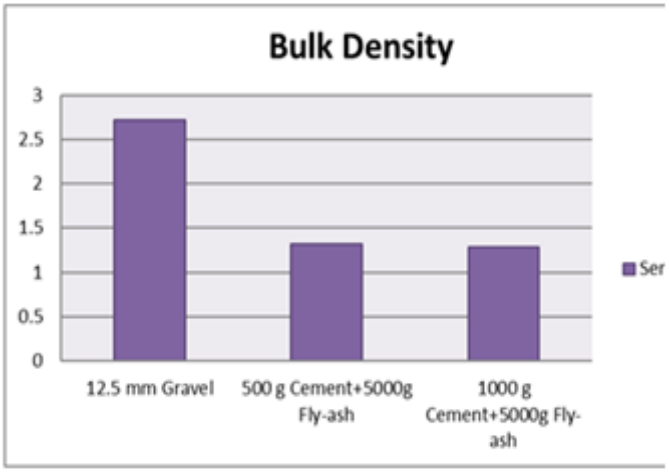
D. Abration value:

Abration value is determined by Los Angeles abration testing machine. Abration of an aggregate is important because the aggregate must resist crushing degradation and disintegration in order to produce higher strength in the aggregate.



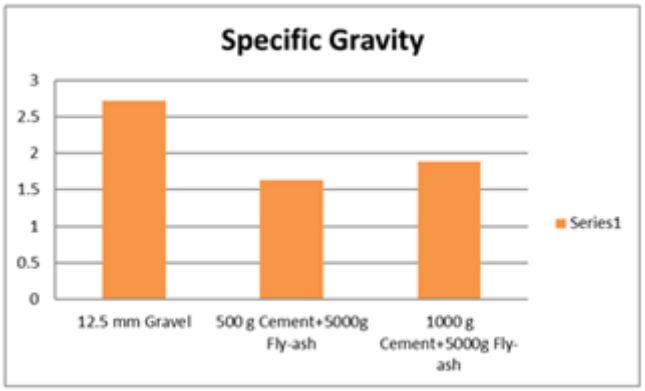
E. Bulk density:

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 bulk density helps us to know packing of the aggregate.



E. Specific gravity:

Specific gravity is mainly used to measure the strength and quality of the material



CONCLUSION

The following conclusion can be drawn from the above test and analysis result:

- The physical properties of the fly-ash aggregates has attained required value as per IS 2386-part3 and IS 2386-part4 is concerned.
- As the pellets produced by both ratio of Fly-ash and cement i.e.5:1,10:1 is giving the values of Abration test(for fly-ash aggregate: 4.35,4.78; for gravel: 3.2) Crushing test(for fly-ash aggregate: 26.52,29.69; for gravel: 34.18)nearly same to that of coarse aggregate so the coarse aggregate can be replaced by the pellets and can give the same strength as that of coarse aggregate in the concrete mix.
- Though the specific gravity of the fly-ash aggregate(1.63,1.89) less than gravel(2.63) and the impact

value of the gravel(20.12) is lesser than the fly-ash aggregate(32.42,28.54)

- The aggregates are very useful in concrete. The using of regular coarse aggregate causes destruction of hills further

points to geological and environmental imbalance. The environmental impacts on extracting of sand and crushing of stone to supply coarse aggregate may cause natural calamities as well. Pollution hazards, noise, dust, blasting vibration, loss of forests and destruction of nature is a great threat for our nature as well as our society. Landslides of weak and steep hill slopes are induced due to destruction of hills for getting coarse aggregate. Whereas in the other side fly-ash coming out from the industries may also concern a great problem to rehabilitate so it will be a great environment friendly step to making the fly-ash pellets as a replacement of coarse aggregate.

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