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**Roads and Bridges
Agrément Certificate
No 00/H042**

*Second issue**

Designated by Government
to issue
European Technical
Approvals

MASTERflex THIN SURFACING SYSTEM FOR HIGHWAYS

This Certificate is issued under the Highway Authorities Product Approval Scheme (HAPAS) by the BBA in conjunction with the Highways Agency (acting on behalf of the overseeing organisations of the Department for Transport; the Scottish Executive Development Department; the Welsh Assembly Government; the Department for Regional Development, Government Department in Northern Ireland), the CSS (formerly the County Surveyors' Society), the Local Government Technical Advisers Group, and industry bodies. HAPAS Agrément Certificates are normally each subject to a review every five years.

Product



• THIS CERTIFICATE RELATES TO THE MASTERflex THIN SURFACING SYSTEM FOR HIGHWAYS, COMPRISING A POLYMER-MODIFIED BITUMEN BINDER, LIMESTONE FILLER AND GRADED COARSE AND FINE AGGREGATES.

• The system is used in conjunction with either a bitumen emulsion or a polymer-modified bond coat, to enhance the adhesion to the substrate.

• The system is for use as a thin road surfacing laid at nominal thicknesses of 15 mm to 40 mm, covering the Classifications A, B and C defined in Table 1 of the Guidelines Document for the Assessment and Certification of Thin Surfacing Systems For Highways (working draft 4, dated 10 January 2000).

• The system can only be laid by Tarmac Limited National Contracting using conventional paving equipment.

These Front Sheets must be read in conjunction with the relevant Detail sheets, which provide information specific to Masterflex systems.

HAPAS Requirements — Detail Sheet 1

1 Requirements

The Highways Technical Advisory Committee (HiTAC) and HAPAS Specialist Group 3 (Thin Surfacing) have agreed with the British Board of Agrément the aspects of performance to be used by the BBA in assessing the compliance of Thin Surfacing Systems with the Guidelines Document. In the opinion of the BBA, the Masterflex System, when manufactured and laid in accordance with the provisions of this Certificate can be designed to meet the relevant requirements and can achieve the levels of performance given in Table 1 of the relevant Detail Sheet.

Regulations

2 Construction (Design and Management) Regulations 1994 (as amended)

Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.

See section: 4 *Manufacture, quality control, delivery and site handling* of these Front Sheets.

Technical Specification

3 Description

3.1 The *Masterflex* Thin Surfacing System comprises a series of mixtures principally consisting of a blend of a polymer-modified bituminous binder, graded crushed coarse and fine aggregates and limestone filler. The system is used in conjunction with either a bitumen emulsion or a polymer-modified bond coat, to enhance adhesion to the substrate.

3.2 The choice of aggregates, types and size used will depend on site specific details, including location, and contractual requirements for Polished Stone Value (PSV), texture depth and/or other properties. Reference should be made to the appropriate Detail Sheet for information on particular *Masterflex* variants.

3.3 The petrological types of aggregates approved for use in the *Masterflex* system include gritstones, basalts, granites and artificial (steel slag).

3.4 The system can be coloured by the addition of pigments. However, the assessment of colour durability and the effect of pigmentation on the properties of the product have not been assessed.

4 Manufacture, quality control, delivery and site handling

4.1 The product is manufactured, controlled and delivered in accordance with Tarmac Limited *Quality Plan for the Manufacture and Laying of Masterflex* (Issue 2, November 2002) which includes requirements for:

binder
aggregate selection and approval
plant suitability and approval
process control of mixing
inspection and testing of finished product
suitability of delivery vehicles and release agents.

4.2 Bond coats may be delivered to site either in bulk by tanker or in 200 kg drums.

4.3 The products are not classified under the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP3). Standard material safety data sheets for hot asphalts apply.

Installation

5 General

Masterflex is a machine-laid thin surfacing system installed by Tarmac Limited in accordance with procedures detailed in the *Quality Plan for the Manufacture and Laying of Masterflex* (Issue 2, November 2002) which includes requirements for:

site inspection and assessment
surface preparation and cleanliness
acceptable weather conditions and road surface temperatures
minimum paver and rolling temperatures
application and type of bond coat
paving equipment type and operation
joint making
compaction procedure
precautions during installation
record keeping.

6 Maintenance and repair

Motorways, trunk roads and other major repairs

6.1 The damaged area is removed by planing, to provide a length of at least 15 m for resurfacing. The planed area is resurfaced using material to the same specification using the techniques described under the *Installation* part of this Certificate.

Minor repairs

6.2 Minor repairs can be carried out by cutting out the damaged section and replacing it with a material of suitable specification agreed between Tarmac Limited and the purchaser.

6.3 The use of *Masterpave* may be considered in place of *Masterflex* and K1-40 bond coat may be used on the receiving course as an alternative to a polymer-modified bond coat except where the reinstatement is in a high stress area, eg junctions and in the wheel track.

6.4 The minimum width of reinstatement shall be 1.5 m and care should be taken to ensure that the existing wearing course is removed to its full depth.

6.5 Joints must be saw cut to a vertical face and painted with hot bitumen.

7 Additional information

The quality management systems of Tarmac Limited have been assessed and registered as meeting the requirements of BS EN ISO 9002 : 1994 by the British Standards Institution Quality Assurance for 'The production and supply of asphalt mixes (macadam, hot rolled asphalt, stone mastic asphalt, coated stone, bituminous materials) to sector scheme 14 as published by the Sector Scheme Advisory Committee for the Quality Assurance of the Production of Asphalt Mixes'. The certificate numbers that apply are:

Tarmac Northern Ltd	—	FM 20007
Tarmac Central Ltd	—	FM 56968
Tarmac Western Ltd	—	FM 56970
Tarmac Southern Ltd	—	FM 56969.

Bibliography

BS EN ISO 9002 : 1994 *Quality systems. Model for quality assurance in production, installation and servicing*

Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways (working draft 4, dated 10 January 2000)

Conditions of Certification

8 Conditions

8.1 This Certificate:

- (a) relates only to the product that is described, installed, used and maintained as set out in this Certificate;
- (b) is granted only to the company, firm or person identified on the front cover — no other company, firm or person may hold or claim any entitlement to this Certificate;
- (c) has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective;
- (d) is copyright of the BBA.

8.2 References in this Certificate to any Act of Parliament, Regulation made thereunder, Directive or Regulation of the European Union, Statutory Instrument, Code of Practice, British Standard, manufacturers' instructions or similar publication, shall be construed as references to such publication in the form in which it was current at the date of this Certificate.

8.3 This Certificate will remain valid for an unlimited period provided that the product and the manufacture and/or fabricating process(es) thereof:

(a) are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA;

(b) continue to be checked by the BBA or its agents;

(c) are reviewed by the BBA as and when it considers appropriate; and

(d) remain in accordance with the requirements of the Highway Authorities Product Approval Scheme.

8.4 In granting this Certificate, the BBA makes no representation as to:

(a) the presence or absence of any patent or similar rights subsisting in the product or any other product;

(b) the right of the Certificate holder to market, supply, install or maintain the product; and

(c) the nature of individual installations of the product, including methods and workmanship.

8.5 Any recommendations relating to the use or installation of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date of this Certificate or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future statutory, common law or other duty of care. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the installation and use of this product.



In the opinion of the British Board of Agrément, the Masterflex Thin Surfacing System for Highways is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 00/H042 is accordingly awarded to Tarmac Limited.

On behalf of the British Board of Agrément

A handwritten signature in black ink, appearing to read 'P. Q. Newson', is written over a light grey background.

Date of Second issue: 19th December 2002

Chief Executive

*Original Certificate issued on 17th January 2001. This amended version issued to include an update to the CDM Regulations, reference to revised constituents of the product and updated test classifications.

Electronic Copy

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Tarmac Limited

MASTERflex 10 mm THIN SURFACING SYSTEM FOR HIGHWAYS

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H A P A S

Roads and Bridges
Certificate No 00/H042
DETAIL SHEET 2
*Second issue**

Product



• THIS DETAIL SHEET RELATES TO THE MASTERflex 10 mm THIN SURFACING SYSTEM FOR HIGHWAYS.

• The system is for use as a thin road surface course laid at nominal thicknesses between 20 mm and 40 mm, covering the Classifications B and C defined in Table 1 of the Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways.

This Detail Sheet must be read in conjunction with the Front Sheets which give additional information on the HAPAS Requirements, Regulations and Conditions of Certification.

Technical Specification

1 Description

1.1 Masterflex 10 mm Thin Surfacing System for Highways comprises a mixture consisting of a polymer-modified binder, limestone filler and graded fine and coarse aggregates.

1.2 The bitumens approved for use in Masterflex 10 mm include Cariphalte M, Cariphalte TS, and Nypol TS.

1.3 The system can be used in conjunction with either a K1-40, K1-60 or a K1-70 bitumen emulsion bond coat, or Mastertack, Aquagrip 60 or Colbond 50 polymer-modified bond coats⁽¹⁾.

(1) Bond coats must be selected in accordance with procedures detailed in the current Tarmac Ltd, Quality Plan for the Manufacture and Laying of Masterflex.

Design Data

2 General

2.1 Masterflex 10 mm Thin Surfacing System for Highways is satisfactory for use as a thin surfacing system on highways.

2.2 The product can be designed and laid to give an initial texture depth which exceeds the minimum requirement of 1.5 mm for high speed trunk roads.

2.3 The product is suitable for use on existing bituminous or concrete surfaces at a minimum temperature of -1°C , measured on a rising thermometer, provided the substrate is free from standing water or ice and that the minimum specified rolling temperature can be maintained.

2.4 The product, when manufactured and laid in accordance with the provisions of this Detail Sheet, can be designed to achieve the levels of performance given in Table 1.

Test parameter	Performance Level achieved ⁽¹⁾	Requirement
Texture depth	3	
untrafficked (mm)		≥ 1.5
after two year trafficking (mm)		≥ 1.0
loss between first and second year (%)		≤ 40
Wheel tracking	3	
rate (mean/max individual) (mm h^{-1})		$\leq 5.0/\leq 7.5$
rut depth (mean/max individual) (mm)		$\leq 7.0/\leq 10.5$
Hydraulic conductivity	0	
mean/min individual (s^{-1})		$>0.03/>0.02$

(1) Performance Levels are defined in Appendix B of the Guidelines Document.

3 Durability

3.1 The product has been used in the United Kingdom since 1994 and available evidence suggests that it will provide a durable surface course suitable for use on all classes of road.

3.2 A monitored installation leading to HA Type Approval showed that, when laid at a nominal thickness of 25 mm on a road of Stress Level 1⁽¹⁾ and estimated traffic level of over 3300 cv/l/d⁽²⁾, the product will meet the Performance Level 3⁽³⁾ requirement for retained texture.

3.3 The results of this trial, when assessed in accordance with Appendix C of the Guidelines Document, indicate that Masterflex 10 mm is suitable for use to achieve Levels 1, 2 and 3⁽³⁾ retained texture on sites with traffic levels C_{max} :

Site Stress Level 1 and 2 $>5000 \text{ cv/l/d}^{(2)}$
 Site Stress Level 3 and 4 $>2500 \text{ cv/l/d}^{(2)}$

(1) Site Stress Levels are defined in Appendix C of the Guidelines Document.

(2) Traffic Levels (cv/l/d) are defined as commercial vehicles/lane/day.

(3) Performance Levels are defined in Appendix B of the Guidelines Document.

Technical Investigations

The following is a summary of the technical investigations carried out on the Masterflex 10 mm Thin Surfacing System for Highways.

4 Tests

Mandatory laboratory and road tests

4.1 A series of tests was carried out on the Masterflex 10 mm system laid on the M6 motorway. The results of the tests are given in Tables 2 and 3.

Table 2 Mandatory laboratory tests carried out on the coarse aggregate, cores taken from the M6 motorway installation trial or on laboratory-prepared samples of the same mixture recipe

Test	Method	Results	Performance Level
Coarse aggregate properties:			
PSV	BS 812-114 : 1989	65	n/a
AAV	BS 812-113 : 1990(1995)	3.2	n/a
Wheel tracking at 60°C ⁽¹⁾ :	Appendix A.1 draft Guidelines Document		
rate (mm h^{-1})		0.31	3
rut depth (mm)		2.35	
Torque bond strength at 20±2°C on 15.5 mm diameter cores (kPa)	Appendix A.3 draft Guidelines Document	>410 (no failure at max test load of 400 Nm)	n/a
Sensitivity to water: retained stiffness (ITSM _{c3}) ⁽²⁾ (%)	Appendix A.2 draft Guidelines Document	93	n/a

(1) Mean core thickness = 38.7 mm.

(2) Retained indirect tensile stiffness modulus at 20±0.5°C after three water conditioning cycles carried out on laboratory-prepared samples.

n/a = Not applicable.

Table 3 Mandatory checks and tests carried out on the M6 motorway installation

Test	Method	Result	Specification
Initial texture depth (sand patch) (mm)	BS 598-105 : 2000		
mean (all sections) ⁽¹⁾		1.73	≥ 1.50
minimum recorded (section)		1.45	≥ 1.20
maximum recorded (section)		2.49	n/a
Visual observations		Good uniform surface with no significant faults or abnormalities noted	

(1) All lanes north bound (chainage 1000–5450) and south bound (chainage 1230–5550).

n/a = Not applicable.

Additional tests

4.2 A series of characterisation tests was carried out on the binders used in Masterflex. See Table 4 for details.

Table 4 Binder characterisation tests

Test	Method
Softening point (°C) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-58 : 1993
Penetration (dmm) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-49 : 1993
Rheology G* at 25°C and 0.4 Hz (Pa) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾ ageing index ⁽⁴⁾	IPPM CM/99 ⁽³⁾

(1) Rolling thin film oven test (RTFOT) in accordance with ASTM D 2872 : 1997.

(2) High pressure ageing test in accordance with the test method developed under the HAPAS scheme for modified binders, Draft 1.0 (October 1997).

(3) IPPM CM/99 Test Method — Determination of the complex shear modulus and phase angle of bituminous binders.

(4) Ageing index is defined as the ratio of complex modulus (G*) at 25°C and 0.4 Hz after and before HiPAT (High Pressure Ageing Test) conditioning.

4.3 A series of optional tests was carried out on a Masterflex 10 mm mixture laid on the M6 motorway near Leyland. The results of the tests are given in Tables 5 and 6.

Table 5 Optional tests carried out on the M6 motorway installation trial

Test	Method	Result
Noise RSI _H [dB(A)] ⁽¹⁾	Statistical pass-by method Guidelines Document, Appendix A.8	-5.5 ⁽²⁾
Max vehicle noise levels [dB(A)]		
light vehicles (L)		79.2 ⁽³⁾
heavy vehicles (H1)		83.4 ⁽³⁾
heavy vehicles (H2)		85.4 ⁽³⁾
age of site when tested (months)		3-4
Hydraulic conductivity (s ⁻¹)	DD 229 : 1996(2000)	0.03
Stiffness (MPa) ⁽⁴⁾	Guidelines Document, Appendix A.2	2950

(1) The high speed Road Surface Influence (RSI_H) is a measure of the difference in noise, that could be expected if compared against a theoretical hot rolled asphalt surface with 2 mm texture depth. A negative result indicates a reduction in noise level. Noise levels will vary according to specific site conditions and system characteristics including texture, age of installation, voids content.

(2) Mean result of two measurements -5.9 and -5.0 made on the north bound and south bound carriageways respectively.

(3) Mean of two measurements. Measurement for light vehicles normalised to 110 kmh⁻¹ and for heavy vehicles 90 kmh⁻¹.

(4) Initial indirect tensile stiffness modulus measured during water sensitivity testing on laboratory prepared cores using samples of the mixture used on the M6 motorway.

Noise

4.4 Noise measurements on the M6 motorway indicate that the product can significantly reduce noise levels generated by vehicle tyres acting on the road surface. The installation was over three months old when the noise measurements were made, and a change in noise levels could occur with time. However, it is expected that the installation will maintain a significant negative RSI_H during its useful service life.

Note: Noise levels will be affected by site specific conditions including location and the condition of the existing road and, therefore, the RSI_H values determined for the M6 motorway installation may not be reproduced on other installations.

Surface regularity

4.5 Test data from installations on the M65 and M6 motorways indicate that Masterflex 10 mm can be laid to give a surface with few irregularities. Test results relating to changes in longitudinal irregularities on the A632 trunk road and initial changes in maximum transverse irregularities measured on the M6 motorway are given in Table 6. However the initial irregularity and initial rut depth values were not numerous or severe enough respectively to allow claims to be made on improvement capabilities under the requirements of the Guidelines Document.

Table 6 Longitudinal and transverse surface regularity

Test	Method	Result
Changes in longitudinal irregularities:	Guidelines Document, Appendix A.6	
initial irregularity value (mm m ⁻¹)		0.44
final irregularity value (mm m ⁻¹)		0.12
profile improvement value (%)		75
Initial changes in maximum transverse irregularities:	Guidelines Document, Appendix A.7	
initial rut depth ⁽¹⁾ (mm)		5
residual rut depth (mm)		1.1
rut improvement value ⁽¹⁾ (%)		80

(1) The initial irregularity and initial rut depth values were not sufficiently numerous and severe for the results to be used to claim regulating ability and rut improvement ability respectively as required under the current Guidelines Document (working draft 4, dated 10 January 2000). The requirements for initial irregularity and initial rut depth where improvement claims are made are ≥ 1.0 mm m⁻¹ and ≥ 6 mm respectively.

4.6 A series of tests was carried out on Masterflex 10 mm to compare the suitability of the various constituents proposed for use in the system. The results, when assessed in accordance with the Guidelines Document, showed that, where applicable the Performance Levels detailed in Tables 1 to 4 can be maintained.

5 Investigations

5.1 An installation trial was carried out to assess the practicability of the installation and on-site quality control procedures. A visual inspection of the site concluded that it was free from significant abnormalities. Results from the installation confirmed that it complied with the contractual requirements.

5.2 A user/specifier survey relating to existing sites that were at least two years old was carried out to confirm the products performance in use. The sites surveyed included the M65 (Blackburn), B800 (Edinburgh) and B2163 (Kent).

5.3 Information relating to the M65 (Blackburn), Forth Road Bridge and Corstorphine Road, reported in TRL Report PR/CE/206/98, provided additional evidence of acceptable performance.

5.4 The manufacturing process was examined by inspection of a typical coating plant, including the methods adopted for quality control, and details were confirmed of the quality and composition of materials used. The inspection confirmed that the plant operated in accordance with the requirements of the Quality Plan and Quality System agreed with the BBA.

Bibliography

BS 598-105 : 2000 *Sampling and examination of bituminous mixtures for roads and other paved areas — Methods of test for the determination of texture depth*

BS 812-113 : 1990 *Testing aggregates — Method for determination of aggregate abrasion (AAV)*

BS 812-114 : 1989 *Testing aggregates — Method for determination of the polished-stone value*

BS 2000-49 : 2000 *Methods of test for petroleum and its products — Bitumen and bituminous binders — Determination of needle penetration of bituminous material*

BS 2000-58 : 1993 *Methods of test for petroleum and its products — Determination of softening point of bitumen — Ring and ball method*

BS 4987-2 : 1993 *Coated macadam for roads and other paved areas — Specification for transport, laying and compaction*

ASTM D 2872 : 1988 *Standard Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)*

DD 229 : 1996 *Method for determination of the relative hydraulic conductivity of permeable surfacings*

Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways (working draft 4, dated 10 January 2000)



On behalf of the British Board of Agrément

A handwritten signature in black ink, appearing to read 'P. C. Newson', is written over a light grey background.

Date of Second issue: 19th December 2002

Chief Executive

**Original Detail Sheet issued on 17th January 2001. This amended version issued to include a new Technical Specification section, additional test data and a revised Bibliography.*



Tarmac Limited

MASTERflex 14 mm THIN SURFACING SYSTEM FOR HIGHWAYS**Product**

• THIS DETAIL SHEET RELATES TO THE MASTERflex 14 mm THIN SURFACING SYSTEM FOR HIGHWAYS.

• The system is for use as a thin surface course laid at nominal thicknesses between 30 mm and 40 mm⁽¹⁾, covering Classification C as defined in Table 1 of the Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways.

This Detail Sheet must be read in conjunction with the Front Sheets which give additional information on the HAPAS Requirements, Regulations and Conditions of Certification.

(1) The system can be laid up to 50 mm thick, see section 4.3.

Technical Specification**1 Description**

1.1 Masterflex 14 mm Thin Surfacing System for Highways comprises a mixture consisting of a polymer-modified binder, limestone filler and graded fine and coarse aggregates.

1.2 The bitumens approved for use in Masterflex 14 mm include Cariphalte M, Cariphalte TS and Nypol TS.

1.3 The system can be used in conjunction with either a K1-40, K1-60 or a K1-70 bitumen emulsion bond coat, or Mastertack, Aquagrip 60 or Colbond 50 polymer-modified bond coats⁽¹⁾.

(1) Bond coats must be selected in accordance with procedures detailed in the current Tarmac Ltd Quality Plan for the Manufacture and Laying of Masterflex.

2 General

2.1 *Masterflex* 14 mm Thin Surfacing System for Highways is satisfactory for use as a thin surfacing system on highways.

2.2 The product can be designed and laid to give an initial texture depth which exceeds the minimum requirement of 1.5 mm for high speed trunk roads.

2.3 The product is suitable for use on existing bituminous or concrete surfaces at a minimum temperature of -1°C , measured on a rising thermometer, provided the substrate is free from standing water or ice and that the minimum specified rolling temperature can be maintained.

2.4 The product, when manufactured and laid in accordance with the provisions of this Detail Sheet, can be designed to achieve the Performance Levels given in Table 1.

Table 1 Performance Levels achieved on trial installations

Test parameter	Performance Level ⁽¹⁾	Requirement
Texture depth	3	
untrafficked (mm)		≥ 1.5
after two year trafficking (mm)		≥ 1.0
loss between first and second year (%)		≤ 40
Wheel tracking	3	
rate (mean/max individual) (mm h^{-1})		$\leq 5.0/\leq 7.5$
rut depth (mean/max individual) (mm)		$\leq 7.0/\leq 10.5$

(1) Performance Levels are defined in Appendix B of the Guidelines Document.

3 Durability

3.1 The product has been used in the United Kingdom since 1998 and available evidence suggests that it will provide a durable surface course, suitable for use on all classes of road.

3.2 A monitored installation leading to HA Type Approval showed that *Masterflex* 14 mm has the required properties to meet Performance Level 3⁽¹⁾ requirement for retained texture.

3.3 The results of this trial, when assessed in accordance with Appendix C of the Guidelines Document, indicate that *Masterflex* 14 mm is suitable for use to achieve Performance Levels 1, 2, and 3⁽¹⁾ retained texture on sites with Traffic Levels of C_{max} :

Site Stress Level 1 and 2	$>5000 \text{ cv/l/d}^{(2)}$
Site Stress Level 3 and 4	$>2500 \text{ cv/l/d}^{(2)}$

(1) Performance Levels are defined in Appendix B of the Guidelines Document.

(2) Traffic Levels (cv/l/d) are defined as commercial vehicles/lane/day.

The following is a summary of the technical investigations carried out on the *Masterflex* 14 mm Thin Surfacing System for Highways.

4 Tests

Mandatory laboratory and road tests

4.1 A series of tests were carried out on the *Masterflex* 14 mm system laid on the M65 motorway and a trial site in Newbury. The results of the tests are given in Tables 2, 3 and 4.

Table 2 Mandatory laboratory tests carried out on the coarse aggregate, cores taken from the M65 motorway installation trial or on laboratory-prepared samples of the same mixture recipe

Test	Method	Result	Performance Level
Coarse aggregate properties:			
PSV	BS 812-114 : 1989	65	n/a
AAV	BS 812-113 : 1990(1995)	3.2	n/a
Wheel tracking at $60^{\circ}\text{C}^{(1)}$: rate (mm h^{-1}) rut depth (mm)	Appendix A.1 draft Guidelines Document	0.65 2.0	3
Sensitivity to water: retained stiffness (ITSM_{c3}) ⁽²⁾ (%)	Appendix A.2 draft Guidelines Document	>100	n/a

(1) Mean core thickness = 48 mm.

(2) Retained indirect tensile stiffness modulus at $20 \pm 0.5^{\circ}\text{C}$ after three water conditioning cycles carried out on laboratory-prepared samples.

n/a = Not applicable.

Table 3 Mandatory road tests carried out on the M65 motorway installation

Test	Method	Result	Specification
Texture depth (sand patch) (mm)	BS 598-105 : 2000		
initial (untrafficked) ⁽¹⁾		1.6	≥ 1.5
after two years trafficking ⁽¹⁾		1.0	≥ 1.0
Visual observations		Good uniform surface with no significant faults or abnormalities noted	

(1) Minimum texture depth recorded from all sections measured.

Table 4 Torque bond strength, cores taken from trial site in Newbury

Test	Method	Result ⁽¹⁾	Performance Level
Torque bond strength at $20 \pm 2^{\circ}\text{C}$ on 152 mm diameter cores (kPa)	Appendix A.3 draft Guidelines Document	$>240^{(2)}$	n/a

(1) Result relates to *Masterflex* 14 mm, polymer-modified binder and Mastertack bond coat.

(2) No failure was recorded at the bond interface.

Additional tests

4.2 A series of characterisation tests was carried out on the binders used in *Masterflex*. See Table 5 for details.

Test	Method
Softening point (°C) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-58 : 1993
Penetration (dmm) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-49 : 1993
Rheology G* at 25°C and 0.4 Hz (Pa) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾ ageing index ⁽⁴⁾	IPPM CM/99 ⁽³⁾

(1) Rolling thin film oven test (RTFOT) in accordance with ASTM D 2872 : 1997.

(2) High pressure ageing test in accordance with the test method developed under the HAPAS scheme for modified binders, Draft 1.0 (October 1997).

(3) IPPM CM/99 Test Method — Determination of the complex shear modulus and phase angle of bituminous binders.

(4) Ageing index is defined as the ratio of complex modulus (G*) at 25°C and 0.4 Hz after and before HiPAT (High Pressure Ageing Test) conditioning.

4.3 Wheel tracking test data on laboratory-prepared samples indicate that *Masterflex* 14 mm can maintain Performance Level 3 for wheel tracking at thicknesses up to 50 mm. See Table 6 for results.

Test	Method	Result ⁽¹⁾	Performance Level
Wheel tracking at 60°C ⁽²⁾ rate (mmh ⁻¹) rut depth (mm)	BS 598-110	0.43 3.0	3

(1) Mean of two results.

(2) Mean core thickness = 50 mm.

4.4 A series of tests was carried out on *Masterflex* 14 mm to evaluate the suitability of the various constituents proposed for use in the system. The results, when assessed in accordance with the Guidelines Document, showed that, where applicable, the Performance Levels detailed in Tables 1 to 6 can be maintained.

5 Investigations

5.1 An installation trial was carried out to assess the practicability of the installation and on-site quality control procedures. A visual inspection of the site concluded that it was free from significant abnormalities. Results from the installation confirmed that it complied with the contractual requirements.

5.2 A user/specifier survey relating to existing sites that were at least two years old was carried out to confirm the products performance in use.

5.3 The manufacturing process was examined by inspection of a typical coating plant, including the methods adopted for quality control, and details were confirmed of the quality and composition of materials used. The inspection confirmed that the plant operated in accordance with the requirements of the Quality Plan and Quality System agreed with the BBA.

Bibliography

BS 598-105 : 2000 *Sampling and examination of bituminous mixtures for roads and other paved areas — Methods of test for the determination of texture depth*

BS 598-110 : 1998 *Sampling and examination of bituminous mixtures for roads and other paved areas — Methods of test for the determination of wheel-tracking rate and depth*

BS 812-113 : 1990 *Testing aggregates — Method for determination of aggregate abrasion (AAV)*

BS 812-114 : 1989 *Testing aggregates — Method for determination of the polished-stone value*

BS 2000-49 : 1993 *Methods of test for petroleum and its products — Determination of needle penetration of bituminous material*

BS 2000-58 : 1993 *Methods of test for petroleum and its products — Determination of softening point of bitumen — Ring and ball method*

ASTM D 2872 : 1997 *Standard Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)*

Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways



On behalf of the British Board of Agrément

Date of issue: 19th December 2002

A handwritten signature in black ink, appearing to read 'P. C. Hewson'.

Chief Executive

**Tarmac Limited****MASTERflex 6 mm THIN SURFACING SYSTEM FOR HIGHWAYS**

Product



• THIS DETAIL SHEET RELATES TO THE MASTERflex 6 mm THIN SURFACING SYSTEM FOR HIGHWAYS.

• The system is for use as a thin road surface course, laid at nominal thicknesses between 15 mm and 40 mm, covering the Classifications A, B and C defined in Table 1 of the Guidelines Document for the Assessment and Certification of Thin Surfacing Systems for Highways.

This Detail Sheet must be read in conjunction with the Front Sheets which give additional information on the HAPAS Requirements, Regulations and Conditions of Certification.

Technical Specification

1 Description

1.1 Masterflex 6 mm Thin Surfacing System for Highways comprises a mixture consisting of a polymer-modified binder, limestone filler and graded fine and coarse aggregates.

1.2 The bitumens approved for use in Masterflex 6 mm include Cariphalte M, Cariphalte TS and Nypol TS.

1.3 The system can be used in conjunction with either a K1-40, K1-60 or a K1-70 bitumen emulsion bond coat, or Mastertack, Aquagrip 60 or Colbond 50 polymer-modified bond coats⁽¹⁾.

(1) Bond coats must be selected in accordance with procedures detailed in the current Tarmac Ltd Quality Plan for the Manufacture and Laying of Masterflex.

Design Data

2 General

2.1 *Masterflex* 6 mm Thin Surfacing System for Highways is satisfactory for use as a thin surfacing system on highways.

2.2 The product can be designed and laid to give an initial texture depth which meets the minimum requirements for Performance Level 2.

2.3 The product is suitable for use on existing bituminous or concrete surfaces at a minimum temperature of -1°C , measured on a rising thermometer, provided the substrate is free from standing water or ice and that the minimum specified rolling temperature can be maintained.

2.4 The product, when manufactured and laid in accordance with the provisions of this Detail Sheet, can be designed to achieve Performance Levels given in Table 1.

Table 1 Performance Levels achieved

Test parameter	Performance Level achieved ⁽¹⁾	Requirement
Texture depth untrafficked (mm)	2	≥ 1.2
after two year trafficking (mm)		≥ 0.8
loss between first and second year (%)		≤ 40
Wheel tracking rate (mean/max individual) (mm h^{-1})	3	$\leq 5.0/\leq 7.5$
rut depth (mean/max individual) (mm)		$\leq 7.0/\leq 10.5$

(1) Performance Levels are defined in Appendix B of the Guidelines Document.

3 Durability

3.1 The product has been used in the United Kingdom since 1999 and available evidence suggests that it will provide a durable surface course, suitable for use on all classes of road.

3.2 Results from an installation on the A473 Penybont Road, Pencoed, showed that, when laid at a nominal thickness of 30 mm on a road of Stress Level 1⁽¹⁾ and an estimated Traffic Level of 352 cv/l/d ⁽²⁾, the product will meet Performance Level 2⁽³⁾ requirements for retained texture.

3.3 The results from this installation, when assessed in accordance with Appendix C of the Guidelines Document, indicate that *Masterflex* 6 mm is suitable for use to achieve Performance Level 2⁽²⁾ (see Table 2) retained texture on sites with Traffic Levels C_{max} :

Table 2 Maximum Traffic Levels (cv/l/d) maintaining Performance Level 1

Site Stress Level	C_{max} (cv/l/d) ⁽³⁾
1	3500
2	1500
3	1000
4	800

(1) Site Stress Levels are defined in Appendix C of the Guidelines Document.

(2) Performance Levels are defined in Appendix B of the Guidelines Document.

(3) Traffic Levels (cv/l/d) are defined as commercial vehicles/lane/day.

Technical Investigations

The following is a summary of the technical investigations carried out on the *Masterflex* 6 mm Thin Surfacing System for Highways.

4 Tests

Mandatory laboratory and road tests

4.1 A series of tests was carried out on the *Masterflex* 6 mm system. The results of the tests are given in Table 3.

Table 3 Mandatory laboratory tests carried out on the coarse aggregate, cores taken from an installation on the A1066 Diss or on laboratory-prepared samples of the same mixture recipe

Test	Method	Results	Performance Level
Coarse aggregate properties:			
PSV	BS 812-114 : 1989	55	n/a
AAV	BS 812-113 : 1990(1995)	4.2	n/a
Wheel tracking at 60°C ⁽¹⁾ : rate (mm h^{-1}) rut depth (mm)	Appendix A.1 draft Guidelines Document	1.75 4.70	3
Torque bond strength at $20\pm 2^{\circ}\text{C}$ (kPa)	Appendix A.3 draft Guidelines Document	>453 (no failure at max test load of 400 Nm)	n/a
Sensitivity to water: retained stiffness ($\text{ITSM}_{\text{c}3}$) ⁽²⁾ (%)	Appendix A.2 draft Guidelines Document	93	n/a

(1) Mean core thickness = 51 mm.

(2) Retained indirect tensile stiffness modulus at $20\pm 0.5^{\circ}\text{C}$ after three water conditioning cycles carried out on laboratory-prepared samples.

n/a = Not applicable.

Texture depth

4.2 Sand patch texture depth measurements made at an installation on Fairfield Road, North Cornelly, showed that *Masterflex* 6 mm can be designed and laid to achieve initial texture depths of ≥ 1.2 mm. The results are given in Table 4.

Table 4 Sand patch texture measurements carried out on Fairfield Road, North Cornelly

Test	Method	Result (mean)	Specification
Initial texture depth (sand patch) (mm) untrafficked	BS 598-105 : 2000	1.2	≥ 1.2
after two years of trafficking (mm)		1.1	≥ 0.8

Additional tests

4.3 A series of characterisation tests was carried out on the binders used in *Masterflex*. See Table 5 for details.

Table 5 Binder characterisation tests

Test	Method
Softening point (°C) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-58 : 1993
Penetration (dmm) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾	BS 2000-49 : 1993
Rheology G* at 25°C and 0.4 Hz (Pa) unaged after RTFOT ⁽¹⁾ after HiPAT ⁽²⁾ ageing index ⁽⁴⁾	IPPM CM/99 ⁽³⁾

(1) Rolling thin film oven test (RTFOT) in accordance with ASTM D 2872 : 1997.

(2) High pressure ageing test in accordance with the test method developed under the HAPAS scheme for modified binders, Draft 1.0 (October 1997).

(3) IPPM CM/99 Test Method — Determination of the complex shear modulus and phase angle of bituminous binders.

(4) Ageing index is defined as the ratio of complex modulus (G*) at 25°C and 0.4 Hz after and before HiPAT (High Pressure Ageing Test) conditioning.

4.4 A series of tests was carried out on *Masterflex* 6 mm to compare the suitability of the various constituents proposed for use in the system. The results, when assessed in accordance with the Guidelines Document, showed that, where applicable, the Performance Levels detailed in Tables 1 to 5 can be maintained.

5 Investigations

5.1 The manufacturing process was examined by inspection of a typical coating plant, including the methods adopted for quality control, and details were confirmed of the quality and composition of materials used. The inspection confirmed that the plant operated in accordance with the requirements of the Quality Plan and Quality System agreed with the BBA.

5.2 *Masterflex* 6 mm and *Masterflex* 10 mm share common binder, aggregate sources and bond coats. Test data relating to *Masterflex* 10 mm and 14 mm, where applicable, has been used as supporting evidence to complete technical investigations on *Masterflex* 6 mm.

Bibliography

BS 598-105 : 2000 *Sampling and examination of bituminous mixtures for roads and other paved areas — Methods of test for the determination of texture depth*

BS 2000-49 : 1993 *Methods of test for petroleum and its products — Determination of needle penetration of bituminous material*

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On behalf of the British Board of Agrément

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