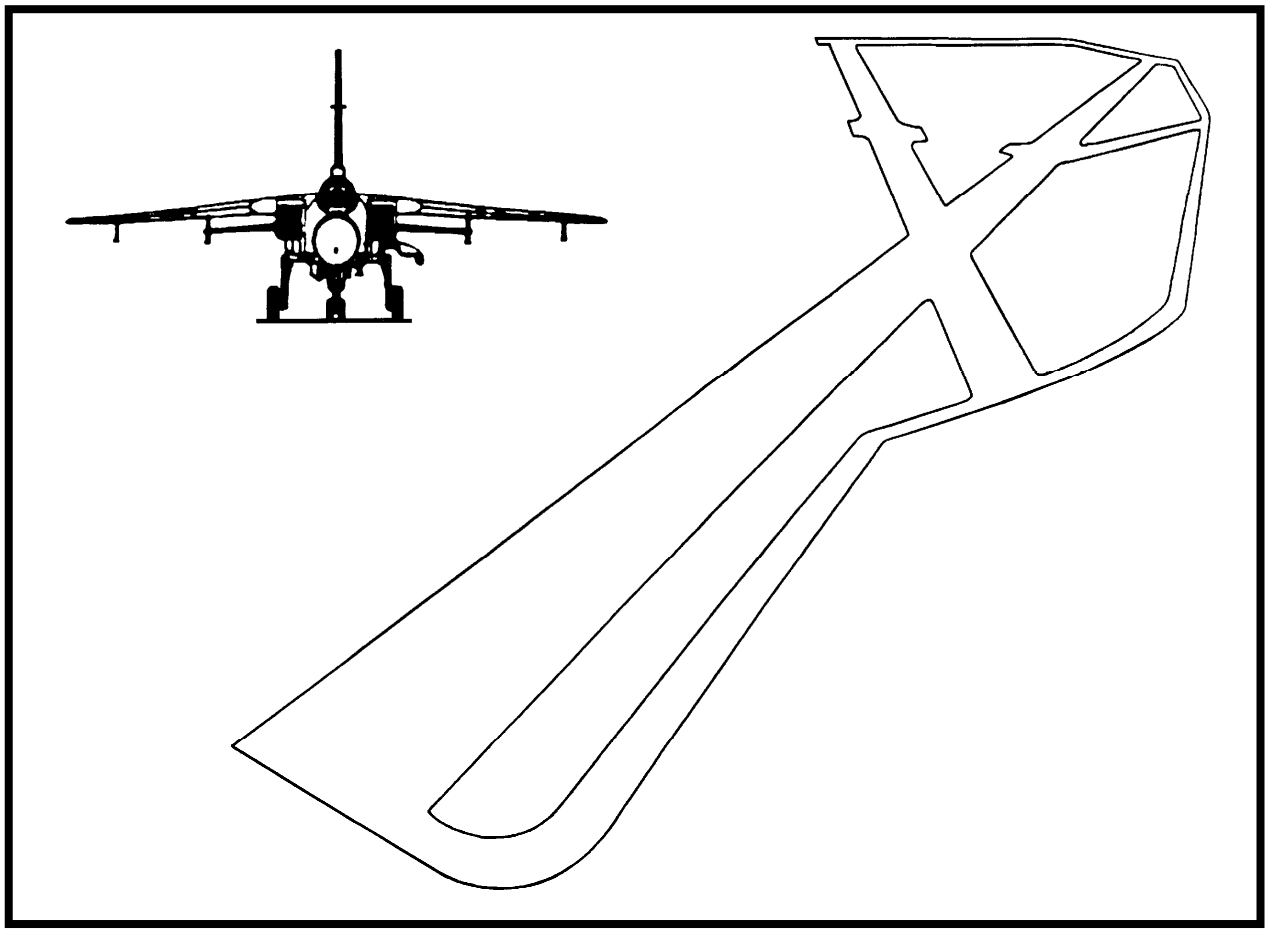
Specification 050



Recycled Bound Materials for Airfields

DEFENCE ESTATES
MINISTRY OF DEFENCE

Specification 050

Recycled Bound Materials for Airfields

December 2009

PROFESSIONAL & TECHNICAL SERVICES

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Ministry of Defence

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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. It has, in part, evolved from standard specifications previously produced by former Government Departments: Air Ministry Works Department, Ministry of Public Buildings and Works and the Property Services Agency.

Foreword

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

This Defence Estates Specification does not supersede any previous edition.

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
Professional and Technical Services
Defence Estates
Kingston Road
Sutton Coldfield
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Introduction to Recycling for Airfield Pavements

Background

MOD currently operates over 50 airfields in the UK. In general these were constructed prior to or during World War 2. Typically, the airfields can consist of concrete pavements onto which many bituminous layers have since been added in order to meet the increased loading requirements, to retain friction characteristics or to maintain integrity in order to avoid foreign object damage (FOD).

With the Rio Earth Summit in 1992 (UNCED, 1997) came the need to promote sustainable development to minimise damage to the environment.

Within airfield infrastructure, there is a substantial opportunity to further the objectives of sustainability and none more so than for pavement construction. This opportunity can contribute to a reduction in energy use and material consumption. For airfield refurbishment works, the traditional approach has been to provide new layers using imported virgin materials with excavated pavement materials transported offsite. The emphasis has now changed to one of reusing excavated materials.

The design of airfield pavements is covered by DMG 27 (DE, 2006). The guide includes the design methods for both flexible and rigid pavements.

Rigid pavements comprise concrete as the main structural layer and the layer distributes load through flexural strength. Rigid pavements for MOD airfields are normally unreinforced pavement quality concrete laid on dry lean concrete.

Flexible and flexible composite pavements usually contain both bound and unbound material and distribute load through the shear strength of the material. Typical materials used are Marshall asphalt in the surface course and binder courses overlying bound bituminous or cementitious layers on top of unbound aggregate.

Recycling for road pavements has been undertaken for some time and the body of knowledge has increased in the past few years. With this in mind, in 2004 DE commissioned a feasibility study through TRL to examine the use of recycling for airfield pavement works. A conclusion was that there was potential to use cold mix recycling for airfields based on the wide experience from trials with different cold mix recycling methods and designs used in road pavements.

Summary of TRL Findings

An initial study identified that recycled material has the potential to be used with appropriate validation in the following layers:

Rigid pavements:
- Recycled concrete with the same properties as Pavement Quality Concrete
- Cement stabilised bases and subbase

Flexible pavements:
- Hot mix recycled asphalt base
- Cold recycled base material
- In situ recycled surface courses (Repave/Remix)
- Cement stabilised bases and subbases

It was also found useful to categorise the types of recycling into the three categories of Layer Renewal, Layer Revision, and Layer Alteration. The text below gives further information on these categories and includes commentary based on recent DE trials and developments. The high loadings and the demanding operational requirements present the airfield pavement engineer with various technical challenges. In certain instances, the recycled material may best be used within the lower layers of the new pavement construction.

Layer Renewal

PQC can make use of recycled concrete aggregates obtained from pavements that have worn out due to fatigue and overloading over a long period; however, pavements subject to alkali-silica reaction should not be used. Existing concrete layers can be broken up and crushed to produce the recycled concrete aggregates. There are no limits to the maximum proportion of recycled concrete aggregate that may be used.

For hot mix asphalt, the process for the production using recycled aggregates is similar to the production of asphalt using virgin aggregates. The

use of reclaimed asphalt (RA) is usually limited to a proportion of total aggregate used. Reclaimed asphalt should have similar performance properties when used in a similar application to an asphalt containing only virgin materials.

Layer Revision

This makes use of aggregate from the pavement or stockpile and with additional binders produces a material having different properties to the original layer.

Bituminous Bound Recycled Materials

Cold recycling is one method used which was reported in the TRL Report TRL 611 (Merrill *et al.*, 2004). CRBM has now been the subject of site trials on MOD airfields.

RA is obtained from the planing of existing asphalt pavements. The aggregates and binder are mixed ex situ, thus permitting the crushing and screening of aggregates and more precise control of binder addition. An ex situ process can be set up preferably within the confines of a site. The mixture generally uses PFA, additional fines, and cement and foamed bitumen. A Quick Visco-Elastic (QVE) material is produced that provides early strength through aggregate interlock and use of cement. However, it is important not to overdose with cement because this would produce a material which is too stiff and could be susceptible to reflection cracking.

Further background information on the application of CRBM for use on roads can, for example, be obtained from the Waste and Resources Action Programme (WRAP) AggRegain case study of its use (AggRegain, 2008) on the A38 ex situ recycling of a trunk road in South Devon in 2005/6.

At RAF Valley, DE has also trialled in situ recycling using the “Repave” method. This trial has been associated with an overlay of traditional Marshall asphalt. This method has also been successfully used for layer renewal on roads for many years.

Hydraulically bound recycled materials

TRL 611 covers experience of in situ recycling using both slow and quick curing hydraulically bound materials. There are potential benefits with their use in that the slow curing mixes with lime continue to gain in strength after one year.

Guidance is also provided by the Concrete Society (Kennedy, 2006) in respect of recycled aggregate such as hydraulic slags.

Series 800 of the Highways Agency Specification for Highway Works provides further requirements for cement and other hydraulically bound mixtures.

Professional and Technical Services, DE should be consulted on the proposed use of these mixtures for airfield work. The Highways Agency Specification Series 900 (HA, 2009) is also available and provides additional information in Clause 926 *In situ recycling: the Repave process*; and Clause 948 *Ex situ cold recycled bound material (CRBM).*

Layer Alteration

Crack and seat

Crack and seat makes use of deteriorated pavements in a manner which can still contribute to the overall redesign of a pavement. The underlying concrete slab construction is changed into a strong cement bound layer. This technique is covered by DE DMG 21 “The Use of Crack and Seat Treatment in the Refurbishment of Airfield Pavements”.

Fine full depth fine cracks are induced by the dropping of a guillotine weight at defined spacings prior to overlay with bituminous material to meet the design requirements. MOD has many existing pavements made up of a concrete layer overlaid with bituminous materials. These bituminous layers have previously provided additional strength and have also deferred the onset of reflection cracking above the joints in the concrete pavement.

DE takes the view that these composite pavements can be refurbished through use of crack and seat in conjunction with CRBM and/or asphalt. The RA for CRBM can be obtained from existing layers that are recycled ex situ and then laid as a base layer within the new pavement.

Rubblisation

Rubblisation is a process by which an existing concrete pavement in poor condition can be turned into a cement bound layer to underlie a new PQC pavement.

Summary of TRL work

In general, the major differences between pavements for roads and airfields are the higher point loadings, higher tyre pressures and friction characteristics. An overriding requirement is the need to achieve a surface free for loose material which can cause FOD.

Because of this need to minimise FOD, it was risk assessed that recycled bound materials should initially be trialled on taxiways.

Construction trials using cold recycled bound materials (CRBM) were initially undertaken at RAF Scampton followed by a more extensive trial at RAF Marham in 2007. The methodology used is that based on the TRL Report TRL 611 (Merrill *et al*., 2004), now applied and adjusted for use on airfields.

At RAF Scampton, the limited trial area was at a crossover located at the end of a disused runway. This trial used a 60 to 70 mm thick CRBM base overlaid with 40 mm of Marshall Asphalt surface course. The area has been subjected to loadings from light aircraft, typically with wheel loads of 560 kg and tyre pressures of 0.6 MPa (87 psi).

At RAF Marham, the recycled area of taxiway was 8 m wide by 50 m long and spanned the centreline. The work involved excavation of approximately 200 mm of bituminous material down to the existing 6 m bay concrete slabs which, in turn, were on 220 mm lean mix. The layer of CRBM was 110 mm thick followed by 50 mm thick Heavy Duty Macadam (HDM) binder course and a 40 mm Stone Mastic Asphalt (SMA) surface course. After seven days, the area was trafficked by 100 passes of a jet fighter loaded to 24 000 kg with the rear wheels inflated to 2.31 MPa (335 psi). There was no discernable deformation of the surface. Further observation in December 2007 confirmed that, despite continued heavy traffic, no deformation had taken place. Furthermore, the material strength from cores taken in December 2007 confirmed that the CRBM met the design stiffness requirements.

Crack and seat was not used on the underlying concrete slab within the trials. This omission was mainly due to the short possession times. In order to abate the onset of reflection cracking, it is recommended that crack and seat be used for projects using CRBM over concrete slabs. For further information, see DE DMG 21 “The Use of Crack and Seat Treatment in the Refurbishment of Airfield Pavements”.

Summary

There is a developing body of knowledge for the use of recycling for airfield projects.

This document, DE Specification 050 “Recycled Bound Materials for Airfields”, has been produced following detailed site trials using CRBM. Every opportunity should be taken to include this and other recycling techniques within airfield projects. It is intended that this document will be expanded in future to include hydraulically bound, hotmix and other recycled materials and processes when further information becomes available.

Professional and Technical Services, DE is available for consultation during the development of airfield Project Briefs and at later stages in the project process.

Recycling reduces the pressure on natural reserves of primary aggregates, reduces the construction transport, energy and carbon dioxide emissions. For airfield pavements, it also has the potential to achieve better value for money.

Further Information

The Highways Agency includes many documents on recycling within their Design Manual for Roads and Bridges. HD 35/04 (HA *et al*, 2004) provides further information on recycling. Clauses 948 of Series 900 (HA, 2009) is also available and provides information on CRBM for roads; and Clause 926 provides information on Repave.

DE is also aware of many innovations taking place within the industry in order to reduce carbon footprint. This can be through greater use of recycled materials and/or more durable materials. DE should be consulted for airfield pavement works.

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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

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 Recycled Bound Materials is one of a series being produced by DE to lay down specification requirements for airfield pavement works. The following clauses are intended to set out the applications of Recycled Bound Materials 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 results 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, including during wet conditions.
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 COLD RECYCLED BOUND MATERIALS

1.3.1 Taxiways

Based on the MOD trials undertaken to date, it is recommended that taxiway projects make use of Cold Recycled Bound Materials (CRBM) within the lower layers. Use of an on site batching plant reduces the use of virgin aggregate and cuts the amount of traffic movement offsite. This reduction leads to cost savings and cuts in the volume of carbon dioxide when compared with traditional reconstruction methods. The majority of MOD World War 2 airfields are of composite construction and typically include a jointed concrete slab underlying bituminous material. Crack and seat of the underlying concrete pavement should normally be used in conjunction with CRBM. In some cases, a reduced width of taxiway consistent with the width requirements of JSP554 can release aggregate for use in a strengthened pavement. The Project Manager should discuss proposals for use of CRBM on taxiways with Professional and Technical Services, DE.

1.3.2 Main Length of Runways

CRBM may be used within the lower layers of a runway construction, however as detailed above the trials have been on taxiways. Risk management suggests that initially CRBM be used for runways with aircraft having light loadings and low tyre pressures. The Project Manager should discuss proposals for use of CRBM on runways with Professional and Technical Services, DE.

1.3.3 Runway Ends and Adjoining Aircraft Holding Areas

Service conditions can be severe in these areas where jet blast and fuel spillage are likely to be most damaging and aircraft carry out sharp turns. CRBM

may be used within the lower layers of a runway construction, The Project Manager should discuss proposals for use of CRBM on these areas with Professional and Technical Services , DE.

1.3.4 Parking and Service 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. The Project Manager should discuss proposals for use of CRBM on these areas with Professional and Technical Services, DE.

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

The Project Manager should discuss proposals for use of CRBM on these areas with Professional and Technical Services, DE.

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

The Project Manager should discuss proposals for use of CRBM on these areas with Professional and Technical Services, DE.

1.4 SPECIFICATION CLAUSES FOR COLD RECYCLED BOUND MATERIALS

Specification clauses are contained in Sections 2 to 7 and Appendix A for Quick Visco-Elastic (QVE) Cold Recycled Bound Materials (CRBM). Guidance Notes for the Project Manager on Quality Systems are given in Appendix Y and for the preparation of job specifications in Appendix Z.

(NOTE. Specification clauses for other classes of recycled cold materials may be added in the future.)

1.5 ADVICE FROM PROFESSIONAL AND TECHNICAL SERVICES , DE

Clause 1.3 provides general advice on the application of this Standard. However, having regard to the various design parameters affecting the choice of construction and specifications, including scope of work, aircraft type and frequency of usage, location of pavement on an airfield, design life, timescale constraints and existing pavement constructions, the guidance notes cannot be exhaustive. Further advice on a project/works specific basis can be obtained from Professional and Technical Services 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

2.2.1 Cold Recycled Bound Material (CRBM) shall be designed to achieve the specified level of the appropriate end performance properties.

2.2.2 CRBMs shall be specified, mixed, transported and laid to the requirements of the following 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
Plant & Workmanship	Section 5
Trials	Section 6
Summary of Tests	Section 7
Straightedge Test	Appendix A

2.3 USE OF COLD RECYCLED BOUND MATERIALS

2.3.1 CRBMs shall be used in the locations indicated on the project drawings.

2.3.2 When CRBM is being offered as a substitute for conventional hot mix material for inlay treatments where a significant portion of the existing pavement remains, the required depth shall be determined by reference to DMG 27. The design shall also be justified with appropriate references to design charts or with an analytical pavement design.

2.4 QUALITY ASSURANCE FOR THE SUPPLY OF ASPHALT MATERIALS

2.4.1 Component materials shall either be CE marked or shall be procured from a supplier with Quality Assurance accreditation to the BS EN ISO 9000 series. All operations in the batching of asphalt materials shall be carried out by a Contractor (or Supplier on his behalf) that has a Quality Management accreditation to the BS EN ISO 9000 series, incorporating "Sector Scheme 14, Production of Asphalt Mixes, 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, incorporating "Sector Scheme 14, 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 are 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 7 and provide the Project Manager with a written copy of the results in accordance with Clause 7.1.

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.

2.5 QUALITY PLAN

2.5.1 A quality plan (QP) for the production of the CRBM shall be agreed with the Project Manager prior to the commencement of works.

2.5.2 The QP shall contain the following elements:

- Sourcing of aggregate components.
- Storage of aggregate components, including any measures to control their moisture content.
- Processing of aggregate components.
- Declaration of constituents.
- Declaration of Job Standard Mixture.
- Process control of mixing.
- Laying process including forming of joints (transverse and longitudinal), and compaction process.
- Inspection and test schedules.
- Demonstration of performance properties.

3 Constituent Materials

3.1 SOURCING OF AGGREGATES

3.1.1 The quality plan shall contain details of all aggregates to be used in the CRBM. Aggregate may include:

- Asphalt material planed or excavated from airfield pavements or other paved area.
- Primary, secondary or recycled aggregate from other sources.
- Fillers from primary or secondary sources (e.g. pulverised fuel ash, PFA).

3.1.2 The processed aggregate, including added filler, shall not contain deleterious material that adversely affects the performance of the mixture.

(NOTE. The aggregate component should be of a quality generally suitable for use in asphalt or cement bound material. However, given the nature of the operation, which involves processing arisings from existing airfield pavements, some discretion should be applied. The emphasis should be on ensuring that deleterious materials, such as clay lumps and badly weathered aggregate, are excluded from the recycled material.)

3.2 PROCESSING OF AGGREGATE

The quality plan shall describe how, in particular, asphalt arisings are to be processed, crushed, screened and stocked to enable consistent production of the CRBM in line with the Job Standard mixture.

3.3 BINDERS AND OTHER CONSTITUENTS

3.3.1 Bitumen emulsion shall conform to BS EN 13808 and be used in accordance with BS 434-2.

3.3.2 Cement shall conform to BS EN 197-1 and be classified as CEM1.

3.3.3 Bitumen used for foaming shall conform to BS EN 12591 and shall be grade 100/150 or harder.

3.3.4 Granulated blast furnace slag (GBS) shall comply with BS EN 14227-2.

3.3.5 Ground granulated blast furnace slag (GGBS) shall comply with BS EN 14227-2.

3.3.6 Lime shall comply with BS EN 14227-11.

3.3.7 Pulverised fly ash (PFA) used as either as filler or pozzolan, shall comply with BS EN 14227-4.

3.3.8 Un-weathered 0/4 mm Basic Oxygen Slag (BOS) used in slow hydraulic material as an activator/accelerator to the GBS shall comply with BS 6463-102.

3.3.9 Other constituents, including setting and hardening agents, may be used to enhance the performance of the mixture, if approved by the Project Manager prior to the commencement of work.

3.3.10 Water shall not contain material that adversely affects the performance of the mixture.

4 Design and Composition

4.1 TYPE OF COLD RECYCLED BOUND MATERIAL

The CRBM shall be classified as Quick Visco-Elastic (QVE).

(NOTE. Types of CRBMs that can satisfy the material classification QVE are listed in Clause Z.1 of Appendix Z.)

4.2 JOB STANDARD MIXTURE

4.2.1 The composition of the job standard mixture shall be declared as follows:

- Source, origin and proportion of all aggregate constituents.
- Combined target grading, including mineral binders and tolerances.
- Source, origin and proportion of all binders.
- Target moisture content.

(NOTE 1. It is essential to undertake mix design evaluation in advance of works on site and everything that is reasonably practicable should be done to ensure that it can be undertaken, even for small projects. Additionally, there will not always be time for the full design procedure and, in particular, the curing stage to be carried out in advance of the works. Where this is the case, information from earlier works with similar material and the same process or accelerated curing regimes should be taken into consideration.)

(NOTE 2. The components used in the mix design stage should represent the materials available in the permanent works. In particular, any reclaimed asphalt planings should have been produced by the same process as will be used for the main works in order to ensure that a similar grading is produced. Where a representative component is unavailable, the contractor should use a replacement component of similar properties in the mix design stage.)

(NOTE 3. The laboratory prepared aggregate should be thoroughly mixed with the measured proportions of the binder and other constituents. The constituents should be the same as those used in the finished works and should be obtained using a method similar to that proposed for the main works.)

4.2.2 The grading, including maximum tolerances, of the job standard mixture (the aggregate together with the other constituents including binders) shall comply with one of the zones in Table 4.1.

TABLE 4.1 PARTICLE SIZE DISTRIBUTION OF MIXTURE FOR COLD RECYCLING

Sieve (mm)	Proportion by mass passing (%)		
	Zone A	Zone B	Zone C
40	100	100	100
31,5	100	100	86 – 100
20	100	100	75 – 100
14	85 – 100	85 – 100	52 – 100
10	68 – 100	68 – 100	44 – 100
4	38 – 74	38 – 94	26 – 74
2	26 – 58	26 – 84	18 – 58
0.5	13 – 38	13 – 64	8 – 38
0.250	9 – 28	9 – 51	5 – 28
0.063	5 – 21	5 – 38	3 – 21

(NOTE. When determining the grading of materials containing asphalt planings, samples should be dried to constant mass at 40 ºC and care should be taken not to break down the aggregated particles of asphalt unnecessarily.)

4.2.3 Zone B or C graded material shall only be used when the results of a full mixture design showing compliance with the required 28 day performance properties are available or when evidence can be provided of satisfactory achievement of the performance requirements on an earlier contract with a similar composition.

4.2.4 The binder addition shall include a minimum of 1 % cement and 3 % bitumen, the latter as the residual from the foamed bitumen or bitumen emulsion. PFA may be added as filler and lime may be added for 'breaking' and adhesion purposes.

(NOTE. Lime, if PFA included as filler, will contribute to the strength.)

4.3 MIXTURE DESIGN VALIDATION

4.3.1 The mixture design validation shall be carried out on aggregates and binders representative of those to be used on the works. The validation shall be carried out on CRBM mixed either in the laboratory or on a pilot basis on a full scale plant.

4.3.2 The target mixture shall comply with Clauses 3.3 and 4.2.

4.3.3 A preliminary exercise shall be undertaken to establish a target grading and suitable moisture content.

4.3.4 Representative samples of the mixture shall be taken from which 150 mm diameter cylindrical specimens shall be produced in accordance with Clause 7.2. The height of these specimens shall be appropriate to the mechanical performance test declared in the quality plan. The time between mixing and specimen production shall be kept to a minimum but within the setting times given in Table 7.2.

4.3.5 The density of each specimen shall be measured in accordance with sub-Clause 7.4.1.

4.3.6 The cylindrical specimens shall be conditioned and tested in accordance with Clauses 7.3.

4.3.7 The Indirect Tensile Stiffness Modulus for the mix shall be determined in accordance with Clause 7.5. The mean predicted 360 day value shall comply with the limits in Table 7.3.

4.3.8 The Moisture Sensitivity shall be determined in accordance with Clause 7.6. The soaked specimens shall not show any signs of cracking or swelling and the ratio of the mean Indirect Tensile Stiffness Modulus of the soaked specimens to the mean Indirect Tensile Stiffness Modulus of the unsoaked specimens at the same age shall comply with the limit in Table 7.4.

4.3.9 The performance properties of the conditioned specimens shall be declared. The results shall be considered as indicative only; the end product compliance criteria shall apply only to the specimens prepared during the execution of the works.

4.4 JOB STANDARD MIX

The job standard mix shall be determined for the pavement. If separate mix designs are undertaken for each section of pavement then each will have a job standard mix. The refusal density value of the job standard mix (or mixes) shall be declared. This will then be used under **5.4.4** Compaction .

(NOTE. Separate mix designs shall be undertaken for each section of pavement from which the asphalt being planed is known to have been constructed using a different mix design or using different aggregate sources e.g. due to variation in source of planings).

5 Plant and Workmanship

5.1 PROCESS CONTROL

5.1.1 Production of the CRBM shall be subject to process control detailed in the QP and meeting the requirements of this clause.

5.1.2 There shall be a description of the plant and the production process, preferably including a flow diagram, detailing how material is to be produced in accordance with this specification.

5.1.3 Calibration schedules for all parts of the plant involved in determining mix consistency shall be provided. These shall be accompanied by calibration records.

5.1.4 Details of transportation shall be provided. These shall include the location of the mixing plant and the expected average time between mixing and laying. The Contractor shall record the duration between mixing and the completion of compaction at the site during the execution of the works.

5.1.5 The measures to maintain quality of construction at joints shall be described. In addition, measures to deal with hard edges and obstructions shall be included.

5.1.6 Measures shall be taken to avoid problems caused by extreme weather. In particular, production shall not proceed if the feedstock is frozen or excessively wet.

5.2 MIXING

The mixing plant shall be located close enough to the site to enable placing of the material within the appropriate setting time.

5.3 LAYING

5.3.1 A written procedure for the laying of the CRBM shall be provided.

5.3.2 The plant used for placing processed material shall be capable of laying the material without significant segregation, evenly and to the required thickness across at least one lane width.

5.3.3 A method for the making of longitudinal and transverse joints, appropriate to the type of CRBM being laid, shall be provided.

5.4 COMPACTION

5.4.1 The plant used for stabilisation shall be capable of achieving controlled batching by weight or volume. The plant shall have hoppers and tanks appropriate for the component materials to be mixed.

5.4.2 The compaction of each layer shall be carried out to a defined rolling pattern until both the required in situ density is achieved and the recycled layer provides a stable and dense tight surface. The stability of the layer after compaction shall be deemed adequate if the finished surface does not shove, rut or exhibit transverse cracking under the load of subsequent traffic. Open edges shall be protected from traffic.

(NOTE. Where a PTR is used to compact the cold recycled layer, it can be also be used to assess the stability of the layer. Rutting can be measured after 8 passes of a PTR with a minimum wheel load of 3 tonnes.)

5.4.3 After trimming and final compaction of the recycled layer, the in situ bulk density shall be measured using a nuclear density gauge in direct transmission mode, or other suitable calibrated device, to a depth within 25 mm of the layer thickness. The meter readings shall be periodically verified.

5.4.4 The in situ bulk density values obtained shall be compared with the refusal density value of the Job Standard Mix. The average in situ bulk density of each set of five values shall be at least 95 % of the refusal density, with no individual in situ density value being less than 93 % of the respective refusal density.

5.5 BOND COATS AND SEALING

5.5.1 A bond coat shall be applied to the substrate and all vertical edges prior to the laying of the CRBM. Bond coats shall have a British Board of Agrément HAPAS Roads and Bridges Certificate.

(NOTE. A tack coat or bond coat is required to improve the bond between layers and all vertical edges to reduce the possibility of FOD and provide overall durability of the structure.)

5.5.2 Unless surfaced immediately or kept moist by light water spraying, the surface shall be sealed using a sprayed membrane of bitumen emulsion to category C 40 B or C 40 P in accordance with BS EN 13808. The bitumen emulsion shall be sprayed at a rate not less than 0.5 l/m^2 to achieve a uniform and continuous seal to the surface of the layer.

5.5.3 The surface of the CRBM shall not be opened to traffic, other than construction traffic, prior to it being overlaid. The amount of construction traffic shall be restricted to the minimum practical.

(NOTE. If there are operational needs that require the works to be open to traffic (other than construction) before it has been overlaid, advice should be sought in good time from DE about possible measures necessary in order to ensure adequate skid resistance.)

5.6 OVERLAYING CRBM

The time between laying CRBM and overlaying it with a binder course shall not be unnecessarily extended.

5.7 SURFACE ACCURACY

5.7.1 The surface accuracy of the 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 A. The surface accuracy of the CRBM layer in a binder course layer shall not exceed 10 mm anywhere in any direction, other than across the crown of a camber or across a drainage channel.

5.7.2 Twenty surface accuracy tests shall be made for every 1000 m^3 laid, of which at least half shall be across lane joints. The location of all tests shall be selected by the Project Manager or his representative and shall be carried out in his presence. The Contractor shall mark with white paint all areas which fail to comply with the specified requirement.

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.

6 Trials

6.1 TRAFFICKING TRIAL

(NOTE. The Trafficking Trial is a trial on the surface of CRBM prior to it being overlaid.)

6.1.1 A trafficking trial shall be undertaken to demonstrate that the CRBM is not prone to excessive rutting.

(NOTE 1. As a general rule, QVE mixtures, which include cement, are less likely to be susceptible to rutting, as are other materials with a stable, angular, granular aggregate content. Particular care should be taken if there is a high proportion of rounded gravel in the mixture.)

(NOTE 2. It is required that the foundation meets the specified requirements in the Permanent Works.)

6.1.2 A trial area shall be laid of not less than 100 m^2 using the materials and plant to be used for the main works and on a foundation typical of that in the main works. The trial area shall be left to cure for * hours after the application of a sprayed membrane to Sub-Clause 5.5.2.

(NOTE. Project Manager to select the value for specific job specification; advice given in Clause Z.2 of Appendix Z.)

6.1.3 The trial area shall then be subjected to controlled trafficking by a heavy goods vehicle with an axle configuration and loading typical of that to be encountered in the construction phase. The number of passes shall equate to the total expected amount of traffic to be carried during construction, with a default value equivalent to 100 standard axles.

6.1.4 The measured rutting in the trafficking trial shall be less than 3* mm after the number of passes equivalent to the total traffic expected during construction. The material shall be removed if the rutting is greater than 3*mm.

(NOTE. * Project Manager can select a different value for specific job specification if more appropriate; advice given in Clause Z.3 of Appendix Z.)

6.1.5 Subsequent monitoring of material moisture content, grading and compacted density shall be monitored to ensure compliance with both the mix design and the conditions during the trafficking trial.

6.1.6 If material characteristics and properties differ from those prevailing in the initial trafficking trial than a re-evaluation of the mix design and a further trafficking trial may be required.

7 Summary of Tests

7.1 INSPECTION AND TESTING

7.1.1 The end-product testing of the CRBM shall be assessed on the basis of representative specimens made up in accordance with the schedule in the quality plan.

7.1.2 There shall be a schedule of inspection and test frequencies to be made during production of CRBM. This schedule shall comply with the minimum frequencies in Table 7.1.

TABLE 7.1 MINIMUM FREQUENCIES FOR INSPECTION AND TEST

Item	Inspection	Test
Aggregate stockpiles	Daily	Grading and moisture content Before production and weekly
Binders	On receipt	Supplier data
Combined grading of mixture	Continual	Daily
Moisture content of mixture	Continual	Daily

7.1.3 Specimens shall be prepared at an overall frequency of three per 1000 tonnes with a minimum of three per working day. Conformity shall be assessed on a rolling basis.

(NOTE 1. This requirement may be relaxed for small and intermittent jobs with the prior agreement of the Project Manager.)

(NOTE 2. 40 kg of material is required for each sample in order to have sufficient material for the three test samples (PRD, Cylindrical and Moisture Content) to be produced. PRD samples require a minimum of 5 kg of material; Cylindrical samples, 4 kg; Moisture Content samples, 3 kg; as well as three PRD tests from a bulk sample of six individual samples.)

7.2 SAMPLE PREPARATION

Representative samples of the CRBM shall be taken either at the mixing plant or from site prior to compaction. 150 mm diameter cylindrical test specimens shall be manufactured in sets of six by compacting to refusal in accordance with method C.1.14 of Table C.1 in BS EN 13108-20. The height of the test specimens and the time period after mixing during which compaction must be completed shall be in accordance with Table 7.2.

TABLE 7.2 SETTING TIMES OF COLD RECYCLED BOUND MATERIAL

Family	Setting time under normal temperature conditions	Sample dimensions prepared to a target density	
		Diameter (mm)	Height (mm)
QVE	2 hours	150	75

(NOTE. Setting time is the maximum permitted time between batching the mixture and completion of compaction of any specimen.)

7.3 CONDITIONING OF SAMPLES

7.3.1 Immediately after compaction, the cylindrical specimens (either in their moulds or after extracting from their moulds if applicable) shall be double wrapped in cling-film plastic using two separate sheets; each of which shall be sufficient to cover the entire circumference of the cylinder and the two ends of the specimen. Once wrapped in cling-film, the sample shall be placed in a sealed plastic bag.

(NOTE. Care should be taken when handling the specimens not to damage the plastic bag or the underlying cling-film layer.)

7.3.2 The specimens shall be stored in air or water at a temperature within 2 ºC of the nominal conditioning temperature.

7.3.3 CRBM specimens shall be conditioned for a period of 28 days at a temperature of:

- (20 ± 2) ºC if they do not contain a pozzolanic binder.
- (40 ± 2) ºC if they do contain a pozzolanic binder.

(NOTE. The purpose of conditioning is to simulate the likely curing over the first year in the pavement. A PRD or other suitable mould may be used. Where long-term storage of materials is required, the use of an inexpensive mould, such as plastic soil pipe, is advised.)

7.4 PERCENTAGE REFUSAL DENSITY

7.4.1 The in situ bulk density of cored samples shall be measured in accordance with Procedure C of BS EN 12697-6 using paraffin wax to seal the specimen. Using the respective moisture content values, the dry density values shall be determined.

7.4.2 The wax shall then be scraped off the core with the pallet knife so as to reduce the mass of the core and wax to less than 1.005 times the mass of the dry core in air. The cores shall be compacted to refusal in accordance with method C.1.14 of Table C.1 in BS EN 13108-20 and the refusal bulk density remeasured.

7.4.3 The percentage refusal density (PRD) shall be calculated as the ratio of the in-situ bulk density to the refusal bulk density in per cent.

7.5 INDIRECT TENSILE STIFFNESS MODULUS

7.5.1 Six specimens of CRBM shall be produced and conditioned in accordance with Clauses 7.2 and 7.3, respectively. The samples shall be tested for Indirect Tensile Stiffness Modulus in accordance with Annex C of BS EN 12697-26. The results shall be multiplied by the relevant factor in Table 7.3 in order to predict 360 day values; other factors may be used with supporting evidence.

7.5.2 The mean predicted 360 day value of Indirect Tensile Stiffness Modulus shall comply with the limits in Table 7.4.

TABLE 7.3 FACTORS TO LINK 28 DAY LABORATORY TEST VALUES AND 360 DAY VALUES

Material Type	Factor
QVE without pozzolanic binder	1.2
QVE with pozzolanic binder	1.0

(NOTE. These factors are based on current knowledge. Although the mix design values are indicative, these values should meet the end product criteria given in Clause 7.3 to provide assurance that the material will comply when tested in the Permanent Works.)

7.6 MOISTURE SENSITIVITY

7.6.1 Six specimens of the CRBM shall be produced and conditioned in accordance with Clauses 7.2 and 7.3, respectively. After the 28 day conditioning period, they shall be soaked in water at (20 ± 2) ºC for 7 days. The soaked specimens shall be tested for Indirect Tensile Stiffness Modulus in accordance with Annex C of BS EN 12697-26.

7.6.2 The soaked specimens shall not show any signs of cracking or swelling and the ratio of the mean Indirect Tensile Stiffness Modulus to the mean Indirect Tensile Stiffness Modulus of the unsoaked values determined in Clause 7.5 at the same age shall comply with the limits in Table 7.4.

7.7 END PRODUCT CRITERIA

7.7.1 The minimum specification compliance criteria for the process control tests shall be as described in Table 7.4. Compliance testing shall be undertaken at a frequency no less than that specified for sample preparation in Sub-Clause 7.1.3.

7.7.2 In the event of test specimens failing to achieve the required mechanical performance from the laboratory test procedure, then additional tests for compliance shall be determined by the testing of cores extracted by dry coring. The result will be dependant on the age and curing of the sample in accordance with the laboratory procedure for samples less than 3 months old.

TABLE 7.4 END PRODUCT CRITERIA

Material property or characteristic	Individual results	Mean from test set of six measurements
Particle Size Distribution	Zone	–
Moisture content	± 2 %	–
Relative in situ density	93 % min.	95 % minimum
Layer thickness	± 25 mm of specified	± 15 mm of specified
Indirect Tensile Stiffness Modulus	N/A	3.1 GPa min., 6.5 GPa max.
Moisture sensitivity	N/A	80 % minimum

(NOTE: The criteria represent the minimum permitted end-product compliance criteria; however, they can be supplemented by other laboratory and non-destructive in situ test methods in the QP. Supplementary testing can be of value to both the Contractor and the Defence Estates and should be viewed as good practice.

Appendix A – Straightedge Test

A.1 SCOPE

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

A.2 APPARATUS

A.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.

A.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.

A.3 PROCEDURE

A.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.

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

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

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 are 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 7), 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 TYPE OF COLD RECYCLED BOUND MATERIAL

The types of CRBMs that satisfy the material classification QVE include:

- Foamed bitumen with CEM1
- Foamed bitumen with CEM1 and PFA
- Foamed bitumen with CEM1 and GGBS
- Foamed bitumen with CEM1 and 'other'
- Bitumen emulsion with CEM1
- Bitumen emulsion with CEM1 and PFA
- Bitumen emulsion with CEM1 and GGBS
- Bitumen emulsion with CEM1 and GBS
- Bitumen emulsion with CEM1 and 'other'

(NOTE. The combinations listed are not exhaustive and alternatives to those shown, as indicated by 'other' in the list, can be considered.)

Z.2 CURING PERIOD

The curing period is usually 24 hours, but it can be set at a different value if the construction will be phased to start after a different time interval. Shorter times may be necessary if the construction period is short or the areas will be needed to be trafficked early, but too short a period could result in the sprayed membrane not having stabilised and being distributed around the site.

Z.3 RUTTING LIMITS

Z.3.1 The maximum limit on the measured rutting in the Construction trafficking trial and/or the pavement trafficking trial can be changed when there are reasons why the usual value is inappropriate. Possible reasons for changing the limits could be:

- The works are only designed to have a limited design life (for increased maximum).
- A more onerous performance is required

Z.3.2 When increasing the maximum limit, the reduction in potential performance must be able to be justifiable.

Z.3.3 When reducing the maximum limit, the ability to accurately measure this reduction must be considered.

(NOTE 1. A trafficking trial is necessary to show that the proposed construction (materials, construction and thicknesses) performs well under the specific site conditions and that the type of construction is of a type that is unlikely to be susceptible to deformation.

NOTE 2. The experience of the contractor with this type of work and evidence of satisfactory application of the same techniques on similar sites in the past should be taken into consideration.)

References

Defence Estates

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
JSP 554		2004	Military Aviation, Aerodrome Standards and Criteria

British Standards Institution

BS 434			Bitumen road emulsions (anionic and cationic)
	Part 2	2006	Code of practice for use of bitumen road emulsions
BS 6463			Quicklime, hydrated lime and natural calcium carbonate
	Part 102	2001	Methods for chemical analysis
BS EN 197			Cement
	Part 1	2000	Composition, specifications and conformity criteria for common cements
BS EN 12504		2000	Testing concrete in structures – Cored specimens – Taking, examining and testing in compression
BS EN 12591		2009	Bitumen and bituminous binders – Specifications for paving-grade bitumens
BS EN 12620		2002	Aggregates for concrete
BS EN 12697			Bituminous mixtures – Test methods for hot mix asphalt
	Part 3+A1	2003	Determination of bulk density of bituminous specimens
	Part 26	2004	Stiffness
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 20	2006	Type testing
BS EN 13808		2005	Bitumen and bituminous binders – Framework for specifying cationic bitumen emulsions
BS EN 14227			Unbound and hydraulically bound mixtures – Specifications
	Part 2	2001	Slag bound mixtures
	Part 4	2001	Fly ash for hydraulically bound mixtures
	Part 11	2001	Soil treated by lime
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