

# Factory-made Portland-limestone cements (PLC)

## Introduction

Low carbon, factory-made Portland-limestone cements (PLC) have been produced commercially by MPA Cement's Member Companies since the mid-1990s and are available packed and in bulk (see also MPA Fact Sheets 14a and 14b - Modern cements). Parts of the concrete sector may still be unfamiliar with this type of cement and its properties and there has been some confusion about the nature and composition of Portland-limestone cements. This Fact Sheet has been prepared to describe the properties and performance of these cements and to differentiate them from CEM I cement which can also have a limestone minor additional constituent (mac) of up to 5% by mass.

## What are Portland-limestone cements?

Portland-limestone cements are types of low carbon, factory-made composite cements conforming to BS EN 197-1. Their production leads to reduced levels of CO<sub>2</sub> emissions and reduced energy consumption when compared with the production of the same quantity of Portland CEM I, thus contributing towards more sustainable construction.

There are two types of PLC with standard notations and limestone contents, as follows:

- CEM II/A-L (or -LL) where limestone content is in the range 6% - 20%:
- CEM II/B-L (or -LL) where limestone content is in the range 21% - 35%.

The suffix -LL, as opposed to -L signifies a source of higher purity limestone with a low content of organic material (TOC). The limestone is generally interground (rather than blended) with Portland cement clinker and PLCs are available from MPA Cement's Member Companies covering a range of standard strength classes as given in Table 1.

Type	Standard notation	
	Standard name	Strength classes of current production
CEM II/A-L and II/A-LL	Portland-limestone cement	32,5 N, 32,5 R, 42,5 N and 52,5 N

NOTE 1. The letters 'A' and 'B' in notations for CEM II cements indicate the range of proportions of the secondary constituent. 'A' indicates from 6% to 20%, whereas 'B' indicates from 21% to 35%, all by mass of the 'sum of the main and minor additional constituents' (i.e. total constituents of the cement excluding calcium sulfate).

NOTE 2. In strength classes, the letter N denotes ordinary early strength, the letter R denotes high early strength and the letter L denotes low early strength.

Portland-limestone cements should not be confused with Portland cement CEM I which is permitted to contain up to 5% of minor additional constituents (mac). The mac often used is limestone fines with a particle size similar to cement. A CEM I that includes a limestone mac is indistinguishable in properties from any other CEM I and can be used whenever and wherever CEM I is specified.

### **What about cement : limestone mixer combinations?**

In addition to factory-made PLC, combinations of CEM I with limestone fines, blended at the mixer are sometimes used in concrete. The properties of limestone fines used in these combinations are described in BS 7979. Limestone : cement mixer combinations currently being produced carry the BS 8500 designations CIIA-LL or CIIA-L and can be used wherever the equivalent factory-made PLC is specified.

### **What are the effects of Portland-limestone cement on concrete properties?**

#### **CEM II/A-L (and -LL)**

Suitability for use of CEM II/A-L (and -LL) Portland-limestone cements in concrete in the UK is established, together with equivalent mixer combinations, in the British Standard for concrete, BS 8500, Parts 1 and 2, which is complementary to the European concrete Standard, BS EN 206-1.

The properties of fresh concrete made with CEM II/A-L (and -LL) cement are similar to those of a concrete containing a CEM I cement although any tendency to bleed is significantly reduced. At the same **water/cement ratio**, concrete made using this PLC can have a slightly lower 28 day compressive strength than concrete made using CEM I therefore higher cement contents may be required to achieve the same strength. At the **same concrete strength**, CEM II/A-L (and -LL) concrete has similar performance to CEM I concrete in respect of carbonation rate, chloride ingress and resistance to freezing and thawing (whether air-entrained or non air-entrained concrete).

BS 8500 applies the same prescriptive requirements to CEM II/A-L (and -LL) concrete as it does to CEM I-concrete where exposed to XC (carbonation), XD (de-icing salts), XS (sea water) and XF (freeze/thaw) conditions; both CEM II/A-LL and CEM I cements are suitable for use in aggressive ground up to Design Chemical Class DC-2. In addition, evidence obtained at room temperature suggests that CEM II/A-L (and -LL) concrete has better resistance to conventional sulfate attack than does CEM I concrete.

#### **CEM II/B-L (and -LL)**

CEM II/B-L (and -LL) are not currently permitted for use in concrete in the UK. However MPA Cement, in association with BSI committees, is to gather evidence for their potential introduction into a range of UK application standards. Agreed work programs are about to begin (2013) to determine if these cements can be introduced as permitted materials into UK standardized practice for:

- standardized prescribed concretes (ST mixes) [BSI committee B/517/1]

- masonry mortars [BSI committees B/519/2 and B/525/6]
- levelling screeds and concrete bases [BSI committee CB/300]
- internal and external renders [BSI committee B/519/2 and B/544/5]

MPA Cement has already contacted the BSI committees identified above and will carry out the agreed investigations in close cooperation with them.

### Where can I find out more?

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