TECHNICAL DATA SHEET

CEMENT AND OTHER HYDRAULICALLY BOUND MIXTURES

The new European Standard

BS EN 14227, Parts 1- 5

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The British In-situ Concrete Paving Association

In 2004 the first five parts of the new European Standard, BS EN 14227, *Hydraulically bound mixtures*, were published. These parts cover hydraulically bound mixtures for roads, airfields and other trafficked areas. They replace the cement bound materials given in the pre-November 2004 *Specification for Highway Works*, but include a wider range of mixtures based on iron and steel slag (gbs) and fly ash (pfa) from coal-fired electricity generation.

The new standard has also introduced new terminology, which is defined in this publication.

Another publication in this series covers the treatment of soils.

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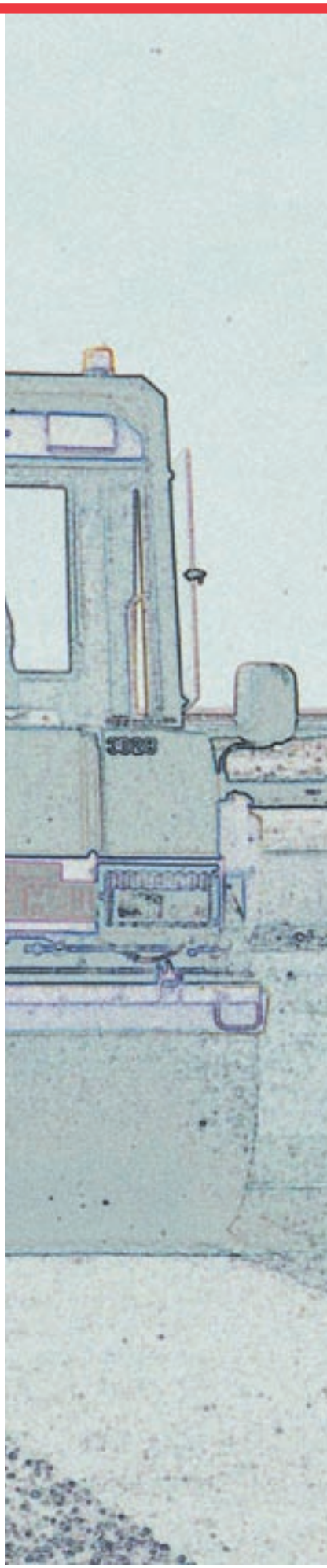
Cement and other hydraulically bound mixtures

The new European Standard BS EN 14227 Parts 1 – 5

Contents



1 Introduction

Hydraulically bound mixtures (HBM) describes mixtures that set and harden using combinations of the following constituents; air-cooled steel slag, cement, fly ash, granulated blast furnace slag, gypsum and lime. Cement bound materials are one example of HBM.

This data sheet describes:

- The scope and nature of the European Standard issued in 2004 for *hydraulically bound mixtures* (HBM) for road and other pavements,
- How the new mixtures compare with those specified for use in the UK prior to 2004,
- How to select and specify the new HBM mixtures.

No British Standards are superseded by the European Standards for HBM since, prior to their introduction in 2004, the requirements for HBM were given in the *Specification for Highway Works* (SHW) or other specifications based on the SHW. However, the European Standards significantly extend the range of HBM since previously the SHW was limited to cement bound materials (CBM).

2 The new standard

The European Standard for HBM introduced in 2004 is in five parts:

- BS EN 14227–1 2004: *Hydraulically bound mixtures*. Part 1. *Cement bound granular mixtures*.
- BS EN 14227–2 2004: *Hydraulically bound mixtures*. Part 2. *Slag bound mixtures*.
- BS EN 14227–3 2004: *Hydraulically bound mixtures*. Part 3. *Fly ash bound mixtures*.
- BS EN 14227–4 2004: *Hydraulically bound mixtures*. Part 4. *Fly ash for hydraulically bound mixtures*.
- BS EN 14227–5 2004: *Hydraulically bound mixtures*. Part 5. *Hydraulic road binder bound mixtures*.

Part 1 covers mixtures bound with cement conforming to the cement standard EN 197–1. It also includes the combination of cement with ground granulated blast-furnace slag added separately at the mixing stage. Note that the combination of cement and fly ash added as separate constituents at the mixing stage is covered by Part 3.

Part 2 covers mixtures based on the hardening properties of slags produced as a by-product of the manufacture of iron and steel. Two types of slag bound mixtures (SBM) are included in Part 2, designated A and B.

- The **A mixtures** are generally all-slag mixtures comprising two or more of the following: air-cooled blast-furnace slag, air-cooled steel slag and granulated blast-furnace slag, although the use of non-slag aggregate is permitted. Apart from grading, there are no specified requirements for the various slags. Such mixtures generally exhibit protracted setting and hardening and are normally, but not exclusively, characterised in the laboratory by the Californian Bearing Ratio (CBR) test.
- The **B mixtures** use the combination of granulated blast furnace slag of specified properties, with either lime or a lime/gypsum combination or steel slag as a catalyst. They are faster setting and hardening compared with the A mixtures although considerably slower than cement bound mixtures (see later in this section).

Part 3 covers mixtures based on the hydraulic and/or pozzolanic properties of fly ash, known as pulverised fuel ash in the UK. Two types of ash are covered: calcareous fly ash and siliceous fly ash. The type of ash depends on the nature of the coal burnt in the power station.

- The first, designated **CaFA**, is hydraulic in its own right and needs no additional constituents for hydraulic reaction. It sets and hardens at a similar rate to cement. However, since the type of coal that produces such ashes is not burnt in the UK, it is not available in this country.

- The second, designated **SiFA**, is a pozzolan and thus needs to be combined with lime for hydraulic reaction to take place. As with SBM, the lime/SiFA reaction is slow. If necessary, gypsum can be added to the lime/SiFA combination, or cement used instead of lime, but both these compromise the slow setting and hardening. In these cases, the mixtures set and harden similarly to the Part 1 mixtures. SiFA is widely available in the UK.

  The setting and hardening of non cement mixtures is slow compared with CBM and extremely protracted when ambient temperatures are lower than 5 ºC. Therefore careful consideration needs to be given to their use in the late autumn and winter months. However in comparison with mixtures containing cement, the slower setting and hardening produces mixtures that:

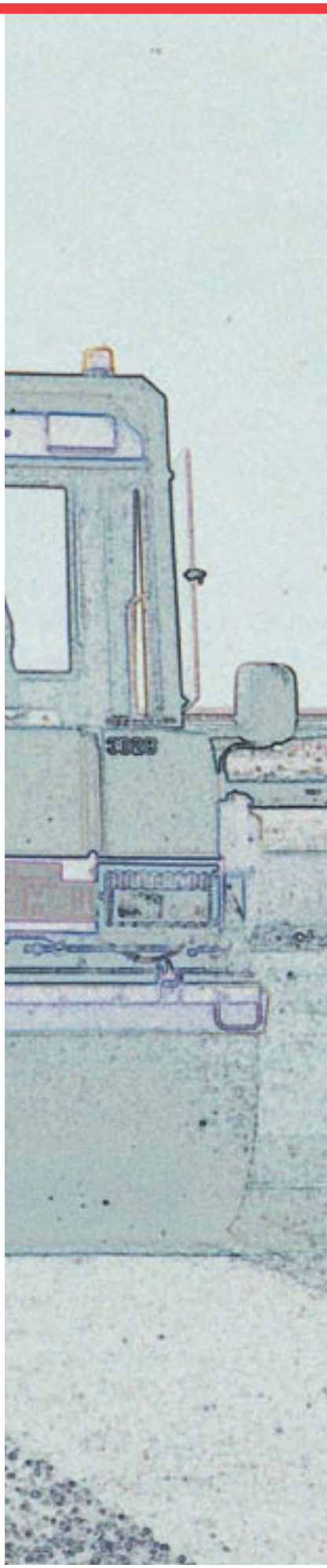
- Exhibit extended handling time between production and compaction.
- Are immediately traffickable even under heavy traffic (see later).
- Have a reduced tendency to crack, leading to less reflective cracking and thus the possibility of reduced asphalt cover.
- Exhibit autogenous healing (the ability to self-heal) when distressed in early life by traffic or earthworks settlement.
- Attain similar ultimate structural properties to CBM so that thickness design is similar to CBM.

Part 4 does not describe an HBM. As the title indicates, it specifies the requirements for fly ash, both siliceous and calcareous, for use in HBM. It is included here for completeness since it is one part of the series that was introduced in 2004 and is necessary for Part 3.

Part 5 covers mixtures based on hydraulic road binders complying with ENV 13282. These are factory produced blends primarily of SiFA or granulated blast furnace slag, usually but not exclusively with small quantities of lime and gypsum. As their name suggests, they are purpose-made hydraulic binders for road use producing HBM with extended handling time during construction. Their mechanical performance is similar to CBM at 7 days, as is their long-term performance.

The above parts cover hydraulically treated aggregates. They are 'open' regarding the property requirements for the 'aggregate', which have to be selected by the user or specifier by reference to BS EN 13242 *Aggregates for unbound and hydraulically bound materials.* They are also 'open' concerning strength, containing strength classes from which the user or specifier selects the appropriate class.

A second tranche of parts will be issued in 2005. These cover the treatment of soils and thus require no reference to BS EN 13242. In these, the term soil is wider than normal, covering natural material as well as industrial by-products and recycled materials. Binders or binder combinations are as above. These standards are not discussed in this data sheet.



3 Terminology

As already apparent, the European Standard described here has introduced new abbreviations and terminology. Those relevant to this document are listed in Table 1.

Table 1: Terminology

ABS	Air-cooled blast furnace slag
ASS	Air-cooled steel slag
CaFA	Calcareous fly ash – fly ash resulting from the combustion of high sulfate coals
CBM	Cement bound mixture
CBGM	Cement bound granular mixture
EN	European Norm or Standard
FA	Fly ash previously known in the UK as pulverised fuel ash
FABM	Fly ash bound mixture
GBS	Granulated blast furnace slag. A sand-like material that can be ground to enhance its hydraulicity. Depending on the degree of grinding, GBS can be designated partially ground, PGBS, or more fully ground, GGBS
Gypsum	$CaSO_4.2H_2O$
HBM	Hydraulically bound mixture. Note that the European standards described here use the word mixture rather than the word material, which we have previously used in the UK
HRB	Hydraulic road binder – a factory produced hydraulic binder for road use
HRBBM	'Hydraulic road binder' bound mixture
Hydraulic binder	A material that sets and hardens with water. CaFA, cement and HRB are hydraulic binders. GBS is a slow setting and hardening hydraulic binder.
Lime	Quick lime [CaO] or hydrated lime [$Ca(OH)_2$]. The latter is also known as the UK as slaked lime. The word does not include agricultural lime (ground $CaCO_3$), which is inert
Pozzolan	A material that in the presence of lime sets and hardens in water. SiFA is a pozzolan
R_c	Resistance in compression or compressive strength
R_{it}	Resistance in indirect tension
R_t	Resistance in direct tension
SBM	Slag bound mixture
SBM A	Type A slag bound mixture
SBM B	Type B slag bound mixture
SHW	*Specification for Highway Works*
SiFA	Siliceous fly ash – fly ash resulting from the burning of low sulfate coals

4 Scope of the new standard

4.1 General

The scope is the same for all the parts, and covers:

- The permitted constituents,
- The permitted types of mixture which are distinguished by type of aggregate,
- The permitted methods of laboratory mechanical performance characterisation, (e.g. strength, stiffness, CBR) with permitted classes from which the appropriate level is selected.

It should be noted that construction, control of construction and compliance are outside the remit of European Standards. These aspects are the prerogative of the member state in accordance with national/local practice and experience. The rationale of the European Standard for HBM is that the mixtures are products, regarded as being off-the-shelf, for specifiers to use according to their own requirements.

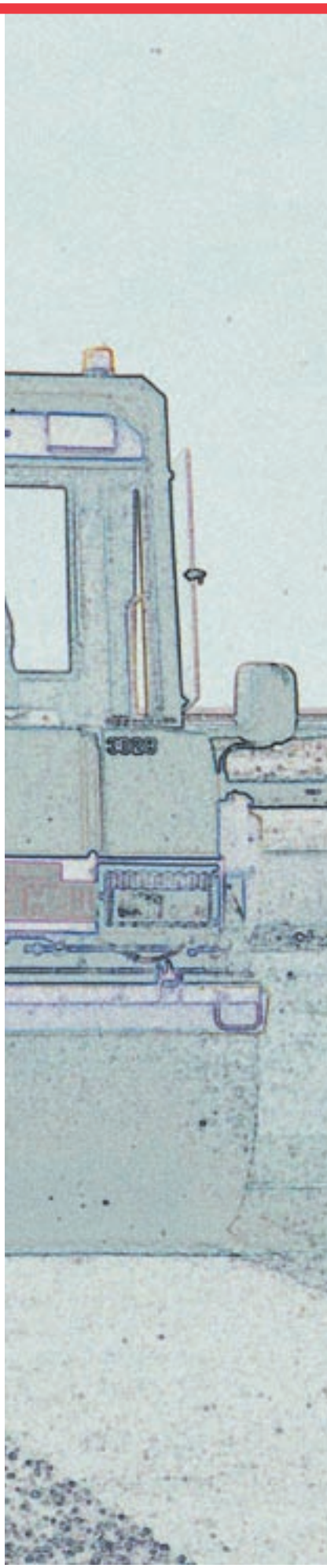
4.2 Constituents

Whatever the mixture, each part lists the permitted constituents including aggregates, binders and other materials. For each of the parts, the main constituents, with reference BS EN where appropriate, are shown and highlighted in Table 2.

Table 2: Constituents

BS EN 14227	Aggregate	Cement	GBS	ASS	Lime	Gypsum	CaFA	SiFA	HRB	Water
Pt 1: Cement bound granular mixtures	BS EN 13242	BS EN 197 –1	GGBS to national regulation	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Pt 2: Slag bound mixtures	BS EN 13242	N/A	BS EN 14227 –2	BS EN 14227 –2	prEN 14227–11*	Require-ments are open	N/A	N/A	N/A	Yes
Pt 3: Fly ash bound mixtures	BS EN 13242	BS EN 197 –1	BS EN 1422 – 2	N/A	prEN 14227 –11*	BS EN 14227 –3	BS EN 14227 –4	BS EN 14227 –4	N/A	Yes
Pt 5: HRB bound mixtures	BS EN 13242	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ENV 13282	Yes

*prEN 14227–11, *Unbound and hydraulically bound mixtures – Specifications* – Part 11: *Soil treated by lime* (to be issued in 2005).



4.3 Types of mixtures

Responsibility for the drafting of the parts described here was split between two task groups, with the Standard for CBGM being drafted by a different task group than that for the other hydraulically bound mixtures. In describing the types of mixtures, it is necessary and convenient to consider CBGM separately from the other mixtures, as illustrated in Tables 3 & 4.

Table 3: Types of mixture covered by part 1 of the standard (with suggested designation given in final column)

Type of mixture	Suggested designation
CBGM with permitted grading envelope 'A' for the aggregate. This covers wide-graded mixtures encompassing sand mixtures and mixtures made from either crusher run, as-raised materials or demolition aggregates etc.	CBGM A
CBGM with permitted grading envelope 'B' for the aggregate. This produces a 31.5 mm well-graded mixture	CBGM B
CBGM with tightly-graded mixture requirements producing either 20, 14 or 10 mm well-graded mixtures	CBGM C 0/20 or C 0/14 or C 0/10

Table 4: Types and designation of mixtures covered by Parts 2, 3 and 5 of the standard

Type of mixture (with specified binder requirements unless stated otherwise)	BS EN 14227–2: Slag bound mixtures	BS EN 14227–3: Fly ash bound mixtures	BS EN 14227–5: HRB bound mixtures
Graded slag mixtures without specified binder requirements	SBM A1 – A5 depending on grading and composition	N/A	N/A
31.5 mm well-graded mixtures	SBM B1 (strictly B1-2 since B1-1, B1-3 & B1-4 which also exist have different nominal sizes and gradings)	FABM 1	HRBBM 1
20, 14 & 10 mm well-graded mixtures with a specified compacity* value	SBM B2 0/20 B2 0/14 B2 0/10	FABM 2 0/20 2 0/14 2 0/10	HRBBM 2 0/20 2 0/14 2 0/10
Sand mixtures	SBM B3	FABM 3	HRBBM 3
Mixtures with declared grading	SBM B4	FABM 4	HRBBM 4
Lime or cement treated fly ash	N/A	FABM 5	N/A

* a theoretical density requirement

As previously mentioned, the quality of the aggregate used for the mixtures in Tables 3 and 4 is at the discretion of the specifier/user. Since grading is specified in the relevant mixture clause, the other aggregate properties that should be considered include shape, hardness, fines quality and soundness. These properties, together with classes, are found in the aggregate standard BS EN 13242. This is discussed in Table 9.

4.4 Laboratory mechanical performance classification

The CBGM, FABM and HRBBM parts permit classification by either compressive strength (R_c) or the combination of direct tensile strength (R_t) and elastic stiffness (E), which is designated R_tE. The SBM standard is the same but also permits classification by CBR, although this classification is primarily reserved for the SBM A mixtures, which exhibit a more protracted set and hardening period than the SBM B mixtures. Whatever method is used, a wide range of classes exists for each method. The specifier or user is free to select the appropriate class.

R_c classes are designated, and range from C0.4/0.5 to C27/36. The first number in the notation is the minimum compressive strength of cylinders with height/diameter (or slenderness) ratios of 2. The second number is the minimum strength of cylinders with slenderness ratios of 1, or cubes. It is important that the full notation is always used since if a single value is used it will not be clear what it relates to.

- When using the CBGM standard, it should be noted that the notation relates to minimum characteristic strength at 28 days using 20ºC curing.
- In the case of the other HBM standards, the notation relates to the minimum strength of the mixture using curing conditions and age of testing as specified in the country of use. Thus for example, as is recommended for the UK on the basis of previous experience, it is suggested that the specification uses the minimum average strength of groups of five cylindrical specimens tested at 28 days, with no individual specimen strength being less than 2/3 of the minimum specified average. However, instead of using 20ºC curing, it is recommended that 40ºC curing be used instead for HBM, since it gives a conservative but realistic picture of the long-term performance.
- It should also be noted that the strength classes in the CBGM standard are different but broadly similar to the classes for the other HBMs. The CBGM classes reflect the European Norms for concrete whilst the other ENs for HBM reflect European experience for slower setting and hardening mixtures.

The R_tE classes are designated T0 to T5 (performance increases as the number increases). In the classification, R_t refers to strength measured in direct tension but R_t can be deduced from the indirect tensile strength, R_{it}, using the relationship $R_t = 0.8R_{it}$. Note that the standard does not state any equivalence between the R_c and R_tE classifications but a general equivalence is suggested here in Table 8 on page 12.

CBR classes are designated $CBR_{XX/YY}$ where the first number designates the immediate CBR, either 30 or 50%, and the second number designates the percentage change in CBR value after 28 days, either 25, 35 or 50%. Thus for mechanical performance purposes, a range of CBR classes at 28 days are possible, ranging from a minimum of about 40 to a maximum of about 80. Note, however, that the ultimate strength will be far in excess of these CBR values and probably equivalent to at least the R_c class C3/4.

The manufacture and testing of specimens for the determination of the various strength requirements above are found in European test method standards listed in Table 5, overleaf.

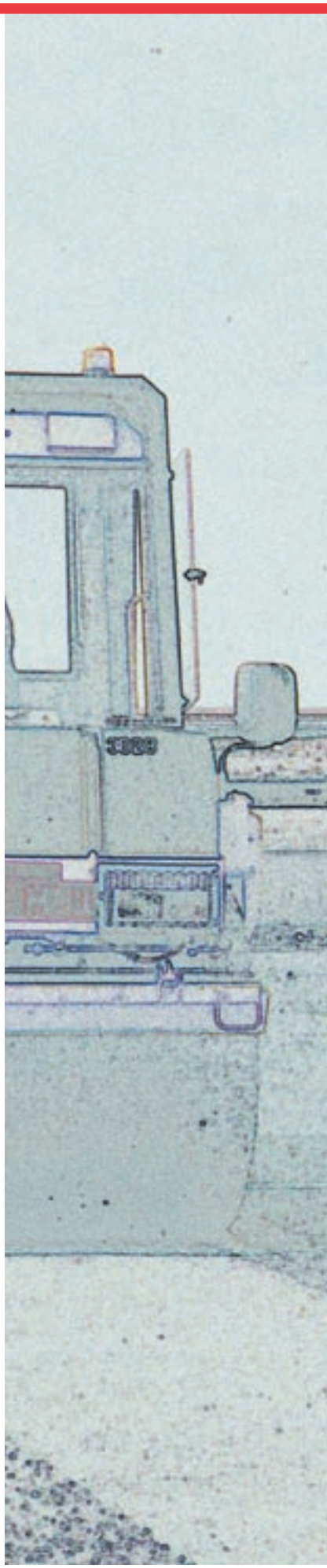


Table 5: Test methods for mixtures

BS EN 13286–40, *Unbound and hydraulically bound mixtures* – Part 40: *Test method for the determination of the direct tensile strength of hydraulically bound mixtures.*

BS EN 13286–41, *Unbound and hydraulically bound mixtures* – Part 41: *Test method for the determination of the compressive strength of hydraulically bound mixtures.*

BS EN 13286–42, *Unbound and hydraulically bound mixtures* – Part 42: *Test method for the determination of the indirect tensile strength of hydraulically bound mixtures.*

BS EN 13286–43, *Unbound and hydraulically bound mixtures* – Part 43: *Test method for the determination of the modulus of elasticity of hydraulically bound mixtures.*

BS EN 13286–47, *Unbound and hydraulically bound mixtures* – Part 47: *Test method for the determination of the California bearing ratio, immediate bearing index and linear swelling.*

BS EN 13286–50, *Unbound and hydraulically bound mixtures* – Part 50: *Method for the manufacture of test specimens of hydraulically bound mixtures using Proctor equipment or vibrating table compaction.*

BS EN 13286–51, *Unbound and hydraulically bound mixtures* – Part 51: *Method for the manufacture of test specimens of hydraulically bound mixtures by vibrating hammer compaction.*

BS EN 13286–52, *Unbound and hydraulically bound mixtures* – Part 52: *Method for the manufacture of test specimens of hydraulically bound mixtures using vibrocompression.*

BS EN 13286–53, *Unbound and hydraulically bound mixtures* – Part 53: *Method for the manufacture of test specimens of hydraulically bound mixtures by axial compression.*

It should be noted from the above list that various methods of specimen manufacture are covered. All of these produce different shapes and density of specimens. Each will thus yield a different strength. It is important therefore that the specifier/user recognises this and specifies what method of manufacture is required. The following is recommended for the UK:

For R_c classification, with R_c determined in accordance with BS EN 13286–41, it is suggested that both cubical and cylindrical specimens be compacted to refusal by vibrating hammer in accordance with BS EN 13286–51. This accords with UK practice and experience with cubes pre 2004.

For R_tE classification, with R_t and E determined in accordance with BS ENs 13286–42 & 43 respectively, it is suggested that cylindrical specimens be used compacted to refusal for R_c.

For CBR classification, specimen compaction as detailed in BS EN 14227–2.

5 Relationship of new mixtures with old mixtures

5.1 Situation before new EN introduced

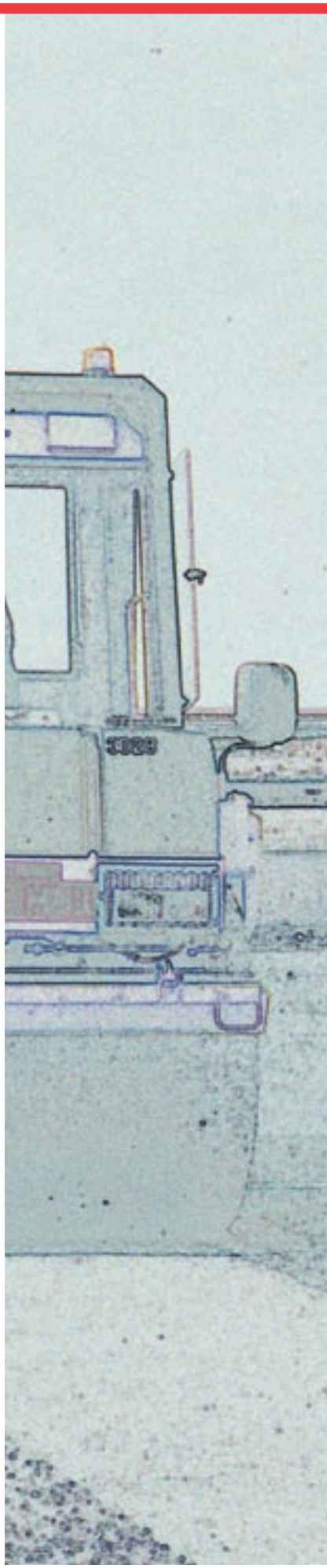
Table 6 describes the situation for HBM that existed in the UK prior to the introduction of the EN in 2004.

Table 6: HBM situation in the SHW prior to November 2004

Property	CBM1	CBM1A	CBM2	CBM2A	CBM3	CBM4	CBM5
Cement	Portland cement only or blends with GGBS(≤65%) or PFA(≤50%)						
Aggregate	Any				BS 882		
Aggregate grading	Any		Broad		Restrictive		
Aggregate 10% fines value	No requirement		≥50 kN		≥50 kN		
Minimum average cube strength (MPa) of 5 specimens compacted to refusal at 7 days	4.5	10	7	10	10	15	20
Minimum individual cube strength (MPa) at 7 days	2.5	7	4.5	6.5	6.5	10	13
Volume stability and durability	Immersed cube strengths not less than 80% of strengths of sealed specimens				Assumed okay		
Primary application	Subbase				Base		

From Table 6 it is apparent that:

- There were three binder situations; cement alone, cement with GGBS, and cement with PFA.
- For aggregates, there were three types of grading: open (CBM1 & 1A), less broad (CBM2 & 2A) and restrictive (CBM3, 4 & 5).
- For mechanical performance, CBM1 had two levels of cube compressive strength, CBM2 had two levels, CBM3 had three levels (the stronger two designated CBM4 and CBM5). Overall, specified cube strengths ranged from 4.5 to 20 MPa.
- Volume stability and durability checks were necessary for CBM1 & 2 but CBM3/4/5 were assumed satisfactory since BS 882 aggregate was specified
- CBM1 & 2 were subbase materials and CBM3/4/5 were base materials.



5.2 New mixtures in BS EN 14227 Part 1 covering cement and cement with GGBS

- There are mixtures that are equivalent to CBM2, 2A, 3, 4 and 5, in terms of binder, aggregate and mechanical performance.
- Until the parts for treated soils are published, there is no direct equivalent for CBM1 and 1A although it is possible, by using the 'no requirement' classes for the aggregate quality for CBGM A, to produce a mixture broadly equivalent in strength to CBM1 and 1A.
- From a mechanical performance point of view, BS EN 14227–1 extends the pre-November 2004 SHW situation by including a broader permissible range of strength levels, not just for cube compressive strength but including also cylinder strengths and tensile strength classification.

5.3 New mixtures in BS EN 14227 Parts 2, 3 & 5 covering slag, fly ash and HRB bound mixtures

These new mixtures extend what is described in 5.2 above to include:

- The binder blend of Portland cement with PFA.
- Binder blends based on lime and/or gypsum activated slag and or fly ash.
- CBR classification for slag mixtures.

5.4 Summary

Thus the whole (and more) of the pre-November 2004 SHW situation is covered by the new EN with the exception of volume stability and durability. In this regard, by using the appropriate levels in the aggregate standard BS EN 13242, it is possible to over-specify the aggregate requirements to avoid problems in this area but to the exclusion sometimes of perfectly acceptable material. However, since it is the final mixture rather than the aggregate that ultimately determines mixture stability and durability, then it can be argued that tests on the hardened mixture are more appropriate than restrictions on the aggregate. This approach was not envisaged by the European Standards but can be covered in the project specification by specifying that the mixture be subjected at mixture design stage to immersion testing. Volume stability and durability is then judged on the ability of specimens to maintain a certain level of strength, usually 80%, compared with the strength of sealed but non-immersed specimens. Such an approach has proved satisfactory in the UK over the last 50 years.

6 Guidance on selection and specification

The information in Section 5 is summarised in Table 7, which gives a view of the SHW equivalence pre and post November 2004.

Table 7: Suggested HBM equivalence pre and post November 2004

BS EN 14227–1	BS EN 14227–2,3,5	Nearest equivalent in SHW pre-November 2004
–	SBM A	No direct equivalent, but depending on selected strength class, SBM A can be considered equivalent to at least CBM1 or 2
CBGM A with no requirements for aggregate	SBM B4 FABM 4 HRBBM 4	CBM 1 & 1A
–	FABM 5	No direct equivalent, but depending on selected strength class, FABM 5 can be considered equivalent to either CBM1 or 2
CBGM A, possibly with selected aggregate properties (see Table 8)	SBM B3 FABM 3 HRBBM 3	CBM 2 & 2A
CBGM B	SBM B1 FABM 1 HRBBM 1	CBM 3, 4 & 5
CBGM C	SBM B2 FABM 2 HRBBM 2	No direct equivalent, but superior to CBM3/4/5 since mixture grading requirements for the new HBMs are superior to those for CBM3/4/5.

Unlike the old CBMs, the new HBMs do not have unique strength requirements. The strength level or class is selected by the specifier. Thus the strength of CBGM A could range from lower than CBM 1 to higher than CBM 5.

Where similar equivalence to the pre-November 2004 CBMs is required, Table 8 is offered for specification guidance purposes.

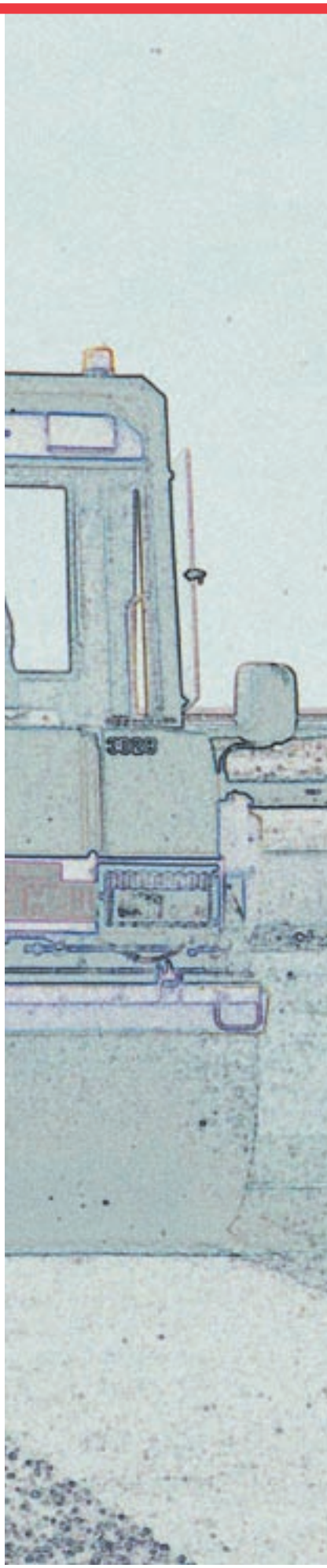


Table 8: Specification guidance

Equivalence required to	From the new standards
CBM1	CBGM A – C5/6 (or T1) SBM B4 – C3/4 (or C6/8 or T1) FABM4 – C3/4 (or C6/8 or T1) HRBBM4 – C3/4 (or C6/8 or T1) SBM A – C3/4 (or C6/8 or T1 or CBR50/35) and FABM5 – C3/4 (or C6/8 or T1) No requirement should be selected for the aggregate properties.
CBM1A	As for CBM1 above except the strength level shall be C10/12 (or T3) for CBGM A and C9/12 (or T3) for the other mixtures
CBM2	CBGM A – C5/6 (or C8/10 or T2) SBM B3 – C6/8 (or T2) FABM3 – C6/8 (or T2) HRBBM3 – C6/8 (or T2) SBM A – C6/8 (or T2) and FABM5 – C6/8 (or T2) Aggregate property requirements can be set as N/R, although for strict equivalence, an aggregate hardness level of LA50 should be selected where applicable.
CBM2A	As for CBM2 above except the strength level shall be C10/12 (or T3) for CBGM A and C9/12 (or T3) for the other mixtures.
CBM3	CBGM B – C10/12 (or T3) SBM B1 – C9/12 (or T3) FABM1 – C9/12 (or T3) and HRBBM1 – C9/12 (or T3) Aggregate shall be non-plastic, hardness shall be LA50, and proportion of crushed material shall be selected for the type B1 and Type 1 mixtures as discussed in Table 9.
CBM4	As for CBM3 above but use C12/15 (or T4) for CBGM B and C12/16 (or T4) for the Type B1 and Type 1 mixtures.
CBM5	As for CBM3 & 4 above but use C16/20 (or T5) for CBGM B and C15/20 (or C18/24 or T5) for the Type B1 and Type 1 mixtures.

Specimen manufacture, curing and testing should be as in 4.4. Although not stated, immersion testing as detailed in Section 5 must also be carried out at mixture design stage unless aggregate is known to be sound.

Construction and control are beyond the scope of this publication since they are not included in the new BS EN. Generally, however, these aspects are similar to those for the old CBM. There is, however, one major difference between the cement and non-cement mixtures. Non-cement mixtures do not require curing or non-trafficking periods. However in order to support traffic immediately without prejudice to long term performance, the immediate stability or bearing capacity of the mixture needs consideration. This is primarily a function of the grading of the mixture and the proportion of crushed faces for the aggregate and secondarily a function of aggregate hardness (Los Angeles Coefficient) but can, in certain cases, be based on the immediate bearing index (IBI) value of the mixture. (IBI refers to 'an immediate CBR test without surcharge'.) Table 9 is presented for guidance and application purposes.

Table 9: Suggested aggregate recommendations for and application of slow setting hardening HBM

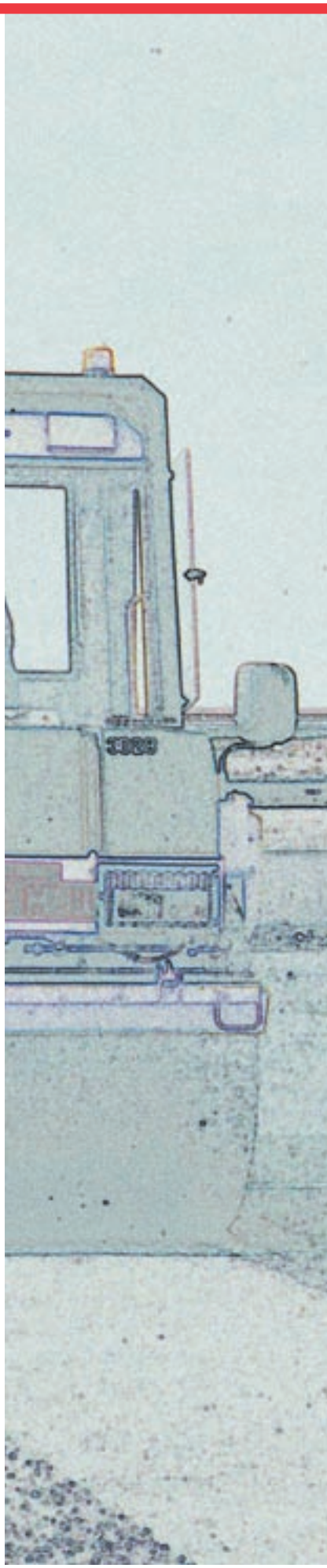
(subject to site trial to illustrate procedures and performance for the Type 3, 4 and 5 mixtures)

Mixture types	Heavily trafficked base (say > 30 msa)		Other bases (say 5 - 30 msa) Subbases for heavy site and/or in-service traffic		Bases for light traffic (say < 5 msa) Other subbases	
	Suggested strength of HBM – C9/12 or T3		Suggested strength of HBM – C6/8 or T2		Suggested strength of HBM – C3/4 or T1	
	Crushed or broken particles category for aggregate	Los Angeles coefficient category for aggregate	Crushed or broken particles category for aggregate (and/or with IBI category for mixture where indicated)	Los Angeles coefficient category for aggregate	Crushed or broken particles category for aggregate (and/or with IBI category for mixture where indicated)	Los Angeles coefficient category for aggregate
A	Mixture not recommended		C90/3	LA50	C50/30	LA60
1 & B1	C90/3	LA50	C90/3	LA50	C50/30	LA60
2 & B2	C90/3	LA50	C90/3	LA50	C50/30	LA60
3* & B3*	Mixture not recommended		IBI 40	Property N/A	IBI 40	Property N/A
4 & B4	Mixture not recommended		C90/3 IBI 50	LA50	C50/30 IBI 50	LA60
5**	Mixture not recommended		Property N/A	Property N/A	Property N/A	Property N/A

Notes to Table 9

1. The IBI test is specified in BS EN 13286-47, *Unbound and hydraulically bound mixtures* – Part 47: *Test method for the determination of the California bearing ratio, immediate bearing index and linear swelling.*
2. With the crushed or broken particles category, i.e. C90/3, the first number is the minimum percentage of crushed material and the second the maximum percentage of rounded particles.
3. With the Los Angeles categories, LA50 is equivalent to a 10% fines value of 50 kN, and LA60 is equivalent to a 10% fines value of 30 kN.
4. Mixtures marked with an asterix are primarily subbase materials.
5. The mixture marked with a double asterix is also a subbase material and requires specific handling. Construction advice can be found in Technical data sheet 6.5 on the UKQAA website, www.ukqaa.org.uk.
6. Suggested requirements and strengths should be conservative but are not cast in tablets of stone. Specified strength will also depend on thickness design.
7. This table may be considered appropriate for CBM.

Note that where any of the requirements of Table 9 are not met, then a curing and non-trafficking period is required until set commences.



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