

**TRANSPORT SCOTLAND INTERIM AMENDMENT No 35/15:
TS2010 Surface Course Specification and Guidance**



**TRANSPORT SCOTLAND (Executive Agency of the Scottish
Government)
TRUNK ROAD AND BUS OPERATIONS (Standards and Asset
Management)**

**Transport Scotland Interim Amendment 35/15:
TS2010 Surface Course Specification and Guidance**

SUMMARY

This Interim Amendment provides revised guidance on the Specification for surface course, TS 2010, intended for use on the trunk road network in Scotland. It also amends HD36/06.



1. BACKGROUND

Transport Scotland first published TSIA 35 in 2010 following a research project which worked closely with the industry supply chain to reconfigure the SMA specification. The study was in response to repeated examples of shorter than anticipated service life from various proprietary Thin Surface Course Systems (TSCS) and generic Stone Mastic Asphalts (SMA). The Specification seeks to provide a more durable surface course material and to improve quality control during the implementation phase. This Interim Amendment provides revised direction on the process for Type Approval Installation Trials (TAIT) and on various performance measures within the Specification. It also provides the necessary amendments to HD36/06 and takes cognisance of the Environmental Noise (Scotland) Regulations 2006.

2. ACTION

2.1 Clause 2.9 and Table 2.2S of the Design Manual for Road and Bridges Volume 7 Section 5 Part 1 HD 36/06 are to be replaced with the amended versions in Appendix A.

2.2 TS2010 will be a permitted surface course material on both new build and maintenance schemes on the trunk road network in Scotland, where specified in tender documents. TS2010: Specification and Guidance Issue 03 (April 2015) replaces TS2010 Issue 02 (January 2012) and is included as Appendix B.

3. IMPLEMENTATION

This Transport Scotland Interim Amendment shall be implemented immediately.

4. FURTHER INFORMATION

Any questions or feedback regarding the use or content of this TSIA should be directed to Transport Scotland TRBO: standards@transportscotland.gsi.gov.uk.

5. Notification

This Specification was notified in draft to the European Commission in accordance with Directive 98/34/EC, as amended by Directive 98/48/EC.

Appendix A

HD36/06: Revised Clause 2.9

The surfacing options permitted in Scotland shall be those shown in amended Table 2.2S below. Where material use is not permitted without restriction, "Approval to Proceed" shall be obtained from the Overseeing Organisation. Where a scheme is within, or near to, a Noise Management Area (NMA), which has been identified in accordance with The Environmental Noise (Scotland) Regulations 2006, increased emphasis shall be placed on the noise attenuation performance when choosing surfacing materials or systems. Further information on the location of NMAs can be obtained from the Overseeing Organisation.

HD36/06: Table 2.2S

Scotland

All construction types

Is Scheme within Noise Management Area?	Use without Approval	Approval to Proceed required
No	Hot Rolled Asphalt (Note 1) TS2010 SMA Surface Course	Thin Surface Course System Generic SMA Porous Asphalt Surface Dressing Exposed Aggregate Concrete Brushed/ Burlap Drag/ Tined Concrete Slurry/Microsurfacing
Yes	Approval to Proceed required in all cases	Hot Rolled Asphalt TS2010 SMA Surface Course Thin Surface Course System Porous Asphalt Generic SMA Slurry/Microsurfacing

Note 1: Refer to Overseeing Organisation on rigid construction

Table 2.2S (Scotland): Permitted Pavement Surfacing Materials for New and Maintenance Construction

Appendix B
TS2010 Version 3



**TRANSPORT
SCOTLAND**

An agency of  The Scottish Government

TS2010

Surface Course Specification & Guidance

Issue 03 (October 2015)

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Contents

1	Introduction	1
1.1	TS2010 Surface Course	1
1.2	Relationship to Overseeing Organisation National Manuals	1
1.3	Specification with Notes for Guidance	2
2	TS2010 Stone Mastic Asphalt Surface Course - Specification	3
2.1	General	3
2.2	Constituent Materials	3
2.2.1	Binder	3
2.2.2	Aggregate	3
2.2.3	Added filler	4
2.2.4	Recycled material	4
2.2.5	Additives	5
2.3	Composition	5
2.3.1	Grading and binder content	5
2.4	Air Voids Content	8
2.4.1	Laboratory prepared	8
2.4.2	Laid and compacted mat	8
2.5	Binder Drainage	9
2.6	Water Sensitivity	9
2.7	Resistance to Permanent Deformation	9
2.8	Temperature of the Mixture	9
2.9	Grit for Application to Surface Course	9
2.9.1	General	9
2.9.2	Material	9
2.9.3	Application	10
2.10	Skid Resistance	11
2.10.1	Early-life skid resistance	11
2.10.2	GripTester Procedure	11
2.11	Texture	12
2.12	Type Approval Installation Trial (TAIT)	13
2.12.1	Fundamental requirement	13
2.12.2	General requirements	13
2.12.3	Grip Numbers – Classification requirements	13
2.12.4	Data recorded	15
2.12.5	Information availability	15
2.12.6	Approval Certificate	15
NG 2	TS2010 Stone Mastic Asphalt Surface Course - Notes for Guidance	18
NG 2.1	General	18
NG 2.2	Constituent Materials	18
NG 2.2.1	Binder	18
NG 2.2.2	Aggregates	19
NG 2.2.4	Recycled materials	20
NG 2.2.5	Additives	20

NG 2.3	Composition	20
NG 2.3.1	Grading and binder content	21
NG 2.4	Air Voids Content	22
NG 2.4.1	Laboratory prepared	22
NG 2.4.2	Laid and compacted mat	22
NG 2.5	Binder Drainage	22
NG 2.6	Water Sensitivity	23
NG 2.7	Resistance to Permanent Deformation	23
NG 2.9	Grit for the Application to Surface Course	24
NG 2.9.2	Material	24
<i>NG 2.10</i>	Skid Resistance	24
NG 2.11	TAIT	26
NG 2.11.2	General requirements	26
NG 2.12	Paving and Compaction	27
NG 2.12.1	Joints	27
NG 2.13.2	Bond coats	28
NG 2.13.3	Compaction	28
NG 2.14	Surfacing Selection	29
3	References	31
Annex A	Example of Approval Certificate	32

1 Introduction

Following problems with the quality and in-service performance of Stone Mastic Asphalt, Transport Scotland worked closely with the industry to put in place measures to adjust the domestic specification and to improve quality control. In parallel with this work, the Agency commissioned TRL to undertake a programme of research to seek out best practice among countries on a similar latitude to Scotland. It quickly became apparent that Germany was producing SMA that was reliable, durable and fit-for-purpose. Research became concentrated on our European neighbour's specifications and practices.

This specification and guidance is based on research and study visits to Germany to gain first-hand knowledge of German specifications, practice and experience as well as the construction and monitoring of full-scale road trials. However, any new specification requires controlled introduction and fine tuning over time. Transport Scotland has agreed with our UK colleagues in the Highways Agency and Welsh and Northern Ireland Governments that this will be undertaken through the UK DMRB Technical Project Board process and in partnership with UK industry practitioners.

We are grateful to German road authorities at state and local level as well as German practitioners and academics who all freely assisted TRL with their time and knowledge. We are also grateful to our own industry for their enthusiasm and assistance with the early trials and the development of this Specification and Guidance.

1.1 TS2010 Surface Course

This new surface course specification, TS2010, comprises a range of Stone Mastic Asphalt mixtures that are based on German specifications and experience. The Stone Mastic Asphalt (SMA) mixtures will contain a gap-graded aggregate mix, polymer modified bitumen, and additives, including fibres. The newly-laid SMA will be treated with grit to increase the early-life skid resistance.

The decision to develop this specification for use in Scotland has been based on its proven track record in Germany.

Research has indicated that it can provide the following benefits:

- superior durability
- lower noise levels
- good skid resistance, including early-life
- high resistance to permanent deformation
- decreased life-time costs
- thin layer application
- excellent ride quality
- reduced use of HFS
- reduced use of expensive imported aggregates
- increased use of a wider range of sustainable aggregate sources.

1.2 Relationship to Overseeing Organisation National Manuals

HD36 (DMRB 7.5.1) Surfacing for New and Maintenance Construction, Table 2.2S sets out the permitted pavement surfacing material requirements for the Scottish Trunk Road Network. An amended Table 2.2S has been issued through a Transport Scotland Interim Amendment TSIA No. 35.

1.3 Specification with Notes for Guidance

This specification (TS2010) was drafted in accordance with PD 6691 and is based on the new European Standard for SMA, BS EN 13108-5. The notes for guidance give more advice on the background to the specifications, testing and other best practice approaches to quality control.

2 TS2010 Stone Mastic Asphalt Surface Course - Specification

2.1 General

The stone mastic asphalt (SMA) described within this specification (TS2010) conforms to BS EN 13108-5 where applicable. Such conformity shall be established in accordance with BS EN 13108-206 and BS EN 13108-21.

Specification clause references within this document are included without a prefix (e.g. 2.2.2.1). Notes for Guidance clauses are prefixed by NG (e.g. NG 2.2.5). References relating to other standards and specifications in all cases include reference to the associated source documentation.

Normative and informative reference documents, such as British Standards, European Standards, UK Overseeing Organisations' publications, etc., to which reference is made in this specification relate to the most recent published edition unless otherwise stated.

The requirements of Clauses 901 and 903 of the Specification for Highway Works apply and the 'Surfacing Integrity - Performance Guarantee' shall be in accordance with paragraphs 24 and 25 of Highways Agency Interim Advice Note 154.

Where references and text relate to ENs and other European Standards and Specifications, a comma is used to denote the decimal separator, in accordance with standard European practice.

It should be noted at the outset that this specification requires an increased level of data reporting which is not related to compliance with specific limits. This is to assist future development of the material.

2.2 Constituent Materials

2.2.1 Binder

The binder shall be 75/130-75 polymer modified binder conforming to BS EN 14023. Compliance and test data for the binder proposed shall be included as part of the Type Approval Installation Trial (TAIT), Stage 1 requirements. (See [Table 2.6](#), [NG 2.2.1](#) and [Table NG 2.1](#))

2.2.2 Aggregate

2.2.2.1 Coarse aggregates

The coarse aggregate used in the SMA shall be material substantially retained on a 2 mm test sieve, conforming to all appropriate requirements of BS EN 13043 and consisting of either crushed rock or crushed gravel of one or more of the following groups: basalt, gabbro, granite, gritstone, hornfels, porphyry or quartzite. Aggregates outwith these rock types that can demonstrate a history of successful use as a thin surfacing aggregate may also be proposed.

2.2.2.1.1 Particle density

The particle density shall be determined in accordance with BS EN 1097-6, Clause 8 or 9, depending upon the size of the aggregate, and the results declared.

2.2.2.1.2 *Particle shape*

The flakiness index for the coarse aggregates shall be FI_{20} (See [NG 2.2.2.1.2](#)).

2.2.2.1.3 *Fines content*

The fines content category for the coarse aggregate shall be f_4 .

2.2.2.1.4 *Resistance to polishing*

The polished stone value category for the coarse aggregate shall be declared (see [NG 2.2.2.1.4](#)).

2.2.2.1.5 *Resistance to fragmentation*

The resistance to fragmentation for coarse aggregates shall be LA_{30} .

2.2.2.1.6 *Resistance to surface abrasion*

The resistance to surface abrasion for the coarse aggregate shall be AAV_{12} .

2.2.2.1.7 *Resistance to wear*

The resistance to wear for the coarse aggregate shall be M_{DE} declared

2.2.2.2 *Fine aggregate*

The fine aggregate used in the SMA shall substantially pass a 2 mm test sieve and be a crushed material from one or more of the groups specified in [2.2.2.1](#).

2.2.2.2.1 *Fines content*

The fines content category for fine aggregate shall be f_{22} .

2.2.3 **Added filler**

2.2.3.1 *Type of added filler*

All added filler used in the SMA shall be limestone and shall comply with the grading of BS EN 13043, Clause 4.3.6. Notwithstanding this, hydrated lime may be added up to a maximum of 2% by mass of the aggregate.

2.2.3.2 *Bulk density*

The loose bulk density in kerosene of added filler, with the exception of hydrated lime, shall be in accordance with BS EN 13043, Clause 8.5.5).

2.2.4 **Recycled material**

2.2.4.1 *Aggregate*

Any recycled aggregate used in the SMA shall comply with [2.2.2](#).

2.2.4.2 *Reclaimed asphalt*

The use of reclaimed asphalt is not permitted (see [NG 2.2.4.2](#)).

2.2.5 Additives

Fibres are a required additive and shall be in pelleted form, either wax-coated or bitumen coated. The SMA mixtures shall include a minimum fibre content of 0,3% by mass (see NG 2.2.5)

Other additives which may be permitted for inclusion are special fillers, adhesion and workability agents. The suitability of any additives to be used shall be demonstrated in accordance with BS EN 13108-5, Clause 4.1.

2.3 Composition

2.3.1 Grading and binder content

The grading of the composition of the SMA shall conform to the relevant column of Table 2.1A or 2.1B. Grading envelopes are given in Figures 2.1 to 2.4. The supplier is required to choose targets that comply with the grading limits given in Table 2.1A and Table 2.1B. Tolerances specified in BS EN 13108-21 will be applied to the target grading.

The tolerance applying to the minimum target binder contents (B_{act}) in Table 2.1A or 2.1B shall be $\pm 0.20\%$ by mass (see NG 2.3). This compliance criterion shall be applied to a rolling mean of the analyses of four samples to determine binder content in accordance with BS EN 12697-1.

Table 2.1A: Limits for composition of the SMA mixtures ^{b)}

D (mm)	6	10	14
Sieve	Proportion passing sieve (% by mass)		
20	-	-	100
14	-	100	93 - 100
10	100	93 - 100	35 - 60
6,3	93 - 100	35 - 52	22 - 36
4	32 - 45	-	-
2	25 - 35	20 - 32	16 - 30
0,5 ^{a)}	-	-	-
0,25 ^{a)}	-	-	-
0,063	8 - 14	8 - 12	8 - 12
Minimum target binder content B_{act} (% by mass)	7,1	6,7	6,3

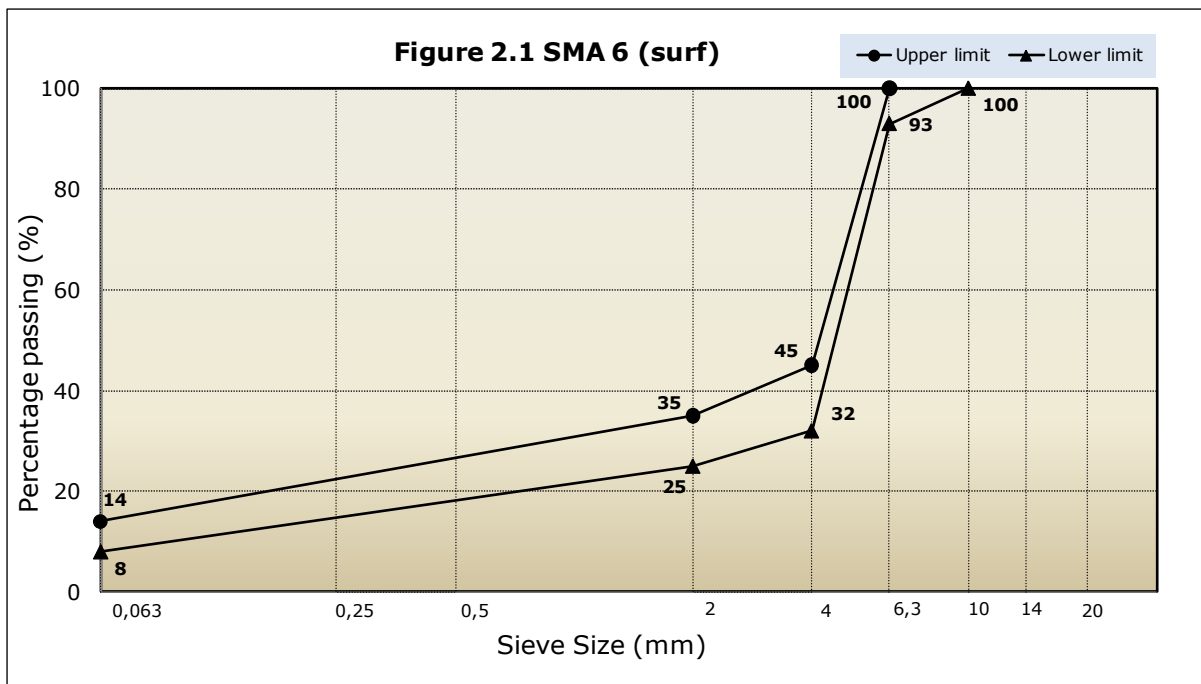
- a) The limits are applied to the 0,5 mm and 0,25 mm sieves shall be established by the producer to ensure consistency and the values obtained shall be recorded within the quality control system.
- b) The SMA mixtures shall include a minimum fibre content of 0,3% by mass (see NG 2.2.5).

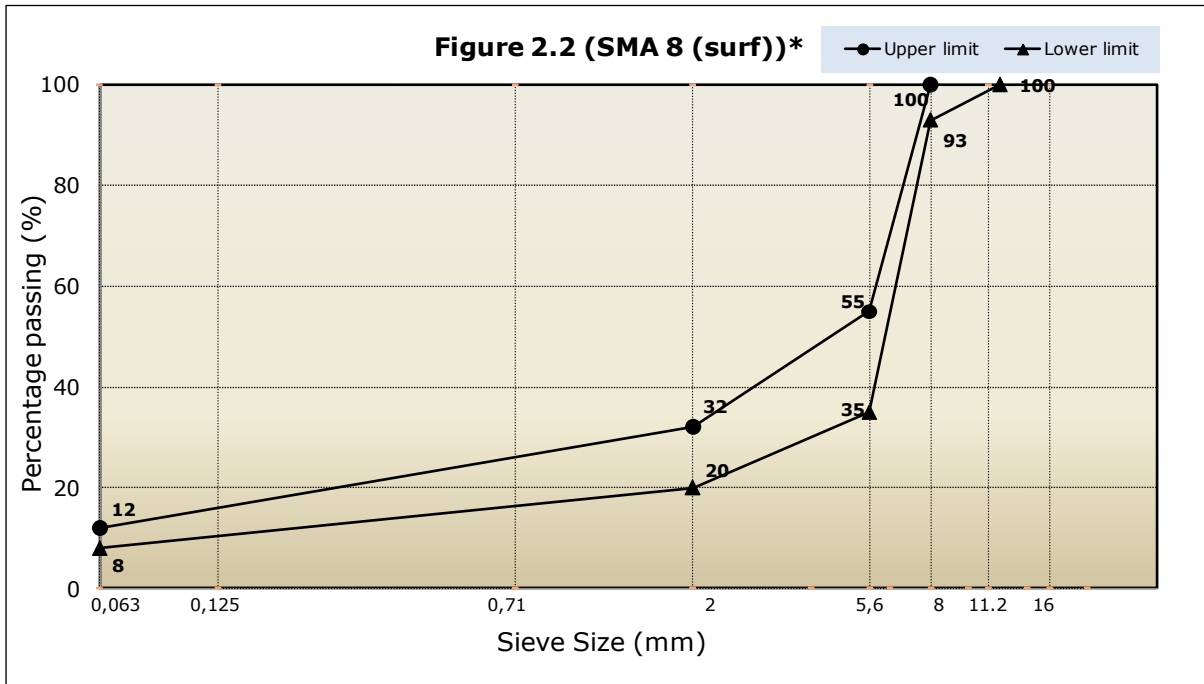
Table 2.1B: Limits for composition of the SMA mixtures ^{b)}

D (mm)	(8)*
Sieve	Proportion passing sieve (% by mass)
16	-
11,2	(100)*
8	(93 - 100)*
5,6	(35 - 55)*
2	(20 - 32)*
0,71 ^{a)}	-
0,125 ^{a)}	-
0,063	(8 - 12)*
Minimum target binder content B_{act} (% by mass)	(6,9)*

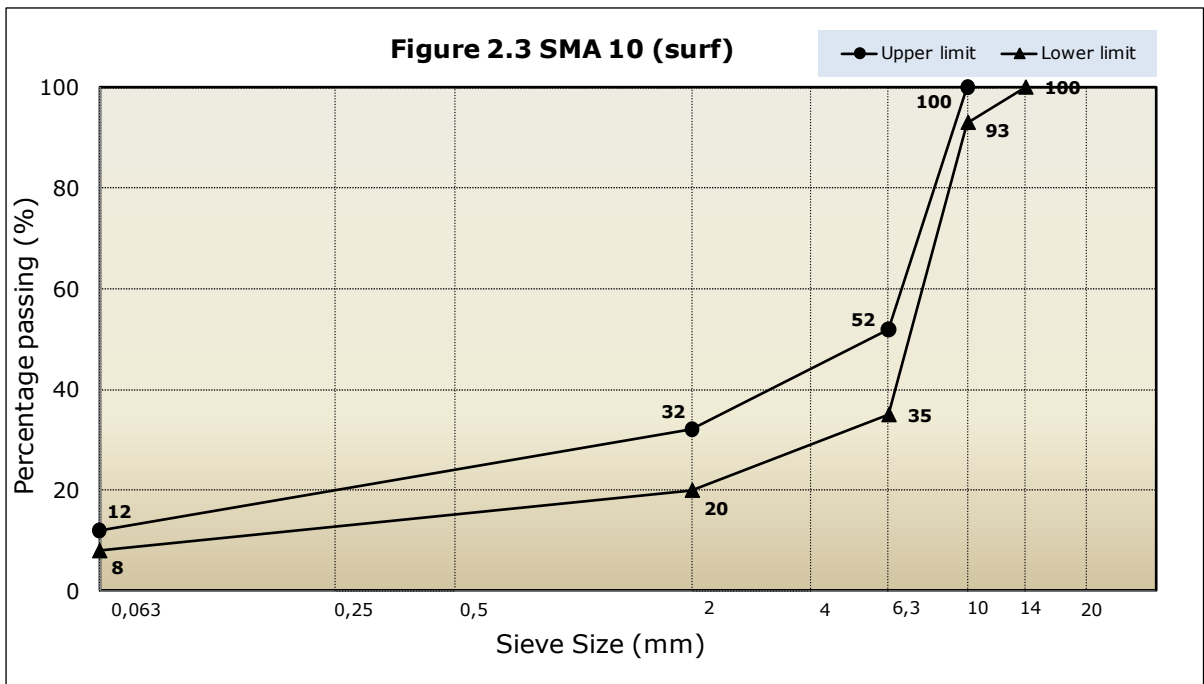
*See NG 2.3.1

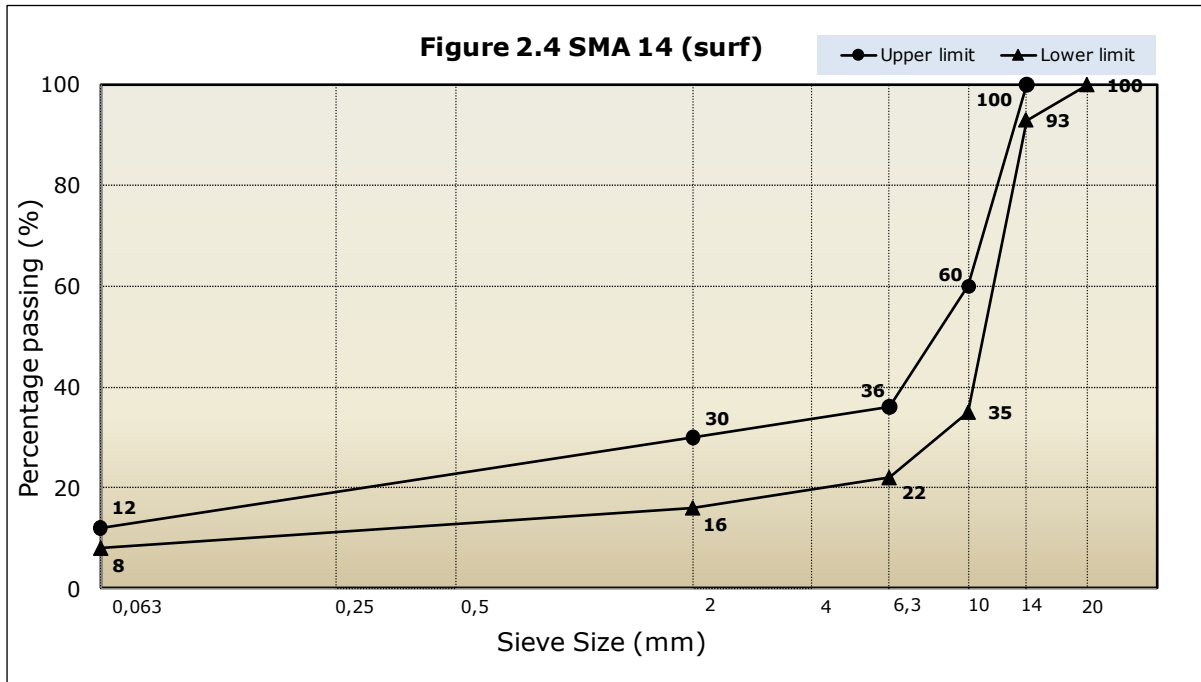
- a) The limits are applied to the 0,71 mm and 0,125 mm sieves shall be established by the producer to ensure consistency and the values obtained shall be recorded within the quality control system.
- b) The SMA mixtures shall include a minimum fibre content of 0,3% by mass (see NG 2.2.5).





*See NG 2.3.1





2.4 Air Voids Content

2.4.1 Laboratory prepared

The air voids content of laboratory compacted specimens of the mixture at target composition prepared and tested as detailed in BS EN 13108-20, Annex C, Table C.1, shall be as follows.

- a) The average void content category for SMA 6 (surf) or SMA 8 (surf) of a set of three specimens shall be: $V_{\min 3,5}; V_{\max 4}$.
- b) The average void content category for SMA 10 (surf) or SMA 14 (surf) of a set of three specimens shall be: $V_{\min 3}; V_{\max 3,5}$.

2.4.2 Laid and compacted mat

The air voids content of cores extracted from the laid and compacted mat as per BS 594987, Annex G (see NG 2.4.2) shall be as follows:

- a) The average void content category for SMA 6 (surf) or SMA 8 (surf) of a set of core pairs from three locations shall be: $V_{\min 2}; V_{\max 6}$.
- b) The average void content category for SMA 10 (surf) or SMA 14 (surf) of a set of core pairs from three locations shall be: $V_{\min 2}; V_{\max 5}$.

2.4.2.1 Surface course thickness

The thickness of the laid surface course shall conform to the relevant column of Table 2.2 (see NG 2.4).

Table 2.2: Laid thickness

Mixture description	Thickness range (mm)	Minimum thickness at any one point (mm)
SMA 6	20 - 40	15
SMA 8	25 - 40	20
SMA 10	25 - 50	20
SMA 14	35 - 60	30

2.5 Binder Drainage

The average binder drainage category of a set of specimens tested in accordance with BS EN 12697-18, Clause 5 (Schellenberg method), shall be $D_{0,3}$.

2.6 Water Sensitivity

The water sensitivity category shall be $ITSR_{NR}$ (see NG 2.6).

2.7 Resistance to Permanent Deformation

The resistance to permanent deformation of samples at target composition taken in accordance with BS 594987, Annex G, shall be determined in accordance with BS EN 12697-22 using the small device and Procedure B in air at a test temperature of 60 °C. The results shall be recorded in the Producer's quality management system and reported as part of the TAIT procedures.

2.8 Temperature of the Mixture

In all cases where mixtures are produced, mixing temperatures shall be documented and declared (see 2.12.2). Guidance on minimum temperatures at delivery and for compaction is found in BS 594987.

2.9 Grit for Application to Surface Course

2.9.1 General

For specification purposes, grit shall be considered as a mixture and evaluation of conformity determined in accordance with BS EN 13108-20 and BS EN 13108-21.

2.9.2 Material

2.9.2.1 Type of grit

Grit shall be coarse aggregate conforming to 2.2.2.1.

2.9.2.2 Grading

The grading of grit shall be as in the relevant column of Table 2.3.

2.9.2.3 Binder content

The binder used to coat the grit shall be 40/60 grade conforming to BS EN 12591. The tolerance on the target binder content as shown in Table 2.3 shall be $\pm 0,5\%$.

Table 2.3: Composition of grit mixture

Test Sieve (mm)	Proportion passing test sieve (% by mass)	
	2/4 particle size	1/2,8 particle size
8	-	-
6,3	100	-
4	90 - 100	100
2,8	-	90 - 100
2	0 - 25	-
1	-	0 - 25
0,063	0 - 2	0 - 2
Target binder content (%)	0,7	1

2.9.2.4 Condition of coated grit on application

The coated grit shall be free-flowing and free from agglomerations or bunching.

2.9.2.5 Evaluation of conformity

Evaluation of conformity shall be carried out in accordance with BS EN 13108-4, Clause 6.

2.9.3 Application

2.9.3.1 General

The grit shall be machine-applied in such a manner as to achieve a uniform distribution as follows:

- a) 2/4 particle size at 1 – 1,5 kg/m² shall be used with SMA 14 (surf).
- b) 1/2,8 particle size at 1 – 1,25 kg/m² shall be used for SMA 6 (surf), SMA 8 (surf) and SMA 10 (surf).

2.9.3.2 Application of grit

The grit shall be applied from hoppers attached to a roller after the asphalt has been laid and after the initial compaction by roller. The rolling pattern shall, as far as practicable, provide a single application of grit to the full width with no overlap.

2.9.3.3 Sweeping

When the material has reached ambient temperature, any surplus grit shall be removed carefully prior to the application of road markings and before the road is opened to traffic.

2.10 Skid Resistance

2.10.1 Early-life skid resistance

2.10.1.1 Grip Number testing – compliance requirements

The surface skid resistance shall be measured using the GripTester braked-wheel fixed-slip device in accordance with BS 7941-2, or equivalent device possessing appropriate validation. The default test speed shall be 50km/h. A higher test speed of 80km/h may be adopted where testing at 50km/h is considered inappropriate. Where the results obtained at 80km/h do not comply with [Table 2.4](#), a re-test at 50km/h shall be undertaken. Tests shall be undertaken four weeks and six months after opening to traffic.

The Grip Number results shall be averaged over each 10m length of surfacing (for each lane) and the mean Grip Number (10m average), calculated as per [2.10.2.3](#), shall be compared against the values given in [Table 2.4](#). Where the four-week 10m-averaged Grip Number values do not achieve those in [Table 2.4](#), this shall be reported to the Overseeing Organisation and no rectification shall be required due to these results alone. Where 10m-averaged Grip Numbers do not achieve the values in [Table 2.4](#) after 6 months of trafficking, rectification shall be undertaken in accordance with [Clause 2.10.1.2](#).

Table 2.4: Minimum mean Grip Number

Site Class	HD 28/04 Site Category ^{a)}	Measuring speed (km/h)	Minimum mean Grip Number (10m Average)
1	A, B & C	50	0.39
2	R, G1 & S1	50	0.51
3	Q, K, G2 & S2	50	0.56

a) Table 4.1 of HD28 (DMRB 7.3.1)

2.10.1.2 Rectification

Where any 10m rolling-average GripNumber, or sequence of them, does not achieve the minimum values in [Table 2.4](#) after six months of trafficking, the full extent of this area plus 10m either side shall be made good by removing and replacing the full depth of the surface course. This shall be carried out over the full width of the lane with fresh material laid and compacted in accordance with this specification. Where such remedial patches are within 20m of each other they shall be combined into a single patch.

2.10.2 GripTester Procedure

The GripTester procedure shall comprise 3 parts:

- Certification
- Survey Procedure
- Reporting

2.10.2.1 Certification

An annual certification process shall be undertaken for each GripTester to be used on the Network. The procedure shall be carried out in accordance with ASTM E1844 test procedures where network machines are verified against the manufacture's reference machine. The testing procedure must produce a check that machines are within a +/- 0.02 GN tolerance of each other.

An additional certification check shall be carried out monthly to ensure that machines continue to read within specification.

2.10.2.2 Survey Procedure

A full calibration check shall be carried out at the start of each survey day. If the machine cannot be calibrated satisfactorily it shall not be used for testing. A reference site shall be nominated for carrying out a test at the start of each week's survey programme. If any value is out with +/- 0.05 of previous values achieved on this reference site, the machine shall not be used for testing.

All sites must be pre-surveyed to ensure that the operators are able to consistently identify the start and end points of the sections to be measured. Start and end points shall be either temporarily or permanently marked as required by the client.

In the first instance each section shall be tested twice. If the section average values of these first two tests are within 0.02, then the 1st run shall be reported as the survey result (see [NG 2.10.2.2](#)).

After each survey both speed and water flow shall be checked and if not within tolerance for 75% of the section the run must be repeated. If speed is out of tolerance due to congestion or other factors, the site shall be revisited when a compliant run can be carried out. Tolerance for speed shall be +/- 10% and tolerance for water flow shall be +/- 20%.

To assist with location referencing GPS data shall be recorded. GPS data shall have accuracy better than 5m and shall be collected with a minimum update rate of 0.1 second.

2.10.2.3 Reporting

A printed report is required and test data provided in an electronic format. Copies of calibration certificates, ongoing calibration results/checks and reference site checks shall be included within this report (See [NG 2.10.2.3](#)). The report shall include test data in the following formats:

- Electronic data file for all test runs (csv format)
- Tabular data showing the 10m averages over the section of all valid runs for the survey with the 1st valid run being indicated as the test result (see [NG Table 2.4](#)).
- A graphical output showing 10m averages as shown in [Figure NG 2.3](#).

2.11 Texture

The surface course shall exhibit a uniform macrotexture. Although there are no specification requirements for texture depth, such measurements are required to be taken as part of the TAIT process.

2.12 Type Approval Installation Trial (TAIT)

2.12.1 Fundamental requirement

The producer shall undertake the Type Approval Installation Trial (TAIT) process set out below for each variant of the TS2010 material. Any change to any of the constituent materials and/or the production plant is considered to be a variant.

2.12.2 General requirements

2.12.2.1 TAIT process

The TAIT takes the form of a three-stage process, as shown within [Figure 2.5](#) and listed in [Tables 2.6, 2.7 and 2.8](#). Stages 1 & 2 (i.e. [Tables 2.6 & 2.7](#)) follow the requirements of BS EN 13108 with the addition of certain other necessary tests. The purpose of the TAIT is to demonstrate that the product is able to be consistently produced in accordance with the requirements of this specification, and that it demonstrates the necessary properties. The grading of the mixture and that of the grit shall comply with the relevant column of [Table 2.1A or 2.1B](#) and [Table 2.5](#) of this document.

The producer shall design and construct the surfacing, of which the TAIT is a representative section, in accordance with documented Factory Production Control System in BS EN 13108-21. The producer shall record all the data required by these documents and any additional information required by Transport Scotland.

2.12.2.2 Relaxation on Stage 2 requirement for alternative plant

Notwithstanding the requirements listed in [2.11.2.1](#) above, where a TS2010 product proposal has achieved Approval by Transport Scotland (through laboratory study, product mix trial and Trunk Road Network Trial) approval to supply that product from an additional or alternative asphalt production plant shall be subject to submission of satisfactory plant information and binder content and grading from trial batching. The requirements are listed in [Table 2.9](#).

2.12.3 Grip Numbers – Classification requirements

The mean Grip Number shall be recorded and compared to the values given in [Table 2.5](#).

Table 2.5: Mean Grip Numbers

Site Class	HD 28/04 Site Category ^{a)}	Measuring speed ^d (km/h)	Minimum mean Grip Number (10m Average)	
			After 4 weeks trafficking	After 6 months trafficking
1	A, B & C	50	0.39	0.56
2	R, G1 & S1	50	0.51	0.62
3	Q, K, G2 & S2	50	0.56	0.67

a) Table 4.1 of HD28 (DMRB 7.3.1)

b) The default test speed is 50 km/h. A higher test speed of 80 km/h may be used where testing at 50 km/h is considered inappropriate. Where 10m-averaged mean grip numbers do not achieve the values above a re-test shall be undertaken at 50km/h.

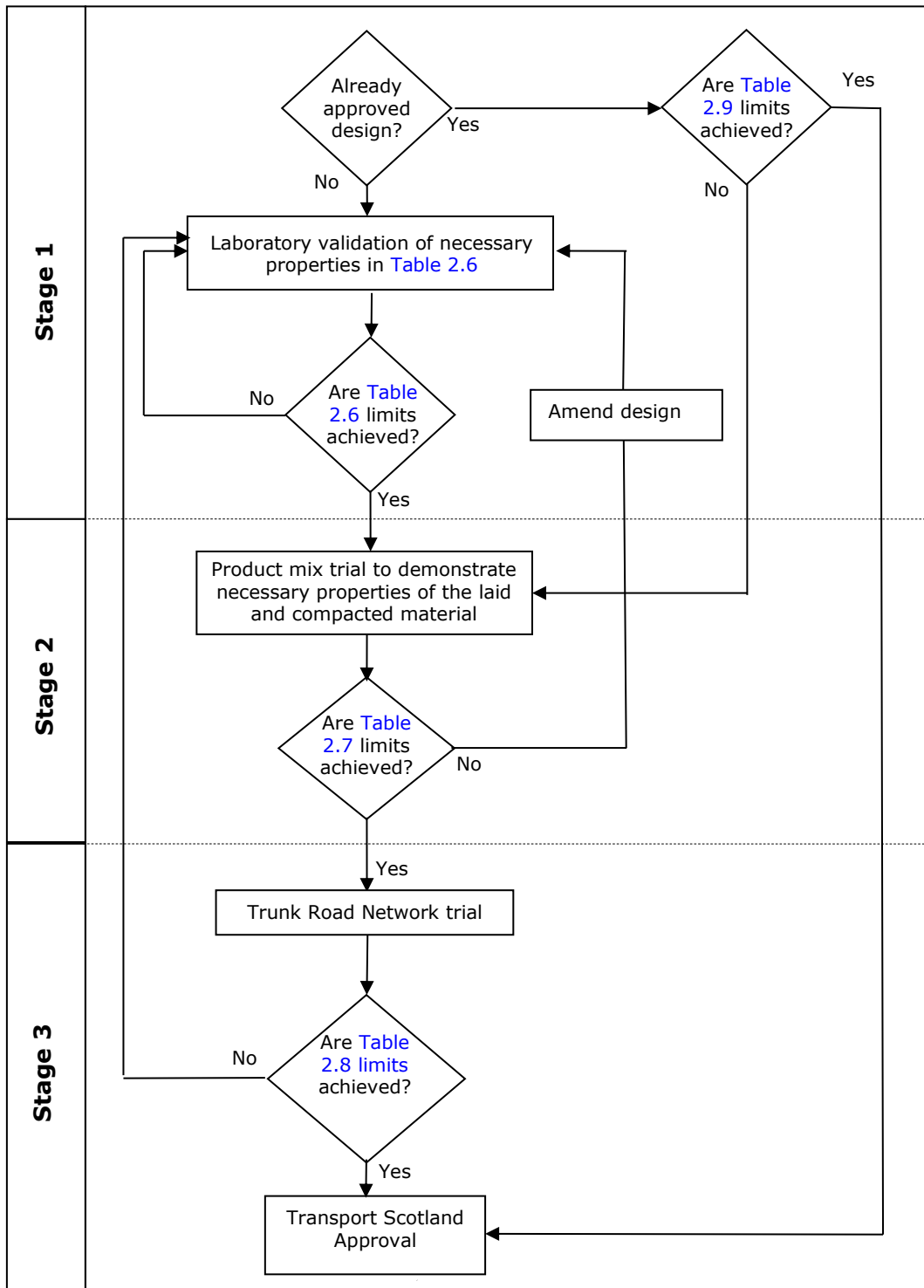


Figure 2.5 TAIT approval

2.12.4 Data recorded

An electronic data sheet shall be used to record the necessary information for the TAIT. An example of the data sheet and information required is shown in [Figure 2.6](#).

TAIT APPROVAL		Version	2.0		
Date of TAIT	<input type="text" value="01/10/2010"/>				
PRODUCER	NAME	ADDRESS	TELEPHONE	CONTACT	
	Rocks R us	Big Rock Quarry Hillside Road	01234 56789	Mr Stone	
LOCATION					
ROUTE NUMBER	<input type="text"/>	Start Link/ Section	<input type="text"/>	End Link/ Section	<input type="text"/>
Lane Number(s)	<input type="text"/>	Start Chainage	<input type="text"/>	End Chainage	<input type="text"/>
Traffic level	<input type="text"/>	Start OS Grid ref.	<input type="text"/>	End OS Grid ref.	<input type="text"/>
Site Class	<input type="text"/>				
MATERIALS					
Designer	<input type="text"/>	Location of asphalt plant	<input type="text"/>		
			Evidence of QMS must be attached		
Rock type - course aggregate	<input type="text"/>	Source	<input type="text"/>		
Rock type - fine aggregate	<input type="text"/>	Source	<input type="text"/>		
Rock type - grit	<input type="text"/>	Source	<input type="text"/>		
Type - Filler	<input type="text"/>	Source	<input type="text"/>		
Type - Fibre	<input type="text"/>	Source	<input type="text"/>		
Type - polymer modified bitumen	<input type="text"/>	Source	<input type="text"/>		
Mixing procedure and times of addition of each element of the SMA mixture					
<input type="text"/>					
Bond coat type	<input type="text"/>		Rate of application	<input type="text"/>	
Please attach relevant test results for materials used at the 3 stages of the TAIT (Tables 2.5, 2.6, 2.7, 2.8 & 2.9)					
Technical contact responsible for TAIT	<input type="text"/>				

Figure 2.6 Specimen data sheet for TAIT

2.12.5 Information availability

The information from the TAIT shall be stored securely by the producer and a copy sent to Transport Scotland, Standards Branch, Buchanan House, 58 Port Dundas Road, Glasgow G4 0HF ([email:TS2010TAIT@transportscotland.gsi.gov.uk](mailto:TS2010TAIT@transportscotland.gsi.gov.uk)).

2.12.6 Approval Certificate

Following successful completion of TAIT Stage 3 procedures, Transport Scotland will issue an Approval Certificate indicating where the material can be used. This certificate will indicate the Site Class for which the material has achieved compliance, taking account of measured Grip Number and level of stress applied by traffic. An example form is shown in Annex B to this specification. This Approval shall be continually reviewed based on measured early-life Grip Numbers from subsequent use of the material and informed by longer-term SCRIM performance. Approval Certificates will be updated based on the findings of such reviews.

Table 2.6: Set of tests for TAIT: Stage 1

Property	Test method/procedure	Limits
Coarse aggregate particle density	BS EN 1097-6	Results declared
Coarse aggregate resistance to polishing	BS EN 1097-8	Declared
Coarse aggregate resistance to abrasion	BS EN 1097-8, Annex A	AAV ₁₂
Coarse aggregate resistance to fragmentation	BS EN 1097-2	LA ₃₀
Coarse aggregate resistance to wear	BS EN 1097-1 Micro Deval method	M _{DE} declared
Flakiness		
Air voids content	BS EN 13108-20	
SMA 6 (surf), SMA 8 (surf)		V _{min3,5} ; V _{max4}
SMA 10 (surf), SMA 14 (surf)		V _{min3} ; V _{max3,5}
Binder content	BS EN 12697-1	Relevant column of Table 2.1A or 2.1B
Binder content for grit mixture	BS EN 12591	Relevant column of Table 2.3
Binder penetration	BS EN 1426	75 - 130
Binder softening point	BS EN 1427	≥75
Grading	BS EN 12697-2	Relevant column of Table 2.1A or 2.1B
Grading for grit mixture	BS EN 12697-2	Relevant column of Table 2.3
Binder drainage	BS EN 12697-18 Schellenberg method	D _{0,3} .
Resistance to permanent deformation	BS EN 12697-22	Rut rate and rut depth shall be reported

Table 2.7: Set of tests for TAIT: Stage 2

Property	Test method/procedure	Limits
Air Voids in mat*	BS 594987, Annex G	
SMA 6 (surf), SMA 8 (surf)		$V_{\min 2}$; $V_{\max 6}$
SMA 10 (surf), SMA 14 (surf)		$V_{\min 2}$; $V_{\max 5}$
Binder content	BS EN 12697-1	Relevant column of Table 2.1A or 2.1B, to Clause 2.3.1 tolerance
Grading	BS EN 12697-2	The tolerance specified in BS EN 13108-21
Texture**	BS EN 13036-1	To be recorded

* See NG 2.4.2, ** See NG 2.11.2.1

Table 2.8: Set of tests for TAIT: Stage 3

Property	Test method/procedure	Limits
Air voids in mat*	BS 594987, Annex I	
SMA 6 (surf), SMA 8 (surf)		$V_{\min 2}$; $V_{\max 6}$
SMA 10 (surf), SMA 14 (surf)		$V_{\min 2}$; $V_{\max 5}$
Binder content	BS EN 12697-1	Relevant column of Table 2.1A & 2.1B, to Clause 2.3.1 tolerance
Grading	BS EN 12697-2	The tolerance specified in BS EN 13108-21
Texture**	BS EN 13036-1	To be recorded
Mean Grip test number after 4 weeks and 6 months	BS 7941-2	Mean Grip Number from relevant column of Table 2.5

* See NG 2.4.2, ** See NG 2.11.2.1

Table 2.9: Test for alternative plant

Property	Test method/procedure	Limits
Binder content	BS EN 12697-1:2012	Relevant column of Table 2.1A & 2.1B, to Clause 2.3.1 tolerance
Grading	BS EN 12697-2:2002	The tolerance specified in BS EN 13108-21
Operating Compliance Level	BS EN 13108-21:2006	Operating Compliance Level B

NG 2 TS2010 Stone Mastic Asphalt Surface Course

- Notes for Guidance

NG 2.1 General

The TS2010 specification is based on the common format and principles of BS EN 13108. This provides a way for a target mixture composition to be declared and demonstrate that certain defined properties have been achieved. However, it should be noted that, unlike BS EN 13108, the TS2010 specification is not restricted to requirements for the mixture produced at the plant, i.e. "in the back of the truck". For example, the specification includes requirements for air voids content of cores extracted from the laid and compacted mat (2.4.2). Requirements for applying grit to the surface course (2.9), and skid resistance (2.10) are also included.

In terms of Initial Type Testing and Factory Production Control, the procedures outlined in BS EN 13108-20 and BS EN 13108-21 are to be followed to demonstrate conformity with BS EN 13108.

Attention is drawn to the 2008 revisions to the 900 Series of the *Specification for Highway Works* that include the introduction of a new Clause 903, *Placing and Compaction of Bituminous Mixtures*. Additional general guidance on the procedures for maximising the durability of asphalt pavements can also be found in Road Note 42 (Nicholls *et al*, 2008).

It should be noted that TS2010 has been developed primarily as a material intended to be machine-laid. It may not be suitable where circumstances require a high degree of hand-working, e.g. urban environment with a high density of road ironwork.

NG 2.2 Constituent Materials

NG 2.2.1 Binder

BS EN 14023 provides a framework of "classes" of polymer modified bitumen (PMB) with different properties. The selection of a class depends on the different characteristics that may be required, e.g. service temperature, cohesion, resistance to hardening and other properties. The choice of class will be strongly influenced by climatic and traffic conditions.

A PMB 75/130-75 has been specified for TS2010. This PMB has a penetration range of 75 to 130 (Class 7) and a minimum softening point of 75°C (Class 3). However, confirmation of all the properties listed in Table NG 2.1 will be required.

Table NG 2.1: Additional PMB information

Characteristic	Property	Test Method	Unit	Selected Class
Consistency at intermediate service temperature	Penetration at 25°C	EN 1426	0,1 mm	75-130 (Class 7)
Consistency at elevated service temperature	Softening point	EN 1427	°C	≥75 (Class 3)
Cohesion	Force ductility (50 mm/min traction)	EN 13589 EN 13703	J/cm ²	≥3 (Class 2)
Brittleness at low service temperature	Fraass breaking point	EN 12593	°C	≤ -20 (Class 9)
Strain recovery	Elastic recovery at 25°C	EN 13398	%	≥ 80 (Class 2)
Additional characteristics	Storage stability - Difference in softening point	EN 13399 EN 1427	°C	≤ 5 (Class 2)

It is recommended that the choice of PMB in accordance with BS EN 14023 is agreed between the bitumen supplier and asphalt manufacturer so that the characteristics required to meet the performance requirements of TS2010 are met.

In 2005, The German Asphalt Association recommended the use of PMB following problems with flushing, or loss of texture, under the action of heavy traffic. The predominant modification of bitumen used in Germany is by the addition of synthetic rubber, with their preference being for styrene-butadiene-styrene (SBS).

NG 2.2.2 Aggregates

NG 2.2.2.1.2 Particle shape

The coarse aggregate particle shape is important as it influences the arrangement and strength of the aggregate matrix and resultant surface texture. It is therefore important that the flakiness index is ≤ 20. A flakiness index of ≤15 is regarded as ideal.

NG 2.2.2.1.4 Resistance to polishing

Currently the minimum PSVs to be applied to different categories of site and related to traffic flow are given in Table 3.1 of HD 36. Paragraph 3.11 of HD 36 states that the minimum values of PSV given in Table 3.1 are the values to be used if no other information is available. With the introduction of the performance requirement for skid resistance within TS2010, and the adoption of a PSV_{Declared} value in the contract, the opportunity to adopt and verify the satisfactory performance of aggregates with variant PSVs has been created. Accordingly values of PSV are required to be stated.

Sustainability objectives

With the safety-related aspects of choosing lower PSV surfacing aggregates satisfactorily addressed (by measuring their performance on the road), there is an enhanced opportunity for the wider use of durable local aggregates for surfacing roadstone on the Trunk Road Network. There has long been a strong economic case for using locally-won resources for surfacing, as opposed to importing high PSV material over long distances from England and Wales, but this has almost invariably hit obstacles due to the prescriptive nature of the default PSV requirements in the DMRB.

NG 2.2.4 Recycled materials

NG 2.2.4.2 Reclaimed asphalt

The use of an all-in graded reclaimed asphalt is not permitted owing to the requirements for consistent control of both binder content and grading requirements.

NG 2.2.5 Additives

In order to achieve the desired high binder content that creates a thick binder film in the TS2010 mixtures, a stabilizing additive is required. Currently it is possible to produce surfacing without the need for a stabilizing additive, i.e. with lower binder contents and the appropriate PMB. However, in addition to a PMB, the TS2010 specification requires an additive to act as a binder carrier to ensure the binder does not drain off the aggregate during production, storage and transportation.

As part of the TAIT process, the producer should provide evidence that technical studies have been undertaken to demonstrate that:

- Fibres are not pulverised or destroyed during dry mixing.
- Fibres do not clump together.
- Good fibre distribution can be achieved with different types of mixing plant.
- After 1 hour at the maximum expected mixing temperature at the mixing plant, binder lost by drainage is limited (see Schellenberg method, [NG 2.5](#)).

Although to a degree subjective, an assessment of the proportion of fibres recovered following binder extraction by sieving and weighing can be made. Around two thirds of the fibres should be retained on the various sieve sizes. If only one third or less can be detected then there could be a problem with fibre distribution. Experience has shown that if recovered fibres are dark brown and the *ring and ball* results are high, then the plant mixing temperature is likely to have been too high.

NG 2.3 Composition

Categorising the binder content in BS EN 13108-5 involves a correction for the density of the aggregate in the mixture. The principle is that the binder content category in the standard is based on an aggregate density in the mixture of 2.650 Mg/m³. If the aggregate is denser than 2.650 Mg/m³, the actual binder content in the true mixture is reduced proportionally, or if the aggregate is less dense, it is increased. This adjustment has the intention of giving the same binder volume in mixtures regardless of aggregate density.

A consideration of UK mixtures and aggregates indicated that this approach might have been detrimental to performance because, in practice, some of the denser aggregates need higher binder contents for durability. For this reason, the binder contents set out in Table 2.1A & 2.1B are those which are required as actual binder contents on analysis of the finished mixture with no density correction. These binder contents are referenced as B_{act} .

B_{act} will need to be corrected back to determine the B_{min} defined in BS EN 13108-5 using the following formula:

$$B_{min} = \frac{\rho_b}{2.650} \times B_{act}$$

where ρ_b is the mean particle density of the aggregate mixture, in megagrams per cubic metre (Mg/m³), determined in accordance with BS EN 1097-6.

NG 2.3.1 Grading and binder content

The distribution of coarse aggregate greater than 2 mm for German SMA (0/11) is typically in the ratio of 4:2:1 for aggregate fractions 8/11:5/8:2/5. The high content of the coarsest aggregate is required to form a mixture that is gap-graded. Such grading is essential to create the desired coarse aggregate skeleton that will accommodate the mastic: i.e. binder, fine aggregate and filler. For illustration purposes, the distribution of mixture constituents for different types of asphalt is shown in Figure NG 2.1.

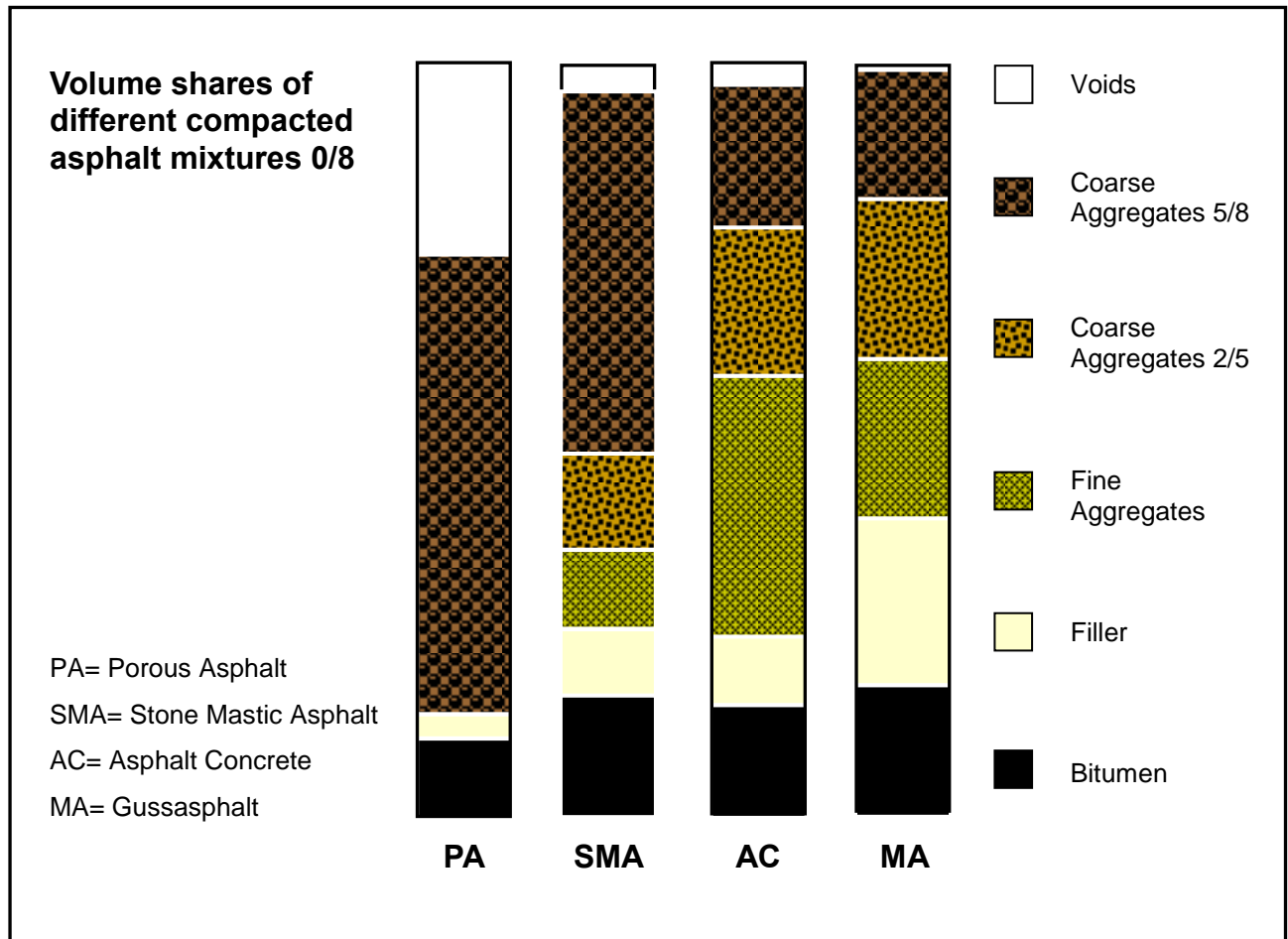


Figure NG 2.1: Composition of asphalt mixtures

SMA 8 (surf)

The introduction of SMA 8 will be a controlled one owing to a lack of industry experience in producing mixtures to such a grading. In particular, attention must be drawn to the use of a 5.6 mm sieve to control the grading of the SMA 8 (surf). This requirement is necessary to ensure that the mixture contains sufficient coarse aggregate in the 5.6 and 8 mm aggregate range.

Binder content tolerance

The use of a tight tolerance $\pm 0.2\%$ (by mass) on the binder content emphasises the importance of closely controlling the amount of binder in the mix. In addition, the target values given are higher than those used in current UK mixtures. Empirical evidence from Germany highlights that high binder contents, with a close degree of control, are a fundamental requirement in ensuring the durability of an SMA mixture. However, it should be noted that, because certain mix designs may be sensitive to binder content above a certain level, the supplier is recommended to use the lower limit of the tolerance as the start point for design purposes.

NG 2.4 Air Voids Content

NG 2.4.1 Laboratory prepared

The limits on the laboratory-prepared specimens are set at a tolerance such that the limits on the laid and compacted mat should subsequently be more readily achievable.

NG 2.4.2 Laid and compacted mat

The protocol described in BS594987:2007, Annex G relates to determining void content and resistance to permanent deformation of SMA binder course and regulating courses. As part of the Stage 2 TAIT, this protocol shall be used to determine the in situ void content of the SMA surface course only. The trial strip shall be as per Annex G but with a nominal thickness of not less than 40mm.

The average in-situ air voids content of the laid and compacted material undertaken as part of the Stage 3 TAIT Trunk Road Network Trial shall be continuously assessed using an indirect density gauge in accordance with BS 594987, Clause 9.4.2, with readings taken at 20 m intervals in alternate wheel-tracks. Each gauge shall be individually calibrated for each mixture to be used. The calibrations shall be continually checked and updated based on correlations between gauge readings and core densities determined from the Stage 2 TAIT product mix trial. The compliance criteria (Clause 9.4.2) shall be applied to a rolling mean of the values from three consecutive locations.

General

Correct compaction of the TS2010 SMA mixtures is important to ensure that a stable and durable pavement layer is constructed. Too low air voids content (<2%) can result in deformation under heavy traffic, while high air voids content (> 6%) can allow water and air to penetrate into the layer. This can lead to an increased potential for water damage, oxidation and subsequent aggregate loss or fretting under trafficking. Permeability can be a concern in SMA mixes as they utilize a gap-grade coarse gradation. For SMA 6 & 8 (surf) the range of 2 to 6% air voids content is considered to be acceptable, but for SMA 10 & 14 (surf) the range of 2 to 5% is deemed to be more appropriate, as these mixtures tend to become permeable when air voids content is above 6%.

NG 2.2.2.1 Surface course thickness

The values in [Table 2.2](#) are taken from BS594987 (Table 1C) with the exception that the maximum laid thickness for SMA 14 has been increased. The values for SMA 8 are the same as those for SMA 10 but with a decreased maximum thickness. The optimum thickness will be influenced by factors such as seasonal/climatic conditions and the nature of the works, in order to balance cost, durability and sustainability to provide best value.

NG 2.5 Binder Drainage

The Schellenberg method (BS EN 12697-18) describes a procedure for determining the binder drainage of asphalt mixtures incorporating fibres and enables the effects of any anti-draining additive to be quantified. The TS2010 specification requires that the difference between the mixture mass before and after heating is less than 0,3%. With percentages based on experience of using the test in Germany, [Table NG 2.2](#) provides additional guidance on assessing the performance of the additive.

Table NG 2.2: Guidance on binder drainage results

Average binder drainage D (%) (as per BS EN 12697-18: 2004)		
<0,2	0,2 – 0,3	>0,3
Good	Acceptable	poor

Where mixing plants are situated long distances from the laying site, or where long truck waiting times are taking place, it is recommended that the material at the point of delivery to the paver should be checked to ensure that no significant binder drainage has taken place.

In many countries around the world, shuttle buggies (Figure NG 2.2) are used successfully to remix the hot asphalt just before it is placed. This reduces the incidence of material segregation and temperature variations caused by subjecting the material to long haul distances or waiting times.



Figure NG 2.2: Example of shuttle buggy in operation

NG 2.6 Water Sensitivity

The test method as specified in the BBA HAPAS Guidelines for the Assessment of Thin Surfacing Systems should be used in preference to other methods if water sensitivity is considered to be an issue with the aggregate to be used.

NG 2.7 Resistance to Permanent Deformation

Due to the lack of experience with the extended wheel tracking test in Scotland, no formal limits have currently been specified although data is required to be measured and reported. In the meantime, however, it is expected that the wheel tracking levels will be in compliance with [Table NG 2.3](#).

Table NG 2.3 Proposed wheel-tracking levels for Stone Mastic Asphalt

Level	Test temperature (°C)	Specimen thickness (mm)	Criteria	Maximum wheel-tracking rate (mm/10 ³ cycles)	Maximum proportional rut depth (%)
3	60	≥ 30	Mean*	0.70	35
			Maximum†	1.00	50
		< 30	Mean*	7/300 x thickness #	35
			Maximum†	1/30 x thickness #	50

- a) Mean = mean result of two consecutive determinations on individual specimens.
- b) † Maximum = maximum result from two consecutive determinations on individual specimens.
- c) # Thickness of specimen tested = nominal depth + thickness of regulating ability.
- d) The table above is an extract from TRL Report 656 (Nicholls et al, 2006).

NG 2.9 Grit for the Application to Surface Course

The TS2010 SMA mixtures, when new, will have a thicker binder film than most conventional asphalts. In the surfacing's early life the binder film can prevent the microtexture on the aggregate particles making contact with a tyre, resulting in potentially lower wet friction than might normally be expected. It has therefore been decided that crushed grit shall be applied to the surface at the point of laying to increase the early-life skid resistance. The application of grit also assists in accelerating the removal of thick binder films from the aggregate at the top of the surface course.

NG 2.9.2 Material

NG 2.9.2.2 Grading

The portion of aggregate allowed to pass the 2 mm and 1 mm sieves for 2/4 mm grit and 1/2,8 mm grit, respectively, has been set at a maximum of 25% by mass. In Germany, the maximum is set at 15%. This latter limit if achievable is the more desirable as it minimises the amount of fine aggregate or dust present in the grit used.

NG 2.9.2.3 Binder content

A target binder content range is given in the specification. It is important that the binder is applied in small amounts and this will be governed by the type of plant available. The overall aim is to ensure that the grit is free flowing and is not prone to clumping.

NG 2.10 Skid Resistance

A performance requirement has been introduced into this specification for the skid resistance testing of TS2010 material in the newly-laid and early-life condition. This has created an opportunity to adopt a more flexible approach than customary to the specification of PSV and the techniques used for the measurement of skid resistance.

NG 2.10.2.2 Survey Procedure

Prior to any section being surveyed a static calibration according to the manufacturer's instructions shall be carried out. As part of the static calibration procedure, it is recommended that the zero-load and zero-drag condition of the GripTester are recorded against the date and time of static calibration. This is a convenient way of recording that the procedure has been carried out correctly in accordance with the manufacturer's instructions. System configuration should be checked to ensure that 1 metre averages are being recorded and that the water film depth is set correctly to 0.25mm.

As stated in 2.10.2.2, each section shall be tested twice in the first instance. If however the section average values of these first two tests are not within 0.02 GN, a third run shall then be carried out and the values of the second and third runs compared. If the average values obtained from these two tests are still not within 0.02 GN limits then the test shall be discontinued and an investigation shall be carried out. In such circumstances the GripTester should be checked fully and the road surface examined for inconsistencies or heavy levels of contamination.

NG 2.10.2.3 Reporting

10m average data shall be supplied in HMDIF format and as a separate GIS data set. The use of the HMDIF format is to allow the data to be imported into the relevant Pavement Management System. The GIS data set will allow the data to be displayed on GIS system such as Arcview or Mapinfo.

Tabular data (as shown in Table NG 2.4) is required to show the 10m average of all valid runs for a survey. The 1st valid run is used as the test result.

Table NG 2.4: Tabular data

Section chainage	Grip Number (10m average)			Test Result
	Run1	Run 2	Run 3	
Required Grip Number				
Difference				

A graphical output is also required to display the raw 10m averages over the section (see Figure NG 2.3). The data sheet shall indicate speed, water flow and minimum required Grip Number.

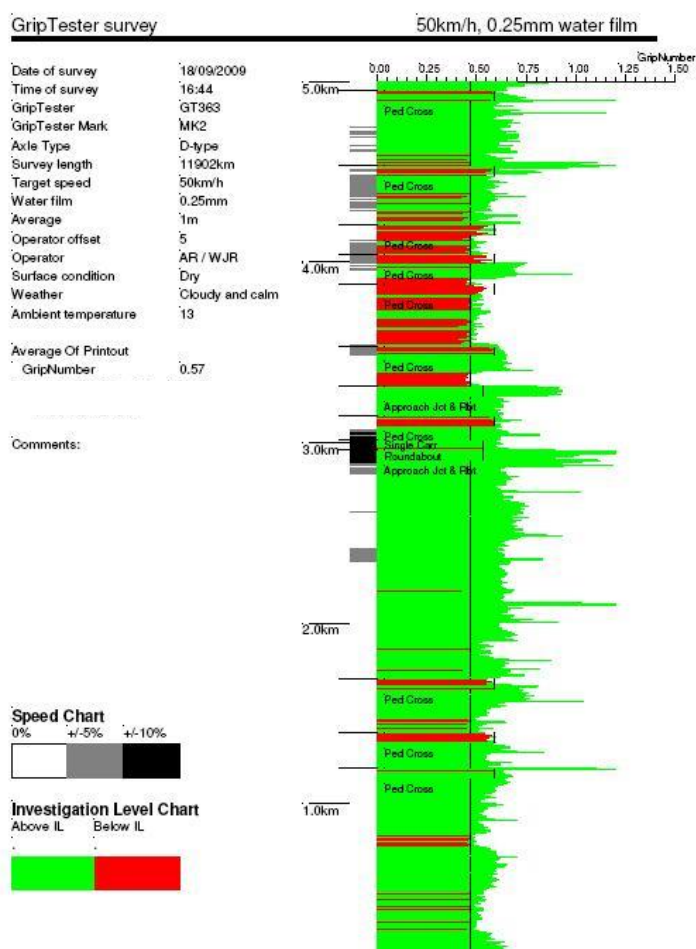


Figure NG 2.3: Graphical display

NG 2.11 TAIT

NG 2.11.2 General requirements

The TAIT comprises a three stage process: laboratory study, product mix trial and Trunk Road Network trial. The laboratory study (Stage 1) relates to designing a mixture that meets the specification. The product mix trial (Stage 2) provides the opportunity to assess the behaviour of the mix under compaction and enables the collection of information that provides the necessary properties of the laid and compacted material. The product mix trial is not permitted to form part of any permanent Trunk Road works pavement, and should comprise at least one 20 tonne batch of the design mixture proposed. The compacted material in this trial should be gritted in accordance with the specification. It should be emphasised that the product mix trial is not a trial on the network and is intended to allow the supplier to become familiar with the process of manufacturing and laying the material.

Following the completion of a satisfactory product mix trial, a Trunk Road Network trial (Stage 3) can then be undertaken. Following satisfactory completion of this, confirmation of formal approval to use the product will be given after 6 months.

NG 2.11.2.1 Texture

The surface course shall exhibit a uniform macrotexture. Texture measurements are to be taken and recorded for monitoring purposes but no specification requirements for texture depth will apply. Measurements are required to be taken as part of the product mix trial. Areas both with and without grit shall be tested and reported as part of Stage 2 of the TAIT. Following site laying on the Trunk Road Network (Stage 3), measurements should be taken in the gritted condition where possible and reported.

NG 2.12 Paving and Compaction

NG 2.12.1 Joints

The durability of the surface course, and underlying pavement, can be extended by limiting the number of longitudinal and transverse joints. Careful planning of the paving works should always be undertaken in order to limit the number of joints. Echelon paving should be adopted whenever feasible.

NG 2.12.1.1 Location

Longitudinal joints shall not be located within wheel track zones. These areas are typically located in zones between 0.5m and 1.1m from lane markings. All joints must be laterally offset from parallel joints in the layer below by at least 300mm.

Transverse joints are always made as a consequence of any interruption to the paving works. Such joints create a local weakness in the pavement, resulting in a shorter service life. Careful planning can reduce the number of stoppages. Transverse joints often also disrupt the smoothness of the longitudinal profile and hence ride quality of the pavement surface. In some instances the poor longitudinal profile created in the area of transverse joints can result in additional dynamic loading that is damaging to the pavement.

NG 2.12.1.2 Construction

The first lane paved is often referred to as the *cold lane* because the hot asphalt cools off by the time the second lane, or *hot lane* is being paved. In addition to the fact it will remain cold when the hot lane is laid, the unconfined edge of the cold lane tends to have a lower density than at the centre of the lane. Maintaining consistent density across this joint is key to the construction of a durable longitudinal joint. The techniques described below have been used to improve the construction of an unconfined edge of which the side compaction wheel is preferred.

NG 2.12.1.3 Side compaction wheel

The use of an edge compaction technique to construct a longitudinal joint is popular in Germany. It consists of a hydraulically-powered wheel, which rolls alongside the compactors drum. The wheel pinches the unconfined edge of the first lane towards the drum. The method is believed to increase the density of the unconfined edge and improve the overall density at the joint. The edge-restraining wheel is bevelled up toward the roller at a range of angles dependent on the thickness and type of material. The bevelled edge produced by the technique provides a longer jointing surface which is thought to improve the adhesion and quality of the joint between lanes.

It should be noted that the technique described above produces a slightly raised profile which can be removed by using the tandem roller in crab-steer mode, i.e. with the rear drum offset by approximately 100mm.

NG 2.12.1.4 Cutting back

The conventional way of treating material at the edge of the surface course cold lane is to carefully cut it back to its full depth. This removes material that is not sufficiently compacted and ensures that the hot lane is laid and compacted against a firm and uniform material. The quality of the joint is dependent upon the skill of the cutting wheel operator. After cutting back the exposed vertical edge must be thoroughly cleaned of all loose material and be sealed with an approved bituminous joint seal in accordance with BS 594987.

The painting of joints is intended to aid adhesion and minimise the ingress of water at the joint. It is therefore vitally important that the vertical face of the cut and cleaned joint is completely coated with the chosen sealant.

NG 2.12.1.5 Joint re-heating

The quality of longitudinal joints may be aided by heating the joint with an approved joint heater. The concept is to re-heat the edge of the cold lane and bring it up to a plastic state prior to the new, adjacent hot mat being laid. The heater must raise the temperature of the full depth of the surface course to within the specified range of minimum and maximum rolling temperatures for a width of not less than 75 mm. It should be noted that if the process is not carried out in a controlled manner there is a danger that heated asphalt may be damaged which can result in premature ageing of the material.

NG 2.13.2 Bond coats

Requirements for bond coats are covered in Clause 920 of the SHW (MCHW 1). Such bond coats are used to promote adhesion and provide some waterproofing capability. Approval to use non-BBA bond coats must be sought from Transport Scotland and details shall include properties and spread rate. The pavement surface receiving the bond coat should be as clean and dry as possible. Existing pavements can be dirty and dusty, and there is a possibility that the bond coat may merely adhere to the dirt and dust rather than the pavement layer to be surfaced.

There can be a problem with the bond coat adhering to asphalt delivery vehicle tyres during hot weather or where haulage has been over a considerable distance, i.e. the vehicle tyres become very hot. In Germany water is often used to cool down vehicle tyres before they traverse surfaces that have been treated with a bond coat (Figure NG 2.4). Water is often applied on the approach to the site and is seen to reduce the amount of bond coat pick-up on vehicle tyres.



Figure NG 2.4: Watering of surface to avoid sticking of bond coat to tyres

NG 2.13.3 Compaction

The TS2010 SMA could possess all the desirable design mixture properties but still perform poorly under traffic if it has not been compacted correctly. As a result of the compaction process, the binder coated aggregates are forced closer together increasing aggregate interlock and inter-particle friction. Proper compaction of the asphalt increases resistance to rutting, cracking, ageing, moisture damage and stability of the mixture.

Experience with laying SMA in Germany is that the temperature of the material in the paver hopper should be evenly distributed and not be at less than 150°C. Compaction of the mat should commence as soon as possible, the initial compaction being with a 3-point roller of 8 to 12 tonnes dead-weight, followed by a tandem roller to complete the process. Experience from the TAIT process builds on the German view that the additional mass of 3-point rollers produces superior initial compaction. All rollers should be smooth steel-wheeled. Rollers should operate as close as possible to the paver. It is considered best practice to have at least two rollers for each lane that is paved. Pneumatic-tyre rollers are not suitable as binder-rich material adheres to them. The use of the vibration function on rollers should be avoided as there is a risk that excessive vibration on cooled material will fracture and damage the surface aggregates.

It is recognised that where small quantities of material are being used, e.g. small areas and patching work, a tandem roller may be sufficient.

All compaction equipment used must be operated by skilled and experienced operators. Skilled equipment drivers are required to observe and react to any detrimental movement of the asphalt. Due to the number of variables involved, such as environmental conditions and mix properties, it is impossible to generalise about the best combination of rolling and roller pattern to use in all cases. However, a 'slow and steady' approach is regarded as desirable to increase both the quality and long-term durability of the rolled pavement. The following should be noted:

- Stoppages in rolling can lead to variations in layer density.
- Too high a rolling speed may result in insufficient compactive effort being applied.
- Large variations in roller speed along the length or across the width of the mat is likely to cause variations in the density achieved.
- Rollers should be turned slightly to the side when reversing direction or stopping (Figure NG 2.5). It is difficult to flatten out marks or indentations if they are perpendicular to the direction of roller travel. It is easier to flatten or remove marks with subsequent passes if they are diagonal to the direction of rolling.



Figure NG 2.5 Roller compaction behind paver

NG 2.14 Surfacing Selection

The TS2010 specification comprises a range of four SMA mixtures. Guidance on what mixture should be specified (represented by the greyed-out areas) is provided in [Table NG 2.5](#). However, it should be noted that experience in using the TS2010 specification is at an early stage and the decision as to which mixture is selected should always be made on a site-specific basis.

Table NG 2.5 Guidance on the selection of TS2010 SMA mixtures

Mixture description	Site category/description					High stress e.g. roundabouts & junctions
	Non-event e.g. Site Class 1*	Medium risk of Skidding e.g. Site Class 2*	High risk of Skidding e.g. Site Class 3*	Noise sensitive area		
				High speed	Low speed	
SMA 14						
SMA 10						
SMA 8 (Developmental)						
SMA 6						

- a) Site Class* 1 comprises site categories A, B & C given in Table 4.1 of HD28 (DMRB 7.3.1)
- b) Site Class* 2 comprises site categories R, G1, & S1 given in Table 4.1 of HD28 (DMRB 7.3.1)
- c) Site Class* 3 comprises site categories Q, K, G2 & S2 given in Table 4.1 of HD28 (DMRB 7.3.1)

3 References

Nicholls, C, M J McHale and R D Griffiths (2008). *Best practice guide for the durability of asphalt pavements.* TRL Road Note, RN42. Wokingham: TRL Ltd.

Nicholls, C, C Roberts and P Samuel (2006). *Implications of implementing the European asphalt test methods.* TRL Report TRL656. Wokingham: TRL Ltd.

Annex A Example of Approval Certificate

Asset Management Branch
Trunk Road and Bus Operations
Buchanan House
58 Port Dundas Road
Glasgow G4 0HF

Direct Line: 0141 272 xxxx
Martin.McLaughlin@transportscotland.gsi.gov.uk

Transport Scotland TS2010 Surface Course

Approval Certificate

Scotia Aggregates Ltd.

Ref N^o: Sc 01

Details of material:

Coarse Aggregate:	Coarse - Blackface Quarry
Fine Aggregate:	Fine - Whiteface Quarry
Filler Aggregate:	Powders Hill
Mixing Plant:	Southbank
Aggregate size:	10mm
Bitumen:	Eurobinders SBS Polymer modified
Fibres:	Celluproducts C1 pellets

The above material is approved for Class 1 sites.

The above material is approved to be produced at the following plants, in code order:

Sc 01	Southbank	Approval date:
Sc 01a	Westbank	xx/xx/xxxx
Sc 01b	Eastbank	xx/xx/xxxx
		xx/xx/xxxx

Signedxxx.....
Engineering and Programme Manager
Transport Scotland

Latest Revision Date: xx/xx/xxxx
Original Approval Date: xx/xx/xxxx