

Best Practice Guide No.1

The Placing and Compaction of concrete containing PFA / Fly Ash

A Guide for Site Engineers and Foremen

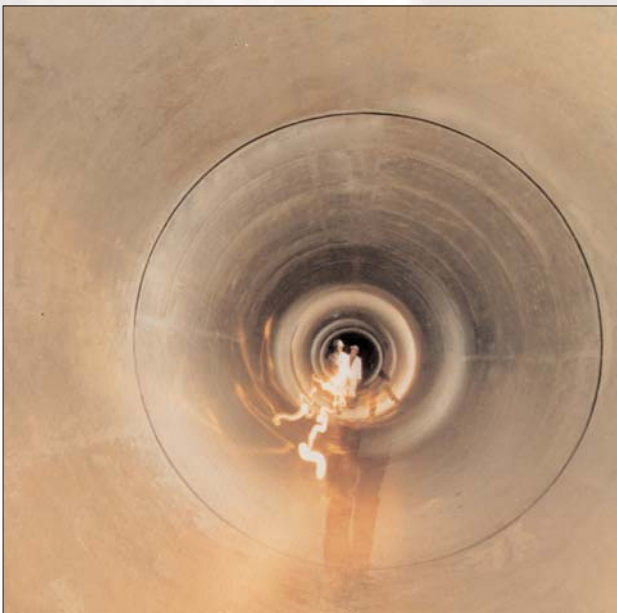
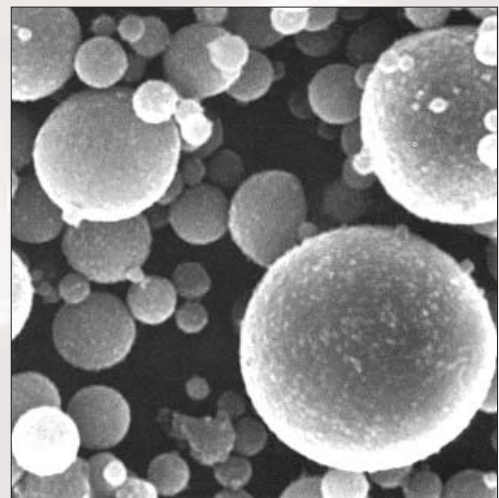
Pulverised fuel ash (PFA) / fly ash may be used as an addition to concrete, which when appropriately designed and placed, will reduce the permeability and improve the long term strength and durability when compared with ordinary Portland cement concrete. The following information is provided to assist Site Engineers and Foremen with achieving the best from concrete made with PFA and to how PFA can be used in all types of concrete structures.

Further information on the specification of PFA for concrete is available from the UKQAA Technical datasheet No.1.0: "Pulverised fuel ash for concrete" and No.1.1: "PFA and Fly Ash as an addition in concrete specified to BS EN206 - Part 1: 2000".

The plastic properties of PFA concrete

PFA is a fine material with spherical particle shape. When added to concrete it produces a more cohesive mix, which looks drier than normal. Usually less fine aggregate will be added to PFA concrete in order to produce the best performance from the mix. The exception is 'Self Compacting Concrete' where the mix is designed to be high in fine material to reduce mix segregation and ensure it is capable of flowing properly. The following are the main factors that you should be aware:

- PFA concrete is often darker than Portland cement only concrete. Colour consistency is similar to other concretes.
- PFA concrete visually appears more cohesive and less workable than Portland cement only concrete. However, do not add water as this will reduce the strength and durability of the concrete. Because of the rounded shape of PFA particles, when vibrated the concrete will become highly mobile and should move readily within shutters.
- PFA reduces the rate of bleeding within concrete. Bleed water that collects at the surface of concrete results in a localised increase in the water/cement ratio, reducing the strength and durability. However, because less water rises with PFA concretes they must be protected from excessive water loss, e.g. in drying windy weather conditions. If the surface of any concrete dries out before sufficient strength has developed early age drying shrinkage cracking may occur. Protection and curing should be carried out earlier to prevent cracking problems.



- PFA concrete normally contains less water than the equivalent Portland Cement concrete. If used with a water reducing admixture, e.g. plasticiser, the effects of reduced rate of bleeding are amplified. If retarding admixtures are used with concrete the risks of early age drying shrinkage cracking is increased.
- In general, the lower the water content of a concrete the less effective is the poker vibrator at compacting it, irrespective of the cementitious type. Because PFA concrete usually has a lower water content the poker should be placed at closer centres for a longer period of time to ensure full compaction of such mixes.

Getting the best from your concrete

PFA is a pozzolana that reacts with the lime produced when Portland Cement is mixed with water. The following should be considered when after the concrete is placed:

- PFA reduces the amount of heat produced in comparison with Portland Cement concretes of the same strength. In thick sections this is a benefit and reduces the risk of thermal cracking. However, for thin sections excessive heat loss may reduce strength, e.g. in cold weather conditions. In cool or cold weather conditions concrete should be protected from heat loss both in the structure and for test cubes. Move test cubes to a heated room at $20 \pm 5\text{C}$ after casting. Insulate your concrete to keep the chemical reactions going.
- When stripping the shutters, if they are removed too early or if the surface of the concrete has been allowed to cool too much, a weak friable layer of concrete will be removed leading to 'scabbing'. Refer to your specification for the minimum stripping times, e.g. BS8110, Highways Specification, etc.
- In hot and drying weather conditions the importance of proper curing regimes cannot be over emphasised. Any exposed surface should not be allowed to dry out for at least 3 days - preferably longer. If kept wet and warm for long periods of time PFA concrete can produce highly durable concrete second to none.
- Test cubes MUST be stripped after 24 hours and stored under water at $20 \pm 5\text{C}$ or preferably at $20 \pm 2\text{C}$. Cubes must be fully compacted using a representative sample of the concrete taken throughout the discharge of the load. Take care not to use excessive amounts of mould oil in cube moulds and ensure the moulds are in good condition - they should be checked annually. Label your cubes so that errors cannot occur but this should NOT be done by scratching the surface of the cube.



(courtesy of Fitzpatrick Contracting Ltd)

The hardened concrete

PFA concrete is very similar in most respects to Portland Cement concrete. The following are a few factors to consider:

- **Colour** - During the first few days and weeks after casting concrete changes in colour as hydration of the cement proceeds. As PFA acts as a pozzolana these reactions will continue for many years in the presence of water. However, as PFA uses excess lime there is a reduced risk of efflorescence from the concrete. Colour is also affected by the absorption of water by formwork materials. Highly absorbent form face materials tends to produce dark concrete. With increasing reuse of formwork lighter concrete will appear as the absorption of the form face reduces because pores are blocked with fine particles and mould oils.
- **Protection** - All concrete should be protected from physical damage. The strength development of all concrete takes time and arisses are easily damaged. Prevent access to the area or provide protection to exposed edges, corners, etc.
- **Making good** - No special procedures are required for PFA concrete. All 'making good' operations should be avoided wherever possible - these are no substitute for care in construction.
- **Durability** - With proper site practice PFA concrete can be exceptionally durable. The Romans used natural pozzolanas, which are similar to PFA, to build the Pantheon in Rome in AD115. There is no reason why concrete on your site shouldn't last 1,000 years!
- **Personal Protective Equipment** - PPE appropriate for normal concreting operations should be worn. Concrete has a high pH value and should be handled with care.
- **Environmental** - Specifying the use of PFA in concrete benefits the environment by replacing manufactured materials with industrial by-products. This reduces the overall CO₂ impacts of the production of the cement and electricity. As all concretes have a high pH value they should be disposed of appropriately.

The information given in this Site Guide is for guidance only. For some conditions and applications differing techniques may be found to be more suitable. For detailed advice contact the UKQAA Technical Officer.

In general usage the term 'fly ash' is used for pulverized coal ash but it can also cover ash from burning other materials. Such 'fly ash' may have significantly differing properties and may not offer the same advantages as ash from burning pulverized coal. UKQAA datasheets only refer to PFA / fly ash produced from the burning of coal in power stations.