

## **Effect of cement replacement by Silica fume and fly ash**

Earlier notion of using high amounts of cement for concrete has now changed on favour of increased use of high amounts of mineral admixtures and super plasticizers with reduced amounts of cement and water in the concrete mixtures. Energy plays a crucial role in growth of developing countries, like India. In context of low availability of nonrecoverable energy sources coupled with requirements of large quantities of energy to materials like cement, steel etc., the importance of industrial wastes as building materials cannot be underestimated. In India about 110 million tones of fly ash has been produced by 68 major thermal power stations and are likely to be doubled within next 10 years. It has been a published fact from research that waste materials like fly ash; silica fume etc, through their use as construction materials can be converted into meaningful wealth.

Also, a partial replacement of cement with fly ash is desirable, and indeed essential due to a variety of technical, economical and ecological reasons. Researchers have reported that silica fume smaller in size and round shape fills the voids between the coarser cement particles which may be otherwise occupied with water. A properly proportional fly ash and silica fume in concrete mix improves properties of the concrete that may not be achievable through the use of Portland cement alone. The resulting concrete mix becomes strong, durable and economical and also eco-friendly as it utilizes an ecological hazardous material.

### **MATERIALS USED – SPECIFICATIONS**

1. Ordinary Portland Cement (OPC), 53 Grade.
2. Silica fume (silicon,  $\text{SiO}_2$  63.1%) as mineral admixture (MA) in dry densified form obtained from ELKEM INDIA Pvt.Ltd., Mumbai.
3. Super plasticizer (chemical admixture) based on Sulphonated Napthalene Formaldehyde-CONPLAST SP 430.
4. Locally available graded aggregate of nominal size 12.5 mm with specific gravity 2.68 and fineness modulus, 5.08 for coarse aggregate (CA).
5. Locally available river sand conforming to Grading Zone II with specific gravity 2.58 and fineness modulus 2.54 for fine aggregate (FA).
6. Water: potable water was used for mixing concrete.
7. Fly ash from Vijayawada thermal power station, Vijayawada, AP, is used.

### **CHEMISTRY OF FLYASH AND SILICA FUME**

The fly ash in concrete makes efficient use of product of hydration of cement such as calcium hydroxide (C-H) which is otherwise a source of weakness in

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normal cement concrete converts it into denser and stronger C-S-H compounds by pozzolanic reaction. The heat generated during hydration initiates the pozzolanic reaction of fly ash. Silica fume is a by-product of silicon or Ferro-Silica industry and is 100 times finer than cement. It consists of amorphous silica and has high reactivity towards lime. The replacement level of silica fume is generally low at about 10%. When SF is used in concrete mix, its introduction affects the physical arrangement of the system, particularly near the aggregate surface where porosity exists. Silica fume starts reacting at the early stage of hydration process. The pozzolanic action of silica fume reduces substantially the quantity and size of "CH" crystals in hydrated cement paste. This phenomenon along with low W/C ratio reduces the thickness of transition zones and thus the preferential orientation of CH crystals is considerably reduced. All these result in more uniform, stronger transition zone potential of micro cracking.