INFORMATION SHEET

CEMENT

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Lafarge CEMBlend CEM III/A Cement

Properties and applications

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This document summarises the general properties and applications of Lafarge CEMBlend CEM III/A cement and is intended to be read in conjunction with the Lafarge cement product datasheet. However, it is not exhaustive and for more detailed advice, or where the properties of concrete are critical, specialist publications should be consulted.

For Health and Safety information please refer to the Lafarge Health and Safety datasheet.

1 Description

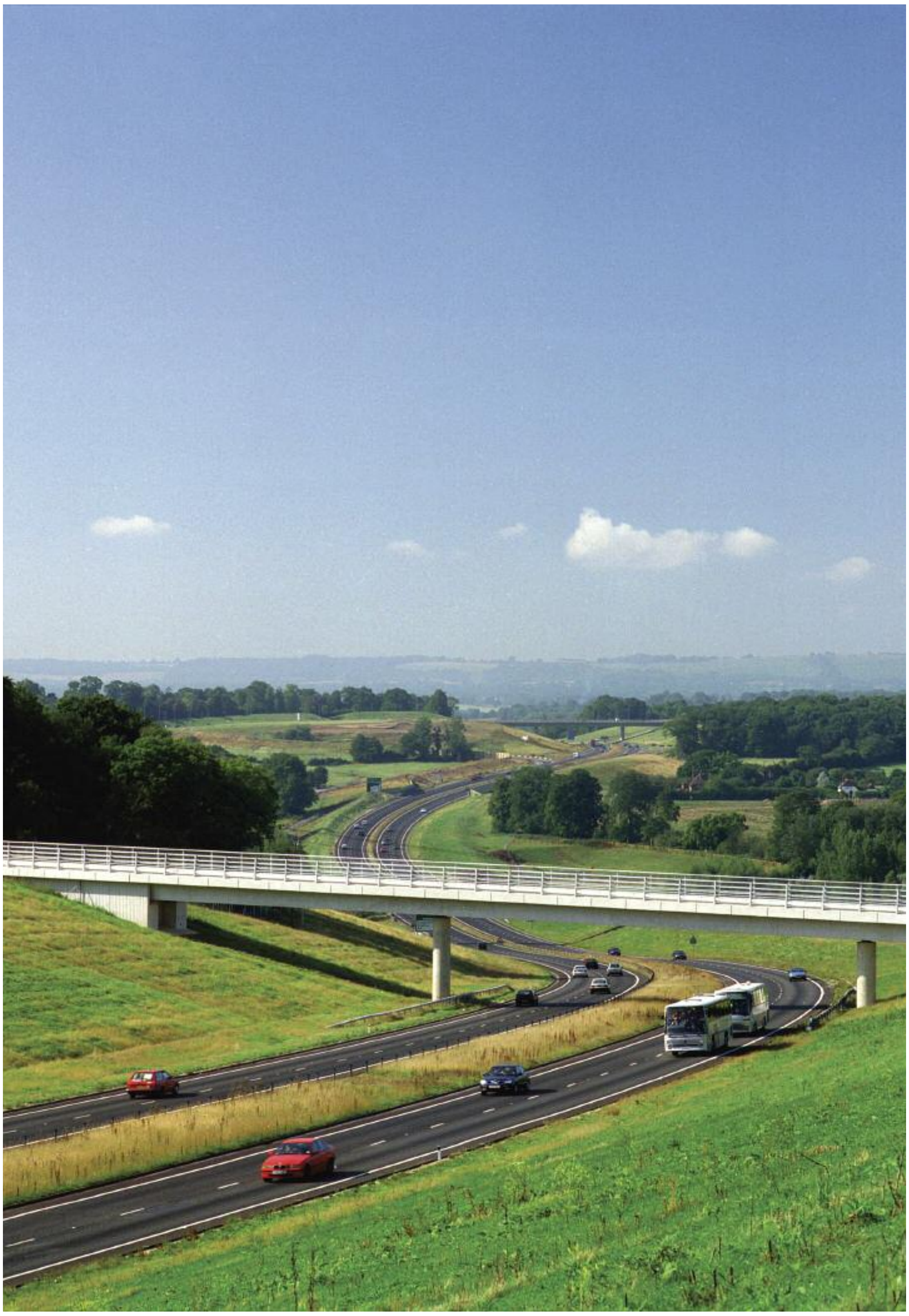
Lafarge CEMBlend CEM III/A is a bulk Blastfurnace cement. This type of cement is designated in a British Standard for cement (BS EN 197-4[(1)]) as:

BS EN 197-4: CEM III/A 42,5L

This designation covers cement containing between 35 and 64% Portland cement clinker, 36 –65% blastfurnace slag and 0-5% minor additional constituents.

Lafarge cement CEM III/A contains a minimum of 50% blastfurnace slag and is cement strength class 42,5 with low (L) early strength development (as would be expected for cements or mixer combinations containing this amount of blastfurnace slag).

CEM III/A is manufactured by controlled blending of the various constituents in such a way as to produce a homogeneous product. It is subject to the same rigorous production control as all BS EN 197 cements and is subject to independent third-party verification and carries a CE Mark.



2 Properties

The properties of CEM III/A are very similar to those of conventional Portland cement (CEM I), but there are some differences that need to be recognised.

2.1 Fresh concrete

At the same cement content, concrete containing CEM III/A will have a slightly reduced water demand and hence the slump at a given water/cement ratio will generally be slightly higher than for a Portland cement concrete.

At constant slump however, the concrete will appear to be slightly less cohesive and bleeding may be increased. The rate of slump loss is also slower.

Perhaps the most noticeable feature of concrete containing CEM III/A is that it will appear lighter in colour than Portland cement concrete.

The setting time of CEM III/A concrete will be increased by up to 90 minutes, this may be even more pronounced in cold weather. Whilst this can be advantageous in large concrete pours, it may be more critical in other applications such as power floated floors.

2.2 Hardened concrete

The strength development of CEM III/A concrete is slower at early ages (less than 7 days) than for Portland cement concrete proportioned to achieve the same 28-day strength. However, the concrete will continue to gain strength after 28 days provided it is properly cured. Because of this strength gain after 28 days, there may be instances where specification of a 56-day strength could be appropriate. This would then lead to possible economies in cement content. Trial mixes are recommended to determine the 28–56 day strength gain.

The *in-situ* strength of CEM III/A concrete, particularly in thick sections, will also often be significantly higher than for Portland cement concrete. It should be noted that the rate of heat generation and peak temperatures generated by CEM III/A concrete are lower than for equivalent Portland cement concrete. This property is often utilised for construction of large concrete elements (see section 5.2)

For concrete of a given strength class ('grade') and similar aggregates, the elastic modulus is slightly higher than Portland cement concrete although creep may be reduced.

3 Durability

3.1 Alkali-Silica Reaction (ASR)

The measures to be taken in order to minimise the risk of ASR are described fully in BRE Digest 330[2]. This document is also referenced by the current British Standard for concrete; BS 8500[3].

The slag content (>50%) of CEM III/A reduces the effective alkali content of the cement and the declared mean alkali content is only 0.40% Na_2O eq (as compared with 0.75% Na_2O eq for Lafarge bulk Portland cements (CEM I)).

In practice, this means that higher cement contents can be used, without increasing the risk of ASR, if CEM III/A is incorporated in concrete compared to using Portland cement (see below). Cement contents are usually limited to a maximum of 550 kg/m^3, except for highly specialised applications.

Aggregate reactivity	Maximum allowable cement content (kg/m³) * Lafarge CEM III/A	Lafarge CEM I
Low	550	550
Normal	550	465
High	550	330

** Assumes no alkali contribution from sources other than the cement*

Consequently, when high cement contents are required to achieve good structural strength, using CEM III/A enables the concrete producer to balance this with minimal risk of ASR.

3.2 Resistance to sulfate attack and aggressive ground

Due to its slag content (>50%), Lafarge CEM III/A qualifies for the '+SR' suffix of BS 8500 and BRE Special Digest 1[4] and is thus designated as: CEM III/A+SR.

CEM III/A is suitable for use in all ground conditions where BS 4027 Sulfate Resisting Portland cement (SRPC)[5] would be used and it is subject to exactly the same limits on minimum cement content and water/cement ratio (see below). It should be noted that whilst the use of CEM III/A in Design Chemical class DC-4m is not permitted, these ground conditions, combining high levels of sulfate with high levels of magnesium, rarely exist in nature.

Design chemical class	Min cement content (kg/m³)*	Max water/cement ratio*
DC-1	-	-
DC-2	320	0.55
DC-2z	320	0.55
DC-3	380	0.40
DC-3z	340	0.50
DC-4	380	0.35
DC-4z	360	0.45
DC-4m	N/A	N/A

** For concrete containing 20mm max size aggregate*

3.3 Resistance to carbonation

For concrete of a given strength class, BS 8500 recognises that for a given concrete strength class, concrete containing cement CEM III/A cement has equivalent resistance to carbonation to concrete containing other cement types in all carbonation classes (XC1, XC2, XC3/4).

3.4 Resistance to chlorides

CEM III/A is inherently more resistant to the ingress of chloride ions than Portland cement. This applies both to chlorides originating in de-icing salts and chlorides from seawater and increases the corrosion protection of the concrete to the embedded reinforcement. In BS 8500, this is recognised by permitting the use of a concrete of a lower strength class for a given cover to reinforcement. The following illustration is extracted from BS 8500-1 Table A.5 for concrete exposed to chloride class XS1 and intended for a working life of at least 100 years.

Nominal cover to reinforcement (mm)	Minimum concrete strength class CEM III/A concrete	CEM I concrete
35+Δc	C 35/45	Not permitted
40+Δc	C 32/40	Not permitted
45+Δc	C 28/35	C 45/55
50+Δc	C 25/30	C/40/50
55+Δc	C 25/30	C 35/45
60+Δc	C 25/30	C 35/45
65+Δc	C 25/30	C 35/45

3.5 Resistance to freezing and thawing

Once again, BS 8500 considers that concrete made with CEM III/A has equivalent resistance to freezing and thawing as concrete of the same grade made with other cement types. For exposure to severe conditions however, air-entrained concrete is always the preferred option.

4 Concrete mix design

Concrete mix design using CEM III/A cement is based on exactly the same principles as for concrete containing Portland cement[6]. There are however, certain slight differences that should be recognised. Trial mixes should always be considered.

4.1 Workability and water content

The smoother surface of the slag particles in CEM III/A slightly reduces the amount of water required to produce a given slump. Typically a water reduction in the region of only 3% can be expected i.e. a reduction from 180 L/m^3 to 175 L/m^3.

The concrete may have a tendency towards higher levels of bleed.

4.2 Strength and cement content

For a given slump and cement content, CEM III/A will achieve a similar 28-day compressive strength to Portland cement. It should be noted that the CEM III/A concrete will however, gain more strength after 28 days than the equivalent Portland cement concrete. The early age strength of concrete containing CEM II/A cement is however, substantially less than for an equivalent CEM I concrete.

4.3 Yield

The typical particle density of CEM III/A (3010 kg/m^3) is slightly lower than that of Portland cement (3150 kg/m^3), consequently the volume occupied by 100 kg of CEM III/A is approximately 5% greater than that occupied by 100 kg of Portland cement. Therefore to maintain concrete yield it would be normal practice to reduce the amount of fine aggregate (sand) in the concrete mix design to compensate for the increased volume of cement. However, in practical terms this is offset by the reduction in water content and in most cases no sand reduction is needed. Care has to be taken with any CEM III/A concrete not to reduce the sand content too much as this can promote bleed, leading to problems with plastic settlement cracking.

4.4 Compatibility with admixtures

CEM III/A is compatible with most commercially available concrete admixtures and is used at similar dosage rates to Portland cement.

5 Applications

Concrete containing Lafarge CEM III/A is appropriate for a wide range of construction applications.

5.1 General construction

Correctly proportioned CEM III/A concrete is suitable for most forms of general construction but proper attention must be paid to the curing process. The extended setting time and slow early strength development of CEM III/A concrete requires extended curing and formwork striking times. This is particularly important for thin concrete elements (where heat loss to the environment is high) and construction in cold weather. Sand runs in formed surfaces may be observed if the concrete mix is not sufficiently cohesive to prevent excessive bleeding.

5.2 Slabs and floors

Slab construction, particularly in hot or windy conditions, requires particular attention. Concrete made with CEM III/A will remain plastic for longer times than Portland cement concrete. The extended setting time increases the time during which plastic cracking can occur[7] and the potentially higher bleed may increase the risk of plastic settlement cracking in particular. Adjusting the concrete mix to increase the fines content, if necessary, (see 4.3) or using finer sand will prevent the mix bleeding excessively, allowing less bleed water to reach the surface. The importance of effective curing of exposed surfaces, as a means of minimising cracks, cannot be over-emphasised.

5.3 Mass concrete/large concrete elements

The low heat evolution of concrete made with CEM III/A is of significant advantage for the construction of mass concrete elements or other large concrete elements. Typically, the standard EN 196-9 heat of hydration (J/kg) of CEM III/A is around 30% lower than for Portland cement. The use of a low heat cement helps to reduce the risk of early-age thermal cracking. For more detailed guidance, consult CIRIA report C 660[8]. The increased potential for bleeding of CEM III/A concrete, if not corrected in the mix design, can lead to an increased risk of plastic settlement cracking ion deep sections.

5.4 Concrete foundations

The reduced heat characteristics discussed above, when combined with the sulfate resisting properties of CEM III/A concrete, make it particularly useful for constructing massive concrete foundations.

5.5 Concrete exposed to seawater

As discussed in section 3.4, concrete made using CEM III/A cement has enhanced resistance to chloride ion penetration and reinforcement corrosion. This gives it advantages for construction of concrete elements exposed to seawater.

5.6 Mortars and screeds

Current standards[9,10] do ***not*** permit the use of CEM III/A in masonry mortars. It may be used in screeds and concrete bases which will subsequently receive flooring[11] but is ***not*** permitted in cementitious wearing screeds (note: concrete made with CEM III/A is permitted in directly finished concrete wearing courses[12]). Attention to proper curing is required for screeds to ensure that full performance is developed.

5.7 Grouts

CEM III/A is suitable for use in most general-purpose grouts, subject to any restrictions in the project specification. However, it should be noted that BS EN 447[13] restricts the cement type in grouts for pre-stressing tendons to Portland cement unless regulations in the place of use permit the use of other EN 197-1 cements.

References

1 Cement – Part 4: *Composition, specifications and conformity criteria for low early strength blastfurnace cements*. BS EN 197-1, 2004: BSI.

2 *Alkali – Silica reaction in concrete: Detailed guidance for new construction*. BRE Digest 330 Part 2, 2004: Building Research Establishment.

3 *Concrete – Complementary British Standard to BS EN 206-1.*

Part 1: *Method of specifying and guidance for the specifier.* BS 8500-1, 2006: BSI.

Part 2: *Specification for constituent materials and concrete.* BS 8500-2, 2006: BSI.

4 *Concrete in aggressive ground*. BRE Special Digest 1, 2005: BSI.

5 *Specification for Sulfate-resisting Portland Cement.* BS 4027, 1996: BSI.

6 *Design of normal concrete mixes* 2nd Edition. 1997: Building Research Establishment.

7 *Non-structural cracks in concrete.* Concrete Society Technical Report 22, 3rd Edn, 1992.

8 P. Bamforth. *Early-age thermal crack control in concrete.* CIRIA report C660, 2007:CIRIA.

9 *Code of practice for use of masonry – Materials and components, design and workmanship.* BS 5628 – 3, 2005: BSI.

10 *Specification for mortar for masonry – Part 1: Masonry mortar.* BS EN 998-1, 2003: BSI.

11 *Screeds, bases and in situ floorings – Concrete bases and cement sand levelling screeds to receive floorings* – Code of practice. BS 8204-1, 2003: BSI.

12 *Screeds, bases and in situ floorings – Concrete wearing surfaces –* Code of practice. BS 8204-2, 2003: BSI.

13 *Grout for pre-stressing tendons - Basic requirements.* BS EN 447, 2007: BSI.

For further information

Technical helpline
Tel: 0845 812 6232
E-mail: info@lafarge.co.uk

Customer services
Tel: 0845 812 6300
E-mail: customerservice@lafarge.co.uk

The information in this datasheet is accurate at the time of printing, but Lafarge Cement UK reserve the right to amend details as part of their product development programme.

LAFARGE CEMENT UK
Portland House
Bickenhill Lane
Solihull, Birmingham
B37 7BQ
Tel. 0845 812 6400
Fax 0845 812 6200
www.lafarge.co.uk

LAFARGE