

Product information

Trojan Range of Blended Cement

Uniclass L621	EPIC F211
C/S/B	Eq2
November 2004	

Durability

Trojan concretes can offer much improved durability characteristics when used correctly. In general, durability performance of Trojan cement concrete exceeds that of plain Portland cement concrete. The following illustrates some of its major advantages.



The Ayr Pumping Station. Photo courtesy of West of Scotland Water

Sulfate Resistance Including Thaumasite Sulfate Attack

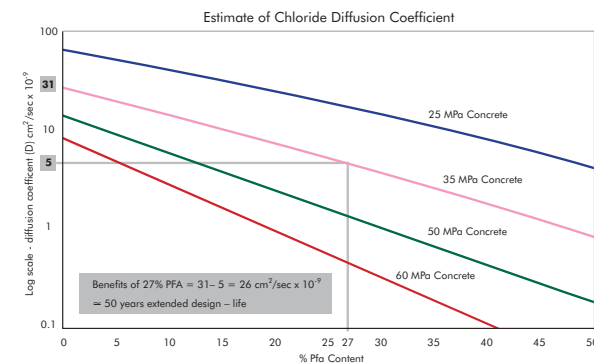
Using Trojan Cement is an ideal way of providing sulfate resistance to concrete, including Thaumasite Sulfate attack. Trojan Cement can be used in all classes of sulfate conditions apart from class DC-4M and the current recommendations given by the BRE are summarised in the chart below.

Chemical Class	Cement Group	Concrete Requirements		Class which Trojan blended cements comply with
		Minimum cement content Kg/m	Maximum water /cement ratio	
DC-1	1, 2, 3	–	–	✓
DC-2	1	340	0.50	✓
	2, 3	300	0.55	
DC-2z	1, 2, 3	300	0.55	✓
	2a	400	0.40	
DC-3	2b, 3	380	0.45	✓
	2, 3	340	0.50	
DC-3z	1, 2, 3	340	0.50	✓
	2a	400	0.35	
DC-4	2b, 3	400	0.40	✓
	2, 3	380	0.45	
	3	380	0.45	
DC-4z	1, 2, 3	380	0.45	✓
	2b, 3	400	0.40	
DC-4M	2b, 3	400	0.40	✗
	3	380	0.45	

Please see current BRE Digest for full concrete requirements
Trojan Cements comply with cement groups 1, 2 and 2a

Chloride Ingress

The correct use of Trojan Cement can reduce chloride ingress by 50% to 90%. In the marine environment where sulfates are additionally present, the use of Trojan blended cements, in place of sulfate resisting Portland cement, is particularly advantageous.

**Alkali-silica Reaction**

Trojan Cement can be effective in reducing the risk of ASR in cases where aggregates cannot be classified as non-reactive. Guidelines are available from the Concrete Society and further information can be obtained through ScotAsh.

Colour

Pfa tends to be slightly darker than Portland cement concrete and the advice of ScotAsh should be sought for the use of blended cement in fair-faced concrete.



Peterhead Repowering Project. Photo courtesy of Siemens Power Generation

Product information**Trojan Range of Blended Cements****Description**

Trojan Cements are blends of quality-controlled pulverized fuel ash (pfa), also known as fly ash and Portland cement. The primary product is Trojan T27 (the 27 defines the percentage of pfa within the total cement) though Trojan blended cements can include up to 55% pfa, subject to the requirements of the customer.

The burning of pulverised coal to generate electricity produces the fly ash. The ash within the coal melts and solidifies in flight as rounded glassy particles which have pozzolanic properties i.e. they have the ability to react with lime released by the hydrating Portland cement to produce cementitious hydrates.

The cement is supplied from Lafarge Cement UK's Dunbar Works in East Lothian. Close co-operation takes place to ensure that the physical and chemical properties of the cement complement those of the fly ash.

Portland fly ash cements are widely attributed to improve the performance of concrete in terms of workability, lower heat of hydration in mass pours and enhanced long-term durability and strength.

Specification

Trojan Cement meets the requirements of BS EN 197-1 for CEM II A/B-V and CEM IV A/B cements. Cements of the CEM II A/B-V type can have up to 35% fly ash (expressed as a percentage of the cement nucleus ie, Portland cement clinker and fly ash, excluding gypsum). This type of cement was previously covered by BS 6588, which will be withdrawn on 1st April 2002. Until then both standards will co-exist. CEM IV/B permits up to 55% fly ash (as % of nucleus) provided mortar strengths meet the requirements of strength class 32.5.

Trojan Cement also complies with BS 6610, which will not be immediately covered under the BS EN 197 range. BS 6610 allows up to 55% pfa with a strength Class 22.5.

Trojan T27 contains 27% pfa and is designed to optimise performance in terms of workability and long term durability without compromising early strength. In this context, Trojan T27 meets strength class 42.5 N.

An abbreviated description of the cementitious product ranges classified under EN 197-1 is given below.

Cement	BS EN 197-1 notation	Clinker content %	Content of other main constituents %	Withdrawn	
				Withdrawn	To co-exist beyond 1st April 2002
Portland cement	CEM 1	95 – 100	–	BS 12 ¹⁾	BS 4027
Portland cement	CEM II/A-S	80 – 94	6 – 20	–	BS 146 ³⁾
	CEM II/B-S	65 – 79	21 – 35		
Portland – fly ash cement	CEM II/A-V	80 – 94	6 – 20	BS 6588 ¹⁾	–
	CEM II/B-V	65 – 79	21 – 35		
Blastfurnace cement	CEM III/A	35 – 64	36 – 65	BS 4246 ²⁾	–
	CEM III/B	20 – 34	66 – 80		
	CEM III/A	5 – 19	81 – 95		
Pozzolanic cement	CEM IV/A	65 – 89	11 – 35	–	BS 6610
	CEM IV/B	45 – 64	36 – 55		

Trojan Cement falls into the category's CEM II/A-V, CEM II/B-V and CEM IV

1) These British Standards will be withdrawn on the 1st April 2002.

2) This British Standard will be withdrawn to a time-scale dictated by the revision of BS 146.

3) BS 146 is to be revised to remove any conflict with BS EN 197-1 and to include the current BS 4246 cement.

*Table reproduced with permission of the British Standards Institution under licence number 2000SK/0584.
Complete standards can be obtained from BSI Customer Services, 389 Chiswick High Road, London W4 4AL*

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Trojan Range of Blended Cement

Health & Safety.

Trojan Cement is classified as an irritant and one should avoid contact with the skin. It is recommended that Personal Protective Equipment includes eye protection, hand and skin protection and dust masks. First Aid Treatment should involve immediately washing/bathing the affected area with water. Further details are included in the Health and Safety Information Sheet on Trojan Cementitious Products.

Quality Assurance

ScotAsh products are manufactured under a total Quality Management System (QMS) which complies with the requirements of BS EN ISO 9002:1994. The QMS is registered and audited by BSI.

Trojan T27 cement is Kitemarked under the BSI Kitemark Registration Scheme and will be CE marked as meeting the requirements of BS EN 197-1.

Applications

Chemically, fly ash is similar to Portland cement being made up of the same basic oxides, but in differing proportions and mineralogy. Fly ash is able to react with lime liberated by Portland cement hydration to form additional cementitious products. Like Portland cement, proper curing is important in order to achieve the full benefits of Trojan blended fly ash cements. Blended fly ash cements can be used in virtually any application where Portland cement can be used.

Factory blended cements are advantageous because:

- No mixer blending is required as factory blending ensures complete homogenisation.
- No additional silo capacity is required at the concrete plant.

Typical examples of its use are given in the table below.

Recommended Construction Uses of Fly Ash Blended Cements	
Excellent	For potentially alkali-reactive aggregate For mass concrete sections For effluent treatment plants In the marine environment For pumped concrete For high quality finishes In sulfate-bearing environments In chloride-bearing environments For high strength applications
Satisfactory	For air-entrained concrete For thin sections For cold weather
Use with care	In high early strength applications

For general-purpose applications, Trojan containing between 21% and 35% fly ash (EN 197-1 CEM II/B-V) is most suitable. Deciding on the actual proportions of pfa depends on many factors, such as:

- Cement content
- Placing method
- Strength requirements
- Durability requirements

An overriding factor is often defined by durability requirements. Trojan 27 should meet asr and sulfate resisting requirements.

Note that special care should be exercised if blended cements containing different amounts of fly ash are to be used in adjacent sections, or alongside plain Portland cement concrete, as there may be visible differences in colour.

Fresh Concrete Properties*Performance*

Pfa imparts physical as well as chemical benefits when blended with cement as in Trojan. Its ultrafine nature leads to improved rheology, reduced bleeding and will normally demand less water thus making the concrete more thixotropic. It will also appear to be 'drier' than plain Portland cement concrete and care should therefore be exercised during mixing to prevent excess water being used.

Pumpability is greatly increased by the use of blended cement and it is often possible to pump mixes directly without altering the fine aggregate proportion.

The finish of blended cement has been noted as being particularly good and this property has been put to good use in the construction industry.

Bleeding of concrete is a common problem especially due to grading of sands. When Trojan Cement is used, the higher content of fine material and reduced water demand results in a more cohesive mix. This results in concrete which has a reduced rate of bleeding.

Mix Design

When using Trojan Cement, normal mix design procedures may be used providing account is taken of its unique properties.

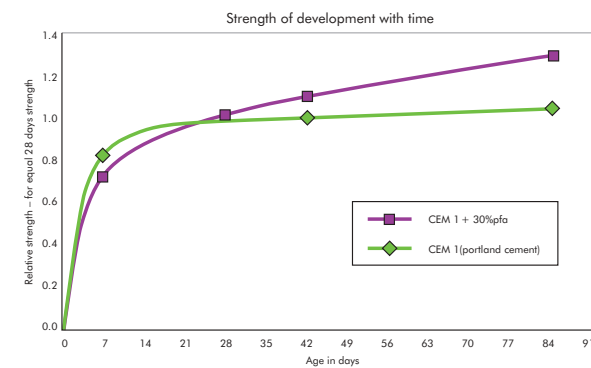
Concrete can be produced by directly replacing the Portland cement with Trojan Cement, although this may lead to a reduction in the early strength. Trojan cement can, however, be designed to meet specific strength criteria at a particular age. Advice on design can be obtained from ScotAsh.

Admixtures

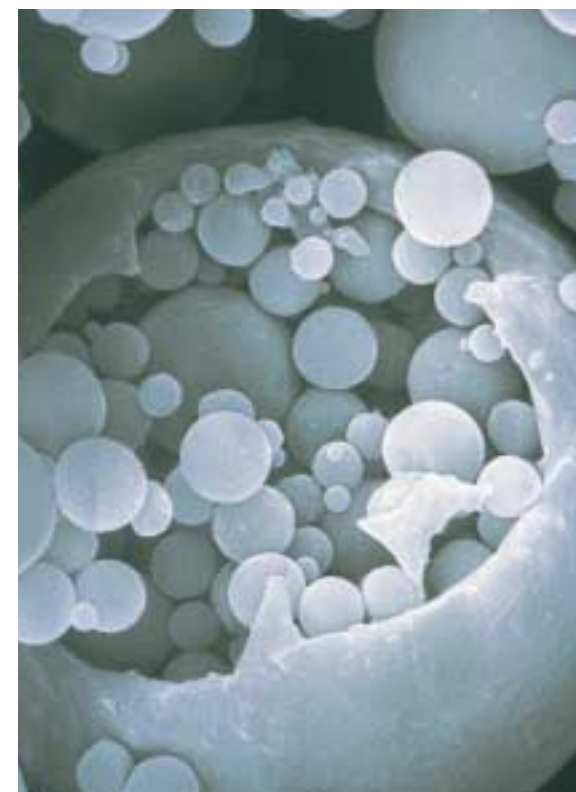
Normal admixtures can be used with blended cements but many manufacturers do supply specially tailored chemicals for the finer particle size of fly ash used in Trojan blended cements.

Hardened Concrete Properties*Strength Development*

The typical strength development of Trojan concrete (Trojan cement strength class 42.5N) compared with a plain Portland cement concrete is shown below. Both are designed for equal 28-day strength. The early strength of Trojan concrete may be slightly lower than that of plain PC concrete designed to give the same 28 day strength and the strength reduction is more pronounced in cold weather, particularly in thin sections. The potential for long term strength developments is considerably higher. ScotAsh should be contacted for further advice where the rate of strength development is of concern.



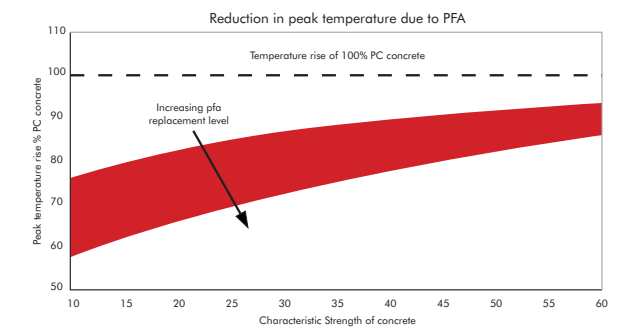
Micrograph of PFA



Small Isles Ferry Scheme. Photo courtesy of Construction Centre Group Limited

Heat of Hydration

One of the main uses to which fly ash blended cements have been put is in controlling the heat of hydration. Reductions in heat generated can be of the order of 20-30%.

*Drying Shrinkage*

The use of pfa in concrete will normally reduce shrinkage.

Creep

Due to the long term strength gain of pfa concrete, creep is significantly reduced compared to PC concrete.

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