Performance study of lightweight artificial aggregate concrete by utilizing industrial waste - A Review

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Abstract: Many research has been conducted in manufacturing aggregates artificially using industrial waste. Artificial aggregates serve two purposes (i.e.) one reducing the weight of concrete, and another is overcoming the disposal problem of industrial waste. Weight of coarse aggregate increases the density of concrete and thereby increasing the overall self weight of the structure. The self weight of the structure very much influences seismic loads. Hence light weight concrete can be achieved by using artificial aggregates in the concrete. Disposal of industrial waste creates many issues in the environment. So utilization of these waste in concrete will overcome this environmental problems. This paper reviews the manufacture and performance of artificial aggregates by utilizing industrial waste such as flyash, GGBS, pond ash, and others.

***IndexTerms* -Artificial aggregates, Cold bonded, Environment, Light weight concrete, Pelletizer**

I. INTRODUCTION

Artificial aggregates are manufactured using many industrial wastes such as flyash, quarry dust, bottom ash, modified waste expanded polystryene, crushed fire brick, etc. The density of concrete can be reduced using artificial aggregates prepared by this industrial waste. Environmental pollution occurs due to the disposal of these waste can be avoided. Pelletizer is the most used equipment in manufacturing artificial aggregates. Angle of disc and speed are the key factors which affect the pelletization process.[1-11]. Binders and admixtures improve the pelletization efficiency [5].

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II. REVIEW OF LITERATURE

Erhan Guneyisi et.al compared the durability properties of cold bonded and sintered aggregates in light weight concrete. In cold bonding, the author used fly ash and Portland cement whereas in sintering method, fly ash and bentonite were used. Silica fume of 10% was used in partially replacing cement. Two different water/binder ratio of 0.35 and 0.55 were used. Eight different mixes were arrived and tested for its durability properties. The author observed that silica fume improved the compressive strength of mix. The author performed various durability tests such as water sorpitivity, rapid chloride ion permeability, gas permeability and accelerated corrosion test and concluded that sintered flyash aggregates had performed well than the cold bonded flyash aggregate.

Markus Bernhardt et.al manufactured light weight aggregate using clay and carbon steel fibers (1-2 mm length and 30 µm dia). Pellets of diameter ranging from 1.8 mm to 12 mm were manufactured in a pilot scale rotary kiln. The author also produced the pellets without adding fibers. Eirich mixer was used to mix the raw materials and for homogenization and granulation. These pellets were fired in a rotary kiln with temperatures 1120° C and 1090° C for pellets without and with fiber respectively. The author used XRF, XRD and SEM techniques to study the chemical composition of matrix phase, bulk mineralogy and microstructure respectively. The author studied the effect of pellet size on density, porosity and strength. Solid strength, crushing resistance and toughness was more for a fiber containing pellets and fiber pullout resistance supports the toughening mechanism. 140% increase in crushing resistance and 54% increase in bulk density was observed for a fiber containing aggregates. The author concluded that high strength of concrete could be achieved by incorporating fibers into light weight aggregate.

Job Thomas et.al investigated the properties of cold bonded aggregates made with flyash and quarry dust. Three types of artificial aggregates were manufactured using pelletizer. Angle of pelletizer and speed of pelletizer are 25° and 26 rpm respectively. Artificial aggregates thus prepared are pre-soaked for 24 hours and then utilized in concrete. Work was executed by varying the water-cement ratio (0.35, 0.45, 0.55 and 0.65). Artificial aggregates containing flyash 80% reported higher workability and strength. Its bulk density was found to be 998 kg/m^3 and crushing strength was 2820 N. 38 Mpa strength was achieved using artificial aggregates.

Jingjun Li et. al., investigated the flexural behavior of high performance polypropylene fiber reinforced lightweight aggregate concrete(HPPF) and steel fiber reinforced lightweight aggregate concrete(SF). Flexural toughness was evaluated by ASTM C1609 and JSCE SF-4 standards. LC30 grade mix was used in the study. Fibre volume fraction used in HPPF were 0.5%, 0.7%, 0.9% and 1.1% respectively and for SF , 0.5%, 1, 1.5% and 2.5 % respectively. Compressive strength of SF was more effective than HPFF.

1.1% volume fraction of HPPF and 2% volume fraction of SF was found to be optimal. SF was found to be effective in pre-peak behavior whereas HPPF was effective in post-peak behavior.

S.Geetha et.al prepared artificial aggregates using bottom ash which was collected from a thermal power plant. Artificial aggregates were prepared in pelletizer with 55° angle of tilt and 50 rpm speed of the disc. The author used fractional factorial design to study the factors influencing the pelletization process and efficiency. Binders and admixtures have been used in manufacturing aggregates. Author manufactured artificial aggregates with different moisture content and optimized the dosage for achieving maximum pelletization efficiency. The author concluded that improvisation of pelletization eficiency and reduction in the duration of the pelletization process could be achieved by using $Ca(OH)_2$. Low dosage of high swelling bentonite and cement binders can be used to achieve maximum pelletization efficiency.

Ramazan Demirboga et.al utilized modified waste expanded polystryene aggregates (MEPS) for preparing artificial aggregates. The author determined specific gravity factor for light weight concrete made of MEPS. SGF is given as the ratio of the weight of aggregates to the effective volume of aggregates. Prewetting of aggregates was done before utilizing the aggregate into concrete and this prewetted aggregate consists of retarding action. Two cement dosages of 400 kg/m^3 and 500 kg/m^3 were used in preparing concrete mix. Author arrived SGF as 0.22 and 0.31 for 400 kg/m^3 and for 500 kg/m^3 it was 0.24 and 0.34 respectively.

Mostafa A.M et.al experimented light weight concrete using aggregates made of crushed fire brick, vermiculite and light exfoliated clay aggregate. Author prepared nine concrete mixes by varying the aggregate materials and incorporating linen fibers. Crushed bricks show poor performance concerning slump. Light exfoliated clay aggregate reduced the weight of concrete and its bulk density was found to be 1.34 Kg/L. The author used linen fibers in some mixes and it improved the tensile strength of concrete. Fibers also contributed to impact strength and stiffness. This light weight concrete recorded lower rebound values in rebound hammer test and lower transmission speed in case of ultrasonic pulse velocity test. Physical and mechanical properties of light weight aggregate concrete were also studied using Artificial neural network which predicted the performance of concrete.

Michala Hubertova et.al used expanded clay for preparing artificial aggregate. Author experimented light weight concrete and light weight self compacting concrete. The author studied the durability characteristics of light weight concrete made of artificial aggregates. Author prepared four concrete mixes using and altering the proportions of cement with black coal fly ash, metakaolin, microsilica powder and micronized lime stone. Concrete mixes were exposed to both gaseous and liquid environment. The mix which contains coal fly ash has positive response interms of resistance and durability. The author investigated the compressive strength and found that mix which contains coal fly ash records higher values when compared to other mixes in a gaseous environment.

Vit Cerny et.al studied the properties of high strength light weight concrete using sintered fly ash aggregates. The author used four different types of flyash aggregates for the study. Author prepared sintered artificial aggregates in a horizontal furnace. 8-16 mm pellets were used for the experimental study. The bulk density of 940 kg/m^3 was recorded for one of the types of flyash during the investigation. The first type of flyash recorded higher strength interms of compression. The strength of 55 Mpa can be achieved using this type of artificial aggregates. This method of producing artificial aggregates are ecofriendly and economic.

P. Gomathi et.al studied crushing strength of aggregates prepared with flyash and furnace slag by varying the proportions. Author manufactured artificial aggregates using pelletization technique in which angle of disc and speed are 36° and 55 rpm respectively. Binder was replaced for flyash in three proportions (10%,20% and 30%). 30% replacement records higher strength and it was found to be optimum. Type and percentage of binder, moisture content and duration of the pelletization process have a significant impact on the strength of pellet. The author concluded that higher pelletization duration and small size pellets yield higher strength.

Mehmet Geso˘glu et.al experimented self compacting concrete in which coarse aggregates were partially replaced by artificial aggregates made of Ground granulated blast furnace slag (GGBFS). Author manufactured artificial slag aggregates using cold bonding pelletization technique. Author prepared six different concrete mix by varying the proportions of artificial slag aggregates. The crushing strength of single pellet was determined for the various diameter of pellets. Fly ash was used in preparing the self compacting concrete by partially replacing cement. 60% replacement of coarse aggregates by artificial slag aggregates recorded higher compressive strength. Highest fluid behavior was achieved when using artificial slag aggregates.

III.CONCLUSION

By all these researches, it is clear that the density of concrete can be reduced by implementing artificial aggregates into the concrete. Artificial aggregates are thus helpful in manufacturing light weight concrete and avoiding the disposal of industrial waste. Cost reduction in concrete is achieved by utilising industrial waste in the manufacture of artificial aggregates.

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