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# Applicability of Alternative Aggregates in Asphalt Pavements and Their Performance Requirements

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## ABSTRACT

The current Design Manual for Roads and Bridges in the UK provides guidance in the HD35 on conservation and use of secondary and recycled materials in pavement construction. This paper aims to identify the existing functional performance requirements of pavement construction materials in the bituminous layers, in order to allow as wide a range as is practicable of recycled materials to be reused in asphalt pavements,. It provides a review of the new European standards and their complementary British standards and the Specification for Highway Works with respect to material compliance and limitations in their usage. It also aims to highlight what changes have been introduced in the new asphalt standards with regards to the use of recycled materials since the EU harmonisation in 2008. The end product testing requirements are also reviewed to establish how suitable they are for performance specification and conformity of production tests.

## INTRODUCTION

This paper summarises the tasks carried out as part of the feasibility study for the UK Highways Agency to deal with the review and definition of performance requirements for the use of alternative materials in pavements. This study was to update the draft HD35/04: "Conservation and the use of secondary and recycled materials in pavement construction", of the Design Manual for Roads and Bridges (DMRB) [The Stationery Office, 2004], as part of the current review process. The objective was to incorporate performance standards and thereby encourage innovation in the use of recycled and secondary materials for pavement construction.

The recycled and secondary aggregate (RSA) materials considered in this document are based on the existing matrix of acceptable materials and pavement layers in the current HD35/04 (see Table 1). The table and text of HD35/04 are intended to extend the permitted range of materials beyond those for which Specific Provision is given in the *Specification for Highway Works* (*SHW*) [Highways Agency et al. 1998]. It also includes materials for which General Provision is given, i.e. not mentioned in the *SHW* but permitted if the material complies with the Specification. The user is, however, invited to refer to the relevant Specification series clauses as certain restrictions still apply: for example, unburnt colliery spoil could be used as general fill material but not as selected fill material. Finally, materials such as steel slag and recycled glass, with potential for volume instability and alkali-silica reaction, are generally excluded from asphalt with the clause that Overseeing Organisations may permit them on a case by case basis if sufficient provision for minimising the risk is

included. HD35/04 also provides more guidance and information on secondary materials as binders, with warning of potential problems, e.g. expansion if gypsum is used.

**Table 1. HD35/04 provisions for the use of secondary and recycled materials [The Stationery Office, 2004]**

| Application and Series → | Pipe bedding | Embankment and fill | Capping | Unbound materials for sub-base | Hydraulically bound mixtures for sub-base and base | Bitumen bound layers | PQ concrete |
|---|---|---|---|---|---|---|---|
| Materials ↓ | 500 | 600 | 600 | 800 | 800 | 900 | 1000 |
| Blast Furnace Slag | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Burnt Colliery Spoil | x | ✓ | ✓ | ✓ | ✓ | x | x |
| China Clay Sand/Stent | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Coal Fly Ash / Pulverised Fuel Ash | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ |
| Foundry Sand | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Furnace Bottom Ash | ✓ | ✓ | ✓ | x | ✓ | x | x |
| Incinerator Bottom Ash Aggregate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Phosphoric Slag | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Recycled Aggregate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Recycled Asphalt | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Recycled Concrete | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Recycled Glass | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Slate Aggregate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Spent Oil Shale Blaise | x | ✓ | ✓ | ✓ | ✓ | x | x |
| Steel Slag | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Unburnt Colliery Spoil | x | ✓ | x | x | ✓ | x | x |

✓ Indicates Specific Provision (permitted as a constituent if the material complies with the *SHW*) or General Provision (permitted as a constituent if the material complies with the *SHW* requirements but not named within the *SHW*).

x Not permitted.

HD35/04 discusses the need for more frequent testing to enable reuse of RSA in high value applications (i.e. high levels within the road pavement construction) due to their anticipated variability. It therefore suggests that *"it may prove more efficient and cost effective to re-use"* in the example, road planings "*lower down in the pavement or in the foundations, or alternatively to limit replacement levels in higher layers to percentages which will minimise additional testing*". Notably, Table 1 does not include the following materials, although some of them are mentioned in the text complementing the table in the HD35/04: Recycled tyres, recycled plastic, fired ceramic waste, spent railway ballast, quarry fines, non-ferrous slags.

There are some limitations on the use of RSA in road applications. For example, some materials can only form part of a composite mixture for certain applications because of their grading; inclusion in HD35 does not mean that the material can be used on its own for any given applications. Some materials are only permitted in certain amounts for some

applications, e.g. recycled asphalt or Incinerator bottom ash aggregate (IBAA). Details are given in the *SHW*, not in HD35/04. The provisions for the use of RSA in relevant asphalt and material standards are discussed next.

## COMPLIANCE WITH ASPHALT STANDARDS

### BS EN 13108

The EU harmonized British Standard BS EN 13108, relates to material specifications in bituminous mixtures which was published in 10 Parts. Only five parts have been referred to in the revised Series 900 of the Specification for Highway Works [SHW, 2008], with the most relevant ones including:

1. BS EN 13108-1 [BSI, 2006a]: Asphalt concrete which applies to coated macadam and EME2 mixtures used in base and binder course layers.

2. BS EN 13108-4 Hot rolled asphalt which is a direct replacement for BS 594-1.

3. BS EN 13108-20 Initial type testing that requires the supplier to declare properties established using mixture design procedures and site trials

### BS EN 13108-1: Asphalt concrete

Asphalt concrete includes coated macadam and EME2 mixtures used in base and binder course layers. In this standard, the requirements are grouped into two broad categories, including requirements for the constituent materials and requirements for the mixtures.

### Requirements for the constituent materials

This covers general suitability, binder, aggregates, reclaimed asphalt and additives.

1. General suitability: This requirement does not make any particular reference to the source of the constituent materials but their use for asphalt concrete is only permitted on the basis of established suitability, resulting from (one or more of) a European Standard, a European Technical Approval (ETA) or material specifications based on a demonstrable history of satisfactory use in asphalt. The evidence for their suitability may be based on research combined with evidence from practice. This standard states "*In the European asphalt industry it is common practice to use additives like inorganic or organic fibres, pigments, waxes etc., which are not covered by a European Standard or ETA. The standard allows the use of those materials*.".

2. Binder requirements: In terms of the binder constituents, the only reference made to alternative materials is for reclaimed asphalt. The amount of reclaimed asphalt is limited to 10% and 20% by mass for surface course and binder course layers, respectively. When these amounts are exceeded, the penetration or the softening point of the binder in the resulting mixture shall meet the penetration or softening point requirements of the selected grade for each of the surface and binder course layers separately.

3. Aggregate requirements: The requirements for aggregates that can be used for asphalt concrete are given by reference in that they have to comply with BS EN 13043 [BSI, 2002b]. The only exception is that, for fundamentally specified mixtures, angularity cannot be specified for fine aggregates or stiffening properties for filler.

4. Additives: The Standard does not make specific reference to the type of additives that can be used in the asphalt, but does refer to the "General Suitability" criterion, established through European Standard, European Technical Approval or Specifications for materials based on a demonstrable history of satisfactory use in asphalt.

Hence, there is nothing explicitly excluding alternative aggregates providing they comply with BS EN 13043 [BSI, 2002b].

5. Requirements for reclaimed asphalt: The nominal aggregate size of the reclaimed asphalt cannot exceed the maximum size of the aggregate used in the mixture. The aggregate properties of the reclaimed asphalt need to fulfil the requirements selected for the aggregate for the mixture. No specific guidance is provided as to the nature of the selected requirements. It could be implied that the requirements given for the performance specification of the mixture ingredients (i.e. adhesion of binder to aggregate, stiffness, resistance to permanent deformation, resistance to fatigue, skid resistance, resistance to abrasion and reaction to fire) should also apply to the reclaimed aggregates.

**Requirements for the mixture**

BS EN 13108-1 sets out two further groups of requirements, these being Fundamental Requirements and Empirical Requirements. Both of these also need to comply with the General Requirements. Among these requirements, items that relate to end performance specification, and the roles that aggregates could play in the mix, are listed here:

*General requirements*, including grading, void content, adhesion of the binder to the aggregate, resistance to abrasion by studded tyres, resistance to permanent deformation, reaction to fire, water sensitivity, resistance to fuel for application on airfields, resistance to de-icing fluid for application on airfields, and resistance to the temperature of the mixture.

*Empirical requirements*, including: Marshall values for application on airfields, voids filled with bitumen, voids in mineral aggregate, and void content at 10 gyrations.

*Fundamental requirements*, including: Stiffness, resistance to permanent deformation in tri-axial compression test (not to be combined with that given in general requirements), and resistance to fatigue.

In addition, BS EN 13108-1 [BSI, 2006a] makes reference to dangerous substances and the requirements applicable to the products falling within their scope (e. g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements also need to be complied with, when and where they apply. Currently, no test specification is provided within this Standard. For example, any sulphur containing products that are added to asphalt could sometimes create problems of health or safety when overheated as hydrogen sulphide can be produced.

The requirements for aggregates that can be used for other types of asphalt in other parts of BS EN 13108 are similar except that there is no set of fundamental requirements.

When used in 'very thin layers', as specified in BS EN 13108-2 [BSI, 2006b], the amount of reclaimed asphalt cannot not exceed 10 per cent by mass of the total mixture. In setting out the role of aggregates in the end performance specification within very thin layers, the General Requirements set out in BS EN 13108-1 [BSI, 2006a] for asphalt concrete also apply.

In addition, a requirement for mechanical stability (i.e. maximum proportional rut depth) is also specified.

### BS EN 13108 - 4: Hot rolled asphalt

The British Standards for hot rolled asphalt, namely BS 594-1 [BSI, 2003a], was withdrawn in January 2008 when harmonised with the European standards. This was replaced with BS EN 13108: Part 4 [BSI, 2006c].

Previously, BS 594-1 made specific references to material types as coarse aggregates for hot rolled asphalt which were limited to the following four types: Crushed rock of one or more of a set of specified groups, gravel of the same set of groups or flint, blast-furnace slag, and steel slag within a range of compacted bulk densities. Therefore, all other types of aggregate, including alternative aggregates, were explicitly excluded. It also made reference to a guidance on the use of secondary and recycled aggregates, e.g. Specification for Highway Works (SHW). Whilst not explicitly permitting such aggregates, the note did imply that a departure from the standard was acceptable by including such alternative aggregates that were found to be suitable. However, little guidance was given as to how to demonstrate suitability other than by inclusion in the *SHW* [Highways Agency et al. 1998], which was then dependant on acceptance by the Highways Agency or other overseeing organisation. The requirements of the *SHW* – Series 900 are discussed later in this paper.

BS EN 13108-4 for hot rolled asphalt makes no reference to recycling or any other materials except for compliance with the aggregate standard BS EN 13043, as noted previously in the discussion of BS EN 13108-1. The only explicit requirement is with respect to reclaimed asphalt and the amount that could be used in surface course and binder course layers (i.e. 10% and 20% by weight, respectively) without requiring additional testing with respect to penetration or the softening point of the binder in the resulting mixture. All other requirements are similar to those listed for BS EN 13108-1.

## COMPLIANCE WITH AGGREGATE STANDARDS

### BS EN 13043

BS EN 13043 [BSI, 2002b] was fully implemented on 1 January 2004, when all conflicting British Standards were withdrawn. Therefore, no British Standard has been considered in this review.

The scope of BS EN 13043 [BSI, 2002b] states: "*This European Specification specifies the properties of aggregates and filler aggregate obtained by processing natural or manufactured or recycled materials for use in bituminous mixtures and surface treatments for roads, airfields and other trafficked areas*". Therefore, the standard explicitly includes alternative aggregates unless they fail to comply with one or more requirements for specific properties.

BS EN 13043 [BSI, 2002b] does not give fixed requirements for the various properties covered but defines categories for each property from which a specifier can choose. The choice of a category for one property does not generally affect the choice for another, allowing each level to be set according to the particular requirements in the final use. The properties covered, including those for which there are no categories but for which values have to be declared, are:

*Geometrical requirements*: Aggregate sizes (*d*/*D*), grading, fines content, fines quality, shape of coarse aggregate, percentage of crushed and broken surfaces in coarse aggregate, and angularity of fine aggregate.

*Physical requirements*: Resistance to fragmentation of coarse aggregate, resistance to polishing of coarse aggregate for surface courses, resistance to surface abrasion, resistance to wear of coarse aggregate, resistance to abrasion from studded tyres of coarse aggregate to be used for surface courses, particle density (results to be declared), water absorption (results to be declared), bulk density (results to be declared), durability – water absorption value as a screening test for freeze-thaw resistance, durability – resistance to freezing and thawing, resistance to thermal shock (results to be declared), affinity of coarse aggregates to bituminous binders (results to be declared), and "sonnenbrand" of basalt.

*Chemical requirements:* Chemical composition (results to be declared), coarse lightweight contaminators, dicalcium silicate disintegration of air-cooled blast-furnace slag (results to be declared), iron disintegration of air-cooled blast-furnace slag (results to be declared), and volume stability of steel slag aggregate.

The properties should not prove an insurmountable problem for alternative aggregates that have been proved to be suitable for mixtures in the relevant end use. However, the relevant categories will need to be appreciated by the specifier and, if necessary, additional chemical requirements similar to those for varies types of slag may need to be added.

CE Marking: With the adoption on 1 January 2003, of the harmonised European Standard for aggregates, BS EN 13043 [BSI, 2002b], all aggregates placed on the market effectively needed to be CE marked in accordance with that standard. The implication is that, before putting an alternative aggregate on the market, the supplier will have to test it in order to identify which category it falls into for each property. The CE marking will have to list these categories, although it can include the "no requirement" category. The concept is that the categorised properties of an aggregate can be compared with those required for a specific job to give assurance that it is appropriate.

**PD 6682-2**

British Standards Institution (BSI) has issued guidance documents with preferred options for use in the UK including PD 6682-2 [BSI, 2003e] on aggregates for bituminous mixtures and surface treatments. This is because of the large number of possible combinations of categories that could be used, as well as to explain the changes with the introduction of the European Standards for aggregates. Although such guidance documents cannot add or subtract from the requirements given in a European Standard, the advice given is regarded as the best available advice and, as such, has to be followed by public procurement. Hence, the available options listed in the previous section are effectively restricted which, if the selected options exclude the values that can be regularly achieved by an alternative aggregate, could exclude these aggregate types.

The advice on geometric properties should not exclude any quality controlled alternative aggregate source other than, possibly, the flakiness of coarse aggregates, where the recommended categories are $FI_{35}$ for hot rolled asphalt and coated macadam and $FI_{20}$ for porous asphalt and pre-coated chippings; no advice is given for other generic mixture types such as thin asphalt concrete and stone mastic asphalt. These limits may limit alternative aggregates produced in such a manner as to produce flaky particles, such as shredded plastic. Furthermore, the relevance of the requirement may be less if the flaky particles are more

malleable than natural aggregate and will bend during the compaction process to allow better packing.

Advice is available on the following physical properties for which categories are to be specified: Resistance to fragmentation of coarse aggregate, resistance to polishing of coarse aggregate for surface courses, resistance to surface abrasion, resistance to wear of coarse aggregate, resistance to abrasion from studded tyres of coarse aggregate to be used for surface courses, durability – water absorption value as a screening test for freeze-thaw resistance, and durability – resistance to freezing and thawing. Therefore, the use of PD 6682-2 [BSI, 2003e] in conjunction with BS EN 13043 [BSI, 2002b] for specifying the aggregates to be used in asphalt should not preclude the incorporation of potentially suitable alternative aggregates.

### *SHW* - Series 900

Since the last review of the Specification for Highway Works (SHW): Series 900, there has been a considerable move towards the recognition of alternative materials for use in asphalt. The current version of SHW – Series 900 [Highways Agency et al. 2008], dated 1998, permits the use of recycled coarse aggregate or recycled concrete aggregate in bituminous materials. Clause 901/3 makes reference to compliance with BS EN 13043 for natural, recycled unbound and manufactured (artificial) aggregates that need to be clean, hard and durable. It states: "*Where recycled coarse aggregate or recycled concrete aggregate is used in bituminous mixtures, it shall have been tested in accordance with Clause 710 and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.*" In Clause 901/4 it explicitly states: "*The use of aggregate derived as a by-product during the extraction of china clay is permitted. It shall comply with the requirements of this clause, BS EN 13043 and the detailed requirements of the relevant annex of BSI PD6691.*"

Series 900 also permits the use of crushed slate aggregate in base and binder course layers. It needs to comply with the requirements of the BS EN 13043, and the detailed requirements of the relevant annex of BSI PD 6691, except for the flakiness category, which shall be subject to prior approval by the Overseeing Organisation. However, mixtures of crushed slate aggregate with coarse aggregate of a different geological type are not permitted.

The materials used in bituminous mixtures are grouped into six categories (in accordance with Clause 710), including asphalt, brick and block (other than lightweight block masonry), concrete and concrete products, lightweight block masonry, normal weight unbound aggregate and other materials such as metal, clay lumps, plastics, wood, glass etc). The content of all foreign materials (including wood, plastic and metal) cannot exceed one per cent by mass. The following requirements are imposed: Hardness requirement - resistance to fragmentation, durability requirement - resistance to freezing and thawing, cleanness requirement, and chemical requirements in relation to dicalcium silicate disintegration, iron disintegration, and volume stability:

### Clause 902: Reclaimed Asphalt

These materials may be used in the production of bituminous surface course, binder course including binder and regulating course, and base. The maximum amount of reclaimed bituminous material permitted is 10 per cent by mass in surface course and 50 per cent in all other layers. Other materials for recycling in bituminous mixtures could only be used with the approval of the Overseeing Organisation. When the amount of reclaimed bituminous material comprises 10 per cent by mass or less, compliance with Clause 902 is not required.

However, when it exceeds 10 per cent by mass, the Contractor is required to carry out trials to demonstrate that the mixed materials comply with the requirements of Clause 902. There is no requirement to check the quality of the aggregate in the recycled materials. It is presumed that as these come from existing pavements, or from a material that was intended for new works, the aggregate quality is adequate for reuse. When more than 25% of reclaimed asphalt is used in designed base or binder course mixture, the Specification requires cores to be taken to be tested for stiffness of the product. It sets out minimum stiffness levels for nominal binder grade of mixture.

**Clause 946: In Situ Cold Recycled Bitumen Bound Material**

The primary aggregate is the cold pulverised material from the existing road structure. The primary binder (stabilising agent) is a foamed bitumen, with cement or lime as an adhesion agent. The aggregate grading could also be adjusted by the addition of a filler. The pulverised granular material should contain no more than 2% of organic matter.

There are clear requirements in the Specification with respect to the end performance of the in situ cold recycled bitumen bound materials. Within 24 hours of completion, the as-installed performance of the stabilised layer needs to be evaluated using a dynamic plate loading or Penetrometer technique to determine values of elastic modulus at points on a nominal grid pattern. Where these criteria are not met, the full extent of the non-compliant material is determined and appropriate remedial measures implemented. This may involve either a delay in construction to allow further curing and stiffening of the layer to occur, or a repeat of all or part of the recycling process, followed by re-evaluation, until a compliant material is achieved.

Also, within 270 days of completion of the surfacing works, a Falling Weight Deflectometer survey is required to assess pavement stiffness values.

**Clause 948: Ex Situ Cold Recycled Bound Material**

This process is becoming more favourable in the UK where the pavement layers contain high levels of carcinogenic properties such as high Poly-Aromatic Hydrocarbons (PAH) ingredients. The cold recycled materials are designed and produced to form the foundation or main structural layer of the road pavement. The Specification allows materials from three sources to be used in this process, namely: asphalt, concrete or granular material planed or excavated from a road or other paved area; primary, secondary or recycled aggregate from other sources; and fillers from primary or secondary sources (e.g. PFA).

This process comprises producing base and binder courses in a fixed or mobile mixing plant using graded aggregate from the three sources. The Specification also allows other materials such as granulated blast furnace slag, lime, fly ash (PFA) used as either as filler or pozzolan and un-weathered 0/4mm Basic Oxygen Slag to be used in the mixture. The aggregates are bound with cementitious, hydraulic or bituminous binders, separately or in combination.

The Specification requires cylindrical samples to be prepared, conditioned in a controlled environment and then tested for end product criteria, including particle size distribution, moisture content, relative in situ density, and Indirect Tensile Stiffness Modulus or Indirect Tensile Test.

**Proprietary thin surfacing systems**

There is an increasing use of the many proprietary asphalt mixtures available on the market which could, theoretically, contain alternative aggregates. Proprietary products may be sold for commercial applications such as factory roads and car parking areas etc without having to comply with any particular specification if considered acceptable to the purchaser in anticipated performance, warranty and price, but for larger jobs, and when the client is a public body, the expected level of performance has to be ensured by adherence to a specification. For proprietary surfacing materials, the specification can make use of the Highway Authorities Product Approval Scheme (HAPAS) by requiring HAPAS certification with the appropriate values of the relevant properties [BBA, 2000].

## END PRODUCT PERFORMANCE REQUIREMENTS

Setting end performance requirements for each pavement layer, including the bitumen-bound surfacing layers, is at an early stage of development. There can be interaction issues between different pavement layers that could prevent the individual layers in the group achieving the performance anticipated for that layer in isolation. The review of various standards shows that the inclusion of alternative aggregates in a given pavement layer should not necessarily compromise the integrity of that layer or any of the adjacent layers. Hence, as a start, the European Standards have concentrated on the end product test specifications which could show the impact of alternative aggregates. Those tests that deal specifically with the quality of bitumen-bound layers, as prescribed by BS EN 13108-8 [BSI, 2005c] have been reviewed and a summary is given in Table 2.

**Table 2. Provisional end product tests for bitumen-bound layers [BSI, 2006d]**

| Constituent | | Test method |
|---|---|---|
| BS EN 13043 aggregates | Grading | BS EN 933-1 [BSI, 1999a] |
| | Density | BS EN 1097-6 [BSI, 2000] |
| BS EN 13043 filler | Grading | BS EN 933-10 [BSI, 2001] |
| | Density | BS EN 1097-7 [BSI, 1999b] |
| Grading of granulated reclaimed asphalt | | BS EN 12697-2 [BSI, 2002a] |
| Water sensitivity (performance based) | | BS EN 12697-12 [BSI, 2003c] |
| Resistance to abrasion by studded tyres | | BS EN 12697-16 [BSI, 2004a] |
| Resistance to permanent deformation of roads | | BS EN 12697-22 [BSI, 2003d]: |
| Resistance to permanent deformation of airfields | | BS EN 12697-34 [BSI, 2004c] |
| Stiffness | | BS EN 12697-26 [BSI, 2004b] |
| Resistance to fuel on airfields | | BS EN 12697-43 [BSI, 2005b] |
| Resistance to de icing fluid on airfields | | BS EN 12697-41 [BSI, 2005a] |

## CONCLUSIONS

The introduction of the harmonised European Standards for asphalt removes any explicit barrier to the use of alternative aggregates in asphalt mixtures, provided both the aggregates and mixture comply with the performance categories specified. To allow wider uptake of alternative materials in asphalt, it may be necessary for the asphalt specifications to include a simple requirement for, say, a proportion of the aggregate to be of one or more alternative aggregate types and a reference to the specification for them. This requires that:

1. The specification identifies the alternative aggregates that are covered and the category for each property that is acceptable by reference to, or even inclusion in, BS EN 13043.

2. Suitable clauses are incorporated into BS EN 13108 and BS EN 13043. This needs international agreement and endorsement by the committees of Comité Européen de Normalisation (European Committee for Standardisation, CEN).

3. In the interim, national guidance documents to the above European standards, such as PD 6682-2 issued by the British Standards Institution (BSI), do include general advice on maximising the use of alternative materials.

4. In the next revision of BS EN 13108 and BS EN 13043, national standard institutions such as BSI reflect on their experience with regards to explicitly allowing a certain proportion of mixture to include materials from alternative sources. This can provide a benchmark across Europe to assess the reduction in the usage of primary aggregates in asphalt mixture.

The end product / performance criteria discussed here provide a starting point for development in connection with other requirements given throughout this paper. It is evident that there is a desire in the market today to effectively utilise this abundant source of recycled and secondary aggregates, reducing the need for primary aggregates in road construction, potentially reducing transport distances, and achieving real benefits in sustainability and cost.

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