

Uniclass L6129	EPIC F122	Oct 02
CI/SfB	Yp4	

Castle Fly Ash is selected to comply with the requirements of BS EN 450 : 1995 Fly Ash for concrete. Definitions, requirements and quality control. Castle Fly Ash can be combined with Castle Ordinary Portland Cement to BS EN 197-1 Type CEM I Class 42,5 to produce a wide range of cementitious products including blended cements and grouting materials.

BS EN 450 Fly Ash is classed as a type II addition, defined in BS EN 206-1 Concrete as a finely divided inorganic pozzolanic or latent hydraulic material used in concrete in order to improve certain properties or to achieve special properties.

Applications

Castle Fly Ash is permitted to be used in concrete according to BS5328 : Part 1 : 1991 Guide to specifying concrete, BS8500 : 2002 Concrete - Complimentary British Standard to BS EN 206-1 and BS8110 : Part 1 : 1985 Structural use of concrete providing that there is enough data on its performance and that its use is properly controlled.

Production

Fly ash, or as it is known in the UK, pulverised-fuel ash (PFA), is a fine particulate mineral residue produced by the firing process in coal burning thermo-electric power stations.

The temperature at combustion is around 1400°C which is above the melting point of most minerals present in the coal. In consequence, fly ash is formed when molten minerals solidify as glassy spheres around a bubble of gas. Physically it consists predominantly of finely divided spherical particles of between 1 and 150 microns.

Approximately 20% of fly ash fuses and agglomerates into larger particles. The selection procedure separates these off as furnace bottom ash or as coarser fly ash which are rejected leaving a uniform fly ash complying with the fineness requirement in BS EN 450.

This selected fly ash is tested in the laboratories of Castle Cement to confirm its compliance with all of the requirements of BS EN 450.

Quality

Castle Fly Ash is a fine grey powder with virtually no odour.

Typical chemical analysis	Average % by weight
SiO ₂	50
Al ₂ O ₃	30
Fe ₂ O ₃	7
CaO	3
MgO	1
K ₂ O	3
Na ₂ O	1
TiO ₂	1
SO ₃	0.5
Cl	0.1
Total alkali (Na ₂ Oaq)	less than 5
Loss on ignition	less than 7
Fineness (residue on 45 microns)	less than 40

Typical properties of fly ash are

- Specific gravity at approximately 2.1 is appreciably lower than those of Portland cement (3.1) or sand (2.7) permitting the formulation of products with lower weight to volume ratios.
- Particle size at between 1 and 150 microns is similar to, or slightly less than, that of Portland cement. The finest fraction improves mix grading, reduces segregation during pumping or injection, reducing voids and increasing durability in the finished works.
- Particle shape is predominantly spherical, improving the workability of concrete and grouts enabling them to be pumped and placed more easily than ones containing cement and sand only.
- Pozzolanic activity of fly ash enables it to combine with the lime liberated from Portland cement during the hydration process producing stable calcium-silicate and aluminate hydrates enhancing durability.

Technical information on the quality of Castle Fly Ash is available to customers on request from Castle's Technical Helpline on 0845 722 7853. Reports of tests providing data on chemistry, strength and fineness are available.

Designing equal strength concrete using fly ash to BS EN 450

A mix design method has been developed at the Concrete Technology Unit (CTU), Dundee University, to build on standard mix design methods (such as BRE Design of normal concrete mixes 2nd ed.) and to take account of fly ash quality to enable the production of equal strength concrete. This is achieved by simple adjustment to either water content, binder content, or both, of the mix which might include the addition of a water-reducing admixture.

The following is an example for mixes incorporating 30% fly ash/70% Portland cement.

Typical mix proportions for 28 day design strength of 35N/mm²

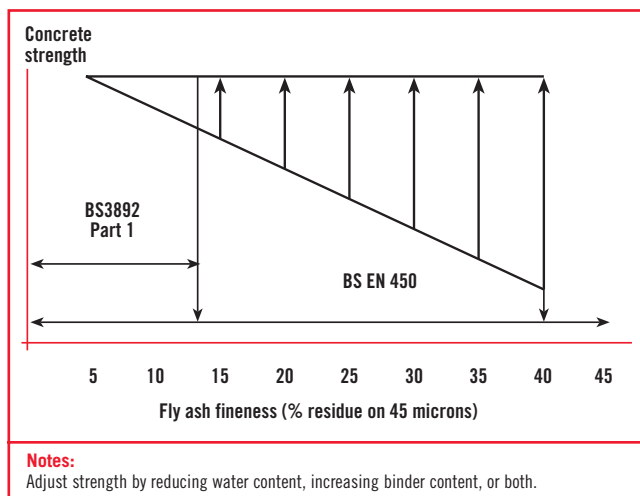
Concrete mix proportions kg/m ³	W/B ratio	Free water	Binder			Aggregate			Slump mm
			PC	Fly ash	Total	Fine	10mm	20mm	
1. Castle Fly Ash Fineness = 3.5% LOI = 3% Normal	0.51	165	230	95	325	715	395	800	70
2. Castle Fly Ash Fineness = 38% LOI = 3.5% Water adjusted	0.47	155	230	95	325	715	410	810	60
Binder adjusted	0.47	165	245	105	350	715	370	740	65

Durability of equal strength fly ash concrete

The Dundee University CTU project demonstrated that concrete mixes of equal strength produced with fly ash quality varying within the BS EN 450 range possessed similar durability properties in terms of chloride diffusion, carbonation rate, sulfate resistance, abrasion resistance, permeability and freeze/thaw resistance. Thus the durability provisions for concrete to BS5328 can be applied to concretes containing fly ash to BS EN 450.

The results validate the use of fly ash to BS EN 450 and the equivalent concrete performance option for durability in BS EN 206. Other work undertaken by the CTU has demonstrated that equivalence extends to engineering properties, including modulus of elasticity, creep and shrinkage, at equal strength using BS EN 450 Fly Ash.

The implications for the limits on fly ash fineness, (<10% variation on the declared mean), for control of concrete quality have been demonstrated by the CTU to result in variations in strength of approximately 3 N/mm². Further to the relationship to establish equivalent design strength shown earlier this can be extended over the BS EN 450 Fly Ash full fineness range as shown below:



Notes:

Adjust strength by reducing water content, increasing binder content, or both.

Admixtures

Admixtures can be used to extend the properties of Castle Fly Ash concretes, mortars and grouts. Trial mixes should be made to establish their compatibility and optimum dosage.

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