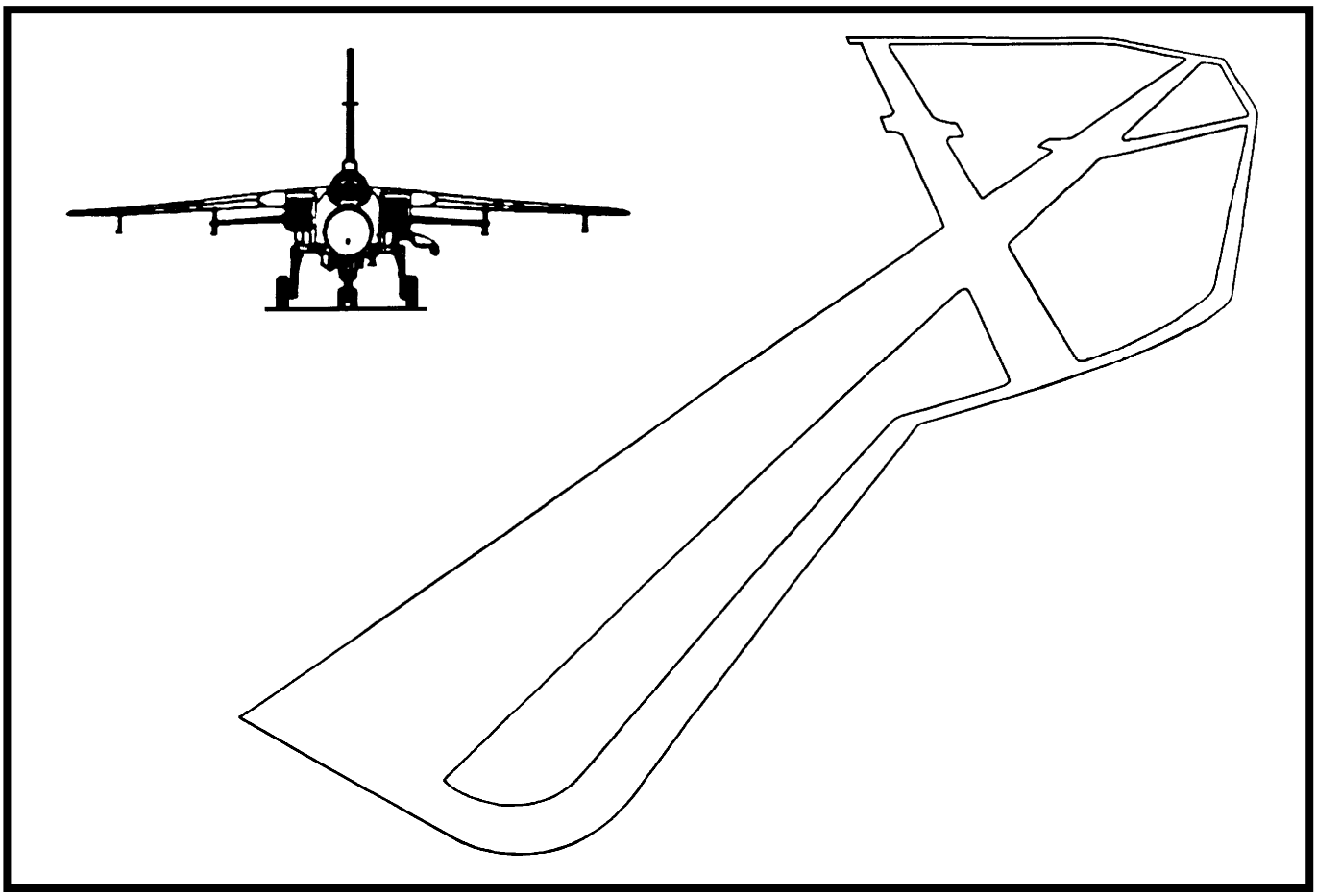
Specification 49



Stone Mastic Asphalt for Airfields

DEFENCE ESTATES
MINISTRY OF DEFENCE

Specification 49

Stone Mastic Asphalt for Airfields

August 2009

CONSTRUCTION SUPPORT TEAM
DEFENCE ESTATES

Ministry of Defence

Acknowledgements

The specifications in this document have been prepared by TRL Limited in conjunction with and under commission to the Construction Support Team, Defence Estates, Ministry of Defence.

Foreword

This document is for the use of Top Level Budget Holders (TLBHs) for application by the Project Sponsors and their Project Managers, Property Managers (PROM), Establishment Works Consultants (EWC), Works Service Managers (WSM) and other parties involved with airfield pavement works.

This DE Specification was prepared under the patronage of the Construction Support Team, Defence Estates, Ministry of Defence, for application to airfield pavement works on the MOD estate.

The application and limitations of the specification requirements in this DE Specification are outlined in Section 1. Further technical assistance regarding the contents of this document can be obtained from DE. Approaches may be made through local DE offices or directly to the airfield pavement Technical Works Authority (DE TA):

Head of Airfield Pavements
Construction Support Team
Defence Estates
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

Tel: 0121 311 2119 or Sutton Coldfield MI 2119

This Specification, "*Stone Mastic Asphalt for Airfields* ", has been devised for use of the Crown and of its Contractors in the execution of contracts for the Crown and, subject to the Unfair Contracts Terms Action 1977, the Crown will not be liable in any way whatever (including but without limitation negligence on the part of the Crown its servants or agents) where the Standard is used for other purposes.

Glossary of Technical Terms

Added Filler	Filler aggregate that is additional to that inherent in the course and fine aggregate
Aggregate / Cement Ratio	The ratio between the total mass of aggregate, including the mass of any absorbed water, in a concrete mix and the mass of cement in the mix.
Asphalt	A mixture of coarse and fine aggregate, filler aggregate and bituminous binder used in the construction of flexible pavements for roads and airfields.
Asphalt Concrete	An asphalt mixture consisting of continuous graded aggregate, filler aggregate and bituminous binder proportioned to produce a dense and impermeable surfacing.
Asphalt Surfacing	A porous friction course, surface course, or a combination of these, and a binder course.
Asphaltic Concrete	Alternative name for ‘Asphalt Concrete’.
Base	Structural layer(s) of a pavement immediately below the Binder Course that are bound.
Basecourse	Previous name for ‘Binder Course’.
Bay (of Concrete)	The area of slab bounded by adjacent pairs of longitudinal and transverse joints or grooves.
Bay Layout	The pattern of joints and grooves on a concrete pavement.
Binder	A material used for the purpose of holding solid particles together as a coherent mass.
Binder Course	The layer or layers of the asphalt surfacing immediately below the surface course. (Previously called ‘Basecourse’).
Bitumen	Binder obtained from crude oil by refinery processes.
Bitumen Emulsion	An emulsion in which bitumen is dispersed in water or in aqueous solution with the aid of suitable emulsifying agents.
Bitumen Macadam	See ‘Macadam’.

Bituminous	Containing bitumen. (Previously included road tar, pitch or mixtures thereof).
Bituminous Surfacing	Alternative name for 'Asphalt Surfacing'.
Bond Coat	Proprietary bitumen spray that provides additional adhesion and imperviousness to that achieved with a Tack Coat and, therefore, improved bond between layers when applied at the rate of application recommended by the proprietor for the particular situation.
Coarse Aggregate	For asphalt, aggregate mainly retained on a 2.0 mm test sieve and containing no more finer material than is permitted for the various sizes in BS EN 13043. For concrete and block making, aggregate mainly retained on a 4.0 mm test sieve and containing no more finer material than is permitted for the various sizes in BS EN 12620.
Cold Recycled Bound Material (CRBM)	A material produced *ex situ* in a fixed or mobile mixing plant from recycling base and binder courses from existing pavements. The recycling process allows for the crushing, screening and grading of excavated material, blended if necessary with other aggregate, and bound with bituminous and hydraulic binder(s) including cement.
Construction Joint	A joint separating area of a concrete pavement slab placed during different pours, usually on different days. May be a longitudinal, or lane, joint or a transverse joint across a lane.
Contraction Groove	A groove formed in the surface of a concrete slab, either during or soon after laying, in order to induce shrinkage cracking to occur in a controlled manner. Usually formed transversely at regular intervals along a lane of concrete by saw cutting so as to subdivide it into approximately square bays.
Crushed Aggregate	Aggregate produced by crushing rock or gravel.
Cutback Bitumen	Bitumen whose viscosity has been reduced by the addition of a suitable volatile diluent.
Dense Bitumen Macadam (DBM)	See 'Macadam'.
Drylean concrete	A cement bound granular material with low water content suitable for use as a Base or subbase. Unlike conventional concrete, it is usually compacted by rolling.

Edge Restraint	Device that serves to prevent sideways movement of paving units and prevents loss of material from the laying course, base or subbase.
Expansion Joint	Joint provided in a concrete pavement to accommodate the expansion which occurs when the temperature of the pavement rises.
Filler Aggregate	For asphalt, aggregate, most of which passes a 0.063 mm sieve as permitted in BS EN 13043, which can be added to construction materials to provide certain properties. For concrete and block making, aggregate, most of which passes a 0.063 mm sieve as permitted in BS EN 12620, which can be added to construction materials to provide certain properties.
Fine Aggregate	For asphalt, aggregate mainly passing a 2.0 mm test sieve and containing no more coarse material than is permitted for the various gradings in BS EN 13043. For concrete and block making, aggregate mainly passing a 4.0 mm test sieve and containing no more coarser material than is permitted for the various gradings in BS EN 12620.
Fines	Any solid material passing a 0.063 mm test sieve.
Foreign Object Damage (FOD)	Damage sustained by aircraft as a result of foreign objects striking the aircraft or being ingested into jet engines. Potential sources of damage are generally referred to as FOD hazards.
Free Water/Cement Ratio	The ratio between the mass of water, less any water absorbed by the aggregates, in a concrete mixture and the mass of cement in the mixture.
Friction Course	See ‘Porous Friction Course’.
Grading	Particle size distribution of an aggregate.
Heavy Duty Macadam (HDM)	See ‘Macadam’.
Hot Rolled Asphalt (HRA)	An asphalt mixture of gap-graded aggregate, filler aggregate and bitumen binder proportioned to a design or recipe to produce a dense and impermeable surfacing material.
Interlock	Effect of frictional forces between concrete blocks that prevent them moving vertically in relation to each other.

Intermediate Restraint	Device that is used to provide restraint of concrete block paving units at intervals in the paved surface.
Joint Filling Material	Material used to fill the joints between concrete blocks. Often referred to as 'joint filling sand'.
Joint Width	The distance between adjacent concrete blocks or concrete blocks and restraint.
Laitance	On a concrete pavement, a thin layer with poor durability formed of fine aggregate, cement and water brought to the surface, usually by overworking.
Lane	A longitudinal strip of a pavement layer produced by one pass of a set of paving equipment.
Lane Joint	A construction joint between adjacent lanes.
Laying Course Material	Layer of material on which concrete blocks are bedded. Often referred to as the 'bedding sand' or 'laying course sand'.
Laying Face	Working edge of the wearing surface when concrete blocks are being laid out.
Laying Pattern	An arrangement of concrete blocks to form specific patterns for structural requirements.
Macadam	An asphalt mixture (nominally an Asphalt Concrete) consisting of graded aggregate coated with bitumen. a. Dense Bitumen Macadam (DBM): A dense, relatively impermeable, Macadam coated with a bitumen binder and with a filler aggregate content of between 2 % and 9 %. b. Heavy Duty Macadam (HDM): A dense bitumen Macadam with 40/60 grade bitumen binder and a high filler aggregate content of 7 % to 11 %. c. Pervious Macadam: A layer of 0/32 mm Porous Asphalt which acts as a topping to protect whilst allowing free penetration of the surface water to French drains.
Marshall Asphalt	An Asphalt Concrete designed to achieve specified stability, flow, voids and density characteristics.
Particle Size Fraction	That portion of aggregate which passes one sieve but is retained on the adjacent smaller sized sieve in the sequence of sieves used to specify that grading.

Pavement	A structure consisting of a layer or superimposed layers of selected materials, whose primary purpose is to distribute the applied load to the Subgrade.
Pavement Quality Concrete (PQC)	A cement concrete of a suitable quality for use as the surfacing on airfield pavements.
Pervious Macadam	See ‘Macadam’.
Petroleum Bitumen	See ‘Bitumen’.
Porous Asphalt	An asphalt mixture consisting of gap-graded aggregate and binder with a relatively open structure that is pervious to air and water.
Porous Friction Course	A relatively thin layer of 2/10 mm aggregate sized Porous Asphalt that allows free penetration of the surface water to the underlying impervious surface course.
Quick Visco-Elastic (QVE)	Type of CRBM in which the primary binder is bitumen but also includes a proportion of Portland Cement.
Ramp	A section of pavement, usually laid at a gradient near the maximum permissible, which accommodates differences in level between adjacent pavements. (Note that, in US terminology, ‘Ramp’ may also be used to indicate an aircraft parking area).
Regulating Material	Asphalt of variable thickness applied to an existing pavement to adjust the shape preparatory to resurfacing.
Road Tar	A viscous liquid derived from crude tar obtained by the destructive distillation of coal which was, but is no longer, used as a component in asphalt.
Roadbase	Previous name for ‘Base’.
Sand (for making concrete)	Now called ‘Fine Aggregate’.
Sieved Fraction	Previous name for ‘Particle Size Fraction’.
Stone Mastic Asphalt (SMA)	A dense gap-graded asphalt with aggregate-to-aggregate interlock that includes fibres as a stabilising additive to carry the binder without drainage.
Subgrade	Upper part of the soil, natural or constructed, that supports the loads transmitted by the overlying pavement.

Surface Course	The layer of the asphalt surfacing immediately below the porous friction course or which directly supports the traffic. (Previously called 'Wearing Course').
Tack Coat	A thin film of bitumen emulsion to improve the adhesion between two courses of asphalt or between an existing surface and a new asphalt layer.
Thin (Asphalt) Surfacing System	A proprietary asphalt product with suitable properties to provide a surface course that is laid at a nominal depth of less than 50 mm (previously limited to 40 mm).
Uncrushed Aggregate	Aggregate resulting from the natural disintegration of rock.
Wearing Course	Previous name for 'Surface Course'.

(NOTE. This glossary is common to all DE Specifications for asphalt and concrete pavement materials and the Project Manager should delete any terms not applicable to a particular project and should add any terms necessary due to the particular nature of that project.)

Contents

Page

1 Introduction

1.1 BACKGROUND

1.1.1 The unique characteristics of military aircraft, in terms of speed, weight, tyre pressures, etc., create specialist requirements in the surfacing of MOD airfields. As such, specialist materials specifications are required to meet these needs.

1.1.2 This Standard, for Stone Mastic Asphalt (SMA), is one of a series being produced by DE to lay down specification requirements for airfield pavement works. The following clauses in this Section are intended to set out the applications of SMA in the construction and refurbishment of MOD airfield pavements.

1.1.3 The use of this Standard does not absolve a Project Manager from any responsibility for his designs, neither does its existence constrain him from using alternatives, provided such alternatives can be demonstrated to provide a result of equal quality.

1.2 FUNCTIONAL REQUIREMENTS OF AIRFIELD PAVEMENTS

The pavements must facilitate safe aircraft ground operations. In order to do this they must meet certain specialist performance requirements. The following sets out the main requirements, the relative importance of which will be dependent on the function of the pavements and the nature and type of aircraft operations:

a. Good rideability.
b. Good friction characteristics.
c. High strengths and stability to withstand the shear stresses induced by heavy wheel loads and high tyre pressures.
d. A durable, hard-wearing weatherproof surface free from loose material and sharp edges which might endanger aircraft.
e. Resistance to fuel spillage and jet blast. Depending on the nature and type of aircraft operations, these requirements are likely to be too onerous for asphalt surfacings in certain areas of the airfield.
f. Facilitate economic maintenance.

1.3 USE OF STONE MASTIC ASPHALT

1.3.1 General

SMA was developed in Germany over 30 years ago as a deformation resistant material for use on highways. It is now widely used on highways in Europe and the USA. SMA was introduced as a surfacing material for airfields in the 1990s, notably in Norway. In the UK, there has been limited but significant use of SMA on airfields since the 1990s, including the resurfacing of two runways at a regional civil airport. Its first use on MOD airfields was limited to trial areas on the taxiways at RAF Lyneham (1997 and 2001) and RAF Wittering (1997). It has subsequently been used for resurfacing MOD taxiways and also part of a primary MOD runway. The following guidance given on the application of this Standard is based on the experience gained from the early projects on MOD airfields together with the testing and evaluation of the trials carried out by TRL for the Construction Support Team / DE and highways experience.

1.3.2 Main Length of Runways

It is important on the main length of a runway to have good rideability and wet weather skid resistance. Asphalt surfacings generally give better rideability than PQC. Good skid resistance/friction characteristics are achieved by a combination of good surface shape to effect efficient surface water run-off and also surface texture to increase friction and allow water to disperse from under the tyre contact area. To meet these requirements, the most favoured option for MOD runways in the UK is the provision of a 20 mm thick Porous Friction Course on Marshall Asphalt surfacing. The alternative is grooved Marshall asphalt.

Limited experience on an MOD runway indicates that good friction values can be achieved on SMA according to the test criteria in JSP 554 but that surface water drainage characteristics appear to be less efficient compared with Porous Friction Course and grooved Marshall Asphalt. Also, friction test results on SMA can be below the minimum requirements of JP 554 in the first few months of it being laid. Limited experience in Europe is similar.

When SMA is being considered for use on MOD runways, Construction Support Team, DE should be contacted for advice.

1.3.3 Runway Ends and Adjoining Aircraft Holding Areas

Service conditions can be can be severe in these areas where jet blast and fuel spillage are likely to be most damaging and aircraft carry out sharp turns. The material most frequently used on runways ends and holding areas at MOD airfields is PQC. However with certain aircraft, the effect of jet blast on the pavement surface is not critical (e.g. piston engined aircraft, turboprops or turbojets where the jet exhaust is located at a safe height above the pavement). In these instances, asphalt provided with a fuel resistant surface treatment or alternatively incorporating a fuel resistant binder is likely to be a viable and economic alternative to PQC. Possible future change of aircraft type or use by visiting or temporarily based aircraft of other types need to be considered when making the decision. With regard to the use of SMA on runway ends and friction characteristics/requirements, the same caveat as made in Clause 1.3.2 applies.

1.3.4 Taxiways

Friction characteristics and rideability for taxiways are not as critical as for runways. Fuel and jet blast are not normally a critical consideration in these areas such that asphalt surfacings are generally a viable and economic construction option. This Standard for SMA is considered to provide an option for taxiway surfaces.

1.3.5 Parking and Servicing Aprons

Friction characteristics and rideability for parking and servicing aprons are not as critical as for the main length of a runway. In general, the need for resistance to fuel and oil spillages and to indentation by high tyre pressure tyres of standing aircraft and to damage from dropped tools, etc., will be such as to require the provision of a concrete surface. In certain circumstances, however, when the frequency of use is very low, asphalt surfacings, including SMA in accordance with this Standard may be a viable and economic alternative to a concrete surface. Such alternatives may incorporate modified binders or the provision of a fuel-resistant surface treatment. It should be noted that SMA is vulnerable to fuel spillages due to its negative surface texture unless a fuel-resistant is used.

1.3.6 Arid Climates

SMA may not be suitable where wind blown sand can accumulate and block the voids in the surface of the material.

1.3.7 Vertical Take Off and Landing (VTOL) Pads and Engine Running Platforms (ERPs)

VTOL pads for Harrier operations and ERPs for high performance jet aircraft provide the most severe conditions for pavements on the MOD airfields. PQC is normally provided in these areas. Its life-span is dependent on frequency and mode of usage but currently the average life-span is 10 years. This compares with an average life-span in excess of 30 years for PQC in other areas of an airfield.

1.3.8 Short Take Off and Landing (STOL) Runways/Strips

Consideration should be given to the use of PQC for STOL runways/strips that are to be used by aircraft with thrust vectoring capability. Further advice on a project/works specific basis can be obtained from the Construction Support Team, DE.

1.4 SPECIFICATION CLAUSES FOR STONE MASTIC ASPHALT

Specification clauses are contained in Sections 2 to 8 of this Standard with Guidance Notes given on the use of the magnesium sulfate test with non-standard aggregate fractions in Appendix A and on suitable temperatures and wind speeds for laying in Appendix C. Guidance Notes for the Project Manager on Quality Systems are given in Appendix Y and for the preparation of job specifications in Appendix Z.

1.5 ADVICE FROM CONSTRUCTION SUPPORT TEAM, DE

Clauses 1.2 and 1.3 provide general advice on the application of this Standard. However, having regard to the various design parameters affecting the choice of construction and specification, including scope of work, aircraft type and frequency of usage, location of pavement on an airfield, design life, time-scale constraints and existing pavement constructions, these guidance notes cannot be exhaustive. Further advice on a project/works specific basis can be obtained from the Construction Support Team, DE.

2 General

2.1 REFERENCES

All references to British Standards and other documents given in this Specification refer to the editions as listed in the References at the end of this document unless otherwise stated.

2.2 OVERALL REQUIREMENTS

SMA shall be specified, mixed, transported and laid to the relevant clauses in this Specification. The requirements of this Specification are arranged in the following parts:

General	Section 2
Materials	Section 3
Design & Composition	Section 4
Pavement Requirements	Section 5
Plant & Workmanship	Section 6
Trials	Section 7
Summary of Tests	Section 8
Magnesium Sulfate Test	Appendix A
Straightedge Test	Appendix B
Temperatures & Wind Speeds	Appendix C

2.3 USE OF STONE MASTIC ASPHALT

SMA surface course, binder course and regulating course shall be used in the locations indicated on the project drawings.

2.4 QUALITY ASSURANCE FOR THE SUPPLY OF ASPHALT MATERIALS

2.4.1 All operations in the batching of asphalt materials shall be carried out by a Contractor (or Supplier on his behalf) that has a Quality Assurance accreditation to the BS EN ISO 9000 series for those operations.

(NOTE. Advice for the Project Manager on Quality Systems is given in Appendix Y.)

2.4.2 Each production unit or depot involved in the work shall be registered under a Quality Management scheme to the BS EN ISO 9000 series and under “Sector Scheme 14”, The Production of Asphalt Mixes. The CE mark documentation or the Quality System documentation for the supply of component materials and batching of asphalt materials, together with other relevant records and certificates, are to be submitted at Tender Stage.

(NOTE. The Project Manager should provide a questionnaire requesting the details of information that is required; advice is given in sub Clauses Y.5.2 and Y.6.4 of Appendix Y.)

2.4.3 Each laying unit involved in the work shall be registered under “Sector Scheme 16”, The Laying of Asphalt Mixes.

2.4.4 The Contractor shall be responsible for having all testing for the supply of asphalt materials carried out in accordance with the requirements of Section 8 and provide the Project Manager with a written copy of the results in accordance with Clause 8.1.

2.4.5 All documentation relevant to the work, including records of temperature control during mixing and test results, shall also be available at the plant or the depot for inspection. The documentation, including worksheets, shall be stored in an easily retrievable form for a minimum of 3 years.

3 Constituent Materials

3.1 AGGREGATES, GENERAL

3.1.1 The Contractor shall inform the Project Manager of the source and aggregate properties for each aggregate. The type of coarse and fine aggregate to be used for a particular material shall be as shown in Table 3.1.

TABLE 3.1 TYPES OF AGGREGATE PERMITTED

Material	Aggregates				
	Coarse			Fine	
	Crushed Rock	Steel Slag	Gravel	Sand	Crushed Rock
Surface course	Yes	No	No	Yes	Yes
Regulating / binder course	Yes	Yes	Yes	Yes	Yes

Yes Suitable for use in material.
No Not for use in material.

3.1.2 Initial approval of aggregates shall be obtained from the Project Manager before mixing starts; approval shall be based on results supplied to the Project Manager of those tests listed in Clause 8.2 and carried out by the Contractor.

3.1.3 All aggregates used in the SMA shall be CE marked.

3.1.4 Aggregates shall conform to BS EN 13043 Categories for fines content, physical properties and durability as defined in Clauses 3.2 and 3.3. Aggregates shall not contain deleterious materials in such a form or in sufficient quantity to adversely affect the strength at any age or the durability of the surfacing, including resistance to frost.

(NOTE. Examples of such deleterious materials include significant quantities of:
- clay, loam or chalk, particularly as an adherent coating;
- mica, shale and other laminated materials;
- coal and other organic or vegetable impurities;
- dust or other material preventing thorough coating with binder; and
- sulfates and chlorides or other reactive substances liable to break down during drying or subsequent exposure to weather or moisture.

This list does not include all possible deleterious materials.)

3.1.5 The resistance to freezing and thawing of each source shall be categorised over all fractions using a modification of the Magnesium Sulfate Test in accordance with BS EN 1367-2 as outlined in Appendix A.

OR

The aggregates do not have to be categorised for resistance to freezing and thawing over all fractions using the Magnesium Sulfate Test in accordance with BS EN 1367-2 provided there is local evidence that the aggregate is sound.

(NOTE. Project Manager to select option for specific job specification; advice given in Clause Z.1 of Appendix Z.)

3.1.6 All aggregates produced or handled by hydraulic methods or which have been washed shall be stockpiled for at least 24 h before use in an area such that unrestricted drainage can occur.

3.2 COARSE AGGREGATES

The properties of the coarse aggregate shall conform to the BS EN 13043 Categories shown in Table 3.2.

3.3 FINE AGGREGATES

3.3.1 Fine aggregates shall be:
- natural bank, river, dune, or pit sand;
- crushed rock; or
- blends of sand and crushed rock

and shall be free from loosely bonded aggregations and other foreign matter. Sea-dredged sand shall not be permitted.

3.3.2 The properties of the fine aggregate shall conform to the BS EN 13043 Categories shown in Table 3.3.

TABLE 3.2 REQUIRED PROPERTIES FOR COARSE AGGREGATES

Property	Test method	Situation	Layer	
			Surface course	Regulating / Binder course
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A ‡	Each source Each fraction	MS_{18} MS_{30}	MS_{18} MS_{30}
Shape	BS EN 933-3	All	FI_{25}	FI_{25}
Resistance to fragmentation	BS EN 1097-2	All except gravel Gravel	LA_{30} n/a	LA_{30} LA_{25}
Water absorption	BS EN 933-3	All except slag Blast furnace slag	$WA_{24}2$ n/a	$WA_{24}2$ $WA_{24}4$
Affinity between aggregate and bitumen	BS EN 12697-11 Part B	All	Not greater than 6 particles from a 150 particle test sample	
Resistance to Polishing	BS EN 1097-8	Runway surface course Taxiway surface course	$PSV_{declared}$ * $PSV_{declared}$ *	– –
Fines content	BS EN 933-1	All	f_4	f_4
Sulphur Content	BS EN 1744-1	Blast furnace slag	n/a	≤ 2 %
Volume Stability	BS EN 1744-1	Blast furnace slag	n/a	$V_{3.5}$
Bulk Density	BS EN 1097-6	Blast furnace slag	n/a	≥ 1.12 Mg/m³

‡ BS EN 1367-2: 1998 is restricted to the 14/10 mm fraction but, for this purpose, the same techniques shall also be used for other fractions of the coarse aggregate. Advice on the use of the test with non-standard aggregate fractions is given in Appendix A.

* Project Manager to provide value for specific job specification; advice given in Clause Z.2 of Appendix Z.

– No category or limit.

n/a Not applicable.

TABLE 3.3 REQUIRED PROPERTIES FOR FINE AGGREGATES

Property	Test Method	Aggregate type	Limit
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A ‡	Each source ‡ Each fraction ‡	MS_{18} MS_{30}
Fines content	BS EN 933-1	All	f_{22}
Fines quality	BS EN 933-9	All	MB_FNR
Water absorption	BS EN 1097-6	All	$WA_{24}2$
Affinity between aggregate and bitumen	BS EN 12697-11 Part B	Parent rock if crushed rock fines	Not greater than 6 particles from a 150 particle test sample

‡ BS EN 1367-2: 1998 is restricted to the 14/10 mm fraction but, for this purpose, the same techniques shall also be used for other fractions of the coarse aggregate. Advice on the use of the test with non-standard aggregate fractions is given in Appendix A.

3.4 ADDED FILLER

3.4.1 All filler aggregate used in the SMA shall be CE marked.

3.4.2 The type of filler aggregate to be used for a particular material shall be selected from cement (to BS EN 197-1), crushed limestone or hydrated lime (to BS EN 459-1).

3.4.3 Filler aggregate shall be stored in dry conditions.

3.4.4 The grading of added filler aggregate shall conform to Clause 5.2.1 of BS EN 13043: 2002.

3.4.5 The loose bulk density in kerosene of added filler aggregate, other than hydrated lime, shall be in accordance with Clause 5.5.5 of BS EN 13043: 2002.

3.4.6 A copy of all filler aggregate delivery tickets shall be passed to the Project Manager on a regular basis during production, for his retention.

3.5 BINDER

3.5.1 All binder used in the SMA shall be CE marked.

3.5.2 The binder to be used for a particular material shall be in accordance with Table 3.4.

TABLE 3.4 ACCEPTABILITY OF PAVING GRADE BITUMENS

Course	Bitumen (BS EN 12591) Grade		
	40/60	70/100	100/150
Surface	Yes	Yes *	No
Binder	Yes	Yes	(Yes)

Yes Suitable for use in course.
Yes * Providing compliant with wheel-tracking criteria in Clause 4.7.
(Yes) Suitable for use in course on pavements with low traffic.
No Not for use in course.

3.5.3 The binder shall be paving grade petroleum bitumen meeting the requirements of BS EN 12591. The Contractor (or Supplier on his behalf) shall have Quality Assurance registration to the BS EN ISO 9000 series incorporating "Sector Scheme 15", Supply of Paving Grade Bitumen.

(NOTE. Advice for the Project Manager on Quality Systems is given in Appendix Y.)

3.5.4 When polymer is used, the bitumen, when combined with the polymer, shall have a British Board of Agrément HAPAS Roads and Bridges Certificate. In the event that no such certificates have been issued, they shall not be used without the approval of the Project Manager.

(NOTE. Polymers can be used to enhance certain properties, including minimizing binder drainage and resistance to fuels and/or de-icing fluids.)

3.5.5 Copies of certificates for the binder shall be passed to the Project Manager for his retention.

3.6 STABILISING ADDITIVE

3.6.1 When paving grade bitumen complying with BS EN 12591 is used as the binder without modification by polymer, at least 0.3 % (by mass of the total mixture) of stabilising additive shall be used. Stabilising additives shall be cellulose or mineral fibres; other suitable fibres may be used with the approval of the Project Manager.

3.6.2 Polymer may be used instead of, or as well as, fibres as the means to control binder drainage subject to 3.5.4.

3.7 TACK AND BOND COATS

3.7.1 Prior to laying surface and regulating courses, a bond coat shall be applied to the existing surface. Prior to laying binder courses and ramps, either a tack coat or a bond coat shall be applied to the existing surface.

OR

Prior to laying any course other than base, either a tack coat or a bond coat shall be applied to the existing surface.

(NOTE. Project Manager to select option for specific job specification)

3.7.2 Tack coat shall be bitumen emulsion complying with either C 40 B 1 or C 70 B 1 of BS EN 13808.

3.7.3 Bond coats shall have a British Board of Agrément HAPAS Roads and Bridges Certificate. In the event that no such certificates have been issued, they shall not be used without the approval of the Project Manager.

3.8 COURSE THICKNESS

The thickness of each course of surfacing shall be as shown on the drawings. It shall be the thickness of the course at any point after compaction. Where the course thickness exceeds the layer thickness allowed in Clause 3.9, the course shall be laid and compacted in two or more layers.

(NOTE. Increasing the thickness of a mat can considerably increase the time that it will take to cool to a temperature below which it cannot be effectively compacted. Therefore, in adverse weather (high winds and/or cold temperatures), the use of a greater course thickness will increase the possibility of having sufficient time to complete compaction.)

3.9 AGGREGATE SIZE

The aggregate size shall be in accordance with Table 3.5 for the relevant combination of course type and nominal layer thickness.

TABLE 3.5 NOMINAL LAYER THICKNESSES

Course	Nominal Layer Thickness (mm)	Aggregate Size (mm)
Surface	20 – 30 (25 – 30) 30 – 50 (30 – 40)	0/6 0/10
Binder	35 – 60 (40 – 60) 50 – 100 (50 – 75)	0/14 0/20
Regulating and Ramping	0 – 25 15 – 50 20 – 50 30 – 60 45 – 100	0/4 0/6 0/10 0/14 0/20

(NOTE. A second range in brackets indicates the range of nominal layer thickness expected to be used when there are no particular constraints on the selection.)

4 Design and Composition

4.1 GENERAL

4.1.1 All SMA incorporated into the permanent works shall be CE Marked in accordance with BS EN 13108-5.

4.1.2 The production of SMA shall be carried out by a Contractor (or Supplier on his behalf) who works to a Quality Assurance scheme to the BS EN ISO 9000 series incorporating "Sector Scheme 14", Production of Asphalt Mixes, with an appropriate scope of application for those operations.

(NOTE. Advice for the Project Manager on Quality Systems is given in Appendix Y.)

4.2 AGGREGATE GRADING

4.2.1 The target grading shall be declared at the sieve sizes and fall within the range given in Table 4.1 for the required aggregate size. When plotted, the grading of the aggregates shall give a smooth curve within the specified aggregate grading.

4.2.2 At least 25 % of the material passing the 0.063 mm sieve in the overall grading to Table 4.1 shall be added separately as added filler in accordance with Clause 3.4.

4.3 BINDER CONTENT

The minimum binder content of the target composition shall conform to BS EN 13108-5 Category in Table 4.2 for the relevant aggregate size after due allowance for the particle dry density of the aggregate in Mg/m³, determined in accordance with BS EN 1097-6.

TABLE 4.2 MINIMUM BINDER CONTENT OF THE TARGET COMPOSITION

Aggregate Size (mm)	Minimum Binder Content † (%)
0/4	7.4
0/6	7.0
0/10	6.4
0/14	6.0
0/20	5.6

† The minimum binder contents limit is before applying any correction for aggregate density as for determining the BS EN 13108-7 Category B_{min}

TABLE 4.1 INFORMATIVE LIMITS AND ADDITIONAL SIEVES ON THE TARGET PARTICLE SIZE DISTRIBUTION LIMITS TO THAT REQUIRED BY BS EN 13108-5

Sieve size (mm)	Aggregate Size (mm)				
	0/20	0/14	0/10	0/6	0/4
31.5	100	–	–	–	–
20	90 – 100	100	–	–	–
14	–	90 – 100	100	–	–
10	40 – 55	60 – 75	90 – 100	100	–
6.3	30 – 40	40 – 50	30 – 50	90 – 100	100
4	–	–	25 – 42	25 – 45	90 – 100
2	17 – 27	18 – 28	20 – 32	20 – 30	30 – 40
0.5	13 – 20	13 – 20	14 – 20	14 – 22	13 – 23
0.063	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0

– Sieve size not used to define target grading

4.4 AIR VOIDS CONTENT

The void content in the proposed mixture shall conform to BS EN 13108-5 Categories $V_{min\ 2}$ and $V_{max\ 4}$. The individual air voids content of each sample taken shall conform to BS EN 13108-5 Categories $V_{min\ 1.5}$ and $V_{max\ 4.5}$.

4.5 BINDER DRAINAGE

The binder drainage of samples, manufactured at the target binder content plus 0.3 % and the target grading using the same coarse aggregates and filler aggregate and stabilising options proposed for use in the Works, shall conform to BS EN 13108-5 Category $D_{0,3}$.

(NOTE. Aggregates vary in their shape and surface characteristics such as binder absorption. The Binder Drainage Test determines the maximum binder content that can be safely used without excessive binder drainage.)

4.6 SENSITIVITY TO WATER

The sensitivity to water of the proposed mixture shall conform to BS EN 13108-5 Category $ITSR_{70}$.

4.7 RESISTANCE TO PERMANENT DEFORMATION

The resistance to permanent deformation of the proposed mixture shall comply to BS EN 13108-5 Categories $WTS_{AIR\ 0.8}$ and $PRD_{AIR\ 8,0}$ when tested at a temperature of 60 °C.

(NOTE 1: The $PRD_{AIR\ 8,0}$ is not a recognised category in BS EN 13108-5:2006 incorporating 2008 corrigendum, but the least severe category of $PRD_{AIR\ 5,0}$ is considered too severe, implying a final rut depth of less than 2.5 mm for a 50 mm thick sample.)

(NOTE 2: If there is evidence that material would have complied with the previous BS 598-110 requirement but fails to comply with the BS EN 12697-22 requirement, a request for a relaxation can be sent with the supporting evidence to the Construction Support Team, DE.)

4.8 RESISTANCE TO FUEL

* The resistance to fuel of the proposed mixture shall comply with BS EN 13108-5 Category 'good'.

OR

* No clause.

(* NOTE. Project Manager to select alternative for specific job specification; advice given in Clause Z.3 of Appendix Z.)

4.9 JOB STANDARD MIXTURES

4.9.1 The target mixture shall be adjusted, if necessary, until it has the properties required in clauses 3.8 to 0 and has successfully completed trials in accordance with Section 7 of this Specification.

4.9.2 The 'Job Standard Mixture' shall be the target mixture as measured on analysis of the approved trial mixture in accordance with BS EN 12697-1 and -2. It shall be the standard for the routine production of SMA for the works.

4.10 VARIATIONS IN PLANT MIXTURES

4.10.1 SMA mixtures that are produced by the mixing plant during normal routine production shall be designated the 'Plant Mixtures'. Samples of 'Plant Mixtures', sampled in accordance with BS EN 12697-27 and tested in accordance with BS EN 12697-1 and BS EN 12697-2, shall have the same composition as the 'Job Standard Mixture' within the relevant tolerances for individual samples given in Table A.1 of BS EN 13108-21 for the aggregate grading and ± 0.5 % for the soluble binder content.

4.10.2 Any variation outside these tolerances shall be investigated. If such variations continue for more than 24 h, all laying shall cease. All plant and processes shall then be checked and immediate arrangements shall be made by the Contractor to make the necessary modifications or corrections, until the Project Manager is satisfied that when laying restarts the mixtures will comply with these requirements. Before laying continues in the construction area, the Project Manager may instruct the Contractor to lay a further trial area of surfacing, as described in Clause 7.3, on disused pavements within the airfield boundary.

5 Laid Material Requirements

5.1 GENERAL

5.1.1 Mixtures shall be transported, laid and compacted according to BS 594987, subject to any additional clauses in this Specification.

5.1.2 The standard of workmanship and finish of all surfacing included in this Contract shall be equal in all respects to that of the "Approved" areas established in the trials in accordance with Section 7.

5.2 WEATHER CONDITIONS FOR LAYING

5.2.1 Laying of SMA shall not proceed unless:

- the surface to be covered is not frozen and is free from ice, snow and de-icing agents;
- the temperature of the surface to be covered is 0 °C or more; and
- the air temperature is either:
  - above 1 °C or
  - between -1 °C and 1 °C and rising.

5.2.2 Laying of SMA shall not proceed during precipitation unless:

- both the surface to be covered and the air temperature are above 0 °C; and
- there is no free water on the surface.

(NOTE. Guidance is given on suitable temperatures and wind speeds for laying in Appendix C.)

5.3 MIXING, DELIVERY AND COMPACTION TEMPERATURES

5.3.1 SMA shall be mixed, delivered, laid and compacted within the material temperature limits given in Table 5.1.

(NOTE. Compliance with the mixing temperature limits given in Clause 5.13 of BS EN 13108-5:2006 incorporating 2008 corrigendum will be achieved by these values.)

TABLE 5.1 TEMPERATURES LIMITS

Bitumen grade (pen)		40/60	70/100	100/150
Mixing	(Min)	160	140	130
	(Max)	200	180	170
Delivery to paver	(Min) †	135	130	125
Paver-out	(Min) †	125	120	115
Compaction	(Min) ‡	95	90	85

† These values are recommended only but need to be achieved in order to have the maximum available compaction time. They are useful for monitoring purposes to ensure that adequate compaction time is available.

‡ This value is the mid-layer temperature at which completion of compaction shall be achieved.

5.3.2 When a polymer modified binder is used, the temperatures shall be in accordance with the recommendations of the binder supplier, which shall be supplied in writing to the Project Manager in advance of their use.

5.4 PERMITTED TOLERANCE ON COURSE THICKNESS

5.4.1 The total compacted thickness of any course of the surfacing material at any point, determined in accordance with BS EN 12697-36, shall not be less than the specified course thickness or exceed this thickness by more than the limits of Table 5.2.

TABLE 5.2 TOLERANCE ON COURSE THICKNESS

Course	Maximum Permitted Tolerance on the Specified Course Thickness (mm)
Binder	+ 25 / – 0
Surface	+ 10* / – 0

* Except in ramps (see Clause 6.19).

5.4.2 The course thickness shall be determined:
- at minimum intervals of every * m² laid or from every 2 h work, whichever is the more frequent; and
- at locations agreed with the Project Manager.

Alternate cores shall be taken so that the edge of the core hole is, at its nearest point, 25 mm to 50 mm from the lane joint. The walls and base of all holes from which core samples have been cut shall be filled in accordance with Clause 6.24.

* Project Manager to provide value for specific job specification; advice given in Clause Z.4 of Appendix Z.

5.5 IN SITU DENSITY

Every core taken as required by sub-Clause 5.4 from the area shall be tested for bulk density according to BS EN 12697-6, Procedure A. The rolling mean of 6 bulk density measurements from cores shall not be less than the Job Minimum Density as defined in sub-Clause 7.3.5. No individual measurement shall be less than 98 % of the Job Minimum Density.

5.6 FINISHED LEVELS

5.6.1 The finished surface levels shall conform with the levels, profiles and contours shown on the drawings and the finished levels of the underlying courses are to be such that at no point will the thickness of any overlying courses be less than the thickness specified.

5.6.2 Where the Project Manager so directs, deviations exceeding 6 mm from the required levels shall be corrected by replacement with new surfacing at not less than the specified course thickness after removal of the appropriate thickness of the offending area. The removal shall be carried out in accordance with Clause 6.22.

5.7 SURFACE ACCURACY

5.7.1 The surface accuracy of the surfacing material shall be measured as the gap between the bottom of a 3 m long test straightedge and the surface of the pavement when the straightedge is placed unsupported on the surface in accordance with Appendix B. The surface accuracy shall not exceed 3 mm for surface course nor 10 mm for binder course anywhere in any direction, other than across the crown of a camber or across a drainage channel.

5.7.2 Tests for regularity of the finished surface shall be carried out
- at minimum intervals of twenty every * m² laid or from every 2 h work, whichever is the more frequent; and
- at locations agreed with the Project Manager.

Alternate tests shall be taken across lane joints.

* Project Manager to provide value for specific job specification; advice given in Clause Z.4 of Appendix Z.

5.7.3 Any non-complying area shall be removed for the full width of the lane and replaced by the Contractor, at his own expense, with material that shall satisfy the acceptance criteria, as specified in Clauses 6.22 and 6.23.

5.8 TEXTURE DEPTH

5.8.1 The texture depth of surface course SMA shall be determined in accordance with BS EN 13036-1 using ten measurements equally spaced across a diagonal across a 50 m length of laid surfacing. The test shall be repeated after every 250 m of length paved.

5.8.2 The average texture depth for each 1000 m length of paving, or for the complete length where this is less than 1000 m, and the individual test measurements shall be within the ranges given in Table 5.3.

TABLE 5.3 TEXTURE DEPTH RANGES

Aggregate size	1000 m Mean	Individual test
0/10	(1.1 ± 0.2) mm	(1.1 ± 0.4) mm
0/6	(0.9 ± 0.2) mm	(0.9 ± 0.4) mm

5.9 PARTICLE LOSS

5.9.1 The third and then every subsequent sixth core taken as required by sub-Clause 5.4 shall be tested for particle loss in accordance with BS EN 12697-17 at (25 ± 2) °C other than that the samples will not be moulded samples. The results of the particle loss shall be submitted to the Project Manager for research purposes.

(NOTE. The Project Manager is requested to issue copies of particle loss results to the Construction Support Team, DE.)

5.9.2 Testing for particle loss shall not be required after 10 results have been compiled.

5.10 PENETRATION OF RECOVERED BINDER FROM COMPACTED MAT

5.10.1 The binder shall be recovered according to BS EN 12697-3 or -4 from the fifth and every subsequent sixth core taken as required by sub-Clause 5.4. The penetration of the recovered binder shall be determined in accordance with BS 2000-49. The results of recovered binder penetration shall be submitted to the Project Manager for research purposes.

(NOTE. The Project Manager is requested to issue copies of recovered binder penetration results to the Construction Support Team, DE.)

5.10.2 Testing for recovered penetration shall not be required after 10 results have been compiled.

5.11 STORAGE OF CORES

Each core taken as required by sub-Clause 5.4 and not damaged in testing as required by sub-Clauses 5.9 and 5.10 shall be marked with a unique identifying number and stored at a temperature below 15 ºC until the works have been completed in case further testing is required.

6 Plant and Workmanship

6.1 REDUCTION IN SURFACE LEVEL OF ASPHALT SURFACES

Where the surface level of an existing asphalt surface is being reduced, thicknesses shall be removed with a planing machine that has been approved by the Project Manager. The machine shall be provided with control devices that enable the rapid adjustment of blades to fine depth-of-cut settings while the machine is operating.

6.2 REDUCTION IN SURFACE LEVEL OF CONCRETE SURFACES

6.2.1 Where the surface level of an existing concrete surface is being reduced, thicknesses from fine fractions up to the limits as specified hereafter shall be removed by scabbling or planing. Scabbling or planing shall be carried out by machines operated in a manner that results in a minimum of over-cutting and uniform exposure of the aggregate, without shattering or otherwise damaging the concrete slabs.

6.2.2 Unless directed by the Project Manager, such reductions in level shall be bounded by joints in the concrete pavement. Where they are not and where the scabbling or planing is not tapered to zero depth, the area to be reduced in level shall first be defined by saw cuts, 5 mm deeper than the depth of the scabbling or planing.

6.2.3 The surface treated as above shall be thoroughly cleaned with hand brooms and all loose debris shall be collected and removed.

6.2.4 Before the area is surfaced, a tack or bond coat appropriate to the surfacing material shall be applied as specified in Clause 6.10 and the exposed vertical edges shall be painted with hot bitumen. The new surfacing shall be made to firmly adhere to the vertical edges.

6.2.5 The whole of the concrete layer shall be removed for its full depth where the thickness required to be removed is greater than the lesser of:

- 100 mm; and
- one third the depth of the slab.

Where the concrete is in bays less than 4.5 m square, the boundary of the area to be removed shall be defined by bay joints. Where the bays are larger, part bays may be removed such that the remaining portion shall not be less than 2.25 m by the full length or full width of the bay.

6.2.6 Care shall be taken to ensure that all concrete remaining in the vicinity of cutting-out remains sound and without fracture and that disturbance to sub-bases and underlying layers is minimised.

6.3 PREPARATION OF EXISTING ASPHALT SURFACES

6.3.1 Before the tack or bond coat is applied, all vegetable growth and loose aggregate or other particles shall be removed from all cracks in the existing asphalt surfacing on which new surfacing is to be laid. Loose laitance and other spalling or debonded slurry seal shall be removed from the surface. The surfaces shall be swept until standing water, mud, grit and all other extraneous matter has been removed. Immediately ahead of tack or bond coating, all dust shall be removed by vacuum extraction cleaning, with or without high-pressure water at the discretion of the Project Manager.

(NOTE 1. Cleaning machines applying high-pressure water and vacuum extraction are very effective in removing debris and cleaning the surface. Water pressures about 50 Bar are adequate for general cleaning, but higher pressures may be used subject to the Project Manager's discretion. At very high pressures, damage to the surfacing can result.)

(NOTE 2. Vacuum extraction after high pressure cleaning generally results in a sufficiently dry surface for application of a tack or bond coat.)

6.3.2 Existing overbanding of the surfacing shall be removed when required by the Project Manager.

(NOTE. When resurfacing comprises only a surface course, it will normally be a requirement to at least remove thick depositions of overbanding.)

6.4 PREPARATION OF EXISTING CONCRETE SURFACES

6.4.1 Before the tack or bond coat is applied, all vegetable growth and loose debris including concrete fractions shall be removed from all cracks, joints and joint edges in the existing concrete surfacing on which the new SMA is to be laid. The surface shall be thoroughly cleaned and all loose debris shall be collected and removed.

(NOTE 1. Cleaning machines applying high-pressure water and vacuum extraction are very effective in removing debris and cleaning the surface. Water pressures about 50 Bar are adequate for general cleaning, but higher pressures may be used subject to the Project Manager's discretion. At very high pressures, damage to the surfacing can result.)

(NOTE 2. Vacuum extraction after high pressure cleaning generally results in a sufficiently dry surface for application of a tack or bond coat.)

6.4.2 All joints in the concrete paving shall be examined and a joint preparation programme shall be agreed between the Contractor and the Project Manager.

6.4.3 When directed, the joint sealing compound shall be removed in joints 20 mm wide or greater where the sealant has lost its original properties and can be removed by hand methods. The sealant shall be replaced with lightly compacted 0/4 mm size Asphalt Concrete (Macadam) in accordance with BS EN 13108-1 using 250/330 bitumen with a minimum binder content of 6.4 %. The asphalt shall be laid to a convex finish slightly proud of the general surface level.

(NOTE. The minimum binder contents limit is before applying any correction for aggregate density as for determining the BS EN 13108-1 Category B_{min}.)

6.4.4 In all other cases, the joints shall be prepared by cutting-off any compound that has extruded above the general level of the pavement with heated tools so as to be flush with the concrete surface. Any unfilled joints less than 20 mm wide may be ignored.

6.4.5 Loose laitance and other spalling or debonded slurry seal shall be removed from the surfaces which shall then be swept until standing water, mud, grit and all other extraneous matter has been removed. Immediately ahead of tack or bond coating, all dust shall be removed by vacuum extraction cleaning, with or without high-pressure water at the discretion of the Project Manager.

6.5 FILLING RAVELLED LANE JOINTS, RAVELLED CRACKS AND POTHOLES IN EXISTING ASPHALT SURFACING

6.5.1 Ravelled joints, ravelled cracks and potholes shall be made good before the new surfacing is laid.

6.5.2 Trenches shall be formed by carefully cutting out the existing asphalt surfacing on either side of the joints or cracks to the full depth of the surface course and, if directed, to the underside of the binder course or to the top of the underlying concrete or pavement base. The new material shall be bonded into the old surfacing.

6.5.3 The cross section of the trench shall be a minimum of 200 mm wide. The side walls of the trench shall be clean vertical cuts and shall be stepped-back a minimum of 50 mm on each side at a convenient plane of separation between any two courses of the existing surfacing. When the existing pavement level is not to be raised, the edges of the trench or patch shall be defined by means of saw cuts extending to the full depth of the surface course.

6.5.4 All loose and crumbling fractions shall be removed from the bottom and sides of the trench. The bottom and sides shall be completely painted with tack coat.

6.5.5 The defective surfacing shall be replaced with the specified surface course material. It shall be placed in the trenches in lifts of about 50 mm each which shall be compacted separately with approved mechanical or hand tampers as specified in Clauses 6.14 and/or 6.15.

6.5.6 At the time of compaction, the mixture shall be within the temperature limits specified in Clause 5.3. The final layer shall be laid so as not to leave a concave finish below the general surface after thorough compaction by rolling.

6.5.7 All loose material shall be removed from any potholes, the bottom and sides of the depressions painted with tack coat and then the potholes backfilled, compacted and finished in accordance with sub-Clauses 6.5.5 and 6.5.6.

(NOTE. Further guidance on making good is given in DE Functional Standard 06, "*Guide to Airfield Pavement Maintenance*")

6.6 REGULATION OF EXISTING SURFACES

6.6.1 Where the irregularities in the pavements to be surfaced are such that the permitted thickness tolerances for that course will be exceeded, the existing surfaces shall be regulated as a separate item in advance of general resurfacing.

6.6.2 Regulation of the existing surface shall continue, subject to the tolerances specified in Clause 5.4, until the regulated surface, when tested with a straightedge in accordance with BS EN 13036-7, achieves an accuracy of:

- 10 mm in 3 m when a surface course only is to be overlaid on it; or
- 25 mm in 3 m when a binder course and surface course are to be overlaid on it.

6.7 MIXING PLANT

6.7.1 The Contractor shall submit his proposals in respect of the mixing plant to be used and whether it will be located on- or off-site with his Tender. For off-site mixing, the location of all plants that may be used shall be included.

6.7.2 Static plant shall be adequate for the purpose of producing fully-coated asphalt in accordance with this Specification. The Contractor shall submit his proposals in respect of static plant with his Tender. Proposals which include the use of continuous drum mixers shall contain details of the means of controlling the grading of aggregates throughout the mixing process, including that of filler/added filler in association with the control and extraction of dust. Recycling of dust in lieu of added filler will not be permitted (see Clause 6.8.1)

6.7.3 The siting of all on-site static plant shall be agreed with the Project Manager and the layout of the units shall be considered in relation to prevailing winds and the local population to minimise nuisance.

(NOTE. See the Guidance issued by the Department of the Environment for details of Local Authority requirements and authorisation of plant in respect of Part 1 of Environmental Protection Act as of 1 April 1991.)

6.7.4 A weighbridge shall be provided on site if a regulating course is required, irrespective of whether the mixing is to be carried out on- or off-site.

6.7.5 The weighing, measuring and recording mechanism and temperature control gauges shall be checked by the manufacturer of the mechanism and gauges, or by an independent testing authority, and the Contractor shall submit proofs certifying that each device is operating accurately or reporting deviation allowances required in respect of each indicator, to the Project Manager, for his retention. These checks shall be carried out before mixing starts, at the end of each month during mixing, and whenever the plant is re-sited or disturbed.

6.7.6 All plant shall be maintained in good working order, controlled by a trained and experienced operator, and shall be subject to inspection by the Project/Works Services Manager. This applies equally to outside mixing plants as well as for on-site mixing.

(NOTE. Approval for mixing outside the airfield should not be given if the distance between mixing plant and site is such that the specified mixing and laying temperatures cannot be routinely achieved.)

6.8 MIXING

6.8.1 The proportion of filler aggregate shall be measured by weight. Where the Specification for the material being mixed requires a definite proportion of added filler aggregate, extracted dust shall not be automatically fed back into the mixer.

6.8.2 The proportion of binder may be measured by either weight or volume.

6.8.3 All mixing plant shall incorporate means of access for samples of mixed material, bitumen and filler aggregate to be taken.

6.8.4 For batch mixers, the hot aggregates shall be screened and separated into the hot-bins after heating for batching by weight in at least three different sizes into the mixing unit. Means of enabling samples to be obtained from each hot-bin shall be provided. Batch-mixing plant which does not incorporate these requirements is prohibited. The hot aggregates and binder shall be mixed together in the correct proportions until the binder is evenly distributed. Filler may be added before or after the binder but mixing shall continue for at least 1 min after the addition of the filler. The total mixing time may only be reduced if the Project Manager is satisfied that thorough mixing can be achieved in less time. In such cases, the Contractor shall obtain the written authority of the Project Manager to reduce the mixing time to a specific period.

6.8.5 For continuous drum mixers, the hot aggregate and binder shall be mixed together in the

correct proportions until the binder is evenly distributed. Filler is to be added simultaneously with the binder to ensure full incorporation and distribution within the mix.

6.9 TRANSPORTING PLANT MIXTURES

6.9.1 The plant mixtures shall be transported without delay to the laying sites from the mixing plant or from hot storage bins taking care to prevent segregation. The vehicles shall be double sheeted during transit and while waiting to prevent loss of heat, contamination and wetting. All vehicles shall be mechanically sound and shall be suitable for the spreading equipment in use and shall have insulated bodies.

6.9.2 The use of water or proprietary products on the surfaces of the transporting vehicles to facilitate discharge shall be strictly regulated to the absolute minimum. If the Project Manager considers that contamination of the mixtures is occurring, the vehicle shall be thoroughly cleaned out to his satisfaction before being used again. The use of diesel oil, dust, sand or other fine particles is prohibited.

6.9.3 The temperature of the load in every transporting vehicle shall be checked in accordance with BS EN 12697-13 whilst discharging from the delivery lorry into the paver hopper. If the temperature of any batch is below the minimum delivery temperature specified in Clause 5.3, the load shall be rejected and shall be removed from site immediately.

6.9.4 Each delivery of SMA to the contract works, whether batched on-site or off-site, shall be accompanied by a delivery ticket giving the following details:

- Delivery ticket number;
- Vehicle registration number;
- Material type and mix classification;
- Paving grade of bitumen used; and
- Quantity.

For material batched off-site, the delivery ticket shall also give the following details:

- Customer name and Delivery site number;
- Source of supply;
- Date and time loaded; and
- Date and time delivered.

Copies of the delivery tickets shall be passed to the Project Manager for his retention.

6.10 TACK AND BOND COAT APPLICATION

6.10.1 The type of tack or bond coat to be used for the particular material being laid is as specified in Clause 3.7.

6.10.2 Tack and bond coats shall be applied not more than 48 h in advance of surfacing. The target rate of application shall be in accordance with BS 594987. Tack and bond coats may be applied to damp surfaces but ponded or standing water shall be removed as specified in Clauses 6.3 and 6.4.

6.10.3 Tack and bond coat shall be applied uniformly, free of streaks and blobs in accordance with BS 434-2 by mobile mechanical tank-spraying units complying with BS 3136-2. The tack or bond coat shall be allowed to 'break' completely before laying proceeds. Where the size or shape of an area to be sprayed precludes mobile operation, pressure spraying equipment or hand-spraying complying in accordance with BS 434-2 will be permitted with the approval of the Project Manager.

(NOTE. The use of paving machines that incorporate equipment to apply the tack or bond coat immediately before the mix is laid will not allow the opportunity to ensure that the tack or bond coat has 'broken'. If the Contractor wishes to use such equipment, he shall seek prior written approval from the Project Manager. Advice for Project Manager is given in Clause Z.5 of Appendix Z.)

6.10.4 Airfield lighting units, gratings, covers and similar fittings shall be adequately masked with an approved protection during application. Care shall be taken to prevent the spraying of porous surfacing of the french drains and, if the Project Manager considers it to be necessary, these too shall be protected.

6.10.5 After application, no traffic of any kind shall be allowed to run over the tack or bond coat until surfacing starts and arrangements shall be made to cordon off the sprayed areas until it does. When surfacing starts, only the minimum amount of traffic essential to the surfacing operations shall be permitted.

6.11 LAYING

6.11.1 A competent supervisor shall be in charge of all laying and finishing operations.

6.11.2 The mixtures shall be spread to surcharged depths necessary to give the specified course

thickness, and to comply with the finished levels and profiles shown on the drawings, after compaction.

6.11.3 Surface course shall be laid on binder courses as soon as practicable in order to provide adhesion with the binder course. Binder courses that have been left exposed for more than seven days shall be tack or bond coated in accordance with Clause 6.10 before the laying of surface course.

6.11.4 The use of hand-rakes shall be prohibited when the mixtures are laid by spreading and finishing machines in accordance with Clause 6.13 except at joint edges and around manholes and pits, where their use shall be restricted to an absolute minimum.

6.11.5 After the spreading units have passed, hand-casting of fines behind the spreader as a means of making-up irregularities or disguising blemishes left by the spreader shall not be permitted.

6.11.6 At all times, the courses shall be kept free from all extraneous matter.

6.12 SAMPLING OF MIXED MATERIALS

6.12.1 Bulk samples of the mixed material sent to the site shall be taken by the Contractor and divided. One sample shall be analysed for grading and binder content, and the other retained for reference in the case of a dispute.

6.12.2 The samples can be taken at the batching plant or at the site, with the alternative selected to be notified at Tender Stage. If the sample is to be taken at the site, it shall be taken from the paver screws after approximately half of the lorry load has been discharged through the paver.

6.12.3 Samples shall be labelled and details shall include material type, date of delivery, vehicle registration number, course location and time of laying and other relevant information deemed necessary by the Project Manager.

6.13 SPREADING BY MACHINE

6.13.1 Except where the conditions of Clause 6.15 apply, the mixture shall be spread, levelled and tamped by self-propelled spreading and finishing machines that have been approved by the Project Manager. The spreading and finishing machines shall be capable of continuously laying to the required widths, profile, camber or crossfall without causing segregation, dragging, burning or other surface defects or irregularities. They shall also be capable of operating effectively with the thickness of SMA being laid.

(NOTE. The method of control should be adequate to achieve the tolerances required and should not be limited by the length of the paving equipment if that is not sufficient. It may be necessary to use a wire guidance system or averaging beam to achieve the required accuracy in certain critical situations, such as at or in the vicinity of wandering crowns or for laying of regulating courses.)

6.13.2 Any extension beyond the basic width of the machine shall be strictly in accordance with the manufacturer's recommendations and shall give a level uniform surface over the full width of the lane to the satisfaction of the Project Manager.

6.13.3 Each spreader shall be maintained in good mechanical condition and shall be correctly adjusted for operation at the speed consistent with the character and rate of delivery of the mixture and the thickness and agreed rolling procedures for the course. The correct adjustment is that which produces a surface of uniform density and texture, free from segregation, dragging, irregularities or other unacceptable surface blemishes. If dragging or other faults should occur, laying shall cease until the mechanism and operation of the units have been checked and the defects have been rectified or modifications made.

6.13.4 As soon as possible after arrival at the laying site, the mixtures shall be discharged continuously to the spreader and shall be laid in accordance with the requirements of Clause 6.11 without delay. When discharging into the spreader, the lorry shall approach and gentle contact shall be made only between rollers on the spreader and the rear wheels of the lorry to avoid causing the paver screed to indent the mat.

6.13.5 Intermittent stopping of the spreader shall be avoided and the rate of delivery to the spreader shall be so regulated to enable the spreader to be operated continuously.

6.14 COMPACTION

6.14.1 The surfacing shall be uniformly compacted in the manner approved during the laying of the trial area described in Clause 7.3, using the type of equipment and loads applied as agreed with the Project Manager.

6.14.2 Rollers shall be in good condition and fitted with smooth rapid acting reverse controls. They shall be equipped with roll scrapers, absorbent mats and tanks connected to spray pipes on both front and rear rolls to ensure a uniform minimal application of water or parting fluid. The rollers shall be operated by skilled and experienced drivers. The weight to which each roller shall be ballasted shall be agreed with the Project Manager during the laying of the trial(s).

6.14.3 Rolling shall proceed in the direction of laying with the rear wheel (3-point roller) or wheels (tandem roller) lapping the edge of any previously laid surfacing and shall progress gradually to the opposite edge of the lane. The lapping of the rolling shall be such that, on completion, all roller marks are obliterated. During rolling, the roller wheels shall be kept moist with only enough water to avoid picking up material. A water bowser shall be provided alongside each spreading unit to ensure that rolling continues with the minimum interruption.

6.14.4 Rollers shall move at a slow but uniform speed that should not exceed 5 km/h and any pronounced steering change in the direction of the roller shall be made on stable material. The line of rolling shall not be suddenly changed or the direction of rolling suddenly reversed, thereby displacing the mix. Rollers shall not be left standing on the new surfacing within 24 h of laying.

6.14.5 The roller types and sequence shall be such as to provide the required standard of compaction and finish. The standard of finish, including that at joints, shall comply with the requirements of this Specification and shall be of the standard achieved in the trials (Sub-Clauses 7.2.4 and 7.3.6). The surface finish shall have no laying defects, such as dragging or surface blemishes result.

6.15 SPREADING AND COMPACTING BY HAND

6.15.1 Spreading by hand will be permitted for:

- filling potholes and cracks;
- repairing joints;
- the regulation of existing surfaces as specified in Clause 6.6;
- feathering;
- shaping drainage channels if impracticable by machine;
- the replacement of old or defective surfacing when the areas are small; and
- areas of irregular shape.

With the approval of the Project Manager, spreading by hand will also be permitted in areas where manholes or pits are concentrated and in areas which are inaccessible to the spreading and finishing machines specified in Clause 6.13.

6.15.2 The mixture shall be unloaded with care to avoid segregation onto an existing hard, clean surface on, or adjacent to, the area on which it is to be placed or, when this is not available, onto a metal sheet of adequate dimensions alongside the area. The mixture shall be spread portion by portion without break with hot shovels to a uniform thickness that, after compaction, shall not exceed the maximum thickness specified for the mixture. The material shall then be finished with hot hand-rakes by skilled rakers to the level required to give the correct shape and profile after compaction.

6.15.3 The exposed edges of manhole frames, grating frames, lighting units and any fixtures in the pavement or the concrete surrounds against which the new surfacing abuts shall be scraped and thoroughly cleaned to the satisfaction of the Project Manager. A sealing system that has been approved by the Project Manager shall be applied around the fixture/surround in accordance with the manufacturer's instructions within 2 h prior to laying the asphalt surfacing. The surfacing shall then be packed tightly around the fixture and firmly tamped into position.

6.15.4 On completion of compaction, the finished surface of the surface course and other materials as used shall be level with the fixture to the accuracy specified in Clause 5.7. Shaping and dishing to the sides of catchpits shall be carefully carried out to the profiles shown on the drawings. In places inaccessible to the rollers that are specified in Clause 6.14, compaction shall be achieved by suitable vibrating rollers or by tamping.

6.16 LONGITUDINAL LANE JOINTS

6.16.1 Longitudinal joints in surfacing materials shall be constructed in such a position that they are at least 600 mm horizontally away from any longitudinal joints in the underlying material. The longitudinal lane joints shall be vertical in straight lines that are continuous for the full length of the pavement, or in smooth curves around bends.

6.16.2 The exposed vertical edges of the longitudinal lane joints in the surfacing materials shall be carefully cut back and trimmed to firm material in the compacted lane, or for a minimum of one and a half times the layer thickness, whichever

is the greater. All loose material arising from this operation shall be removed from the pavement before the cut edge is painted.

6.16.3 Edge rolling shall only be used as an alternative to cutting back if it can be demonstrated during the trials to the Project Manager that satisfactory standards of compaction, surface/joint finish and adhesion can be achieved.

(NOTE. Cores should be taken for test at these joints to demonstrate good adhesion and air voids content within the limits specified in Clause 4.4.)

6.16.4 Cutting back and trimming will not be required when two or more spreading units operate in echelon in close proximity, permitting adjacent lanes to be continuously compacted before the material around the joint between the lanes falls below the compaction temperature specified in Clause 5.3.

6.16.5 After cutting back and trimming, the exposed vertical edges of the longitudinal lane joints shall be thoroughly cleaned of all adherent material and shall then be painted with a uniform thickness of bitumen just ahead of the spreading unit laying the adjacent lane. Painting shall completely and uniformly cover the exposed edge for its full depth. Excess material to the top and base of the joints, streakiness and blobs shall be avoided.

6.16.6 On completion, the joints shall present the same texture as the remainder of the surface and the accuracy of the surface across the joints shall meet the criteria specified in Clause 5.7.

6.16.7 When laying during cool windy weather, a joint heater may be used subject to the discretion of the Project Manager.

6.17 TRANSVERSE JOINTS

6.17.1 Transverse joints are required at the end of a day's work and following any interruption in laying that prevents continuity of rolling at, or above, the specified minimum temperature. Transverse joints shall be formed at right angles to the longitudinal joints and shall be vertical.

6.17.2 The exposed vertical edges of the transverse joints of all layers shall be cut back for at least 300 mm and trimmed. All loose material arising from this operation shall be removed from the pavement and the underlying surface cleaned. The exposed joint edges shall then be cleaned and painted with bitumen as specified in Clause 6.16 immediately before the laying of the lane continues.

6.17.3 On completion, the joints shall present the same texture as the remainder of the surface and the accuracy of the surface across the joints shall meet the criteria specified in Clause 5.7.

6.18 JOINTS BETWEEN NEW SURFACING AND EXISTING PAVEMENTS

6.18.1 Existing asphalt surfacing against which new surfacing is to be laid shall be cut back as necessary to a line removing all loose or weathered material and shall be finished with a vertical edge. Immediately prior to the laying of new material, either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- a joint seal that has been approved by the Project Manager and used in accordance with the manufacturer's instructions,

shall be applied over the complete face.

6.18.2 Where asphalt resurfacing is ramped into an existing asphalt surface and the ramp ends at a point abutting an existing concrete surface, the exposed vertical face of the concrete shall be cleaned thoroughly and either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- a joint seal that has been approved by the Project Manager and used in accordance with the manufacturer's instructions,

shall be applied over the complete face within 2 h prior to laying the asphalt surfacing.

6.18.3 The edge of existing concrete surfacing against which a completely new asphalt surfacing is to be laid shall be exposed and thoroughly cleaned to its full depth and for the appropriate length. Unless shown otherwise on the drawings, an expansion joint shall then be formed below the new surfacing by:

- placing a joint filler of non-extruding, heat and rot-proof board against the bottom of the exposed concrete face that is 25 mm thick and of a height equal to the depth of the concrete slab less the greater of:
  - 100 mm and
  - the total thickness of the new surfacing;
- installing a joint sealing material, approved by the Project Manager, in accordance with the manufacturer's instructions to the upper margin of the exposed face; and

- carrying the new surfacing over the top of the joint filler aggregate within 2 h of installing the joint sealing material.

The new surfacing at the junction shall be a minimum of 100 mm thick for a distance of at least 3 m back from the junction, laid in a minimum of two layers.

6.19 RAMPS BETWEEN NEW SURFACING AND EXISTING PAVEMENTS

6.19.1 Junctions to be made with ramps between the new surfacing and existing pavements are shown on the drawings, for which typical details are given in Figures 6.1 and 6.2.

6.19.2 Where appropriate, the new binder course shall be reduced in thickness at a slope parallel to that of the finished surface to a minimum thickness of 40 mm. It shall be further feathered down at the same slope in hand-laid surface course or binder course material using the materials specified in sub-Clause 6.6.1.

6.19.3 The width of these reductions in level shall be as shown on the drawings and shall be formed so the surface course remains within the tolerances of thickness specified in Clause 5.4 at all points within it. The surface course shall, however, be permitted to exceed the higher tolerance in the limited area immediately following the end of the binder course ramping.

6.19.4 Where the existing surface is asphalt, the end of the ramp furthest away from the new surfacing shall be defined by a clean saw cut to the depth shown in Figure 6.2 before planing is commenced.

6.19.5 Where the existing surface is concrete, the end of the ramp furthest away from the new surfacing shall be along the line of existing joints or grooves. The surface so prepared shall be thoroughly cleared of all loose materials and either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- a joint seal that has been approved by the Project Manager and used in accordance with the manufacturer's instructions,

shall be applied over the complete face within 2 h prior to laying the asphalt surfacing.

6.19.6 The exposed vertical edges of the existing surfacing shall be painted with bitumen and the new surfacing shall be compacted against it.

6.19.7 In areas where ramping as described above is not considered necessary (i.e. non-trafficked areas), a ramp finished to a step not exceeding 15 mm in the material specified in sub-Clause 3.9 is permissible.

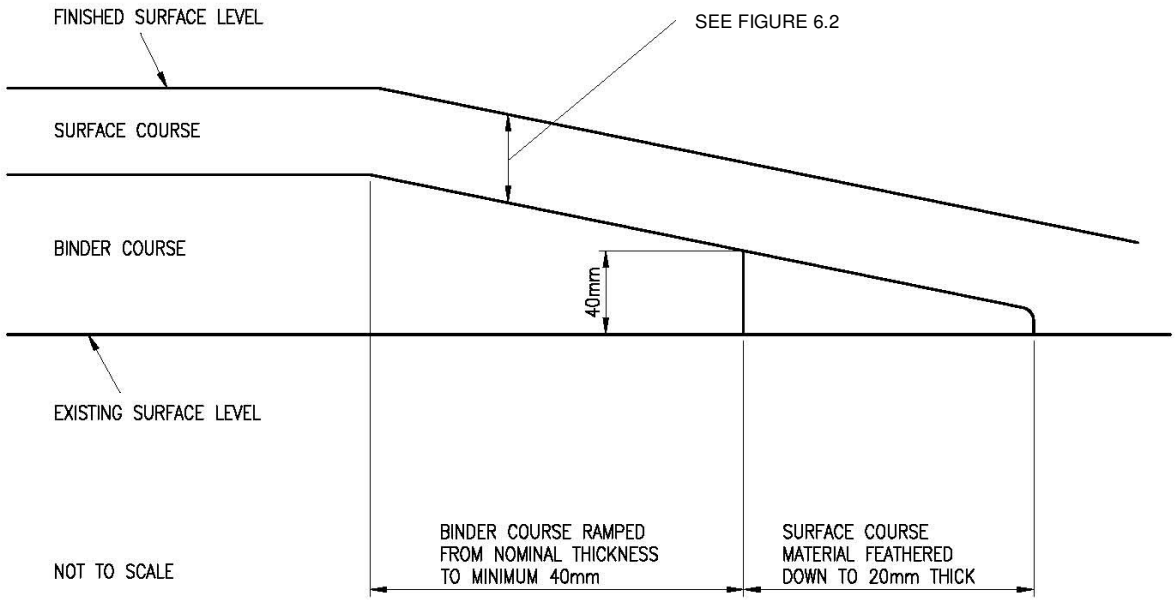


Figure 6.1 – Ramps between New Surfacing and Existing Pavements

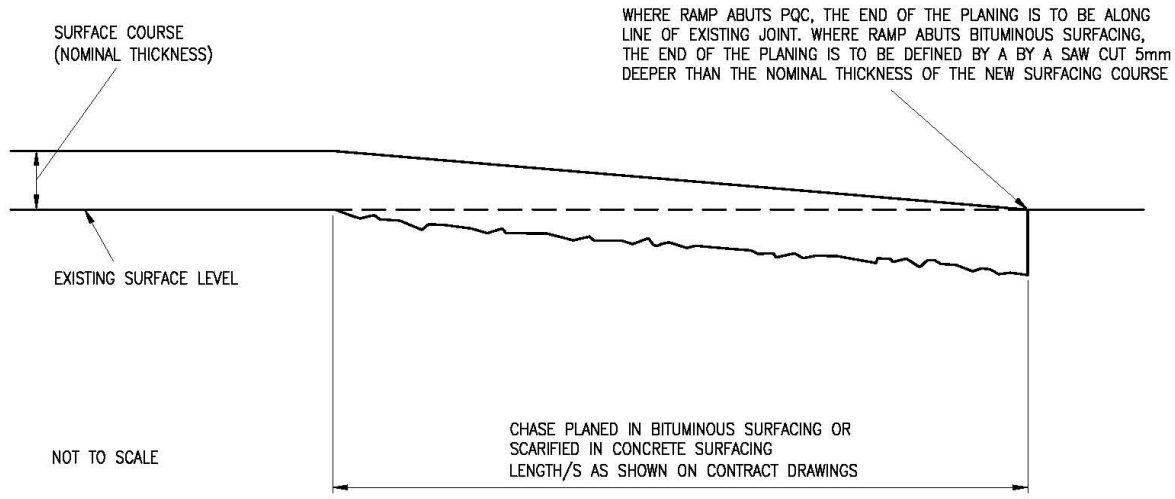


Figure 6.2 – Ramps between Surface Course and Existing Pavements

6.20 TEMPORARY RAMPS

(NOTE. This is a specimen clause only; the Project Manager must agree the details with the Aerodrome Authority/Station staff on a job-specific basis. Further advice for the Project manager is given in Clause Z.6 of Appendix Z.)

6.20.1 Temporary ramps (e.g. to enable aircraft operations to continue during daylight hours with construction work being carried out at night) shall be constructed in the same manner as specified in Clause 6.19. However, where the Contractor can demonstrate to the satisfaction of the Project Manager that he can provide an acceptable and sound surfacing without the use of the saw cut, the saw cutting may be omitted.

6.20.2 Prior to the commencement of work each *, the Contractor shall obtain the approval of the Project Manager to the proposed layout of the temporary ramps. At no time shall there be more than one ramp in the length of each course and the ramps shall be transverse to the line of aircraft movement or as directed by the Project Manager. The ramps shall slope in the same direction unless directed otherwise. On runways, the construction work shall proceed from the primary takeoff/landing end such that temporary ramps slope down in the direction of aircraft movement. If the Contractor proposes to lay any areas of the ramps by hand methods or methods not approved in the trial areas, he shall seek prior approval of the Project Manager.

* Project Manager to provide the relevant period for the specific job specification; advice is given in Clause Z.6 of Appendix Z.

6.20.3 Temporary ramps shall be arranged so as to avoid covering manholes and aviation ground lighting fixtures whenever practicable. When this is not practicable, the manholes and aviation ground lighting fixtures shall be covered by the temporary ramps.

OR

Temporary ramps shall be arranged so as to avoid covering manholes and aviation ground lighting fixtures wherever practicable. When this is not practicable, ramping, which must be smoothed over as approved and described in sub-Clause 6.20.7, shall also be carried out to all edges of manhole surrounds and aviation ground lighting fixtures.

(NOTE. Project Manager to select option for specific job specification; advice given in sub-Clause Z.6.2 of Appendix Z.)

6.20.4 Ramps on the runway surface within * m of the centre line shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction;
- The gradient of any ramp shall not exceed ± * in the transverse direction, and there shall be no transverse ramps within * m of the runway centre line;
- The depth of any ramp shall not exceed * mm;
- The spacing of successive ramps shall not be less than * m in the longitudinal direction;
- The profile of the ramps shall be such that it does not create ponding on the surface; and
- All ramps shall be planed into the existing surface to ensure a minimum thickness of * mm of ramping material.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.6 of Appendix Z.

6.20.5 Ramps on the taxiway and the extended taxiway to a point * m from the runway centre line shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction;
- The gradient of any ramp shall not exceed ± * in the transverse direction;
- The profile of the ramps shall be such that it does not create ponding on the surface; and
- All ramps shall be planed into the existing surface to ensure a minimum thickness of * mm of ramping material.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.6 of Appendix Z.

6.20.6 Ramps on the runway paved shoulders shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction; and
- The gradient of any ramp shall not exceed ± * in the transverse direction.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.6 of Appendix Z.

6.20.7 All ramps shall be inspected prior to the completion of each * work and are to be modified or made good to the satisfaction of the Project Manager where he deems them to be unsatisfactory. There shall be no uncovered tack or bond coat material, oil, petrol, grease or similar contaminants and no steps, ruts, pits or bumps of greater than 3 mm in height/depth. The surface shall be cleaned and swept of all plant, equipment, unsound or ragged materials, debris, dirt and similar, all to the satisfaction of the Project Manager.

* Project Manager to provide the relevant period for the specific job specification; advice is given in Clause Z.6 of Appendix Z.

6.20.8 All or part of the temporary ramps are to be planed out at the commencement of the next period of work to ensure that a minimum of * mm of material can be laid. The planing out of ramps and laying of the new material is to be carried out in accordance with Clause 6.22.

* Project Manager to provide the value (if this sub-clause is required) for the specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.6 of Appendix Z.

6.21 TRAFFIC ON FINISHED SURFACING

6.21.1 No trafficking of freshly laid surfacing is permitted until the surfacing has cooled to ambient temperature and no stopping or parking of vehicles is permitted within:

- 24 h of laying a surfacing in summer conditions; and
- 12 h of laying a surfacing in winter conditions.

Traffic allowed on finished cold surfacing shall be restricted to the minimum required for the conveyance of mixed materials for the laying of the surfacing immediately adjacent to the area being laid.

6.21.2 If early trafficking of freshly laid material is required, the Contractor shall propose a method of measuring the temperature of the surfacing and validate it during the trials (Section 7).

(NOTE. Advice for the Project Manager on the assessment of the temperature of freshly laid surfacing is given in Clause Z.7 of Appendix Z.)

6.21.3 The Contractor shall be responsible for maintaining the finished surfacing in good and clean condition. He shall make good any defects, damage or defacement which occurs during the Contract by the means, and to the standards, described in this Specification.

6.22 CUTTING OUT DEFECTIVE OR OLD SURFACING

6.22.1 When defective surfacing is cut out, the full depth of the layer shall be removed. The area to be cut out shall extend across the full width of the lane between the longitudinal joints, and shall extend at least 300 mm beyond the defective area into sound material. The area of the lane to be cut out shall be defined by straight saw cuts, at least 40 mm deep or the full thickness of the layer, whichever is the thinner.

6.22.2 The area shall be cut away carefully by approved mechanical scabbling or planing machines. Pneumatic spade cutters may also be used if the risk of damage to operatives from hand arm vibration syndrome (vibration white finger) has been minimised and the remaining risk has been assessed as acceptable. Where spade cutters are

used, the cutting tool blades shall overlap the previous cut on each move and each cut shall penetrate the course for its full thickness.

6.22.3 The surface of the exposed material below shall be thoroughly cleared of all loose fragments and cleaned, using high-pressure water and vacuum extraction, or as directed by the Project Manager.

6.22.4 Replacement shall not begin until the Project Manager has approved the conditions of cleanliness of the base.

6.22.5 When the level of the pavement is to be raised by 20 mm or more, saw cutting shall be omitted.

(NOTE. Guidance may be found in DE Functional Standard 06, "*Guide to Maintenance of Airfield Pavements*".)

6.23 REPLACEMENT OF DEFECTIVE OR OLD SURFACING

6.23.1 A tack coat in accordance with Clause 6.10 shall be applied over the exposed base, care being taken to include all corners, angles and irregularities. The exposed vertical faces of the surfacing shall be painted with bitumen.

6.23.2 The replacement surfacing shall comply with the specified course thicknesses shown on the drawings and tolerances specified in Clause 5.4, and with the standards detailed in this Specification.

6.24 FILLING CORE HOLES

The walls and base of all holes from which core samples have been cut are to be painted with bitumen and filled with the specified surfacing material, well rammed in lifts not exceeding 50 mm.

7 Trials

7.1 GENERAL

Trials shall be carried out on all SMA mixtures proposed for use in the works. For small works, the procedures and requirements for the trial may be modified at the discretion of the Project Manager.

7.2 PRELIMINARY TRIALS

7.2.1 For each SMA mixture, after the 'Laboratory Design Mixture' has been approved by the Project Manager (see Clause 4.9), the Contractor shall mix at least one 20 tonne batch of the material for laying in preliminary trials. At the discretion of the Project Manager, this requirement may be modified for regulating or ramping material.

7.2.2 Preliminary trial mixtures shall be made up in the mixers that the Contractor proposes to use at the appropriate mixing temperatures and with the aggregates proportioned from either:

- the various hot bins for a Batch Mixer; or
- the cold feed hoppers for a Continuous Drum Mixer

to produce the required aggregate grading with the binder content at the appropriate design binder content.

7.2.3 The preliminary trial mixtures shall be laid on disused pavements within the airfield boundary, in locations selected by the Project Manager. The mixture shall be transported to the airfield and laid and compacted on a clean firm and level test area, not being part of the works, using delivery, paving and compaction machinery that the Contractor proposes to use during the works. The area shall be tack or bond coated prior to laying. The materials shall be laid and compacted according to the requirements of this Specification.

7.2.4 The Contractor shall select paving and compaction operations such that no laying defects such as dragging or surface blemishes result, to the satisfaction of the Project Manager. The Project Manager may order further 20 tonne loads to be laid until a satisfactory result is achieved.

(NOTE 1. Attention needs to be given to the material feed rate via the paver screws to the screed to avoid dragging and segregation.)

(NOTE 2. For planning purposes, the following equations will assist the Contractor to select paving and rolling rates to achieve the minimum specified number of roller passes before the surfacing has cooled to the minimum temperature for compaction:

Rolling length (m) = average paving speed (m/min) x 8 (min)

Roller passes = (Rolling rate/Paving Rate) x No of Rollers

where:

Rolling rate (m^2/min) = Roller width (m) x Roller speed (m/min)

Paver rate (m^2/min) = Paver width (m) x Paver speed (m/min))

7.2.5 The paving and rolling rates, demonstrated to be satisfactory during the laying of the trial mixture, shall be agreed with the Project Manager and shall be adhered to during the main works.

7.2.6 The Contractor shall submit the results of an analysis, carried out in accordance with BS EN 12697-1 and BS EN 12697-2, to the Project Manager for each load of the trial mixture laid to demonstrate compliance with the compositional requirements of Clauses 4.2, 4.3 and 4.10.

7.2.7 If the preliminary trials indicate that a trial mixture:

- is unsatisfactory for mechanical spreading and compacting; or
- fails to produce the surface accuracy specified in Clause 5.7; or
- results in surface blemishes that are unacceptable,

the proportion of binder and the grading of the combined aggregates and filler aggregate may be slightly modified within the limits of the Specification.

(NOTE. If changes outside of the specification limits are required, a new design may be necessary.)

7.2.8 Further preliminary trials shall then be laid to demonstrate that a satisfactory mixture has been achieved. The Project Manager will then agree the mixture and appropriate specification limits and authorise the laying of a final trial area as described in Clause 7.3.

7.2.9 After completion of all preliminary trials, the edges of the lanes shall be feathered off in asphalt surfacing as necessary for the requirements of vehicular traffic to the approval of the Project Manager.

7.3 FINAL TRIAL AREAS

7.3.1 Following completion of the preliminary trials described in Clause 7.2, a trial area of surfacing, not less than 60 m or more than 300 m long by two rips wide, shall be laid for each layer thickness for each mixture. Duplicate areas shall be laid for each additional spreader and for each thickness on which each particular spreading unit will be working. The trial areas shall be laid along the outside edges of the pavements in positions approved by the Project Manager.

7.3.2 Each trial area shall contain at least one 60 m continuous length of longitudinal joint and at least 4.5 m of transverse joint.

7.3.3 The Contractor shall submit the results of an analysis, carried out in accordance with BS EN 12697-1 and BS EN 12697-2, to the Project Manager for each lorry load of the trial mix laid to demonstrate compliance with the requirements of Clauses 4.2, 4.3, 4.4 and 4.10.

7.3.4 When the trial surfacing has cooled to ambient temperature, six 150 mm diameter cores shall be cut according to BS EN 12697-27 using a coring machine that has been approved by the Project Manager. The cores shall be evenly spaced along the length of the trial surfacing with at least 2 cores being taken adjacent to longitudinal lane joints at a distance not exceeding 50 mm or nearer than 25 mm from joint edges. The initial and final cores shall not be taken within 7 m of the ends of the length of surfacing. From these cores:

- the thickness shall be determined according to BS EN 12697-36;
- the bulk density shall be determined according to BS EN 12697-6, Procedure A;
- the maximum density shall be determined according to BS EN 12697-5, Procedure A; and
- the air voids content shall be determined according to BS EN 12697-8.

The average air voids content shall not exceed 5.5 % nor be less than 2.0 % and an individual result shall not exceed 6.5 %.

(NOTE. For very small works and at the discretion of the Project Manager, the maximum density and air voids content may be omitted.)

7.3.5 If the trial area is approved, the Job Minimum Density shall be defined as 93.5 % of the mean maximum density determined in accordance with Sub-Clause 7.3.4.

7.3.6 The Contractor shall demonstrate the effectiveness of his compaction method as defined by the requirements of sub-Clause 7.3.4. The standard of finish, including that at joints, shall comply with the requirements of this Specification and be acceptable to the Project Manager as the standard to be achieved in future laying. The surface finish shall have no laying defects, such as dragging or surface blemishes.

7.3.7 When the Project Manager has approved the trial area, the Contractor shall confirm in writing the weights, proportions and overall grading of the mixture used in the trial to the Project Manager. Thereafter, they shall be used as targets for future plant mixing with due regard for the tolerances in this Specification.

7.3.8 The approved length of the trial area shall be permanently marked 'Approved' and dated and the approved longitudinal and transverse joints are to be permanently defined.

7.3.9 If the trial area is approved, it shall be allowed to remain. Otherwise, the full length shall be removed as specified in Clause 6.1 and replaced with new material to the required standard at the Contractor's expense.

7.3.10 Until approval has been given, the general laying of SMA surfacing required by the Contract will not be permitted to start.

7.3.11 The standard of workmanship and finish of all surfacing included in the Contract shall be equal to that of the 'Approved' areas and shall not be changed afterwards without the specific approval of the Project Manager.

7.3.12 If for any reason the quality, grading or supply source of any of the aggregates is changed, a new mixture shall be designed and approved on the basis of further trial areas.

7.3.13 Based on the trials, the rollers and rolling method to be adopted for each course shall be agreed with and approved by the Project Manager.

7.3.14 No change shall be made afterwards in the mixing and spreading plant or rolling methods without the approval of the Project Manager, and then only after new trials have been carried out and approved.

8 Summary of Tests

8.1 TEST RESULTS

The Contractor shall be responsible for having all testing carried out in accordance with the requirements of this Section and provide the Project Manager with a written copy of all results at the first reasonable opportunity but not later than 2 working days after completion of each test. Testing shall be started on specimens within 2 working days of sampling and shall be carried out in an expeditious manner.

8.2 TESTS FOR INITIAL APPROVAL OF MATERIALS

8.2.1 Before mixing starts, the Contractor (or his materials supplier on his behalf) shall provide current CE mark certificates for all aggregates showing conformity with all requirements of Section 3.

8.2.2 In addition to 8.2.1, the Contractor (or his materials supplier/s on his behalf) shall have carried out the aggregate tests in Table 8.1 for comparison with the relevant specification clauses

TABLE 8.1 ADDITIONAL AGGREGATE TESTS FOR INITIAL APPROVAL

Component material	Cl. No.	Test	
		Title	Reference
Coarse Aggregate	3.2	Magnesium Sulfate Val. Affinity between ag. & bitumen	Appendix A BS EN 12697-11 Part 2
Fine Aggregate	3.3	Magnesium Sulfate Val. Affinity between ag. & bitumen *	Appendix A BS EN 12697-11 Part 2

* Test on particles of rock from the same source when crushed rock fines are used

8.2.3 In addition, the Contractor shall submit the appropriate certificates for:

- the binder;
- other constituents, including tack or bond coat; and
- tack or bond coat spray-bar equipment.

8.3 TESTS FOR THE PROPORTIONING AND DESIGN OF MIXTURES

Before mixing starts, the Contractor shall provide current CE mark certificates for all mixtures showing conformity with all requirements of Section 4 and the relevant specification clauses in Tables 8.2, 8.3 and 8.4.

TABLE 8.2 TESTS FOR DESIGN OF MIXTURES

Cl. No.	Test	
	Title	Reference
4.3	Binder drainage	BS EN 12697-18
4.4	Air voids content	BS EN 12697-8
4.6	Water sensitivity	BS EN 12697-12
4.7	Wheel-tracking	BS EN 12697-22

TABLE 8.3 TESTS FOR PAVEMENT REQUIREMENTS

Cl. No.	Test	
	Title	Reference
4.10	Binder content Aggregate grading	BS EN 12697-1 BS EN 12697-2
5.3	Temperature	BS EN 12697-13
5.4	Course thickness	BS EN 12697-36
5.5	In situ bulk density	BS EN 12697-6
5.7	Surface accuracy	Clause 5.7
5.7.3	Texture depth	BS EN 13036-1
5.9	Particle loss	BE EN 12697-17
5.10	Penetration of recovered binder	BS EN 12697-3 or -4 and BS 2000-49

TABLE 8.4 TESTS FOR TRIALS OF MIXTURES

Cl. No.	Test	
	Title	Reference
7.2.6	Binder content	BS EN 12697-1
	Aggregate grading	BS EN 12697-2
7.2.7	Surface accuracy	BS EN 13036-7
7.3.3	Binder content	BS EN 12697-1
	Aggregate grading	BS EN 12697-2
7.3.3 and 7.3.4	Course thickness	BS EN 12697-36
	Bulk density	BS EN 12697-6
	Air voids content	BS EN 12697-8

8.4 ROUTINE TESTS ON BULK SUPPLIES THROUGHOUT PLANT MIXING

8.4.1 The Quality Assurance procedures for the supply of component materials and asphalt mixtures shall include carrying out tests in order to:

- check on the consistency of bulk supplies;
- compare with the properties and gradings of the conformity declaration; and
- check on the capability of the dryers to function efficiently with aggregates of variable moisture content.

The tests should include those in Table 8.5.

8.5 ROUTINE TESTS ON MIXTURES THROUGHOUT PLANT MIXING

As part of the Quality Assurance requirements in Clause 2.4, the Contractor (or his materials supplier on his behalf) shall carry out the tests listed in Table 8.6 on mixtures prepared for the works. The procedure shall ensure that the position of plant mixtures from which test samples are taken or specimens made are fully traceable in the finished pavement layer.

8.6 ROUTINE TESTS DURING LAYING AND ON COMPACTED CORES

As part of the Quality Assurance requirements in Clause 2.4, the Contractor (or his materials supplier on his behalf) shall carry out the tests listed in Table 8.7 on the asphalt as laid in the works.

8.7 ADDITIONAL TESTS WHEN ROUTINE TESTS ON THE MIXTURES AND ON THE COMPACTED COURSES FAIL

8.7.1 The Contractor (or his materials supplier on his behalf) shall carry out the following additional tests when routine tests fail to establish the extent to which material already laid fails to meet the requirements specified for:

- grading and binder content;
- course thickness;
- in situ density; or
- surface accuracy.

8.7.2 The samples for these additional tests shall be cut from the compacted course, at positions selected by the Project Manager. The positions shall be within the lane width at a distance of not more than 5 m from the location in the pavement at which the mixture was laid which failed to satisfy the routine test requirements specified. Two additional tests shall be carried out on both sides of the

TABLE 8.5 ROUTINE TESTS ON BULK SAMPLES

Test	Method	Sampled From	Min. Frequency
Grading of aggregate	BS EN 933-1	Each stockpile	Daily on receipt
Moisture content of aggregate at mixing	BS EN 1097-5	Mixer but without binder added	Weekly

TABLE 8.6 ROUTINE TESTS ON MIXTURES

Test	Method	Sampled From	Minimum Frequency
Grading	BS EN 12697-2	After completion of the mixing process	Every 4 h, but not less than twice a day, for each mixer
Binder content	BS EN 12697-1		
Temperature	BS EN 12697-13	Lorry	Every load

TABLE 8.7 ROUTINE TESTS DURING LAYING AND ON COMPACTED CORES

Test	Method	Sampled From	Minimum Frequency
Material temperature	BS EN 12697-13	Paving train	Each load
Course thickness	BS EN 12697-36	Previous day's work	Cores from every * laid (or from every 2 h work, whichever is the more frequent); and at locations agreed with the Project Manager.
In situ bulk density	BS EN 12697-6		
Recovered binder penetration †	BS EN 12697-3 or -4 and BS 2000-49		
Finished levels	Levelling survey	Previous day's work	Daily
Surface accuracy	BS EN 13036-7		
Texture depth	BS EN 13036-1		

* Project Manager to provide value for specific job specification; advice given in Clause Z.4 of Appendix Z.

† Guidance is required from the binder supplier on the appropriate recovery method if a polymer modified binder is used.

location where the routine test failed to meet the specified requirement.

8.7.3 If any one of the additional test results for grading, binder content or course thickness also indicate failure to meet the specified requirement in Clause 4.10, further tests shall be made on 3 more samples. These samples or cores shall be cut at further positions selected by the Project Manager, also within the lane width and at a distance of not more than 10 m further along the lane from the location of the previous failure point. Should one of these additional samples also fail to meet the specified requirement, the above process shall be repeated until the results for all samples are satisfactory. The area covered by the failed samples shall be cut out and replaced by the Contractor, at his own expense, as detailed in Clauses 6.22 and 6.23.

8.7.4 When a routine test result fails to meet the requirements of Clause 5.7, an additional 20 straightedge tests in accordance with BS EN 13036-7 shall be made over the area between the adjacent points where the routine test was undertaken for which the results complied with the requirements of Clause 5.7. If three or more of these additional tests also fail to meet the specified requirement, this area of the surfacing shall be condemned. The condemned areas shall be removed and replaced by the Contractor, at his own expense, as specified in Clauses 6.22 and 6.23.

8.7.5 Attempts to correct the surface accuracy with fine bituminous dressings, synthetic resin formulations, surface dressing applications, or emulsion slurry films shall not be allowed.

8.7.6 When a routine test fail to meet the requirements of Clause 5.8, an additional texture depth test involving 10 measurements shall be made 10 m on either side of the area where the routine tests failed. If either of these additional tests also fail to meet the specified requirement, this area of the surfacing shall be condemned. The condemned areas shall be removed and replaced by the Contractor, at his own expense, as specified in Clauses 6.22 and 6.23.

Appendix A – Use of Magnesium Sulfate Test with Non-Standard Aggregate Fractions

A.1 SCOPE

This Appendix specifies a procedure extending the method in BS EN 1367-2 for assessing how an aggregate behaves when subjected to the cyclic action of immersion in magnesium sulfate, followed by oven drying, to all fractions.

A.2 APPARATUS AND REAGENTS

Apparatus and reagents as detailed in BS EN 1367-2, Clauses 7 and 8, (except that the balance for coarse aggregate, sub-Clause 6.2, to be accurate to 1 g) together with:

- 20 mm and 6.3 mm sized square hole perforated plate test sieves and 2 mm, 1 mm, 0.5 mm and 0.25 mm sized woven wire test sieves; the additional test sieves shall comply with BS EN 933-2; and
- at least two brass or stainless steel mesh baskets for immersing aggregate specimens for fractions other than 10 to 14 mm with the maximum dimension of the apertures not more than half the maximum aperture of the sieve on which the specimen is retained, but not less than 0.125 mm.

A.3 PREPARATION OF TEST PORTIONS

A.3.1 Bulk samples from each nominal size of aggregate being delivered from each source of supply to be used shall be tested separately and the procedure described hereafter shall be applied to each separate sample.

A.3.2 Prepare two test portions from the bulk samples of each aggregate supplied as in BS EN 1367-2, Clauses 8.1 and 8.2, replacing "*minimum mass of 500 g of the 10 mm to 14 mm size*" in Clause 8.1 by the relevant masses from Table A.1.

A.4 PREPARATION OF AGGREGATE TEST SPECIMENS FOR EACH FRACTION

A.4.1 The grading of the test portion shall be determined by the dry sieving method described in Clause 8.3 of BS EN 1367-2 using the 20 mm, 10 mm, 6.3 mm, 2 mm, 1 mm, 0.5 mm and 0.25 mm sieves. For coarse aggregate test specimens, the fractions retained on the 20 mm sieve and passing the 1 mm sieve shall be discarded and not taken into account in the calculation of the test result. The remainder of the reduced sample shall be considered as the test portion. The grading shall be recorded giving the percentage of the mass of the test portion retained between each pair of sieves, together with that passing the 0.25 mm sieve for fine aggregate test specimens, to the nearest whole number.

A.4.2 Those fractions retained whose proportions are less than 5 % by mass of the test portion shall be discarded. Nevertheless, the proportions that the discarded fractions represent shall be taken into account in the calculation of the test result.

A.4.3 One test specimen, of mass in accordance with Table A.1, shall be taken out of each fraction retained after completion of sub-Clause A.4.2. If there is insufficient material in any of these fractions to provide a test specimen of the required size, the procedure shall be repeated starting from sub-Clause A.3.2. The grading recorded shall be that obtained from all the material sieved out.

TABLE A.1 REQUIRED MASS OF COARSE AGGREGATE TEST SPECIMENS

Sieves		Mass of specimen before test (g)
Passing	Retained	
20 mm	10 mm	1000 ± 10
10 mm	6.3 mm	300 +10 / –0
6.3 mm	2 mm	100 +10 / –0
2 mm	1 mm	100 +10 / –0
1 mm	0.5 mm	100 +10 / –0
0.5 mm	0.25 mm	100 +10 / –0

A.5 PROCEDURE

Procedure for each test specimen as in BS EN 1367-2, Clause 9, replacing "*10 mm sieve*" in Clause 9.6 by the sieve relevant to the lower size of the aggregate fraction.

A.6 CALCULATION AND EXPRESSION OF TEST RESULTS

A.6.1 Calculate the magnesium sulfate value of each test specimen as in BS EN 1367-2, Clause 10.1, replacing "*10 mm sieve*" by the sieve relevant to the lower size of the aggregate fraction.

A.6.2 Fractions not tested because they represent less than 5 % by mass of the test portion shall be assumed to have a magnesium sulfate value equivalent to:

a) the mean of the magnesium sulfate value found by the tests on specimens of the two fractions immediately adjacent to it in size; or
b) the magnesium sulfate value found by the test on a specimen of the fraction, either larger or smaller, immediately adjacent to it if only one of these fractions were tested; or
c) the mean magnesium sulfate value found by the tests on specimens of the two fractions next but one adjacent to it if both these fractions were tested and the adjacent fractions were not; or
d) the magnesium sulfate value found by the test on a specimen of the fraction, either larger or smaller, in this order of priority, most nearly adjacent to it.

A.6.3 For samples of fine aggregate, the material passing the 0.25 mm sieve shall not be tested but shall be taken as having a magnesium sulfate value equivalent to that of the specimen passing the 0.5 mm sieve but retained on the 0.25 mm sieve.

A.6.4 The magnesium sulfate value of each test portion of aggregate shall be the sum of the magnesium sulfate values found for each aggregate fraction times the proportion by mass of that fraction in the test portion.

A.6.5 The magnesium sulfate value for the aggregate shall be the mean of the two results for the test portions to the nearest whole number. The magnesium sulfate value for each fraction of the aggregate shall be the mean of the magnesium sulfate values for the two results for the test specimens to one decimal place.

(NOTE. A suitable worksheet (with two examples, one fine aggregate and one coarse aggregate) is shown on the following pages.)

A.7 PRECISION

As in BS EN 1367-2, Annex A.

A.8 TEST REPORT

As in BS EN 1367-2, Clause 11, together with:

g) The magnesium sulfate value and the individual magnesium sulfate values of the two specimens for each aggregate fraction tested.

EXAMPLE A.1

Blackstone Quarry, 6 mm nominal single size. Tested 8-25 August 2003						
Sieve Size		Grading of Test Portion (% of total mass)	Mass of Test Specimen		Magnesium Sulfate Value (% of original mass)	Weighted Mag. Sulfate value (%)
Passing (mm)	Retained (mm)		Before Test (g)	After Test (g)		
First Test Portion						
37.5	20	*0*	–	–	–	*0*
20	10	*0*	–	–	–	*0*
10	6.3	*26.4*	*303.2*	*278.2*	*8.2*	*2.18*
6.3	2	*69.4*	*104.9*	*98.6*	*6.0*	*4.17*
2	1	*4.2* †	–	–	*6.0* ‡	*0.25*
Total		*100*			Total	*6.60*
Second Test Portion						
37.5	20	*0*	–	–	–	*0*
20	10	*0*	–	–	–	*0*
10	6.3	*28.7*	*296.1*	*272.3*	*8.0*	*2.31*
6.3	2	*66.2*	*98.4*	*92.5*	*6.0*	*3.97*
2	1	*5.1*	*104.1*	*98.2*	*5.7*	*0.29*
Total		*100*			Total	*6.57*
					Mean	7

† Less than 5 % by mass of total sample, no test specimen.
‡ Taken as equivalent to that for 6.3 mm to 2 mm size under sub-Clause A.6.2, indent (b).

EXAMPLE A.2

Sandy Heath Pit, Coarse Sand. Tested 8-12 August 2003						
Sieve Size		Grading of Test Portion (% of total mass)	Mass of Test Specimen		Magnesium Sulfate Value (% of original mass)	Weighted Mag. Sulfate value (%)
Passing (mm)	Retained (mm)		Before Test (g)	After Test (g)		
First Test Portion						
10	6.3	*4.6* †	–	–	*11.9* ‡	*0.55*
6.3	2	*10.8*	*97.2*	*85.6*	*11.9*	*1.29*
2	1	*17.0*	*101.8*	*94.2*	*7.5*	*1.27*
1	0.5	*25.2*	*92.9*	*89.0*	*4.2*	*1.06*
0.5	0.25	*26.2*	*104.1*	*99.3*	*4.6*	*1.21*
0.25	–	*16.2*	–	–	*4.6* *	*0.75*
Total		*100*			Total	*6.12*
Second Test Portion						
10	6.3	*4.4* †	–	–	*11.2* ‡	*0.49*
6.3	2	*10.9*	*104.1*	*92.4*	*11.2*	*1.23*
2	1	*17.3*	*106.8*	*98.3*	*8.0*	*1.38*
1	0.5	*25.1*	*101.7*	*96.8*	*4.8*	*1.21*
0.5	0.25	*26.1*	*100.3*	*96.1*	*4.2*	*1.09*
0.25	–	*16.2*	–	–	*4.2* *	*0.68*
Total		*100*			Total	*6.08*
					Mean	6

† Less than 5 % by mass of total sample, no test specimen.
‡ Taken as equivalent to that for 6.3 mm to 2 mm size under sub-Clause A.6.2, indent (b).
* No test but mass loss taken as equivalent to that for 0.5 mm to 0.25 mm size under sub-Clause A.6.3.

Appendix B – Straightedge Test

B.1 SCOPE

This Appendix shall be followed to determine the surface accuracy of bituminous surfacing layers in this Specification.

B.2 APPARATUS

B.2.1 The straightedge for the tests shall be purpose made and 3 m long. It shall have a flat square edge of metal, at least 75 mm wide, along the full length of its base. The straightedge shall be fitted with lifting hand grips or handles.

B.2.2 A calibrated wedge may be used to determine the straightedge clearance. The wedge should have an angle of (5.75 ± 0.05)°, and engraved at 10 mm intervals across the incline, starting at the apex, representing clearances increasing in 1 mm intervals up the incline.

B.3 PROCEDURE

B.3.1 The straightedge shall be placed unsupported on the surface, anywhere in any direction, other than across the crown of a camber or across a drainage channel. The location shall be selected by the Project/Works Services Manager or his representative, and the tests shall be carried out in his presence.

B.3.2 Twenty tests shall be made for every 1000 m² laid and at least half of these tests shall be across lane joints.

B.3.3 The Contractor shall mark with white paint all areas which fail to comply with the specified requirement.

Appendix C – Guidance on Suitable Temperatures and Wind Speeds for Laying

C.1 In addition to the requirements in Clause 5.2, Table C.1 gives recommended wind speed and air temperature limits for the laying of SMA with paving grade bitumen.

(NOTE 1. When a polymer modified binder when is employed, guidance on laying conditions should be sought from the binder supplier.)

TABLE C.1 RECOMMENDED WIND SPEED AND AIR TEMPERATURE LIMITS

Bitumen Grade	Thick-ness (mm)	Maximum Wind Speed (km/h) 2 m height	10 m height	Min. Air Temperature (°C)
40/60	≤ 25	See Note 2		
	30 – 40	As in Figure C.1		
	≥ 45	40	50	0
70/100	≤ 25	See Note 2		
	30 – 40	As in Figure C.2		
	≥ 45	40	50	0
100/150	≤ 25	See Note 2		
	30 – 40	As in Figure C.3		
	≥ 45	40	50	0

(NOTE 2. The limiting wind speed and air temperatures relate to a compaction time of 6 min for the mid-layer temperature to fall from the specified maximum to minimum compaction temperatures.)

(NOTE 3. Very thin asphalt layers cool very quickly. At 15 mm thickness, less than 2 min is theoretically available for compaction within the specified compaction temperature limits. Prompt rolling is essential and it is recommended that this material should only be laid in still conditions.)

(NOTE 4. The values and graphs were calculated using the previous grades of bitumen, and the results for mixtures with 70/100 and 100/150 bitumen may need to be revised.)

C.2 Wind speed can be measured by either:

- an anemometer erected at a height of (10 ± 0.5) m situated on the airfield; or
- a portable anemometer erected at a height of (2 ± 0.1) m situated in close proximity to the laying works.

The anemometer should be fitted with a digital accumulative device. The average wind speed over the previous hour should be used to define the prevailing wind speed.

(NOTE 1. If the wind speed is increasing, anemometer readings should be made at 15 min intervals.)

(NOTE 2. To aid planning works, weather forecasts may be obtained from the nearest Regional Weather Centre.)

C.3 * Meteorological records for the airfield are available.

OR

* No clause.

(* NOTE 1. Project Manager to select alternative for specific job specification; advice given in Clause Z.8 of Appendix Z.)

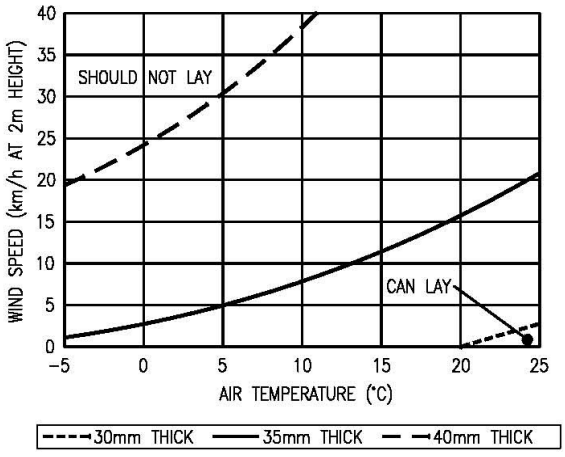


Figure C.1 – Acceptable weather conditions for laying SMA with 40/60 bitumen

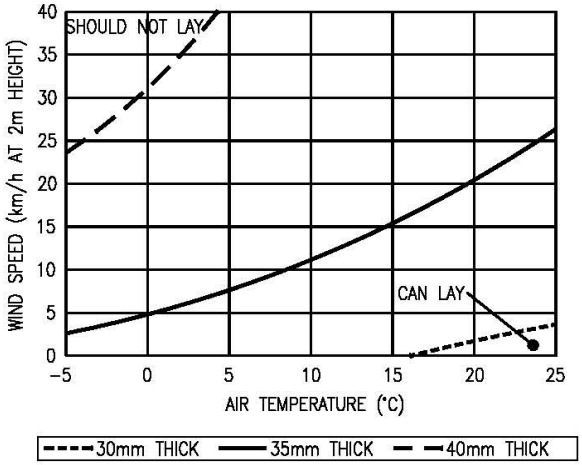


Figure C.2 – Acceptable weather conditions for laying SMA with 70/100 bitumen

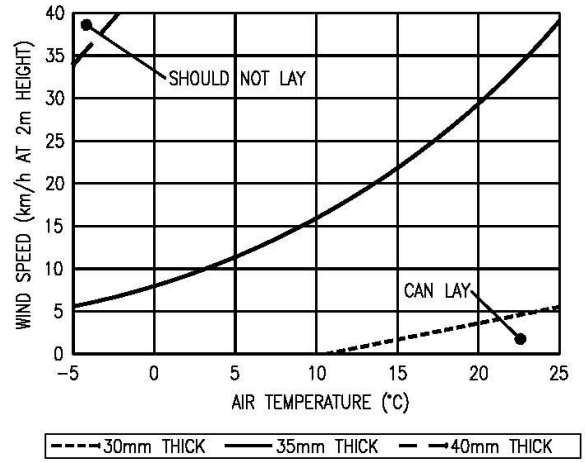


Figure C.3 – Acceptable weather conditions for laying SMA with 100/150 bitumen

(NOTE 2. The descriptions “Should not lay” and “Can lay” apply to above and below the lines for the 35 mm thick layers, respectively. The lines for the 30 mm thick layers are not sufficiently high and some of those for the 40 mm thick layers are not sufficiently low to accommodate doing the same for them.)

(NOTE 3. The acceptable conditions are developed assuming 6 min is required for compaction. If adequate compaction can routinely achieved in less time, these curves can be move up whereas, if more time is needed for any reason, they should be moved down.)

(NOTE 4. The lines for 30 mm thick layers are sufficiently close to the bottom right hand corner of the graphs to indicate that they can only be laid on still, warm days unless the time required for compaction can be reduced from 6 min.)

Appendix Y – Guidance Notes on Quality Systems for Project Managers

Y.1 INTRODUCTION

These Guidance Notes are intended to assist Project Managers in assessing Suppliers' Quality Assurance (QA) systems for the supply of component and mixed materials as required by Clause 2.4. In particular, guidance is given on:

- how to appraise and evaluate different Quality Systems offered by Suppliers when tendering for jobs (Clauses Y.5 and Y.6); and
- how to monitor work undertaken (Clause Y.7).

Separate clauses are devoted to each aspect.

Y.2 GENERAL

Y.2.1 These Guidance Notes are not intended to replace the BS EN ISO 9000 series and associated documentation.

Y.2.2 The generic term "Client" or "Purchaser" in these Guidance Notes is to include the person or organisation that is acting for, or on behalf of, the Property Manager or the Project Sponsor in the role of either a Project Manager.

Y.2.3 The generic term "Supplier" is used to cover any person or organisation that has, or is tendering for, a Contract with the Client to supply a product or service, and includes those traditionally referred to as the (main) Contractor.

Y.2.4 Products which are specified by means of a Harmonised European Standard under the Construction Products Directive are subject to CE marking. It is not permitted to require additional quality assurance or testing requirements over and above those required for Attestation of Conformity within the European Standard. The CE mark certificate should be taken as sufficient evidence of product conformity.

Y.3 QUALITY SYSTEMS

Y.3.1 It is now the accepted practice that all suppliers of goods and services should:

- install and maintain a Quality Management System; and
- become registered to a United Kingdom Accreditation Service (UKAS) accredited third party certification scheme as a Supplier of assessed capability.

Y.3.2 It is general practice that, once a Quality Management Scheme has been set up within an organisation, application for registration to a second or third party certification scheme will be made.

Y.3.3 Second party assessment is carried out by the purchasing organisation; this is very expensive because the resource requirements for systematic and continuous auditing and the management of an assessment scheme are extremely high. Consequently, this form of registration is now in decline and organisations which previously carried out second party assessment, such as British Telecom, British Gas, what used to be the National Coal Board and the MoD, are beginning to insist that their suppliers obtain third party assessment and, hence, pay the costs of quality assurance.

Y.3.4 Certification of a Supplier's Quality Management System by a third party should provide the Purchaser with the confidence that the Supplier is:

- operating and maintaining a fully documented Quality Management System that addresses consistent requirements; and
- operating within the scope of registration.

This avoids the need for the Purchaser to undertake his own structured regime of second party assessments to ascertain the adequacy and focus of the Supplier's Quality Management Systems.

Y.3.5 However, this does not absolve the Project Manager of his responsibilities on behalf of the Client to ensure that the Quality System of the Supplier addresses all the requirements and needs. This is because the Quality Standards are interpreted differently by individual organisations.

Y.3.6 In principal, the more independent the assessment and audit regime, the more confident the Purchaser can be as to the value of a Supplier's

Quality Management System. Once registered under a certifying body's scheme, there is still a need to audit, by both the Supplier and the third party certification body, that procedures and standards are being maintained.

Y.3.7 Assessments and audits can be carried out by:

- the Supplier's management – Under his own audit and monitoring regime;
- the Client (Project Manager) – Second party assessment scheme; or
- an independent body – Third party assessment scheme.

Y.4 PROCESSES COVERED UNDER THE QUALITY SYSTEM

Y.4.1 For a Quality Management System to be effective, it must cover all the operations and processes that are relevant to the business conducted by the Supplier.

Y.4.2 Dependent upon the type of work being tendered for, but as a minimum for the purpose of this Standard, the following areas should normally be addressed:

- procurement, inspection and safe storage of constituent materials;
- training of plant operatives;
- setting up on-site mixing plants and the mixing of asphalt materials;
- off-site supply and mixing of asphalt materials;
- storage and transportation of asphalt materials prior to use/despatch;
- laying and compaction of asphalt materials;
- inspection and test regimes and records at appropriate stages;
- sub-contractor/supplier assessment and control;
- calibration of equipment; and
- statistical techniques to be used for trend analysis, statistical process control and inspection.

Y.4.3 Quality Management Systems should include provisions for planned and systematic audits, inspections and tests by participating organisations. The Project Manager has the responsibility to evaluate and audit the system being operated by the Supplier to ensure adequacy. This should include checking records to substantiate that the procedures are being followed and that the Supplier has evidence that the materials and works are conforming to the specified standard.

Y.4.4 A Quality Plan in accordance with Defence Standard 05-67 should be stipulated in the Contract as a deliverable, but may be included in the *Invitation to Tender* if required. The activities described within the Quality Plan shall be stated unambiguously and concisely so that their intent is clear and that, upon implementation, they can be conducted, assessed, audited, demonstrated, measured or verified.

Y.4.5 The Quality Plan must state or contain definitions as to the levels of quality assurance and control to be applied throughout the Contract, which should include:

- traceability of materials;
- frequency and stages of inspections and tests;
- process controls; and
- records (including the retention periods and reviews).

Y.4.6 As quality standards are not extensively defined in relation to the process control, it is the responsibility of the Project Manager to ensure that all processes and methods proposed in Quality Plans are clearly defined and understood with regard to how the Supplier will deal with these aspects of the operation, and that all anomalies, shortfalls, errors and omissions are documented and resolved.

Y.5 ASSESSMENT OF QUALITY MANAGEMENT SYSTEMS

Y.5.1 The assessment of Quality Management Systems is a logical and progressive multi-stage process that encompasses good management precepts.

Y.5.2 A list and records should be maintained of acceptable suppliers and only suppliers on this list should be chosen. Therefore, any solicited or unsolicited suppliers should, as the first stage in the selection process, be required to complete a supplier questionnaire and must, as a minimum, include the following elements:

- verification/proof that the Supplier's Quality Management System is registered by a Certification Body accredited by NACCB;
- that the registration certificate is current;
- that the offices/sites from which the works or services are to be provided are covered by the registration certificate;
- that the scope of registration is appropriate for the works/services to be provided;
- experience or references of other users of the Supplier's services;

- the Supplier's past performance, covering experience and results with similar work/projects;
- financial information;
- insurance information; and
- Health and Safety information.

Y.5.3 If the responses to the above are satisfactory, an assessment of the Supplier's Quality System can be undertaken.

Y.5.4 The extent of the assessment can range from a visit to the Supplier's premises to overview the Quality Management System in operation on a similar project, to a full formal audit conducted against the BS EN ISO 9000 series and in accordance with BS EN 30011 by the Project Manager's own QA staff.

Y.5.5 It is the responsibility of the Project Manager to decide if an assessment is necessary. The decision for, and the scope of, such an assessment should be taken on the basis of the size, complexity, cost and length/duration of the Contract in conjunction with the level of confidence that can be established from other sources.

Y.6 ASPECTS TO ASSESS TENDER ACCEPTABILITY

Y.6.1 The requirements for the purchasing of goods and services should, as a minimum, be those set down in the BS EN ISO 9000 series. In order to ensure successful procurement, it is a prerequisite that the purchaser (the Project Manager) provides a clear definition of requirements in the form of contractual conditions and specifications. This aspect applies equally to Quality Management System requirements.

Y.6.2 All *Invitations to Tender* must contain elements outlining the quality requirements. These should be in the form of asking tenderers to provide:

- proof of registration to the pertinent part of the BS EN ISO 9000 series with an appropriate scope of registration for that particular Contract;
- method statements for all processes to be carried out;
- inspection/test schedules; and
- other information relevant to the Contract.

Y.6.3 When the Supplier returns a tender, his submission must be scrutinised to assess whether his Quality Management System covers all the areas that are relevant to the processes necessary for him to carry out in order that the work is to the required standard. Where only part of the required elements is covered in the Quality Management System, it may be acceptable for the tenderer to address these areas in his Quality Plan and to compile site-specific procedures for unique elements of the Contract.

Y.6.4 The returned tenders must provide precise details against the information requested in the *Invitation to Tender*, which is to include the following:

- the Quality System that will be enforced throughout the duration of the Contract;
- the method and procedures to be used to ensure the positive identification and issue status of specifications, drawings, inspection instructions and other data including the requirements for the approval of operational procedures, equipment, staff, operative training and outputs;
- the method and procedures to be used to ensure the conformance to the Specification by processes, inspection and test criteria; and
- methods for the procurement of raw materials, services, etc.

Y.6.5 It is the responsibility of the Project Manager to select those suppliers that they consider will provide the level of confidence that they require to meet the Specification and fulfil their obligations under the Contract.

Y.6.6 Information, in the form of Inspection Records, Test Certificates and Certificates of Conformity, from the Supplier will not normally be supplied automatically unless particularly requested or made a contractual requirement. To make sure that the Supplier understands these requirements, a Quality Plan can be required as part of the tender response. The Quality Plan must be evaluated as part of the tender selection process.

Y.6.7 Where the Supplier proposes that some of the work is carried out by sub-contractors, it does not absolve the Supplier of any of his responsibilities to ensure that the work is carried out to the contracted specification and quality.

Y.6.8 The Supplier is to ensure that, where sub-contractors have their own Quality Management System, it is found by scrutiny to be acceptable and they work to it. Where a sub-contractor does not have his own Quality Management System, the Supplier is to extend his own to include the sub-contractor. The Project Manager has a responsibility to audit both the Supplier and any sub-contractors to ensure compliance to the tender proposal.

Y.7 MONITORING THE QUALITY MANAGEMENT SYSTEM AND PROCESSES

Y.7.1 Whilst the Supplier may have registration to the BS EN ISO 9000 series, it does not necessarily mean that his system is fully focused on the specific requirements of the Contract, nor does any second party scheme run by another purchaser. Monitoring of the system should take place irrespective of whether the Supplier has, or has not, achieved registration.

Y.7.2 The Supplier should have procedures in place for the auditing, monitoring, recording and rectifying of all his activities. The Project Manager should ensure, by conducting surveillance audits of the Supplier's system, that:

- these are being carried out;
- the system is effective; and
- the system is focused on the Contract requirements and deliverables.

Y.7.3 Within the Contract, there are requirements for the Supplier to carry out tests on the materials, etc. The Supplier may not have his own test laboratory, in which case he will send samples out to a test house. Any test laboratory, whether part of the Supplier's organisation or an independent test house, conducting the tests for initial approval of materials and design of mixtures should be a United Kingdom Accreditation System (UKAS) accredited test house with an appropriate test schedule. Site laboratories used to carry out routine tests on bulk supplies and mixtures throughout plant mixing shall be either UKAS accredited or, subject to the Project Manager's approval, work to a Quality Assurance scheme.

Y.7.4 Where non-compliances are found, whether within the system being operated or the goods or services provided, they can be either random instances when the value is outside the specified range or an indication of a trend. If the running mean of the last, say, twenty results has remained reasonably consistent with a standard deviation that also has not fluctuated, then it is likely to be a random instance. Preferably, the running means and standard deviations should be monitored to allow corrective action before non-compliances occur. All actions taken to deal with non-compliances are to be documented.

Y.7.5 Rates of sampling and testing must be appropriate to the Contract and stated clearly in the Quality Plan. Where rates are stipulated in the Contract (see Section 8), these will take preference.

Y.7.6 The procedures for sampling and testing asphalt materials are to be in accordance with the appropriate parts of the latest editions of relevant British Standards, and also with the latest edition of the appropriate Appendices to this Standard. All samples and testing should be carried out by suitably trained personnel. The results are to be supported by valid Test or Sample Certificates.

Y.7.7 The use of a Quality System should minimise the need for the Project Manager to carry out his own tests. Therefore, they can:

- do nothing because the Supplier is carrying out sufficient inspections and tests, and assessing the results and implications;
- assess the inspection and test results for the material provided for the Contract to ensure that checks are being made and that the results indicate compliance to the Contract and Quality Plan is being achieved; or
- conduct a separate inspection and test regime of his own to check for compliance.

Y.8 RECORDS

Y.8.1 The training records of all operatives, sampling and testing personnel are to be maintained by the Supplier and are to be made available for inspection.

Y.8.2 The results of all inspections, tests, etc. for the Contract should be obtained and retained for record purposes. All documentation (including work-sheets, Inspection and Test Certificates and Certificates of Conformity) that are relevant to the Contract should be:

- available at the place of work (usually the plant or depot) for inspection by the Project Manager for the duration of the Contract; and
- handed over to the Project Manager on completion of the Contract.

Appendix Z – Guidance Notes on the Preparation of Job Specifications

Z.1 RESISTANCE TO FREEZING AND THAWING OF AGGREGATES

For small works, the magnesium sulfate test on all fractions can be omitted provided there is local evidence that the aggregate has adequate resistance to freezing and thawing. In such cases, the standard BS EN 1367-2 magnesium sulfate test conducted on the 10/14 mm size fraction may be considered satisfactory and it is unnecessary to require testing in accordance with Appendix A.

Z.2 PSV CATEGORY FOR SURFACE COURSES

Z.2.1 The requirement for the resistance to polishing of coarse aggregate on runway surface courses should normally be Category PSV_{50}. For high frequency traffic, a requirement for PSV of Category $PSV_{\text{declared 55}}$ should be set.

Z.2.2 The requirement for the resistance to polishing of coarse aggregate on taxiway surface courses should be Category PSV_{44}. However, for low frequency traffic, the category PSV_{NR} may be used except for fast exit taxiways.

Z.2.3 The frequency of trafficking is as defined in "*A guide to airfield pavement design and evaluation*" (Property Services Agency, 1989) but with the overriding requirements as follows:

Low frequency	Maximum of 50 movements per week by aircraft in the critical tyre pressure range; and
Medium frequency	Maximum of 500 movements per week by aircraft in the critical tyre pressure range.
High frequency	Greater than 500 movements per week by aircraft in the critical tyre pressure range.

Z.3 RESISTANCE TO FUEL

Z.3.1 All asphalt used on airfields for the surface course will need to have some resistance to the degradation caused by fuel, but locations where there is greater potential for fuel spillages, such as where aircraft are refuelled or maintained, that fuel resistance needs be enhanced. However, the type of aircraft, nature of operations and frequency of usage can vary considerably and these factors can influence the degree of resistance to fuel required.

Z.3.2 All properly designed and compacted asphalt should have a degree of resistance to fuel. Simple mixture design procedures and workmanship techniques can be used in order to minimise the sensitive to fuel, including:

- using proprietary polymer-modified binders that have been developed to enhance fuel resistance;
- reducing the permeability of mixture by making the grading finer; and
- providing greater assurance that full compaction is routinely achieved.

If appropriate, the Project Manager should seek guidance from the Construction Support Team, DE about the suitability of a contractor's proposal.

Z.4 REGULARITY FOR TAKING CORE SAMPLES AND/OR MEASURING SURFACE REGULARITY

The regularity for taking cores for monitoring should be a minimum of two every 1000 m². The regularity for measuring surface regularity should be a minimum of twenty every 1000 m². For small works, the regularity may have to be increased in order to obtain sufficient results to make an assessment on.

Z.5 PAVING MACHINES INCORPORATING EQUIPMENT TO APPLY TACK OR BOND COAT

The Project Manager should seek guidance from the Construction Support Team, DE. In the absence of more definitive information, approval would need to be subject to a laying trial and laboratory tests to demonstrate good adhesion, that the tack or bond coat had broken and that moisture had not been trapped.

Z.6 TEMPORARY RAMPS

Z.6.1 Phased working to allow aircraft operations to continue, either throughout or at intervals during the construction period (e.g. night working and daytime flying) may necessitate the provision of temporary ramps. Guidance is provided at Appendix 3A of CAP 168, *Licensing of Aerodromes* (Civil Aviation Authority). Clause 6.20 may need to be modified or augmented for specific job specifications and must be subject to prior agreement with the Aerodrome Authority/Station staff.

Z.6.2 The choice of whether to cover over or ramp around manholes and aviation ground lighting fixtures will depend upon, respectively:

- the services located in the manhole and the importance of maintaining immediate access to them; and
- the needs of the Aerodrome to maintain all ground lighting fixtures operational.

Agreement should be sought with the Aerodrome Authority/Station staff.

Z.6.3 Typical values that can be used in sub-Clauses 6.20.4 to 6.20.6 subject to agreement with the Aerodrome Authority/Station staff are as given in Table Z.1.

Z.7 TEMPERATURE OF SURFACING

In assessing the temperature of the freshly laid surfacing, consideration should be given to the likelihood of the temperature at depth being greater than that at the surface. If the temperature is required to be taken, a hole should be drilled 40 mm deep, a measurement device with suitable accuracy (± 1°C) inserted and the hole filled with glycerine. The temperature should be determined after the reading has stabilised whilst at different depths.

Z.8 METEOROLOGICAL DATA

In deciding whether to offer meteorological data about the site, the ease of availability of the data and the possible usefulness of the data (in terms of the expected season when the work is to be carried out and the size of the works) need to be considered.

TABLE Z.1 TYPICAL LIMITS FOR TEMPORARY RAMPS

	Sub-Clause 6.20.4	Sub-Clause 6.20.5	Sub-Clause 6.20.6
Distance from runway centre line: Limit of applicability of sub-Clause Minimum for transverse ramps	 22.5 m 10.0 m	 22.5 m †	 n/a n/a
Maximum longitudinal gradient Maximum transverse gradient	1.0 % * 2.0 %	2.0 % * 2.5 %	2.0 % * 2.5 %
Minimum spacing of ramps Minimum thickness of ramp material Maximum depth of ramp	110 m 40 mm 75 mm	† 40 mm †	n/a n/a n/a

* If the existing longitudinal gradient is at, or close to, the maximum permissible in the standard criterion then, depending on the direction of working, it may be necessary to obtain dispensation from the Aerodrome Authority/Station staff to increase this value for temporary ramps.

† Not normally applicable, but otherwise to be agreed with the Aerodrome Authority/Station staff on a job specific basis.

References

FS 06	1994	Functional Standard 06, Guide to Maintenance of Airfield Pavements
SPEC 12	2007	Specification 12, Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields
SPEC 13	2007	Specification 13, Marshall Asphalt for Airfields
SPEC 33	2005	Specification 33, Pavement Quality Concrete for Airfields
SPEC 35	2005	Specification 35, Concrete Block Paving for Airfields
SPEC 40	2007	Specification 40, Porous Friction Course for Airfields
SPEC 49	2007	Specification 49, Stone Mastic Asphalt for Airfields
DMG 27	2005	Design and Maintenance Guide 27, A guide to Airfield Pavement Design and Evaluation
DMG 33	2005	Design and Maintenance Guide 33, Reflection Cracking on Airfield Pavements – a design guide
JSB 554	2004	Military Aviation, Aerodrome Standards and Criteria

British Standards Institution

BS 434			Bitumen road emulsions (anionic and cationic)
	Part 2	1984	Code of practice for use of bitumen road emulsions
BS 2000			Methods of test for petroleum and its products
	Part 49	2000	Bitumen and bituminous binders – Determination of needle penetration
BS 3136			Specification for cold emulsion spraying machines for roads
	Part 2	1972	Metric units
BS 594987		2007	Asphalt for roads and other paved areas – Specification for transport, laying and compaction and design protocols
BS EN 197			Cement
	Part 1	2000	Composition, specifications and conformity criteria for common cements
BS EN 459			Building lime
	Part 1	2001	Definitions, specifications and conformity criteria
BS EN 933			Tests for geometrical properties of aggregates
	Part 1	1997	Determination of particle size distribution – Sieving method
	Part 2	1996	Determination of particle size – Test sieves, nominal size of apertures
	Part 3	1997	Determination of particle shape – Flakiness index
	Part 9	1999	Assessment of fines – Methylene blue test
BS EN 1097			Test for mechanical and physical properties of aggregates
	Part 2	1998	Methods for the determination of resistance to fragmentation
	Part 5	1999	Methods for the determination of water content by drying in a ventilated oven
	Part 6	2000	Determination of particle density and water absorption
	Part 8	2000	Determination of the polished stone value
BS EN 1367			Test for thermal and weathering properties of aggregates
	Part 2	1998	Magnesium sulfate test
BS EN 1744			Tests for chemical properties of aggregates
	Part 1	1998	Chemical analysis
BS EN 12591		2000	Bitumen and bituminous binders – Specifications for paving-grade bitumens
BS EN 12620		2002	Aggregates for concrete

BS EN 12697			Bituminous mixtures – Test methods
	Part 1	2000	Soluble binder content
	Part 2	2002	Determination of particle size distribution
	Part 3	2000	Bitumen recovery: rotary evaporator
	Part 4	2000	Bitumen recovery: fractionating column
	Part 5	2002	Determination of the maximum density
	Part 6	2003	Bulk density, measurement
	Part 8	2003	Air voids content
	Part 11	2005	Affinity between aggregates and binder
	Part 12	2003	Determination of the water sensitivity of bituminous specimens
	Part 13	2000	Temperature measurement
	Part 17	2004	Particle loss of porous asphalt specimen
	Part 18	2004	Binder drainage
	Part 22	2003	Wheel tracking
	Part 27	2001	Sampling
	Part 28	2001	Preparation of samples for determining binder content, water content and grading
	Part 36	2003	Thickness of a bituminous pavement
BS EN 13036			Road & Airfield Characteristics – Test methods
	Part 1	2002	Measurement of pavement macro-texture depth using a volumetric patch technique
	Part 7	2003	Method of measuring surface irregularities: The straightedge test
BS EN 13043		2002	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
BS EN 13108			Bituminous mixtures – Material specifications
	Part 1	2006	Asphalt concrete
	Part 5	2006	Stone mastic asphalt
BS EN 13808		2005	Bitumen and bituminous binders – Framework for specifying cationic bitumen emulsions
BS EN 30011			Guidelines for auditing quality work
	Part 1	1993	Auditing
	Part 2	1993	Qualification criteria for quality systems auditors
	Part 3	1993	Management of audit programmes
BS EN ISO 9000		2000	Quality management and quality assurance standards
PD 6692		2006	Asphalt – Guidance on the use of BS EN 12697 “Bituminous mixtures – Test methods for hot mix asphalt”

Her Majesty’s Stationery Office

DS 05-67		1980	Defence Standard 05-67, Guidance to Quality Assurance in Design

British Board of Agrément

HAPAS	SG3	2002	Guideline document for the assessment and certification of thin surfacing systems for highways

Civil Aviation Authority

CAP 168			Licensing of Aerodromes