Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

Fly-Ash Pellets as a Replacement of Coarse Aggregate in Concrete Mixture

Biswaroop Ghosh[1], Dr. A. K. Rath[2]
[1] Student, [2] Professor
[1,2]School of Civil engineering,
KIIT University, Bhubaneswar.

Abstract: **- In this study, the coarse aggregates are completely replaced by fly ash pellets in fly ash concrete. A mix design was provided for M-25 grade of concrete by IS-10262:2009 method. Ordinary Portland cement of 43 grade and fly-ash and water was mixed with proper proportion to make the fly-ash pellets. The physical properties of fly ash pellets were studied. The cement and fly ash proportions 10:1, 5:1 were mixed with suitable water having water cement ratio of 0.3 to get the fly ash pellets. The concrete block of cube and cylinder-shaped were casted with fly ash pellets obtained from the above two cement fly ash proportion. Then the compressive strength was tested. This paper briefly presents the compressive strength development of fly ash aggregate concrete at different days of curing along with the cost of the cube casting in laboratory scale.**

Keywords: Palletisation, Water Cement Ratio, Fly Ash Aggregates, Light Weight, Economical, Compressive Strength, Cube, Cylinder

INTRODUCTION:

Coal is a very promising material in industry for a growing country like India in thermal power plants and steel plants. But the fly-ash which is the waste coming from burning the coal is creating a great threat to the environment. Fly-ash is mainly used for the dumping purpose or as a fine aggregate or in purpose of making of bricks. The study is aimed to develop a technique for producing an aggregate with the fly-ash cement 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, they were used for producing different types of concrete mixture. Different types of concrete specimens were produced where the proportions of fly-ash aggregates of different sizes differ in each specimen by using different types of super plasticizer. Based on the test results of the physical and chemical properties of the specimens, they were tested for compressive strength for 7 days,14 days and 28 days and the gradation of concrete mixture was determined. These pellets, used in concrete mixture will be light in weight and will have high load bearing capacity. 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.

In conventional concrete, density of concrete where is in the order of 2200 to 2600 kg/m^3 makes it an uneconomical building material compared to low density concrete produce with the fly ash pellets. In order to produce concrete of desired density to suit the required application, the self-weight of the members are to be reduced. Hence economy is achieved in the design of supporting the elements which lead to the development of fly-ash concrete. Fly-ash concrete is defined as a concrete that has been made by fly-ash aggregates and its weight is lighter than the conventional concrete by changing coarse aggregate by fly-ash aggregates. Though fly-ash concrete cannot always substitute normal concrete for its strength, it has its own advantages like reduced dead load, and thus economic structures with enhanced seismic resistance, high sound absorption and good fire resistance can be erected. Because of the above reasons the study on fly ash pellets concrete is taken in this research work.

FORMATION OF FLY-ASH PELLETS:

The materials are used like cement; fly ash and water are used to produce the fly ash pellets. Water is used as the binding material to react and helps the aggregate to gain good strength.

Fig: Pellets

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

MATERIALS USED IN MAKING OF Fly-Ash Pellets:

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	62.5	21.4	2.35	1.82	0.56	0.39	1.23	2.83
Fly-ash	1.5	54.95	31.25	8.98	1.2	2.12	1.64	2.58

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.

METHODS OF PREPARATION OF FLY-ASH AGGREGATES:

The desired grain size distribution of a lightweight aggregate is either crushed or by the help of agglomeration process. The pelletization process is used to produce fly-ash pellets; some of the parameters need to be considered for the quality of the production of pellets such as speed of revolution of pelletizer disc, moisture content, and angle of pelletizer disc and time duration for pelletization. The different types of pelletizer machine were used to make the pellet such as disc type, drum type, cone type and mixer type. With disc type pelletizer the pellet size distribution is easier to control. The small grains are formed initially and are subsequently increased of size particle by disc type pelletization. The disc pelletizer size is 0.75m diameter and side depth of the disc as 0.50 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 vertical manner should have a varying speed as 35 to 55 rpm. In cold bonded method fly-ash pellets are made in order to increase the strength of the pellet water/cement ratio is provided 0.3 and above (by weight). In this case study two type of fly-ash cement ratios are used here such as 5:1 and 10:1 to check the strength of aggregate in the concrete.

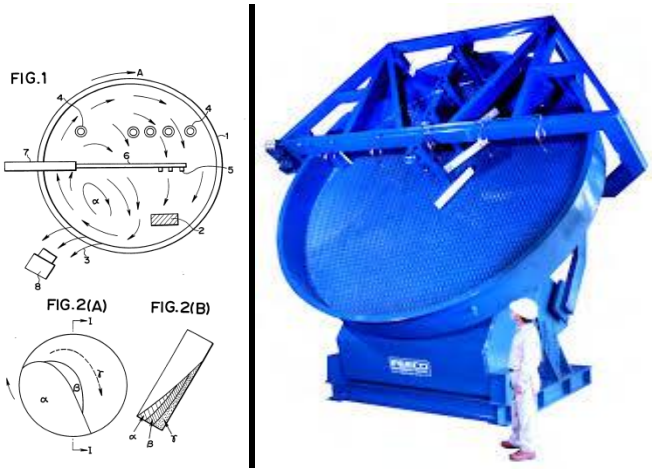


Fig: Pelletization Process; Disc Pelletizer

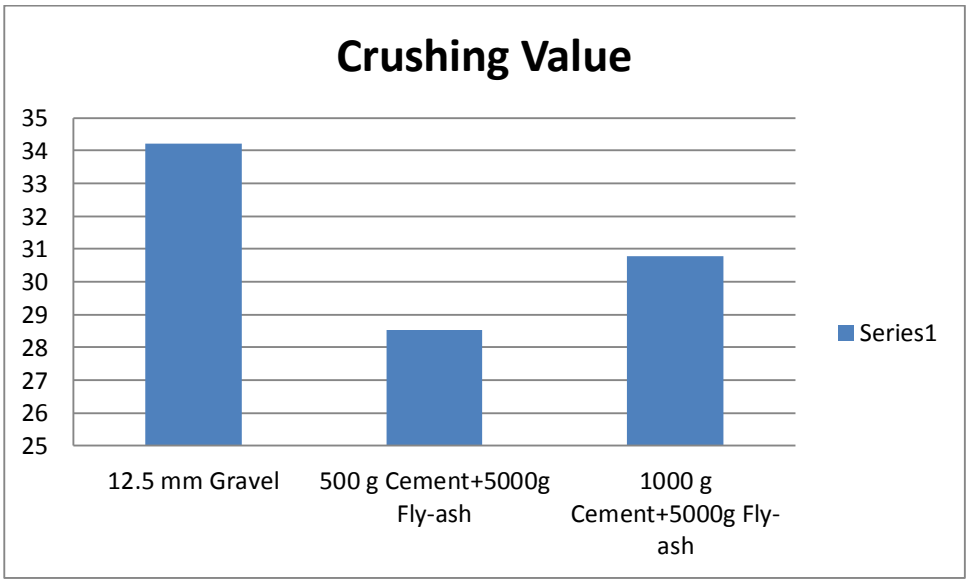
COMPARISON OF PHYSICAL PROPERTIES OF AGGREGATE:

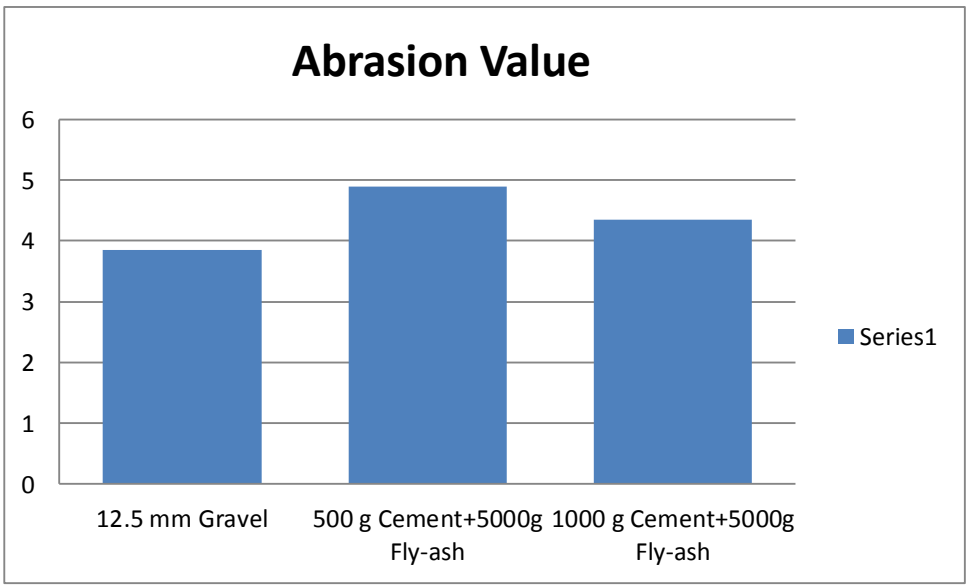
Aggregate passing through 12.5 mm sieve and retained 10 mm sieve were used for both for Fly-ash aggregates and coarse aggregate to find the strength of the material. Crushing value, Impact value, Abrasion value test were performed as per IS 2386 Part-4; and water absorption, Bulk density, Specific Gravity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

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

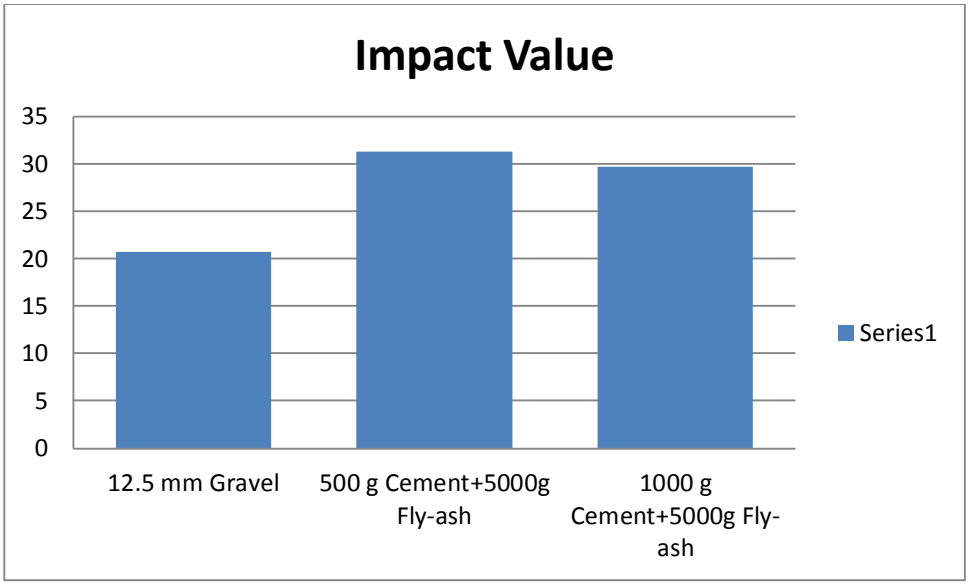
Table: Test performed on coarse aggregate and Fly-ash aggregate

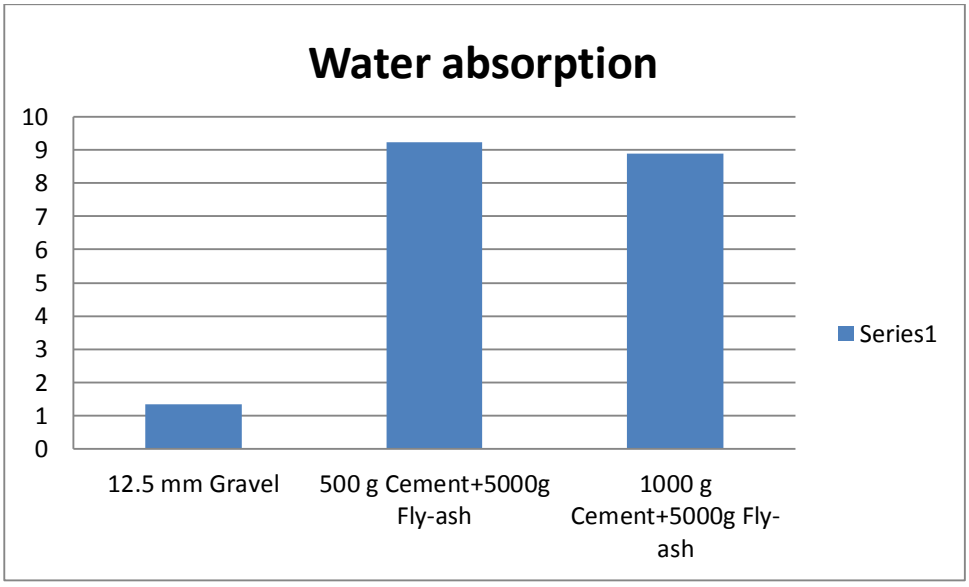
	Units	12.5 mm Gravel	500 g Cement+5000g Fly-ash	1000 g Cement+5000g Fly-ash	Allowable limit	Reference
Water Absorption	%	1.33	9.23	8.89		IS 2386 Part-3
Crushing value	%	34.21	28.52	30.79	<45%	IS 2386 Part-4
Impact Value	%	20.72	31.32	29.64	<45%	IS 2386 Part-4
Abrasion Value	%	3.85	4.89	4.35	<50%	IS 2386 Part-4
Bulk Density	kg/lts	2.73	1.56	1.29		IS 2386 Part-3
Specific Gravity		2.7	1.86	1.90		IS 2386 Part-3
Size	mm	4.75-20	4.75-20	4.75-20		
Shape		Angular	Circular	Circular		





International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017





MIX DESIGN:

The preparation of concrete with fly ash pellets is made as that of conventional concrete. But the changes in the mix design must be done to corresponding to the changes in the densities of the coarse aggregates. Here are the list of materials used along with their quantity and the final mix design.

(i) Cement = 330 kg/m^3

(ii) Fine Aggregate = 740 kg/m^3

(iii) Coarse Aggregate = 1498 kg/m^3

Mass of 20 mm=1063 kg/m^3
Mass of 10 mm =435 kg/m^3

(iv)Water =145 kg/m^3

(v) Admixture= 1.5 kg/m^3

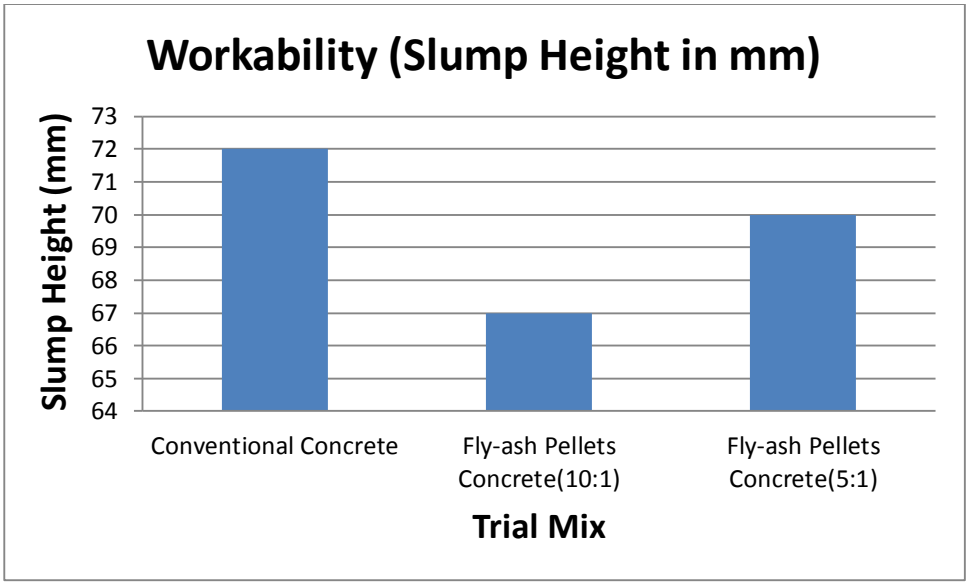
(vi) Water cement ratio = 0.43
Extra quantity of water added for the absorption of Coarse aggregate for 1% WORKABILITY OF CONCRETE

SPECIMEN:

The shape and texture of aggregate affects the fresh property of the concrete. Fly ash aggregate is rounded in shape. Rounded aggregates promotes workability of concrete while the angular nature of natural gravel gives a better bonding property but requires more cement mortar for better workability.

Trial Mix	Workability (Slump Height in mm)
Conventional Concrete	72
Fly-ash Pellets Concrete(10:1)	67
Fly-ash Pellets Concrete(5:1)	70

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017



CHARACTERISTIC COMPRESSIVE STRENGTH OF FLY ASH PELLETS CONCRETE:

For cubes:

Table 1. Compressive strength of cube specimen

	Grade of concrete	Concrete with 10:1 fly-ash pellets	Concrete with 5:1 fly-ash pellets
7 days curing	M25	20.67mpa	22.53 mpa
28 days curing	M25	30.91 mpa	31.62 mpa

For Cylinder:

Table 2. Split strength of cylinder specimen

	Grade of concrete	Concrete with 10:1 Fly Ash pellets	Concrete with 5:1 Fly Ash pellets
7 days curing	M25	17.56 mpa	18.64 mpa
28 days curing	M25	25.75mpa	26.62 mpa

COMPARISON OF COMPRESSIVE STRENGTH:

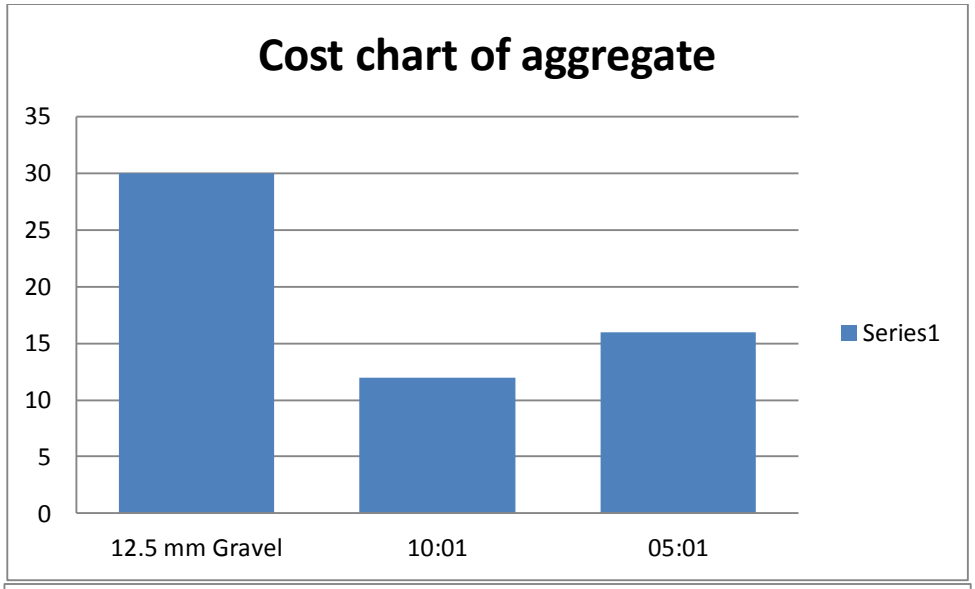
SL.NO	SPECIMEN	DAYS	CONVENTIONAL CONCRETE	FLY ASH PELLETS CONCRETE	
				10:01	05:01
1	Cube	7	23.7 MPa	20.67 MPa	22.53 Mpa
2	Cylinder	7	19.6 Mpa	17.56 MPa	18.64 MPa
3	Cube	28	31.45 Mpa	30.91MPa	31.62MPa
4	Cylinder	28	26.68 MPa	25.75 MPa	26.62 MPa

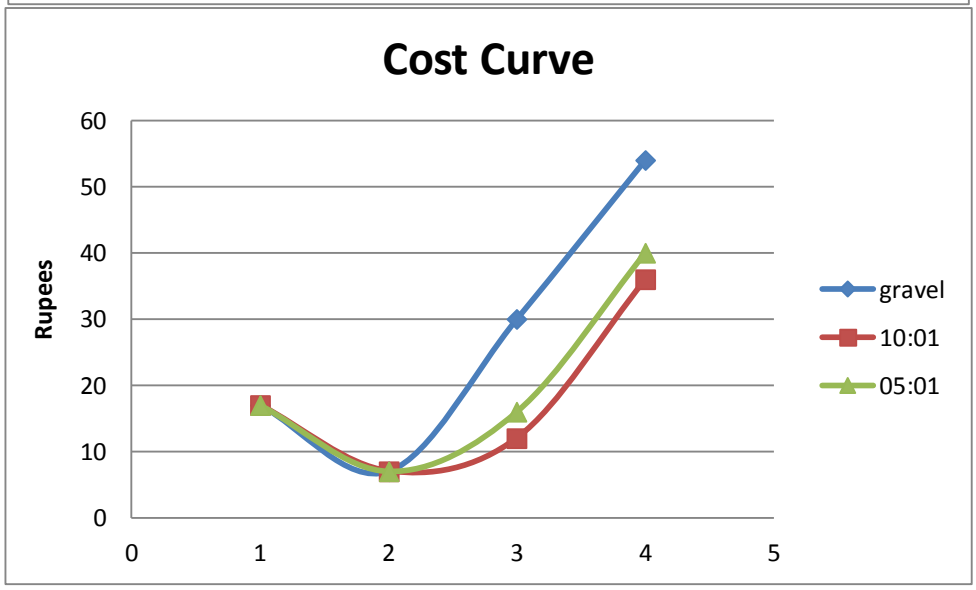
COMPARISON OF COST FOR ONE CUBE (.15M X .15M X.15M):

Here cost of both conventional concrete and fly ash pellets concrete for one cube (.15m x .15m x.15m) in lab scale are discussed

		CONVENTIONAL CONCRETE		FLY ASH PELLETS CONCRETE			
				10:01		05:01	
S.NO	MATERIAL	QUANTITY	RATE	QUANTITY	RATE	QUANTITY	RATE
1	Cement	2.5 Kg	Rs 17/-	2.5 Kg	Rs 17/-	2.5 Kg	Rs 17/-
2	Fine aggregate	2.5 Kg	Rs 5/-	3.15 Kg	Rs 6/-	3.15 Kg	Rs 6/-
3	Coarse aggregate	5Kg	Rs 32/-	5.6 Kg	Rs 17/-	5.6 Kg	Rs 18/-
4		Total	Rs 54/-	Total	Rs 40/-	Total	Rs 41/-

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017





The above table compares the costing variation of conventional concrete and fly ash pellets concrete for a cube. From comparison it is found the concrete from 5:1 ratio pellets shows more cost efficient i.e. nearly 35% of cost saving when compared conventional along with having proper strength. The cost efficiency is directly proportional to the efficiency in the manufacturing of pellets. That is if the production is fully efficient the cost efficiency will increase to a greater extend in large scale purpose.

CONCLUSION:

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

- The physical properties of the fly-ash pellets 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 Abrasion test(for fly-ash aggregate: 4.35,4.89; for gravel: 3.85) Crushing test(for fly-ash aggregate: 28.52,30.79; for gravel: 34.2)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(1.86,1.9) less than gravel(2.72) and the impact value of the gravel(20.72) is lesser than the fly-ash aggregate(31.32,29.64)
- The compressive of the Class F fly ash pellets concrete has surpassed the minimum strength that a M25 concrete have i.e. 25 Mpa
- The cost analysis also proved that Class F fly ash pellets are more cost effective than conventional aggregate.
- We prefer 5:1 ratio than that of 10:1 ratio though having mostly same cost having more strength than of regular M25 concrete cube have.
- The coarse aggregates are very useful in concrete. The using of regular coarse aggregate causes destruction of hills may cause geological and environmental

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 08, August - 2017

imbalance. The environmental impacts on 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.

ACKNOWLEDGEMENT

The authors convey their sincere thanks to CSIR-IMMT, Bhubaneswar, India, for providing their lab to produce fly-ash aggregate for this research and also NALCO for providing Fly-ash. The authors also like to thank the Dean of School of Civil Engineering of KIIT University for the facilities provided to carry out the experiments.

REFERENCES:

[1] Biswaroop Ghosh, Dr.A.K.Rath "fly-ash pellets: a replacement of coarse aggregate" International Journal of Technical Research and Applications Volume 5, Issue 2 (March - April 2017), PP. 3-6
[2] Gokhan Banjkal, Ata Gurhan Doren. (2000). "Utilisation of fly ash by pelletization process", application of areas and research results, resources, conservation and recycling 30 (2000), PP 59 to 77.
[3] IS 10262-1982 recommended guide lines for concrete mix design
[4] Gao Li-Xiang, Yao Yan and Wang Ling. "Research on sintered fly ash aggregate of high strength and low absorption of water".
[5] Rajamani N.P, Annie peter J. , Sabitha D. and Gopalakrishanan S. (2004). " Studies on development on bonded fly ash aggregates for use as coarse aggregate in structural grade concretes" New building materials and construction world
[6] Rajamani N.P and Ambily P.S. (2006). "Selection of mortar for light weight aggregate concrete made with fly ash based aggregate", New building materials and construction world journal June 2006(pp : 80 to 88) August 2006.
[7] Wu, H.C., and Sun , P., 2007, "New Building Materials from Fly Ash-based Lightweight Inorganic Polymer,
[8] International Journal of Construction and Building Materials", No.1,(21), pp.211–217.
[9] Sukesh,C., Bala Krishna ,K., Teja, L.S., and Rao S.K., 2013, "Partial Replacement of Sand with Quarry Dust in Concrete", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN, 2, (6),pp. 2278-3075.
[10] Niyazi Ugur Kockal, Turan Ozturan, 2011, "Durability of lightweight Concretes with Lightweight Fly Ash Aggregates, Construction and Building Materials", 25, pp. 1430–1438.
[11] Manikandan, R., Ramamurthy, K., 2008, "Effect of Curing Method on Characteristics of Cold Bonded Fly Ash Aggregates, Cement & Concrete Composites", 30, pp. 848–853.
[12] Priyadharshiny, Ganesh, G.M., and Santhi, A.S., 2011, "Experimental Study on Cold Bonded Fly Ash Aggregates", International journal of Civil and Structural Engineering, (2), pp.493-501.
[13] IS: 12269-1987, Bureau of Indian standards, New Delhi, India, 53 grade Ordinary Portland Cement-specification.
[14] IS: 383-1970, Bureau of Indian standards, New Delhi, India, Specifications for Coarse and fine aggregates.
[15] Harikrishnan, K.I., Ramamurthy,k., 2006, "Influence of Pelletization Process on the Properties of Fly Ash Aggregates". Waste Manag, 26, pp.846-852.
[16] Bijen JMJM 1986, "Manufacturing Processes of Artificial Lightweight Aggregates from Fly Ash", Int. J. Cement Composite, Lightweight concrete, 8(3), pp.191-199.
[17] Manikandan, R., Ramamurthy, K., 2007, "Influence of Fineness of Fly Ash on the Aggregate Pelletization Process", Cement & Concrete Composites, 29, pp.456– 464.
[18] IS: 2386-1963, Methods of test for aggregates for concrete, pp.1-8.