Fly Ash in Civil Construction

It was an usual scorching summer day and I was to collect and despatch a few bags of fly ash for detailed testing in an off-site laboratory. It was an area where the mercury was habituated in fumbling around the 50¤C mark, especially, during the pinnacle of the summer season. Sweating happily under the glaring disk up in the sky I played my sweet (or rather, sweat) little part that I was supposed to.

Incidentally, that happened to be the first rendezvous of this author with this otherwise rather uninteresting material which, on the other hand, is turning out to be growingly useful by the years. Until then, whatever idea I had on fly ash was all theoritical.

That was when I was engaged in a thermal power project in the inspection of civil construction and quality control domains several years back. Thermal power plants can be gas based as well, but only the coal based (coal fired) thermal power plants generate fly ash as a by-product or residue. Like gas based thermal power plants use natural gas as their fuel to produce electricity, the coal based thermal power plants burn coal for the same purpose.

Plenty of ash is continuously generated due to the incessant combustion of coal during the process of generation of electricity in such power plants. Many of these ash particles get mixed up with other waste gases generated during the process. In earlier days these waste gases along with the ash particles were used to be released into the atmosphere at high altitudes through tall exhaust chimneys. In the course of time though, it was realised that the ash particles present in the exhaust gases were actually serious environmental hazard. So much so that sooner or later releasing of these particles into the atmosphere had to be banned by most countries of the world.

Thus, the need for expunging these burnt coal ash particles from the exhaust gases before releasing the gases into the air became of utmost importance. This entailed the introduction of a particle filtration system that could isolate these particles from the waste gases before sending the gases to the exhaust system (chimneys) for eventual disposal.

The most commonly used ash particle removal or filtration system worldwide is the Electrostatic Precipitation (ESP) system. The unit or the equipment that catches and removes these particles from the gases using this mechanism is called the Electrostatic Precipitator Unit or ESP unit. ESP is thus an environmental unit and not a core unit of a coal based thermal power plant. In other words, such a

power plant can function even without an ESP unit in order to produce electricity, yet, because of the mandatory environmental regulations such an unit has become a very important limb of the overall structure of a coal based thermal power plant. The project in which the author worked also had an ESP unit for the same purpose.

The ash so generated in the process, which is collected and separated for further disposal, is known as fly ash. Thus, coal based thermal power plants are single-handedly responsible for the generation of this material worldwide.

With the continuous and ever-increasing generation of fly ash from such sources, the safe and secure disposal of the same too became a growing issue. This is not a substance that can simply be dumped virtually anywhere unlike many other bio-degradable materials. Suitable dumping areas or landfill zones need to be specially identified and earmarked for that purpose. In fact, that is the most commonly adopted practice of disposing fly ash. Yet, the never-ending process of generation and the ever-increasing piles of the substance can very well pose the issue of finding newer and newer areas for disposal.

Fortunately, successful use of fly ash in several important aspects of construction came as a breather to an extent. A very common use of fly ash is it's use as cement replacement in cement concrete. Such cement is called fly as cement.

As to the composition of fly ash, the key constituents are Silica, Alumina, Iron and Lime among others. Since, all kinds of fly ash possess pozzolanic properties it is regarded as a pozzolan.

The term "fly ash" originated in the USA sometime during the first half of the previous century. Later, ASTM classified it into two classes – Type C and Type F. This classification has since been adopted virtually worldwide. Although the nature of fly ash varies substantially depending upon the type of the originating coal, most fly ash suitable for use in construction fall in one of these two classes. Type C fly ash has higher lime content as compared to type-F fly ash. In fact, it is the % of lime (CaO) content that basically determines wheather the fly ash is of type C or F.

As already mentioned, a very common and important use of fly ash is it's use in cement (Portland) concrete where a portion of Portland cement is replaced with fly ash. Replacement of 25 to 30% of Portland cement is quite usual. Carefully designed mixes can achieve much higher % replacement resulting in much economic concrete mixes without compromising the quality parameters.

Fly ash of type F is usually used in cement concrete. Besides, fly ash fulfilling certain criteria only are regarded as suitable for cement replacement in concrete. The most important one is the fineness which is measured by the % retained in a 45 micron sieve.

The purpose of this article is not to go into the minute details of fly ash but to present an overall picture on the material along with some quite relevant technical details. Neither do I have records of test results of fly ash sent by me for testing years back nor have I taken a lot of involvement on testing or use of fly ash. Fly ash specifications are always available in precise details in relevant codes and other technical literature.

Yet, as a good approximation it can be assumed that if less than 30% of a fly ash sample is retained in 45 micron sieve it can be regarded as suitable for use in concrete along with cement. The finer the ash the better it's quality for this purpose. If less than 10% gets retained in the 45 micron sieve, the fly ash is of excellent quality for cement concrete from fineness point of view. 20 to 25% replacement of cement by weight is quite usual in fly ash cement concrete. Well designed mixes can enable 35 to 40% cement replacement. There are also instances where even higher fly ash cement ratios have been successfully achieved resulting in much economy.

After fineness, a couple of other important factors are the particle size distribution and the carbon content in fly ash measured by Loss on Ignition method. Fly ash with Loss on Ignition of less than 4% is regarded as quite suitable for the purpose.

There are plenty of other examples of very effective use of fly ash as well in construction such as fly ash bricks, mass concrete in dams, road embankments, asphalt concrete, pavement concrete, etc, etc. I had some preliminary interaction with a fly ash brick manufacturer on setting up of a small-scale fly ash brick manufacturing machine including studying a little bit of it's mechanism and so on in the same thermal power project I mentioned above. While I don't remember all the details, it is important to know that usually Class C fly ash (ie high lime fly ash) is used for manufacturing of fly ash bricks. That's because fly ash of this category has reasonable cememtitious properties which is good for bricks. Like fly ash cement fly ash bricks too are more economical and can be of equal or even better quality than the commonly used clay bricks.

Class F type fly ash is also quite suitable for embankment construction. Fly ash belonging to both C & F classes have been found suitable for use in asphalt concrete for road construction. There are many other uses of fly ash too in diverse civil construction works. The ones mentioned above are some of the major

utilisations of this growingly useful material that result in consumption of fly ash in bulk – thus mitigating the issue of it's disposal to a great extent.

Source: http://civilconstructionresourcez.wordpress.com/2012/09/12/fly-ash-in-civil-construction/