FACT SHEET 13

Specifying factory-made CEM II cements for use in masonry mortars

Introduction

CEM II [pronounced sem-two] cements are factory-made alternatives to, and in general interchangeable with, traditional Portland cement CEM I when used in masonry mortars. CEM II cements conform to BS EN 197-1 [1] and comprise Portland cement clinker, a permitted secondary constituent from a range that includes fly ash, blastfurnace slag and limestone plus an optimised amount of 'gypsum' (set-regulator). By definition, the content of secondary constituent can vary from a minimum of 6% to a maximum of 35% by mass but, in practice, the achievement of the standard strength classifications of 32,5, 42,5 or 52,5 tends to restrict commercial products to a narrower range of compositions.

Which factory-made CEM II cements do BCA Member Companies currently make?

BCA Member Companies currently make the standardized CEM II cements identified in Table 1. These are marketed under a variety of brand names but even within a given company these names tend to differ depending on whether the cement is supplied in bulk or packed in bags. The generic 'standard designations' are, however, always included on delivery documents and bags.

Table 1. BCA Member Company factory-made CEM II cements

Standard designation		
Notation (type of cement)		**Strength classes of current production**
Portland-limestone cement	CEM II/A-L and II/A-LL	32,5 R, 42, 5 N and 52,5 N
Portland-fly ash cement	CEM II/A-V	32,5 R and 42,5 N
	CEM II/B-V	32,5 N, 32,5 R and 42,5 N

NOTE 1. The letters 'A' and 'B' in standard notations for CEM II cements indicate the range of proportions of secondary constituent in the cement. 'A' indicates from 6% to 20% by mass, whereas 'B' indicates from 21% to 35% by mass.

NOTE 2. In strength classes, the letter R denotes rapid early strength gain in comparison with the normal N.

Standardized specification of masonry mortars

Designed mortars

Since the publication of BS EN 998-2 [2], standardized specification of factory-made *designed* masonry mortars has been 'performance-based' by way of compressive strength within 'mortar classes'. A tabulated list of these strength classes, designated by an ‘M’ followed by the compressive strength in MPa (N/mm^2), is given in the standard. The mortar producer is then responsible for selecting the mix proportions of the specified constituents to produce a mortar of the required strength at 28 days.

Prescribed mortars

Prescribed mortars and BS EN 998-2

In the case of *prescribed* mortars there is a requirement in BS EN 998-2 that the proportion of constituents (e.g. 1 : 1 : 6 cement : lime : sand by volume) has to be included in the designation in relation to compressive strength or to an M class. In addition, National Annex NA.1 of BS EN

998-2 tabulates the relationship between M class and the prescriptive mix proportions used historically in the current UK Code of Practice BS 5628-3 [3] and the former BS 4721 [4]. It should be noted that these M classes are numerically different to those specified for *designed* mortars in BS EN 998-2.

Prescribed mortars and BS EN 1996-1-1

BS EN 1996-1-1 [5], the European Code of Practice for the design of masonry structures, together with its National Annex [6] aligns with BS EN 998-2 in that it:

- recommends that both an M class and constituent proportions be specified;
- leaves it to National Annexes to ascribe equivalent mortar mix proportions to stated M classes;
- identifies M classes which are the same as those tabulated in NA.1 of BS EN 998-2 for prescribed mortars.

Specification of CEM II cement masonry mortars by traditional volume mix proportions

In order to assist the mortar producer with the selection of mix proportions that will satisfy the M classes using CEM II cements, the BCA has carried out practical research using a number of cement types made by its Member Companies in order to examine the equivalence of the familiar prescriptive mortar mixes that meet the BS 5268-3 'designations' to the M classes for *designed* and *prescribed* mortars in BS EN 998-2 and BS EN 1996-1-1. In the case of factory-made CEM II cements, equivalence is demonstrated in Table 2.

Table 2. Equivalent masonry mortar mixes using BCA Member Company CEM II cements (strength classes 32,5 and higher)

Mortar Classes			**Equivalent mix proportions**		**BS 5628-3 mortar designation**
***Designed* mortars to BS EN 998-2**	***Prescribed* mortars to NA.1 of BS EN 998-2**	***Prescribed* mortars to draft NA of BS EN 1996-1-1**	**CEM II : Lime : Sand (with*/without air-entrainment)**	**CEM II : sand (with*/without air-entrainment)**	
M 10	M 12	M 12	1: ¼ : 3	Not suitable	**(i)**
M 5	M 6	M 6	1 : ½ : 4 to 4½	1 : 3 to 4	**(ii)**
M 2,5	M 4	M 4	1 : 1 : 5 to 6	1 : 5 to 6	**(iii)**
M 1	M2	M2	1 : 2 : 8 to 9	1 : 7 to 8	**(iv)**

*Where cements incorporate an air-entraining/plasticising additive the addition of air-entraining admixtures on site is usually unnecessary (except with poor sands) and may impair strength and durability.

NOTE. A designation (iii) mortar is equivalent to the 'general purpose mortar' described in BRE Digest 362 [7].

Selection of mortar mix

Selecting the appropriate 'designation' of mortar for the anticipated exposure condition(s) is the 'key' to specifying durable mortar. The designation should be selected by reference to BS 5628-3, Part 3 of the Code of Practice for Use of Masonry and, as can be seen from Table 2, mortar mixes based on CEM II cements can meet the requirements of each of the designations in BS 5628-3.

Do factory-made CEM II/B-V cements produce sulfate-resisting masonry mortars?

Factory made CEM II/B-V Portland-fly ash cements that contain at least 25% fly ash by mass produce sulfate-resisting masonry mortars. This minimum quantity is accepted within UK standards and guidance documents to confer sulfate-resisting properties on this CEM II sub-type. For example, in concrete specified to BS 8500-2 [8] CEM II/B-V cements (with a minimum proportion of fly ash of 25%) take the '+SR' sulfate-resisting suffix. It should be noted that traditional sulfate-resisting Portland cement (SRPC) to BS 4027 [9] is a CEM I cement and is likely, for various reasons, including the demands of the sustainability agenda, to become less available in the UK. In consequence, there will be an increasing need to specify other cements, such as sulfate-resisting CEM II/B-V types to replace SRPC in sulfate-resisting masonry mortars (and in concrete).

Is further guidance available on use of factory-made CEM II cements in masonry mortar?

The BCA has published a simple booklet titled *Guide to materials for masonry mortar* [10]. The British Standards Institution has published PD 6678 [11] a broadly based *Guide to the specification of masonry mortar*. In addition, the Concrete Society has published detailed practical guidance in its *Good Concrete Guide 4 – Mortars for masonry – Guidance on specification, types, production and use* [12].

Where can I find out more?

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References

[1] British Standards Institution. BS EN 197–1, *Cement–Part 1: Composition, specifications and conformity criteria for common cements*

[2] British Standards Institution. BS EN 998-2 *Specification for mortar for masonry - Part 2: Masonry mortar*

[3] British Standards Institution. BS 5628-3 *Code of practice for use of masonry – Part 3: Materials and components, design and workmanship*

[4] British Standards Institution. BS 4721 *Specification for ready-mixed building mortars*, WITHDRAWN

[5] British Standards Institution. BS EN 1996-1-1 *Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

[6] British Standards Institution. *National Annex to BS EN 1996-1-1*, see [5] above

[7] Building Research Establishment. Digest 362 *Building mortar*

[8] British Standards Institution. BS 8500-2 *Concrete – Complementary British Standard to BS EN 206-1 – Part 2: Specification for constituent materials and concrete*

[9] British Standards Institution. BS 4027 *Specification for sulfate-resisting Portland cement*

[10] British Cement Association. *Guide to materials for masonry mortar*

[11] British Standards Institution. PD 6678 *Guide to the specification of masonry mortar*

[12] Concrete Society. *Good Concrete Guide 4 – Mortars for masonry – Guidance on specification, types, production and use*

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