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Application of Bed Ash Produced From Captive Power Plant asa Additional of Gypsum In Cement Plant

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Abstract :*A method has been established to utilize the big quantities of ash discharged from coal-fired fluidized-bed combustion boilers as a substitute of gypsum in cement plant. The fluidized-bed boiler has been studied as a result of it will burn fuels like anthracite coal that can't be burnt in fine-grained coal-fired boilers and alternative standard boilers, and since it eliminates the requirement for a flue gas desulfurizing facility. Consequently the disposal of fluidized-bed combustion ash is graduallyworrying, and thus costlier, as a result of tighter legislation on waste management. Temporarily, the excavation of road base material is additionally subject to stricter rules owing to fears of environmental impact. This has caused a shortage of fabric for construction in some areas. It might be helpful if ash from fluidized-bed combustion may well be processed into as a substitute of gypsum in cement plant. Present paper discussed on the conditions needed to yield optimum merchandise and therefore the check results.*

Keywords:Coal ash; Fluidized combustion, bed ash,

I. INTRODUCTION

Intoday'squicklygrowingeconomy, sustainabilityhas becomemajorchallenge & thereforeuse of differentmaterial or waste stream material is turning into terribly important. Natural resources conservation has become a most imperative task now on a daily basis. At Shree Cement Limited, Ras District- Pali, Rajasthan, we are having four AFBC boilers in CPP, CVPL Trichyusing Lignite & F Grade Coal as fuel and generating around 20-30 tonnes of Bed material per day. This bed material may be a waste matter and therefore the plant needs to dump it somewhere. To mitigate this environmental issue and threat of dumping 6000 mt material annually, its acceptable utilization was seen as the solely chance of resolving this issue. This challenge has forced the analysis team to explore the varied choices and within the preliminary investigation supported sieve analysis findings the coarser size distribution of this material, the chance of use it as a substitute of gypsum in cement planthas been opted and additionally investigated. The size fraction analysis confirms that the material is falling beneath the Zone-1 of the IS 383-1970 specification. In the present analysis, compatibility study of bed material generated from our captive station against the gypsum has been explored very well.

II. EXPERIMENTAL

At Shree Cement Limited, Ras District - Pali, R&D workplace has done a series of experiment and test on this bed material, started with comparison by Loss on Ignition determination of natural stream sand and Bed material to the granulometry examination, grading of sand, soundness test and water absorption etc based on the relevant IS standard. The whole exercise has been finished with the aim to explore the compatibility for its usage as replacement of natural fine aggregate.

3.1 chemical properties of Fly Ash

The constituent of fly ash can be classified under two categories, primary constituents includes Silica (SiO_2), Alumina ((Al_2O_3), Ferric Oxide (Fe_2O_3) and a reactive constituent Calcium Oxide (CaO) and secondary constituent includes MgO, Na_2O, K_2O, SO_3 , MnO, TiO_2 and unburnt carbon. The primary constituents varies in their quantity as follows : Silica (25- 60%), Alumina (10-30%) and Ferric Oxide (5-25%). The fly ash consisting of 70% or more of the three, primary constituent and less than 10% of reactive constituent calcium oxide is technically termed as class F fly ash. This fly ash is obtained as a product of burned anthracite or bituminous coal and exhibits pozzolanic properties. The fly ash having 50% or more of the three, primary constituent and 10% or more of reactive calcium oxide then it is termed as class C fly ash. This fly ash is obtained as a product of burned lignite or sub-bituminous coal and exhibits both pozzolanic and hydraulic properties.

Siliceous fly ash is characterised by its immense silicate glass content which has high amount of silica and low reactivity mullite, magnetite and quartz in crystalline form. Siliceous or Alumino-silicate glass is the active component of class F fly ash and class C fly ash (Calcareous fly ash) consist Calcium Alumino-silicate glass, free lime (CaO), Anhydrate ($CaSO_4$), Tricalcium Aluminate and occasionally calcium silicate as active components. Calcium hydroxide and alkali hydroxides released from cement fly ash system has tendency to react with glassy materials of fly ash, this leads to formation of cementitious gel, which is responsible for providing additional strength.

3.2Physical properties of Fly Ash

Physically fly ash particles are characterised by their spherical shape, they are glassy and can be hollow or solid. Hollow and spherical fly ash particles are termed as cenosphere. Fineness is an important characteristic of fly ash that effects its performance in cement concrete. Generally the fineness of the fly ash particle varies between 1 micron to 1mm in size. Fineness of fly ash particle is dependent upon specific surface area of the fly ash which is measured using Blaine's specific area technique. More the specific surface are better will be fineness of particle. Dry and wet sieving is another method employed for measurement of fineness of fly ash particles. The specific gravity of fly ash lies between 1.9 to 2.55.

3.3 Gypsum in cement plant

Gypsum could be a kind of mineral and a hydrous salt in chemical kind. It plays a significant role in compensating the speed of hardening of the cement. It’s wont to management the setting time of cement however if it's in excess it should unsound the cement concrete owing to salt. Gypsum is associate evaporate mineral most ordinarily found in bedded matter deposits in association with sodium chloride, anhydrite, sulphur, calcite, and dolomite. It’s terribly just like Anhydrite. The chemical distinction is that gypsum contains 2 waters and anhydrite is while not water. Gypsum is that the commonest salt mineral.

Gypsum is additional to Portland cement to control the otherwise extreme setting reaction that happens within the presence of water. The gypsum content of cement is expressed in terms of its salt (SO_3) content. Salt could be a promptly determined live of gypsum in cement. Portland cement typically contains around five-hitter gypsum, which is capable or so a pair of 2.1% SO_3. The utmost SO_3 content allowed by AS 3972 Portland and integrated Cements is 3.5%. Further as influencing the setting time, gypsum additionally has associate influence on different properties of cement. A lot of vital of those properties square measure strength, strength development and volume stability. Gypsum additionally influences the grind ability of the cement that is that the grinding energy needed to supply cement.

3.4 Fly ash Analysis

TEST-Blain (minimum 320), Lime reactivity (min 4.5Mpa), Dry shrinkage (max .15), Comparative Strength (Not less than 80%).

	Lime Reactivity	**Dry Shrinkage**	**Comparative Strength**	
Lab Temp. /RH	27°C ± 2 / 65% ± 5	27°C ± 2 / 65% ± 5	27°C ± 2 / 65% ± 5	
Test Specimen	50mm	25/250mm	50mm	
Require Sample	1: 2M: 9 H.Lime: Pozz: Sand 150:300M:1650gm	0.2N :0.8 :3 Pozz: Cement: Sand 60N:240:900gm	0.2N :0.8 :3 Pozz:Cement:Sand 100N:400:1500gm	0.8:3 Cement: Sand 400: 1500gm
Require Water(Table Flow)	70±5% with 10 Drop in 06 Second	100-115% with 25 drop in 15 second	105± 5% with 25 drop in 15 Second	
Age of Testing	10 Day	35 Day	7,28,90 Day	3,7,28 Day
Testing Condition	2 day RH chamber (27°C±2°C&>90%) 8 day environment Cmb. (50±2°C&>90%)	24 hour RH chamber (27°C±2°C&>90%) 6 day water tank- **I** 28 day Environment Chamber (27±2°C& 50%)-**II**	24 hour RH chamber (27°C±2°C&>90%) 7,28,90 day water tank (27±2°C)	24 hour RH chamber 7,28,90 day water tank (27±2°C)
		Dry Shrinkage= II-I	28 day not less than 80% to blank strength	Blank Strength

	M=$\frac{Specific\ gravity of Pozz\ .}{Specific gravity of H\ \ .lime}$	N=$\frac{Specific gravity of Pozz\ \ .}{Specific gravity of Cement}$	N=$\frac{Specific gravity of Pozz\ \ .}{Specific gravity of\ \ Cement}$	

3.5 Strength
Strength, durability, permeability and wear resistance are important properties associated with the concrete. For the purpose of concrete proportioning, structural design, and evaluation of concrete generally strength at the age of 28 is considered. This strength is dependent on water - cement or water - cementitious material ratio [w/c or w/(c+p)]. Net quantity of water required per unit quantity of cement or total cementitious materials determines the strength of concrete, provided the set of materials and conditions remains same. Water absorbed by the aggregates is not included in net water content. Following are the factors that may cause difference in the strength of concrete for a given water- cement (w/c) ratio or water cementitious materials {w/(c+p)} ratio (p indicates pozzolana or supplementary cementitious materials): maximum size of aggregate; grading, surface texture, shape, strength, stiffness of aggregate particles, differences in cement types and sources, air content. Chemical admixtures can also effect the overall strength by affecting the hydration process of cement or by developing cementitious properties.

3.6 Durability
Following factors can deprive the concrete of its serviceability: heating & cooling, wetting & drying, freezing & thawing in cold countries, chemicals, de-icing agents etc. The concrete should be able to endure all such exposure. In order to improve the resistance of concrete against such factors certainspecial ingredients are used such as, low-alkali cement, fly ash, Ground Granulated Blast Furnace (GGBF) slag, and silica fume. For the cases where the concrete is subjected to seawater or sulphate- bearing soil, or aggregate composed of hard minerals and free of excessive soft particles, requires substantial enhancement in resistance to surface abrasion and durability, this can be achieved through use of above special ingredients. Low water-cement or water cementitious materials ratio [w/c or w/(c+p)] increase the life of concrete by reducing the penetration of aggressive liquids.

3.7Specific gravity
Specific gravity of Cement is analysed as per IS 2386- part 3. As a result of its light weight & porous nature, Cement specific gravity was observed within the vary of 1.90 to 2.10 as against of the gypsum, which is 2.40 to 2.80.

3.8 Workability of Concrete:
Spherical in shape, the fly ash particle substantially reduce the requirement of the water content for a given slump. This spherical shape also leads to reduction in friction between the concrete and pump line as well as between the aggregate particles. As a result enhanced workability and improved pump ability of concrete is obtained. Fly ash in concrete results in increase of fineness volume and decrease in the water content of concrete and hence reduces the concrete blending.

Workability and Consistency:
Ability of concrete to be placed, compacted and finished without segregation defines the workability of concrete. The workability is dependent of the following parameters: the grading, particle shape, proportions of aggregate, the quantity & qualities of cement and cementitious materials, the presence of entrained air and chemical admixtures, and the consistency of the mixture. The relative mobility of concrete mixture is called as consistency and is calculated in terms of slumps. The ease of concrete flow during placement depends upon the mobility of mixture which is dependent on the amount of slump. Higher the slump more will be the ease of flow. Consistency is related to workability. The requirement of unit water content for a well proportioned concrete to produce a given amount of slump is affected by various parameters. With increase in the angularity of aggregates and increase in roughness of texture the requirement of water content increases. With entrainment of air the requirement of water content decreases. Water content requirement can be significantly reduced by employing certain water reducing admixture.

3.9 Sulphate attack
Sulphate from the external source and atmosphere has tendency to react with surplus lime present in concrete and forming etrringite, this process is known as sulphate attack. Etrringite cause the destabilisation of the volume and leads to expansion of concrete. Addition of fly ash in concrete provide effective resistance against sulphate attack, as it continuously react with leached out lime to form additional C-S-H gel. The C-S-H gel reduces the permeability and prevents the ingress of sulphate ions by filling the capillary pores of cement paste.

III. ADVANTAGE OF USING FLY ASH IN CEMENT CONCRETE

- Reduced thermal cracking and enhanced soundness of concrete is obtained as a result of reduced heat of hydration.
- Better workability and pump ability of concrete is obtained.
- Concrete strength is increased as a result of conversion of released lime from hydration of OPC to additional binding material.
- Enhanced impermeability is achieved as a result of pore and grain refinement, which takes place due to reaction of fly ash with liberated lime.
- Resistance against penetration of moisture or harmful gases is increased as a result of enhanced impermeability. This also results in better durability.
- Cost of concrete is significantly reduced as the cement requirement is lowered for the same strength due to use of fly ash.

4.1 Environmental benefits of fly ash use in concrete

Fly ash mixed with concrete comes with immense environmental advantages and can be termed as eco-friendly. For producing the same strength fly ash reduces the need of cement considerably and leads to saving of raw materials like coal, limestone etc. involved in cement manufacturing. Cement industries are energy intensive and per tonne of cement production involve emission of about one tonne of CO into atmosphere. Decrease in the requirement of cement leads to energy saving and reduced green house gas emission. Thermal power plants in India use coal which is having a low calorific value and high ash content, producing large quantity of fly ash. These fly ash is either stored or is disposed of at ash pond areas. Creating of such ponds involves acquisition of valuable agricultural land. Utilisation of this fly ash in cement industries can reduce the area requirement for such ponds and can save valuable agriculture land.

4.2 Concrete Mix design

Depending upon the application balance is required between economy, workability, consistency, strength, durability, density and appearance, based on which the concrete proportion is determined. Heat of hydration is also an important parameter taken into consideration before proportioning concrete.

Primary components of cement concrete include cement (OPC / PPC/ Slag), aggregate and water. Secondary cementitious material includes fly ash, silica fumes and chemical admixture. Reduction in early heat of hydration,permeability and increase in strength, résistance to alkali aggregate reaction and sulphate attack, résistance tothe intrusion of aggressive solutions is obtained along with the economy as a result of using fly ash with cement. Chemical admixture can be used to accelerate, retard, improve workability, reduce mixing water requirement, increase strength or alter other properties of the concrete.

IV. CONCLUSION:

Presently the Builders and Construction companies are facing very acute scarcity of natural sand to be used in mass construction works. This has become more evident in metropolis like Delhi and Mumbai where government has already banned the use of natural sand. Hence the utilisation of manufactured sand(crushed sand) was used as an alternative of natural sand. Hence study on the bed ash generated from thermal power plant as an alternate source of natural sand has become possible only after this thorough study and after its use in concrete application also. Soundness test by sodium and magnesium sulphate shows better durability and less erosion. The chemico- physical study of this bed ash has proved that it can be successfully used up to 25-75%of natural sand. The complete study reveals that this bed material of thermal power plant is the better substitute of natural sand and can be successfully utilised as the replacement. These types of innovative works definitely resolve the issues of scarcity of natural river sand and other construction material. This above R&D study can be replicated for the bed ash material generated from all CFBC and AFBC types of boilers using any type of fuel in our country. This will definitely solve the full disposal and consumption of this type of material as a replacement of natural sand for construction industries which will definitely have a significant contribution in reduction of cost and show a path for long term sustainability.

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