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STUDIES ON FLY ASH OF CEMENT AND THERE HARMFUL EFFECTS

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***ABSTRACT**:-* India is the second largest cement producer in the world after China. India produced 280 million tonnes of cement in the year 2014, with an expected annual growth of approximately 8% to 10% annually in the coming years. As the pressure on the industry is expected to continue to grow, the prices of cement have been rising constantly due to increasing demand and costs of raw materials. Being relatively new, most of the cement plants in India utilise state-of-the-art technologies that are energy and resource efficient. It has been projected that the production of cement in India is expected to reach 550 MT by 2020, and thus, further improvements in these efficiencies are required. As the production of cement increases, the emissions are also expected to increase proportionally, unless a change in the cement production technology or cement composition takes place. Supplementary cementitious materials such as fly ash offer the most promising means of reducing these emissions.

KEYWORDS:- Fly ash, cement and India.

INTRODUCTION:-

Concrete is the most used construction material in the world. Cement is the main binding material in concrete. Over the past 3 decades, the production of cement has grown rapidly all over the world. The cement production in India is expected to grow three-folds by 2050 (WBCSD-IEA 2006). However, cement production has major environmental issues that are of concern worldwide (Barcelo et al. 2014; Davidovits 1994). For every one tonne of clinker manufactured, approximately one tonne of CO2 is released to the atmosphere (Benhelal et al. 2013), which contributes almost 5-7% of global anthropogenic carbon dioxide emissions. In the manufacturing process of cement, the main sources of gas emissions are combustion of fuels and decomposition of CaCO3 to CaO and CO2. Supplementary cementitious materials are used to partially replace clinker, which eventually reduces the harmful emissions.

Pulverised fuel ash extracted from flue gases by electrostatic precipitators or cyclone separators of a coal-fired thermal power plant is known as fly ash and the coarse ash particles that are too heavy to fly with the flue gases and settle in the boiler are known as bottom ash. While bottom ash has coarse and crystalline particles, fly ash is usually as fine as cement and consists of glassy spherical particles as well as residues of quartz, mullite, hematite, magnetite, char and other crystalline phases formed during cooling. The glassy and amorphous particles of fly ash are known to be reactive in the alkaline conditions offered by cement pastes. In India, almost 70% of the total electricity generation is from coal based thermal power plants (CEA 2015). The coal used in India has a higher ash content of about 35-40%, which produces more quantity of fly ash during combustion of coal in electricity generation (Haque 2013). The energy consumption and CO2 emissions associated with the manufacturing of cement can be reduced when fly ash is used as a partial replacement of clinker. This, at the same time, allows the productive use of an industrial by-product, which would otherwise have ended in landfills. The utilization of fly ash as cement replacement material in concrete or as an additive has many benefits from economical, technical and environmental points of view. The cost of fly ash is much lower than cement, approximately Rs. 300 per tonne of fly ash compared to Rs. 6000 per tonne of cement. Inclusion of fly ashes improves the workability of concrete by reducing segregation and bleeding (Thomas 2007); it also improves resistance to corrosion of reinforcing steel and chemicals by lowering the permeability of concrete (Bouzoubaa et al. 2001; Jiang et al. 2004; Malhotra 1990; Plowman and Cabrera 1996). Except in regions experiencing freeze thaw cycles (Valenza and Scherer 2007), which are not common in India, the use of fly ash has also been associated with the improvement in the long term performance of concrete (Siddique 2004). The use of fly ash is known to result in three main advantages: 1) use of low cost raw materials, 2) conservation of natural resources and 3) the elimination of wastes (Cheerarot and Jaturapitakkul 2004). It can be said that fly ash is not a waste and is a valuable resource material (Kumar et al. 2005).

MATERIALS AND METHODS:-

Fly ash consists primarily of oxides of silicon, aluminum iron and calcium. Magnesium, potassium, sodium, titanium, and sulfur are also present to a lesser degree. When used as a mineral admixture in concrete, fly ash is classified as either Class C or Class F ash based on its chemical composition. Ordinary Portland cement (OPC) is made by heating a mixture of calcareous and siliceous minerals like limestone and clay at a temperature of around 1450°C. Nodules of clinker are produced as a result of partial fusion reactions, after which, the clinker is mixed with 3% to 5% of calcium sulphate and ground finely to make cement. Calcium sulphate, commonly in the form of gypsum (CaSO4.2H2O), is added to control the rate of setting and to influence strength development. Clinker is mainly composed of the combined oxides of calcium, silicon, aluminium and iron. The chemical reactions in the cement kiln lead to the formation of the crystalline phases of Portland cement, viz. tricalcium silicate (3CaO.SiO2), dicalcium silicate (2CaO.SiO2), tricalcium aluminate (3CaO.Al2O3) and tetra-calcium alumina-ferrite (4CaO.Al2O3.Fe2O3). The names of these phases are abbreviated as C3S, C2S, C3A and C4AF where C stands for CaO, S for SiO2, A for Al2O3 and F for Fe2O3. In clinker, these phases contain impurities and are commonly referred to as alite, belite, aluminate and ferrite respectively. Alite typically constitutes 50-70%, belite 15-30%, aluminate 5-10% and ferrite 5- 15% of the weight of cement (Taylor 1997). Indian cements are known to contain less alite and lower calcium content than cements elsewhere. Gypsum is abbreviated as C$H2 where $ is sulfate and H is water. The process of reaction of cement with water is known as hydration. In the presence of water, silicates and aluminates of Portland cement form products of hydration that occupy more space than the reactants, leading to the hardening of cement.

DISCUSSION AND CONCLUSION:-

Fly ash is the major solid waste product and also a particulate pollutant derived from the combustion of cement plants. The pollutants when released into the environment, affects vegetation directly or indirectly. Disposal of flyash will continue to be one of the major national problems. However, the research and development units are active and are trying to innovate methods to reduce flyash pollution with sophisticated techniques like ammonia prevention technology (not described yet in their reports). A lot of emphasis is being laid on the biological and non-biological utilization of flyash. As the physico-chemical properties of flyash depends on the type and nature of cement, its special effect with respect to the particular affected areas, especially on the vegetation, is a matter of concern for the environment research explorers. Finer fly ashes tend to have a higher amorphous content. Reduction of particle sizes of a fly ash using air-classification can also increase its amorphous content. The calorimetry and chemical shrinkage results show that the fly ashes can have a significant effect on the rate of hydration of cement. While fly ashes mostly prolong the induction period, finer fly ashes can increase the rate of hydration during the acceleration period. When ash is disposed in dry landfills or wet ponds, there are associated environmental effects. Inhalation or ingestion of the toxins in fly ash can have impacts on the nervous system, causing cognitive defects, developmental delays, and behavioral problems while also increasing a person's chance of developing lung disease, kidney disease, and gastrointestinal illness.

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