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Aggregates

Part 2: Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas – Guidance on the use of BS EN 13043

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Foreword

Publishing information

This Published Document is published by BSI Standards Limited, under licence from The British Standards Institution and came into effect on 31 October 2009. It was prepared by Technical Committee B/502, *Aggregates*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

PD 6682-2:2009+A1:2013 supersedes PD 6682-2:2009, which is withdrawn.

Information about this document

Text introduced or altered by Amendment No. 1 is indicated in the text by tags 〈A1〉 〈A1〉. Minor editorial changes are not tagged.

This part of PD 6682 gives guidance on the use of BS EN 13043, which specifies requirements for aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas. BS EN 13043 superseded BS 63-1:1987, BS 63-2:1987 and BS 1047:1983, which were withdrawn in June 2004.

PD 6682-2 is one of nine parts of PD 6682, *Aggregates*, that give guidance on the use and application of a series of European Standards for aggregates:

- *Part 1: Aggregates for concrete – Guidance on the use of BS EN 12620;*
- *Part 3: Aggregates for mortar – Guidance on the use of BS EN 13139;*
- *Part 4: Lightweight aggregates for concrete, mortar and grout – Guidance on the use of BS EN 13055-1;*
- *Part 5: Lightweight aggregates for bituminous mixtures and surface treatments and for unbound and bound applications excluding concrete, mortar and grout – Guidance on the use of BS EN 13055-2;*
- *Part 6: Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction – Guidance on the use of BS EN 13242;*
- *Part 7: Armourstone – Guidance on the use of BS EN 13383;*
- *Part 8: Aggregates for railway track ballast – Guidance on the use of BS EN 13450;*
- *Part 9: Guidance on the use of European test method standards.*

Attention is drawn to the fact that BS EN 13043 fully takes into account the requirements of the European Commission mandate M/125, Aggregates [1], given under the EU Construction Products Directive (89/106/EEC) [2].

Presentational conventions

The word "should" is used to express recommendations of this Published Document. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document cannot confer immunity from legal obligations.

0 Introduction

This document provides guidance for the UK on the use of BS EN 13043, which superseded the British Standards for aggregates for use in bituminous mixtures and surface treatments, BS 63 and BS 1047.

BS EN 13043 has been amended since it was first published in 2002. In 2004, Corrigendum No. 1 corrected the CE Marking information in Annex ZA and amended a note about national regulations for dangerous substances.

NOTE The term "asphalt" is often used in the UK as the generic term that refers to the range of bituminous mixtures used on roads and other paved areas. BS EN 13043 uses the term "bituminous mixtures", as does BS EN 13108. Both terms are to be considered as synonymous.

BS EN 13043 specifies a range of categories for properties to enable purchasers to select appropriate limiting values for the wide range of aggregates in bituminous mixtures and surface treatments within Europe. In most instances, provision is also made for producers to identify a declared value for properties when the value is outside indicated categories.

The purchaser needs to define BS EN 13043 categories for properties that are relevant to the particular end-use of an aggregate. Example specifications listing aggregate designations for particular properties for aggregates with different end-uses are provided in Annex A, Annex B, Annex C, Annex D and Annex E.

BS EN 13043 includes manufactured and recycled aggregates within its scope and indicates that their suitability should be assessed in accordance with the regulatory requirements in the place of use. In the UK, further guidance on recycled aggregates can be found in the Highways Agency's Specification for Highway Works [3].

1 Scope

This part of PD 6682 gives guidance for the UK on the use of BS EN 13043, which specifies the properties of aggregates and filler aggregates obtained by processing natural, manufactured or recycled materials for use in bituminous mixtures and surface treatments for roads, airfields and other trafficked areas.

NOTE For simplicity, this document uses the shortened term "bituminous mixtures".

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 933-11*, Tests for geometrical properties of aggregates – Part 11: Classification test for the constituents of coarse recycled aggregate*

BS EN 13043*, Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas*

[A1] BS EN 16236, *Evaluation of conformity of aggregate* [A1]

3 Overview of BS EN 13043

3.1 General requirements

3.1.1 General

BS EN 13043 specifies requirements using the following groups of properties:

- geometrical properties, including grading, shape and fines content;
- mechanical and physical properties, including resistance to fragmentation;
- weathering properties, including freeze-thaw resistance;
- chemical properties, including volume stability of slags.

Additional aggregate properties, such as polishing and abrasion resistance, have been called up in the UK in the Highways Agency's Specification for Highway Works [3].

3.1.2 Geometrical requirements

The requirements specified in BS EN 13043 for the following geometrical properties are usually considered appropriate for aggregates used in bituminous mixtures in the UK.

a) Aggregate size, described using the designation *d*/*D*.

b) Grading, measured by the washing and sieving test method specified in BS EN 933-1.

c) Fines content, measured as part of the washing and sieving test method specified in BS EN 933-1.

d) Shape of coarse aggregate, measured by determining the flakiness index as specified in BS EN 933-3.

e) Percentage of crushed and broken surfaces in coarse aggregate, measured in accordance with BS EN 933-5.

Further details are given in **4.2**.

3.1.3 Physical requirements

The requirements specified in BS EN 13043 for the following physical properties are usually considered appropriate for aggregates used in bituminous mixtures in the UK.

a) Resistance to fragmentation, measured by the Los Angeles test method as specified in BS EN 1097-2.

b) Resistance to polishing of coarse aggregate for surface courses, measured by determining the polished stone value (PSV) in accordance with BS EN 1097-8.

c) Resistance to surface abrasion, measured by determining the aggregate abrasion value (AAV) in accordance with BS EN 1097-8.

d) Particle density and water absorption, measured in accordance with BS EN 1097-6 and declared on request.

e) Bulk density, measured in accordance with BS EN 1097-3 and declared on request.

Further details are given in **4.3**.

3.1.4 Durability requirements

BS EN 13043 initially specifies durability in terms of resistance to freezing and thawing, using the water absorption test in BS EN 1097-6. This is used as a screening test for weathering properties.

In the UK, it is usually considered appropriate for durability of aggregates used in bituminous mixtures to be specified using the magnesium sulfate soundness test in BS EN 1367-2.

Further details are given in **4.3.8**.

3.1.5 Chemical requirements

The requirements specified in BS EN 13043 for the following chemical properties for coarse and fine aggregates are usually considered appropriate for aggregates used in bituminous mixtures in the UK, when tested in accordance with BS EN 1744-1.

a) Dicalcium silicate disintegration of air-cooled blast furnace slag.

b) Iron disintegration of air-cooled blast furnace slag.

c) Volume stability of steel slag aggregate.

Further details are given in **4.4**.

3.1.6 Requirements for filler aggregates

The requirements specified in BS EN 13043 for the following properties are usually considered appropriate for the filler aggregates traditionally used in the UK.

a) Grading, tested in accordance with the "air jet" method specified in BS EN 933-10.

b) Loose bulk density in kerosene, tested in accordance with the appropriate annex to BS EN 1097-3.

c) Particle density, tested in accordance with BS EN 1097-7 and declared on request.

BS EN 13043 also specifies the use of test methods that are based on experience with mixed fillers that are rarely used in the UK. The specified tests include:

1) voids in dry compacted filler (Rigden), tested in accordance with BS EN 1097-4; and

2) "delta ring and ball", tested in accordance with BS EN 13179-1.

Further details are given in **4.5**.

3.2 Evaluation of conformity

〈A1〉 BS EN 13043 requires that producers undertake initial type tests and factory production control in accordance with BS EN 16236 to ensure that the product conforms to BS EN 13043 and to declared values as appropriate. 〈A1〉

〈A1〉 BS EN 16236 requires that producers undertake initial type tests relevant to the intended use to show conformity with BS EN 13043 in the following circumstances:

a) to characterize properties for new sources of aggregates;

b) where there is a major change in raw materials or processing which can affect the properties of the aggregates.

The results of the initial type tests are documented as the starting point of the factory production control for that material. Factory production control is used to monitor conformity of the aggregates with the relevant requirements and the producer's declared values.

For recycled aggregates in the UK, evaluation of conformity can also include compliance with the WRAP Quality Protocol [3].

BS EN 16236 specifies the minimum frequencies of tests in the requirements for factory production control. Further details are given in **4.7**. 〈A1〉

Guidance on the requirements for attestation of conformity and compliance with the provisions of the EU Construction Products Directive [2] is given in Clause **5**.

4 Requirements of BS EN 13043

4.1 General

Each clause in BS EN 13043 that specifies aggregate properties starts with a general subclause which draws attention to the necessity only to specify those properties relevant to the particular aggregate and end-use of the aggregate. In such instances, the wording "when required" is used.

BS EN 13043 allows the purchaser to choose an appropriate "category" for each property. The style of category designation is intended to be self-explanatory and related to the specified limiting value. For example, category FI_{25} means that aggregates having a flakiness index with a maximum value of 25 are required.

This style becomes more complex in the case of grading and a careful understanding of the grading requirements is necessary. For example, $G_C85/15$ is the grading designation for a coarse aggregate with a minimum 85% passing the upper size sieve *D* and a maximum of 15% passing the lower size sieve *d*.

NOTE The aggregate descriptions are identified in BS EN 13043 as d/D, but the d and D values appear in the reverse order in the grading categories. Thus, the percentage passing D is given before the percentage passing d, e.g. a 10/20 aggregate with a grading category of $G_C85/20$.

An option to use a "no requirement" category is also provided. For example, a resistance to abrasion from studded tyres category of A_NNR is included in BS EN 13043, which means that there is no specified requirement for resistance to abrasion from studded tyres. This can be used to indicate that there is no specified requirement for resistance to abrasion from studded tyres because these are not permitted on UK roads.

The "no requirement" category should be selected in all cases where a property is not relevant or an alternative method is used to cover the end-use requirement.

BS EN 13043 has provision for the use of "declared values". When the value of a particular property falls outside the range of any specified categories, the producer may provide information about this property in the form of a declared value. For example, if the resistance to fragmentation of coarse aggregate measured by the Los Angeles coefficient exceeds 50, the producer can state the maximum value of $LA_{Declared}$. Thus if the value were 55 the producer would state LA_{55} and the aggregate purchaser should determine whether this is adequate for their purposes.

4.2 Geometrical requirements

4.2.1 Aggregate sizes

BS EN 13043 specifies the following three options of sieve size ranges for use in the description of aggregate size:

a) basic set;

b) basic set plus set 1;

c) basic set plus set 2.

In the UK, aggregates will generally be supplied to the basic set plus set 2.

The aggregate size is described in BS EN 13043 in millimetres with the designation *d*/*D*, where *d* is the lower limiting sieve size and *D* is the upper limiting sieve size. The majority of the particle size distribution of an aggregate should lie between these two values and requirements for this are specified in BS EN 13043.

The fine aggregate fraction described in BS EN 13043 is linked to a 2 mm size or less with an oversize tolerance.

NOTE The use of the 2 mm size sieve to define fine aggregate specified in BS EN 13043 is different to that specified in other European Standards for aggregates. In practice, this anomaly is of little consequence because the fine aggregate is usually only one constituent of a mixture of different sizes, each with undersize particles. It is probable that the definition of fine aggregates will be harmonized across all the standards.

Table 1 lists established BS EN 13043 designations.

Table 1 **UK aggregate size designations**

BS EN 13043 aggregate
mm
20/40
20/31.5
10/20 or 14/20[A)]
6.3/14 or 8/14[A)]
4/10 or 6.3/10[A)]
2.8/6.3 or 2/6.3[A)]
1/4 or 2/4[A)]

[A)] Where two alternative designations are recommended, the choice of which designation to select depends on the end-use of the product.

4.2.2 Sieve sizes

BS EN 13043 expresses grading requirements in terms of percentages passing lower (*d*) and upper (*D*) sieve sizes and in percentages passing sieves with sizes which are multiples or fractions of *d* and *D*. When using the BS EN 13043 basic set plus set 2 range of sieve sizes, as has been adopted for use in the UK, some of these multiples and fractions are not exact sieve numbers from the ISO 565, R 20 series. Therefore, footnotes to BS EN 13043:2002, Table 2 and Table 3, give provision for the selection of next nearest sieve sizes in such circumstances.

For the UK, a selection of next nearest sieve sizes from the ISO 565 R 20 series is given in Table 2 to cover such eventualities. It shows how they relate back to the multiples or fractions of the *d* and *D* sieve sizes given in the BS EN 13043 basic set plus set 2 range.

The sieve sizes given in Table 2 are recommended for use in the UK for aggregates for bituminous mixtures and surface treatments. The gradings in Table 3, Table 4 and Table 5 have been created using the sieve sizes in Table 2.

Table 2 **Recommended sieves, including next nearest multiples and fractions from the ISO 565 R 20 series**

Recommended sieves for the UK[A)]	**Sieve sizes in the BS EN 13043 basic set plus set 2 range**			
mm	mm			
	2*D* for *D* =	**1.4*D* for *D* =**	***D*/2 for *D* =**	***d*/2 for *d* =**
80	40	—	—	—
63	31.5	40	—	—
40	20	31.5	—	—
31.5	14	20	—	—
20	10	14	40	—
16	—	—	—	—
14	6.3	10	31.5	—
10	—	6.3	20	20
8	4	—	—	—
6.3	2.8	4	14	—
4	2	—	10	10
2.8	—	2	6.3	6.3
2	—	—	—	4
1	—	—	—	2
0.500	—	—	—	—
0.250	—	—	—	—
0.125	—	—	—	—
0.063	—	—	—	—

[A)] These sieve sizes are multiples or fractions of the *d* and *D* sieve sizes given in the BS EN 13043 basic set plus set 2 range of sieve sizes. However, where the sieves calculated are not exact sieve numbers in the ISO 565 R 20 series the next nearest sieve size has been used.

4.2.3 Grading

4.2.3.1 General

General grading requirements for aggregates for use in bituminous mixtures and surface treatments for roads, airfields and other trafficked areas are specified in BS EN 13043.

However, it should be noted that BS EN 13043 requires that testing and declaring geometrical properties, such as grading, is limited according to the particular application at end-use or origin of the aggregate. Only when required by the purchaser is the supplier required to test geometrical properties, such as grading, in accordance with the tests in BS EN 13043.

The current method of producing asphalt is to combine various coarse aggregate sizes with one or more fine aggregate sizes so as to meet the specified grading requirements for the bituminous mixture. There are a near infinite number of size combinations which can be put together in order to produce any required grading in the finished asphalt, so use of particular specified gradings of either coarse or fine aggregate is not a necessary requirement in the specification of asphalt. The grading categories in BS EN 13043 should therefore be considered only as categories of convenience that may be used in commercial transactions.

Where, for contractual reasons, the grading limits are referenced directly to BS EN 13043 and this Published Document, the grading category and grading limits should be selected from Table 3, Table 4 and Table 5. These tables detail the recommended BS EN 13043 grading categories for coarse aggregates for the manufacture of asphalt, coarse aggregates for surface treatments and fine and all-in aggregates in a tabulated form.

4.2.3.2 Grading of coarse aggregates

4.2.3.2.1 General

BS EN 13043 specifies the oversize/undersize requirements to which coarse aggregates are required to conform.

For coarse aggregates with a fairly wide grading range, defined as $D \geqslant 2d$, additional requirements are specified to ensure greater consistency of grading, including overall limits for the percentages passing mid-size sieves and tolerances to be applied about the producer's declared target grading passing these mid-size sieves.

4.2.3.2.2 Coarse aggregates for bituminous mixture

As described in **4.2.3.1** the specification of the grading of coarse aggregate for use in the production of asphalt in the UK is a matter of convenience between supplier and purchaser. There is no universal category that has to be used in all cases.

Generally, the grading of the coarse aggregate will be agreed between purchaser and producer. However, where the purchaser wishes to specify a grading category and grading limits for the aggregates to be supplied, in addition to the aggregate size, the BS EN 13043 coarse aggregate grading and grading category should be selected from Table 3.

When specifying aggregate size it is sufficient to quote the aggregate size and grading category, e.g. 10/20, G_C85/35.

Table 3 **Recommended BS EN 13043 grading categories and corresponding grading limits for coarse aggregates used in the manufacture of asphalt**

Recommended BS EN 13043 aggregate size mm	20/40	20/31.5	10/20	6.3/14	4/10	2/6.3	1/4
Recommended BS EN 13043 grading category	G_C85/20	G_C85/35	G_C85/20	G_C85/20	G_C85/20	G_C80/20	G_C90/10
Sieve size mm	**Percentage by mass passing sieve**						
80	100	—	—	—	—	—	—
63	98–100	100	—	—	—	—	—
40	85–99[A)]	98–100	100	—	—	—	—
31.5	—	85–99[A)]	98–100	100	—	—	—
20	0–20	0–35	85–99[A)]	98–100	100	—	—
14	—	—	—	85–99[A)]	98–100	100	—
10	0–5	0–5	0–20	—	85–99[A)]	98–100	—
8	—	—	—	—	—	—	100
6.3	—	—	—	0–20	—	80–99[A)]	98–100[A)]
4	—	—	0–5	—	0–20	—	90–99[A)]
2.8	—	—	—	0–5	—	—	—
2	—	—	—	—	0–5	0–20	—
1	—	—	—	—	—	0–5	0–10
0.5	—	—	—	—	—	—	0–2

[A)] The inclusion of 99% in lieu of 100% is to ensure consistency and to prevent smaller size aggregate being classified as *D* sized aggregate. However, BS EN 13043 indicates that the percentage passing *D* may be greater than 99% by mass, but in such cases the producer is required to document and declare the typical grading, including the sieves *D*, *d*, *d*/2 and sieves in the basic set plus set 2 intermediate between *d* and *D*.

4.2.3.2.3 Coarse aggregates for surface treatments or chippings for rolling into asphalt

Coarse aggregates for use in surface treatments or as chippings for rolling into asphalt should be specified in accordance with one of the categories in BS EN 13043. The grading categories recommended for these uses in the UK are shown in Table 4.

When specifying aggregate size it is sufficient to quote the aggregate size and grading category, e.g. 6.3/10, G_C85/20.

Table 4 **Recommended BS EN 13043 grading categories and corresponding grading limits for coarse aggregates for surface treatments or as chippings for rolling into asphalt**

Recommended BS EN 13043 aggregate size mm	14/20	8/14	6.3/10	2.8/6.3	2/4
Recommended BS EN 13043 grading category	G_c85/20	G_c85/15	G_c85/20	G_c85/15	G_c85/20
Sieve size mm	**Percentage by mass passing sieve**				
40	100	—	—	—	—
31.5	98–100	100	—	—	—
20	85–99[A)]	98–100	100	—	—
14	0–20	85–99[A)]	98–100	100	—
10	—	—	85–99[A)]	98–100	—
8	—	0–15	—	—	100
6.3	0–5	—	0–20	85–99[A)]	98–100
4	—	0–2	—	—	85–99[A)]
2.8	—	—	0–5	0–15	—
2	—	—	—	—	0–20
1	—	—	—	0–2	0–5

[A)] The inclusion of 99% in lieu of 100% is to ensure consistency and to prevent smaller size aggregate being classified as *D* sized aggregate. However, BS EN 13043 permits the percentage passing *D* to be greater than 99% by mass provided the producer documents and declares the typical grading, including the sieves *D*, *d*, *d*/2, and sieves in the basic set plus set 2 intermediate between *d* and *D*.

4.2.3.3 Fine aggregates and all-in aggregates

BS EN 13043 specifies the oversize/undersize requirements to which fine aggregates and all-in aggregates are required to conform.

For fine aggregate and all-in aggregate 0/*D* with $D \leqslant 8$ mm, BS EN 13043 specifies additional requirements intended to ensure greater consistency of grading, including tolerances to be applied about the producer's declared target grading.

To allow the UK to continue to produce a fine aggregate other than 0/2, 0/4 can be specified using the BS EN 13043 requirements for grading appropriate to an all-in aggregate. The BS EN 13043 grading category and grading limits for 0/2 fine aggregate and 0/4 all-in aggregate are shown in Table 5.

The specification for these fine and all-in aggregates specifies requirements for a fixed oversize limit, with the percentages passing smaller sieves controlled by tolerances around a supplier's declared grading. This is on the principle that consistency of grading is more important than the absolute values. The BS EN 13043 tolerances on the producer's declared grading for 0/2 fine aggregate and 0/4 all-in aggregate are also shown in Table 5.

Table 5 **Recommended BS EN 13043 grading categories and corresponding grading limits for 0/2 fine aggregate and 0/4 all-in aggregate**

Recommended BS EN 13043 aggregate mm	0/4 all-in	0/2
Recommended BS EN 13043 grading/tolerance category	$G_A85/G_{TC}20$	$G_F85/G_{TC}20$
Sieve size mm	**Percentage by mass passing sieve**	
8	100	—
6.3	98–100	—
4	85–99 (±5)	100
2	(±20) [A)]	85–99 (±5)
1	—	(±20) [A)]
0.063	(±3) [A)]	(±3) [A)]

NOTE ( ) = BS EN 13043 tolerances on the producer's declared typical gradings.

[A)] Producer declares a value against this sieve.

When specifying the grading of the fine or all-in aggregate for use in asphalt, it is sufficient to identify the aggregate size and grading category, e.g. 0/4 all-in $G_{TC}20$.

4.2.4 Fines content

The fines content specified in BS EN 13043 relates to the percentage passing a 0.063 mm sieve, measured as part of the washing and sieving test in accordance with BS EN 933-1.

BS EN 13043 specifies a range of fines content categories. The categories appropriate for use in the UK for aggregates for bituminous mixtures and surface treatments are listed in Table 6.

Table 6 **Recommended BS EN 13043 categories for fines content**

Use	**Aggregate type**	**Recommended BS EN 13043 category**
Course aggregate		
Rolled asphalt	Crushed rock/ slag	f_4
	Gravel	f_4
Asphalt concrete	Crushed rock/ slag	f_{NR}
	Gravel	f_1
Surface dressing	Crushed rock/ slag	f_1
		f_2
Fine aggregate		
Rolled asphalt		
– Base, binder course, regulating	Sand and crushed rock	f_{22}
– Surface (wearing) course: design	Sand	f_{10}
	Crushed rock	f_{16} or f_{22}
– Surface (wearing) course: recipe	Sand and crushed rock	f_{10}
Asphalt concrete	Sand	f_{10}
	Crushed rock	f_{NR}

4.2.5 Shape of coarse aggregates

BS EN 13043 requires the shape of coarse aggregates to be determined in terms of the flakiness index in accordance with BS EN 933-3.

NOTE This flakiness index test differs from the superseded test specified in BS 812-105.1 because it is based on different dimensional ratios.

BS EN 13043 categories for flakiness suitable for use in the UK are listed in Table 7.

Table 7 **Limits for the flakiness of coarse aggregates**

Use	Recommended BS EN 13043 category
Rolled asphalt/asphalt concrete	FI_{35}
Porous asphalt	FI_{20}
Surface treatments	FI_{30} or FI_{20}
Coated chippings	FI_{20}

BS EN 13043 gives an option to use the shape index specified in BS EN 933-4. It is not anticipated that this will be used in the UK for aggregates for bituminous mixtures and it is recommended that the category SINR is specified.

4.2.6 Percentage of crushed and broken surfaces in coarse aggregates

In order to ensure adequate mechanical interlock when using crushed gravel aggregate, the percentage of crushed or broken particles is specified in BS EN 13043. To date, such requirements have not been considered necessary in the UK because resistance to deformation is controlled by other means, e.g. by the direct measurement of the deformation resistance. It is recommended that category CNR is specified.

4.2.7 Fines quality

BS EN 13043 provides a means for assessing the quality of fines, using the methylene blue test specified in BS EN 933-9 to assess the level of harmful fines (e.g. swelling clay).

Since there is no history of this problem with aggregates used in asphalt in the UK it is recommended that the category MB_FNR is adopted when dealing with established aggregate sources.

4.2.8 Angularity of fine aggregate

BS EN 13043 specifies that, when required by the purchaser, the angularity of fine aggregates shall be determined in accordance with BS EN 933-6. To date, such requirements have not been considered necessary in the UK. It is recommended that category E_{CS}NR is adopted.

4.3 Physical requirements

4.3.1 Resistance to fragmentation of coarse aggregate

BS EN 13043 specifies the determination of resistance to fragmentation in terms of the Los Angeles coefficient in accordance with BS EN 1097-2, when required by the purchaser.

Table 8 lists recommended categories for the maximum values of the Los Angeles coefficient specified in the UK for bituminous mixtures and surface treatments.

Table 8 **Recommended BS EN 13043 categories for the Los Angeles coefficient**

Use	Recommended BS EN 13043 category
Porous asphalt	LA_{30}
Surface treatments	LA_{30}
General paving asphalt	LA_{30}
Blast furnace slag in surface treatments and asphalt	LA_{50}

Whilst the Los Angeles test is the reference test for resistance to fragmentation, BS EN 13043 includes an option to assess resistance to fragmentation by determining the impact value in accordance with BS EN 1097-2. This alternative test requires the use of special equipment not available in the UK and it is recommended that the category SZ_{NR} is adopted.

4.3.2 Resistance to polishing of coarse aggregate for surface courses

BS EN 13043 specifies the selection of a polished stone value (PSV) determined in accordance with a test method specified in BS EN 1097-8 when required by the purchaser.

Categories for PSV are given in BS EN 13043. In the UK, guidance on minimum PSV values is given in the Highways Agency Design Manual for Roads and Bridges [4]. Where the values recommended in the Highways Agency Design Manual for Roads and Bridges do not coincide with the categories specified in BS EN 13043, the category $PSV_{Declared}$ should be adopted.

4.3.3 Resistance to surface abrasion

BS EN 13043 specifies the selection of an aggregate abrasion value (AAV) determined in accordance with a test method specified in BS EN 1097-8 when required by the purchaser.

Categories for AAV are given in BS EN 13043. In the UK, guidance on maximum AAV values is given in the Highways Agency Design Manual for Roads and Bridges [4]. Where the Highways Agency Design Manual for Roads and Bridges requires a value of 10, the category AAV_{10} should be chosen. For other values, the category $AAV_{Declared}$ should be adopted.

4.3.4 Particle density and water absorption

BS EN 13043 specifies the determination and declaration of particle density and water absorption in accordance with BS EN 1097-6. Values for these properties are determined for use in mix design and volumetric calculation. The specification of categories for these properties is not appropriate, but provision is made in BS EN 13043 for suppliers to declare the values of these properties.

The individual clauses and annexes of BS EN 1097-6 contain different test methods that reflect the traditions of a number of countries. The wire basket method for large coarse aggregate and the pyknometer methods for coarse aggregate and fine aggregate are appropriate for use in the UK.

4.3.5 Bulk density

BS EN 13043 specifies the determination of bulk density in accordance with BS EN 1097-3 when required by the purchaser. No levels are specified for bulk density, but values can be useful for mixture design procedures, particularly when using blast-furnace slag aggregate.

4.3.6 Resistance to wear of coarse aggregate

BS EN 13043 specifies determination of resistance to wear in terms of the micro-Deval coefficient test in accordance with BS EN 1097-1 when required by the purchaser. The micro-Deval test is not considered relevant for aggregate for use in bituminous mixtures and surface treatments.

It is recommended that category M_{DE}NR is adopted.

4.3.7 Resistance to abrasion from studded tyres of coarse aggregates to be used for surface courses

BS EN 13043 specifies resistance to abrasion from studded tyres in accordance with BS EN 1097-9 when required by the purchaser. This is specifically intended for countries which use studded tyres and is not required in the UK. It is recommended that category A_NNR is adopted.

4.3.8 Durability: Water absorption and magnesium sulfate soundness

BS EN 13043 provides a means for assessing the durability of an aggregate by determining its freeze-thaw resistance, using the determination of the water absorption value in accordance with BS EN 1097-6 as a screening test.

In the UK, aggregates should be considered satisfactory without further testing if they conform to water absorption category $WA_{24}2$. Aggregates with water absorption greater than 2% should be considered satisfactory for general purposes if they conform to the magnesium sulfate soundness category MS_{25}. Other categories of magnesium sulfate soundness may be adopted for special uses, for example, airfield pavements.

4.3.9 Resistance to thermal shock

BS EN 13043 specifies the determination of thermal shock in accordance with BS EN 1367-5 when required by the purchaser. It provides a method for asphalt producers to determine the extent to which aggregates degrade through heating during the drying process.

It is not anticipated that this requirement will be adopted in the UK.

4.3.10 "Sonnenbrand" of basalt

Sonnenbrand is a type of rock decay that is assessed in order to determine the susceptibility of certain types of young basalt aggregates, found in some European countries, to degradation through mineralogical instability. This phenomenon is not experienced in the UK and it is not anticipated that this test will be applied in the UK. It is recommended that category SB_{NR} is adopted, although further information should be obtained on the susceptibility of imported basalt aggregates.

4.4 Chemical requirements

4.4.1 Constituents which affect the volume stability of blast-furnace and steel slags

BS EN 13043 requires that, when required by the purchaser:

- air-cooled blast furnace slag aggregate shall be free from dicalcium silicate disintegration when tested in accordance with BS EN 1744-1 and the results declared;
- air-cooled blast furnace slag aggregate shall be free from iron disintegration when tested in accordance with BS EN 1744-1 and the results declared;
- the volume stability of steel slag aggregate shall be determined in accordance with BS EN 1744-1.

  NOTE There is still little experience of the limits specified in BS EN 13043. It is therefore recommended that the purchaser obtains the advice of the supplier of the steel slag in this respect.

4.4.2 Coarse lightweight contaminators

BS EN 13043 specifies the determination of the content of coarse lightweight organic contaminators, when required by the purchaser, in accordance with BS EN 1744-1. Coarse lightweight organic contaminators are only likely to occur if recycled aggregates are used and so testing is recommended only for recycled aggregates. In the case of natural aggregates, it is recommended that category $m_{LPC}NR$ is adopted.

4.5 Requirements for filler aggregate

BS EN 13043 specifies requirements for filler aggregates from a wide variety of sources, both natural and artificial. BS EN 13043 specifies that the testing and declaring of properties for filler aggregates shall be limited according to the particular application at end-use or origin of the aggregate.

The fillers used in asphalt production in the UK are almost exclusively derived from natural aggregates. For these fillers it is recommended that only the following requirements are specified:

a) grading in accordance with BS EN 933-10;

b) loose bulk density in kerosene in accordance with BS EN 1097-3.

It is not recommended that requirements are specified by the purchaser for the other properties specified in BS EN 13043. Where the option is given, the "no requirement" category should be adopted.

4.6 Constituents of recycled aggregate

BS EN 13043 does not require the producer to declare the proportions of constituent materials in recycled aggregate used in bituminous mixtures. However, it is accepted practice in the UK to use recycled aggregates as a proportion of the aggregate; for example, processed asphalt arisings and crushed container glass.

When required, the proportions of constituent materials in coarse recycled aggregate should be determined in accordance with a visual sorting test in accordance with BS EN 933-11.

NOTE In most circumstances, it will be more appropriate to carry out the visual sorting test on the combined aggregate used in the mixture, instead of the individual aggregate components.

4.7 Evaluation of conformity

4.7.1 General

〈A1〉 BS EN 13043 contains requirements for the evaluation of conformity necessary for producers to demonstrate that their products conform to BS EN 13043. These requirements are specified in BS EN 16236 and are divided into:

a) initial type tests;

b) factory production control. 〈A1〉

These are part of the procedure for attestation of conformity to be used for demonstrating compliance with the requirements of the EU Construction Products Directive [2].

As explained in the Scope to BS EN 13043, unfamiliar materials from secondary sources placed on the market as aggregates might be covered by national regulations for dangerous substances.

4.7.2 Initial type tests

〈A1〉 Initial type testing is a series of tests carried out on the aggregate, relevant to its intended end use, before it is first placed on the market. This testing is used to identify the categories specified within BS EN 13043 and BS EN 16236 to which the aggregate conforms. 〈A1〉

Initial type testing is required for new sources, when there is a major change in raw materials, or when the aggregate is to conform to a new requirement for which it has not previously been tested.

Where purchasers require additional data or properties for particular uses of the aggregate, these should be requested prior to ordering, allowing sufficient time for testing.

4.7.3 Factory production control

A1 Factory production control is the means of defining the quality system which producers are required to operate to demonstrate ongoing conformity of their product to BS EN 13043. Detailed requirements for factory production control are given in BS EN 16236. A1

For recycled aggregate placed on the market, factory production control is also part of the Quality Protocol for the production of aggregates from inert waste, published by the Waste and Resources Action Programme (WRAP) [5].

NOTE The WRAP Quality Protocol [5] requires the delivery documentation to state that the aggregate was produced under a system for factory production control conforming to the Protocol.

5 Provisions of the EU Construction Products Directive

BS EN 13043, Annex ZA, addresses the provisions of the EU Construction Products Directive [2]. Both BS EN 13043 and its Annex ZA were produced under a Mandate [1] given by the European Commission and the European Free Trade Association to CEN.

Annex ZA is described as "informative" but its contents become mandatory to ensure compliance with the Mandate and/or where CE marking is applicable to aggregates.

BS EN 13043 identifies the characteristics that are subject to regulatory requirements for the specified application in one or more European Member States. There is no obligation to determine or declare a value for a characteristic in a Member State where there is no regulatory requirement for that characteristic, unless it is subject to a "threshold" value.

Conformity with these identified requirements confers a prescription of fitness of the aggregate and fillers for the intended uses indicated in BS EN 13043. However, to meet the provisions of the EU Construction Products Directive [2] fully, aggregates are also required to conform to any transposed European legislation and national laws relating to any dangerous substances referred to in BS EN 13043.

BS EN 13043, Annex ZA, also makes reference to the type of compliance requirement, for example:

- pass/fail threshold value;
- categories;
- declared value.

BS EN 13043, Annex ZA, also details the allowed levels for attestation of conformity as "2+" or "4". The requirements of the two levels are summarized in Table 9.

In the UK, the level of attestation for aggregates is "4", with the exception of aggregates for use in skid-resistant surfacings.

Coarse aggregates for use in skid-resistant surfacings have been defined as high specification aggregates with an influence on road safety. As a consequence of this, aggregates with a declared PSV of 58 or higher are subject to a level of attestation of "2+".

For other applications where the purchaser has particular concerns that the integrity of the aggregate will have a major impact on:

a) safety when in use; or

b) other performance properties of an installation (for example, asphalt applications involving the storage or containment of dangerous substances),

the purchaser should adopt appropriate contract-specific quality assurance procedures or acceptance testing regimes to give the required degree of confidence. It is not appropriate to expect higher attestation of conformity requirements, as these are general national requirements related to the demonstration of fitness to be placed on the market for general use and are not readily flexible to meet contract-specific needs. However, wherever possible, such additional requirements should follow the same basic format as those in BS EN 13043.

Table 9 **Levels of attestation of conformity in accordance with the EU Construction Products Directive [2] and referred to in BS EN 13043**

Tasks	**Conformity attestation EU numbering system**	
	2+	4
Tasks for the producer		
Factory production control	Yes	Yes
Further testing of samples taken at a factory according to a prescribed test plan	Yes	No
Initial type testing	Yes	Yes
Tasks for third party notified accreditation body		
Certification of factory production control	Yes	No
Surveillance of factory production control	Yes	No

BS EN 13043, Annex ZA, identifies the requirements for CE marking and labelling.

The UK and two other EU Member States do not currently consider that there is a mandatory requirement to CE mark products. Consequently, there is no current legal requirement to CE mark aggregates supplied within the UK or to or from Ireland and Sweden. CE marking will be required for aggregates supplied to or within another Member State, translated into the language of the Member State supplied.

If producers voluntarily or otherwise decide to CE mark their aggregates, the producers need to strictly comply with the indicated requirements. Where the CE mark identifies a particular characteristic, the supplier is required to indicate the category or declared value appropriate to the aggregate. The purchaser is responsible for confirming that the declaration of properties on the CE mark conforms to their particular requirements.

It should also be noted that, where aggregates are placed on the market in a European Member State where there is no regulatory requirement for a particular characteristic, the supplier is not required to determine the performance for this characteristic. In this case "no performance determined" may be stated in the CE marking information.

BS EN 13043, Annex ZA, also provides a link with national regulations for dangerous substances. Procedures to ensure compliance with national regulations are still being developed.

Annex A (informative) Example specification for aggregates for surface treatments

An example format of a preferred specification for aggregates for surface treatments is given in Table A.1.

Table A.1 **Example specification for 10 mm aggregate for surface treatments**

Property	Category
Grading	6.3/10 G_c85/20
Fines content	f_1
Flakiness index	FI_{20}
Resistance to fragmentation	LA_{30}
PSV	Site specific[A)]
AAV	Site specific[A)]
Durability:	
– Water absorption to BS EN 1097-6, pyknometer method	$WA_{24}2$
– For WA > 2%, magnesium sulfate soundness	MS_{25}

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

[A)] Insert appropriate category from BS EN 13043.

Annex B (informative) Example specification for aggregates for specialized surfacings

An example format of a preferred specification for aggregates for specialized surfacings, e.g. thin surfacings, is given in Table B.1.

Table B.1 **Example specification for aggregates for specialized surfacings**

Property	Category
Grading	To meet the grading requirements appropriate for the end product
Fines content (coarse and fine)	To meet the grading requirements appropriate for the end product
Flakiness index	FI_{20}
Resistance to fragmentation	LA_{30}
PSV	Site specific[A)]
AAV	Site specific[A)]
Durability:	
– Water absorption to BS EN 1097-6, pyknometer method	$WA_{24}2$
– For WA > 2%, magnesium sulfate soundness	MS_{25}

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

[A)] Insert appropriate category from BS EN 13043.

Annex C (informative) Example specification for 20 mm chippings for rolling into rolled asphalt

An example format of a preferred specification for 20 mm chippings for rolling into rolled asphalt is given in Table C.1.

Table C.1 **Example specification for 20 mm chippings for rolling into rolled asphalt**

Property	Category
Grading	14/20 G_c85/20
Fines content	f_1
Flakiness index	FI_{20}
Resistance to fragmentation	LA_{30}
PSV	Site specific[A)]
AAV	Site specific[A)]
Durability:	
– Water absorption to BS EN 1097-6, pyknometer method	$WA_{24}2$
– For WA > 2%, magnesium sulfate soundness	MS_{25}

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

[A)] Insert appropriate category from BS EN 13043.

Annex D (informative) Example specification for filler aggregate

An example format of a preferred specification for filler aggregate is given in Table D.1.

Table D.1 **Example specification for filler aggregate**

Property	Requirement
Grading	As BS EN 13043
Loose bulk density in kerosene	As BS EN 13043 (range 0.5–0.9 Mg/m^3)

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

Annex E (informative) Example specification for aggregate for asphalt mixes (other than specialist surfacings)

An example format of a preferred specification for aggregate for asphalt mixes (other than specialist surfacings) is given in Table E.1.

Table E.1 **Example specification for aggregate for asphalt mixes (other than specialist surfacings)**

Property	Category
Grading	To meet the grading requirements appropriate for the end product
Fines content (coarse and fine)	To meet the grading requirements appropriate for the end product
Flakiness index	FI_{35}
Resistance to fragmentation	LA_{30}
PSV	Site specific (wearing course)[A)]
AAV	Site specific (wearing course)[A)]
Durability:	
– Water absorption to BS EN 1097-6, pyknometer method	$WA_{24}2$
– For WA > 2%, magnesium sulfate soundness	MS_{25}

NOTE Specifying values for all other properties described is not necessary because they are not appropriate to the particular application at end-use or origin of the aggregate.

A) Insert appropriate category from BS EN 13043.

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3) Available at: http://www.aggregain.org.uk/quality/quality_protocols/

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