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Bituminous mixtures and surface dressings for airport pavements

Guide to the application of standards

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Bituminous mixtures and surface dressings for airport pavements

Guide to the application of standards

2nd edition

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Summary

France's standards for asphalt concrete materials are derived from European standards. They specify the requirements for mixtures from the same family of products used for surface courses and/or base courses of roads, airport pavements and other movement areas.

Given the specific nature of airport pavements and the wide diversity of bituminous materials available on the market, the time has come to undertake a much-needed revision of the application guide published in 2003. The aim, as before, is to help project managers to make better choices and to define more precisely in their contracts performance criteria for mixtures and the characteristics of their components, with a view to responding more pertinently to the requirements of each project.

This document covers only the most common types of requirement encountered in French metropolitan and overseas airports. It does not deal with particular cases that would require specific studies.

Analysis

The document describes the characteristics and mixture designs commonly used in France for all hot bituminous mixtures intended for surface courses or base courses, and for surface dressing and cold coat material. It links the earlier French terminology to the designations defined by NF EN European standards. Compared to the previous version, the guide introduces a new concept called «aircraft group». This concept is more representative of the impact made by an aircraft on an airport pavement than simply its weight. It is arrived at by taking into consideration the aircraft's landing gear configuration and tyre pressures.

The document also includes a number of appendices in table form. This approach is intended to help the designer to determine which products to use, and to determine their mechanical performance.

Summary

Preface

Given the specific nature of airport pavements, and the appearance of new product standards derived from European standards, the time has come to undertake a much-needed revision of the application guide published in 2003, in order to help project managers to make the right product choices for their airport pavement construction and rehabilitation projects.

The work consists of 3 parts and a series of annexes.

The first part provides a reminder of airport terminology and definitions.

The second part indicates the procedure to be followed when choosing products and defining the performance requirements of mixtures (formulation) and the characteristics of their components, in order to provide the best possible response to the project requirements.

The third part provides recommendations for characteristics to be achieved, both in laboratory testing (mix design sample for type testing, and formulation levels) and on site, from production of the mixture to its application.

The annexes consist of various summary tables intended to facilitate the designer's task.

1 – Terminology and definitions

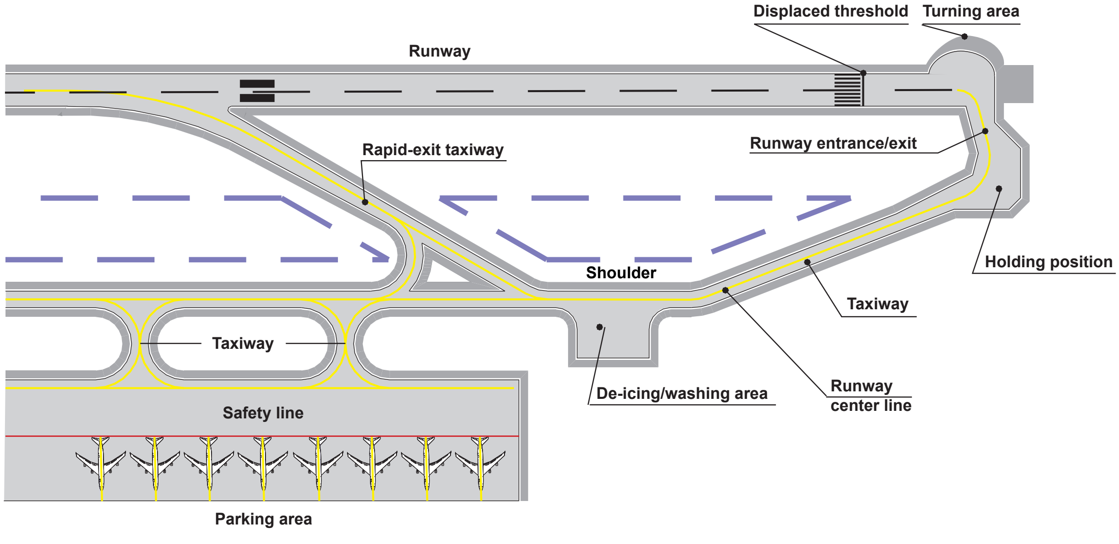
1.1 - Airport terminology

Table 1 below is a reminder of the terms used in describing airport infrastructures. For the other terms, the reader is invited to refer to the French technical instructions for civil airports ITAC (Instruction Technique sur les Aérodromes Civils - Chapter 1)

Tableau 1 – Airport Terminology

Movement area	That part of an airport used for aircraft takeoff, landing and on-ground taxiing; it comprises the manœuvring area and the airport ramp or apron.
Manoeuvring area	That part of an airport which is used for aircraft takeoff, landing and ground-level taxiing, excluding the airport ramp or apron.
Airport ramp or apron	A particular area within a land-based airport intended to receive aircraft during passenger embarkation and disembarkation, loading and unloading of mail, freight, etc., the taking on of supplies and fuel, as well as for parking or maintenance purposes.
Runway	A rectangular area of a land-based airport designed to enable aircraft to take off and land. Its long sides are called runway edges; its smaller sides are the runway ends and the longitudinal axis is known as the runway centreline.
Threshold	The beginning of that part of the runway which can be used for landing. When the runway extremity is not the threshold, the term displaced threshold is used
Turning area	An area provided at a runway end to facilitate the turning round of aircraft.
Takeoff and landing area	That part of the runway between the displaced threshold and the far extremity, being the area available for takeoff.
Parking area	See apron.
Taxiway	A pavement within a land-based airport designed for the ground movement of aircraft, enabling them to pass between the various parts of the movement area.
Holding bays	A designated area where aircraft may wait, or allow others to overtake them, to facilitate ground movements of aircraft (these include de-icing, washing and parking areas).
Taxiway intersections	Specially widened parts of taxiways constructed where taxiways and/or runways cross each other, to enable aircraft to change direction.
Runway entrance/exit	The junction of a taxiway with a runway, enabling aircraft to enter or exit the runway.
Shoulder	A strip of land bordering a pavement, treated so as to provide a connection between the pavement itself and the surrounding land, and designed so that if an aircraft should accidentally leave the runway it will be able to avoid sustaining structural damage, foreign bodies will not enter the engines, and matter will not be expelled from the aircraft.

Parts of the movement area



1.2 - Characteristics and particular features of airport pavements

Although airport pavements experience qualities of usage which are identical to those of roads, it is to be noted that the stresses induced by air traffic movements vary enormously, both in intensity and in number.

The essential differences between these two types of pavement, notably in their surface courses, are identified in Table 2 below.

Table 2 – Characteristics and particular features of airport pavements

Road pavements	Airport pavements
Loads applied	
• loads are applied in a way that presents very low lateral dispersal (which could cause rutting)	• on runways, traffic is dispersed (only the central third of the surface is occupied) and landing gear configurations vary from one aircraft to another. On taxiways, this dispersal is less marked
• a large number of movements (up to 50,000 per day) of relatively light loads (42 t total weight, 4.2 t maximum wheel load), engendering fatigue mainly due to the high frequency of movements each causing small stresses	• a very small number of movements (from very few to more than 100 per day) of differing loads (up to 550 t or more total weight, 45 t for a twin-wheel undercarriage and 115 t for a bogy), causing fatigue mainly due to infrequent movements each causing large stresses
• tyre pressures must not exceed 0.8 MPa (8 bars)	• tyre pressures may attain 1.7 MPa (17 bars) for certain aircraft
• the most aggressive loads are applied at low speeds (less than 90 km/h)	• speeds are highly variable : - very low speeds, which can cause runtting phenomena - very high speeds during takeoff and landing (over 300 km/h)
Particular features	
• particular stresses which require good tyre contact to the pavement in order to provide the best possible roadholding and satisfactory braking performance for vehicles using it	• geometrical and environmental conditions which expose pavement mixtures over long periods to the action of rain, sun etc.
• surface evenness (with no surface defects) is largely related to passenger comfort	• surface evenness is largely related to aircraft safety when taxiing at high speeds
• roughness develops essentially as a result of a polishing phenomenon affecting aggregates over time	• roughness develops progressively as a result of rubber deposits from tyres
• traffic has sometimes to be diverted or stopped in the event of road works	• the operating and safety constraints on traffic make it very difficult for traffic to be stopped or reduced when maintenance or renovation work has to be carried out

These characteristics and particular features influence the choices to be made in terms of the formulation of bituminous mixtures and their constituents, as well as in terms of methods of application and control.

For this reason it has been considered useful and practical to provide designers with a specific guide to the use of bituminous mixtures in airport pavements. The guide covers most needs, as it does not restrict itself to bituminous concretes intended for use in airports, but deals with all standardized bituminous mixtures (including high-modulus mixtures) and maintenance techniques for surface courses such as surface dressing and slurry seals.

1.3 – Reminder of definitions

1.3.1 – Constitution of a pavement

In general, a pavement consists, from top to bottom, of various courses of materials designed to enable it to resist traffic-induced stresses and to distribute these to the pavement base or foundation.

● **Surfacing** must be resistant to flow and punching phenomena, and withstand the ageing caused by atmospheric agents, thermal gradients and hydrocarbon attack **:**

- **the surface course,** in actual contact with tyres, must be capable of providing the adherence characteristics prescribed by air transport specifications,
- **the binder course** is an intermediate layer between the wearing course and the road base or old pavement. In airport pavements, a binder course is not systematically used. Its principal application is in maintenance works, to improve evenness or to delay the spread of cracks from the deeper layers to the wearing course**.**

● The foundation and base course utilize appropriate materials to provide sufficient mechanical resistance to bear the vertical loads imposed by traffic, and to spread them over the ground or subgrade.

● The capping layer renders the subgrade more homogeneous, and improves its bearing capacity characteristics.

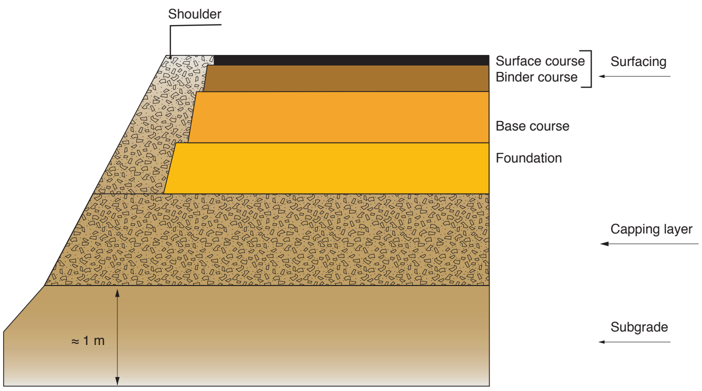
1.3.2 – Role of the tack coat

Tack coats play an important part in ensuring long pavement life. Their functions are as follows :

● **mechanical adhesion between the different courses of the pavement structure**; the quality of this adhesion strongly influences the rigidity of the pavement. The design calculation should assume that all courses must be tack coated, and that any defect in the tack coating will in the long term result in structural deterioration**.**.

● **resistance to shearing;** where severe tangential stresses exist, defects in the tack coating can have short-term consequences such as horizontal flow, causing ridging and/or cracking in the surface course.

● **waterproofing;** the contribution of tack coating to waterproofing is particularly important with aggregates of small size**.**.



1.3.3 – Causes of deterioration in airport pavements

Deterioration occurs in airport pavements through the effects of aircraft traffic and climatic factors.

● Traffic effects causing mechanical stresses :

- **shearing**, which results from horizontal stresses caused by tangential efforts transmitted by tyres when aircraft make turns,

- **rutting**, the permanent strain due to frequent passages of loads at low speeds

- **punching**, due to permanent strains caused by static loads.

● Climatic effects :

- **ageing** which only affects the surface course, and which depends on the climate, the nature of any products applied to it, and any pollution. The ability of a pavement to resist ageing is called its « **durability** ».

Other aggressive effects include chemicals (e.g. accidental spillage of oils or hydrocarbons). Although these can have a very aggressive effect on the life expectancy of a pavement, they are not a sufficiently discriminating factor to be considered as a criterion when assessing the levels of aggression presented in table 3 below.

However, this factor will be taken into account when determining the choice of bituminous mixture to be implemented, and defining its mechanical properties.

1.3.4 - Friction characteristics

The surface friction of a pavement is characterized by the quality of its surfacing and its ability to retain its roughness. It is defined by :

- Its **macrotexture**, representing all surface irregularities with horizontal dimensions ranging from 0.5 mm to 50 mm, and vertical dimensions of between 0.2 mm and 10 mm. Macrotexture is related to surface treatment and how it is applied, as well as to deterioration and any partial surface treatments.
- Its **microtexture**, which represents all surface irregularities that may come into contact with tyres, and which have horizontal dimensions of between 0 mm and 0.5 mm and vertical dimensions from 0 mm and 0.2 mm. Microtexture is thus related to surface irregularities of the aggregate.

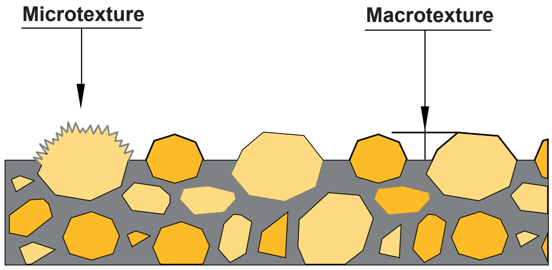


Table 3 –Assessment of aggression levels and surface quality characteristics of a pavement

		Shearing	Rutting	Punching	Durability	Friction
Aera of airport		++	+++	+++	++	++
Runways	Main part	+	+	+	++	+++
	Turning area	+++	++	+	+++	++
	Exit	+++	+	+	++	+++
	Threshold (*)	+++	+	++	+++	+++
Taxiways	Main part	+	++	+	++	++
	Intersections	++	++	++	+++	++
Apron or holding area		+	+++	+++	++	++

(*) including touch-down area

+: Low level
++: Medium level
+++: High level

2 – Choosing the right products ? Recommendations ?

2.1 - Products

Table 4 below recapitulates the products available for use in building and renovating airport pavements.

The table gives for each product its classification, grading and dimensions in use, and prescribes maximum acceptable strains for existing pavements before application of a new course of a bituminous mixture.

The product names quoted associate the French NF EN standards with the older NF P standards.

Class 0, defined for certain products, does not specify a performance level for the rutting resistance test.

2.2 – Terminology

EB10-BBA C : airport bituminous concrete, grading 0/10 continuous

EB14-BBA C : airport bituminous concrete, grading 0/14 continuous

EB10-BBA D : airport bituminous concrete, grading 0/10 discontinuous

EB10-BBA D : airport bituminous concrete, grading 0/14 discontinuous

EB10-BBME : high-modulus bituminous concrete, grading 0/10

EB14-BBME : high-modulus bituminous concrete, grading 0/14

EB10-BBM : thin bituminous concrete, grading 0/10

EB14-BBM : thin bituminous concrete, grading 0/14

BBTM 6 : very thin bituminous concrete, grading 0/6.3

BBTM 10 : very thin bituminous concrete, grading 0/10

EB10-BBSG : semi-granular bituminous concrete, grading 0/10

EB14-BBSG : semi-granular bituminous concrete, grading 0/14

EB14-GB : bitumen-bound graded aggregate, grading 0/14

EB20-GB : bitumen-bound graded aggregate, grading 0/20

EB10-EME : high-modulus bituminous mixture, grading 0/10

EB14-EME : high-modulus bituminous mixture, grading 0/14

EB20-EME : high-modulus bituminous mixture, grading 0/20

EP : grouted previous bituminous mixtures

EB4 or EB6 : bitumen-bound sand, grading 0/4 or 0/6

ECF : slurry surfacing

ESU : surface dressing.

Table 4 – Products which may be used for airport pavements

Products					Average thickness in use and minimum thickness at any point	Maximum acceptable lack of flatness of existing substrate
Name		Classification Class or type	NF EN reference	Grading (1)		
EB10-BBA C	surface course and binder course	Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/10	6 to 7 cm 4 cm	≤ 2 cm
EB10-BBA D	surface course	Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/10	4 to 5 cm 3 cm	≤ 2 cm
EB14-BBA C	surface course and binder course	Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/14	7 to 9 cm 5 cm	≤ 2 cm
EB14-BBA D	surface course	Class 0,1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/14	5 to 7 cm 4 cm	≤ 2 cm
EB10-BBME	surface course and binder course	Class 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/10	5 to 7 cm 4 cm	≤ 2 cm
EB14-BBME	surface course and binder course	Class 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/14	6 to 9 cm 5 cm	≤ 2 cm
EB10-BBM	surface course and binder course	Type A, B or C according to grading curve Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/10	3 to 4 cm 2,5 cm	≤ 1,5 cm
EB14-BBM	surface course and binder course	Type A, B or C according to grading curve Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/14	3,5 to 5 cm 3 cm	≤ 1,5 cm
BBTM 6	surface course	Class 1 or 2	NF EN 13 108-2	0/6,3	2 to 3 cm 1,5 cm	≤ 1 cm
BBTM 10	surface course	Class 1 or 2	NF EN 13 108-2	0/10	2 to 3 cm 1,5 cm	≤ 1 cm

Table 4 – Products which may be used for airport pavements (continued)

Products					Average thickness in use and minimum thickness at any point	Maximum acceptable lack of flatness of existing substrate
Name		Classification Class or type	NF EN reference	Grading (1)		
EB10-BBSG	surface course and binder course	Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/10	5 to 7 cm 4 cm	≤ 2 cm
EB14-BBSG	surface course and binder course	Class 0, 1, 2 or 3 according to mechanical performance	NF EN 13 108-1	0/14	6 to 9 cm 5 cm	≤ 2 cm
ECF	-	-	In progress	0/6 to 0/10	Dosage to 10 or 15 kg/m²	≤ 1 cm
EB14-GB	Base	Class 2, 3 or 4 according to mechanical performance	NF EN 13 108-1	0/14	8 to 14 cm 6 cm	≤ 2 cm
EB20-GB	Base	Class 2, 3 or 4 according to mechanical performance	NF EN 13 108-1	0/20	10 to 16 cm 8 cm	≤ 3 cm
EB10-EME	Base	Class 1 or 2 according to mechanical performance	NF EN 13 108-1	0/10	6 to 8 cm 5 cm	≤ 2 cm
EB14-EME	Base	Class 1 or 2 according to mechanical performance	NF EN 13 108-1	0/14	7 to 13 cm 6 cm	≤ 2 cm
EB20-EME	Base	Class 1 or 2 according to mechanical performance	NF EN 13 108-1	0/20	9 to 15 cm 8 cm	≤ 2 cm
ESU	-	Class A, B or C	NF EN 12 271	2/4	-	≤ 2 cm
EB4 or EB6 sand-mix (2)	-	-	NF EN 13 108-1	0/4 or 0/6	2 cm	≤ 1 cm
Grouted previous bituminous mixtures (EP)	-	-	None	-	4 to 5 cm	≤ 2 cm

(1) A grading corresponding to sieve D of series 1 is admissible.
(2) This is generally prescribed to limit or retard the occurrence of cracks, particularly in the case of foundations treated with cementitious binders (see « Techniques anti-remontée de fissures », a paper on techniques for avoiding cracks, published by STAC in 1999).

Stone Mastic Asphalt (SMA), although it is little used in France, may be employed in new pavement construction or maintenance projects. Its use should be restricted to the main part of the runway, and to the surface course only.

The characteristics of SMA and demands made of it must conform to standard NF EN 13 108-5.

Its characteristics in use are as follows : grading 0/10, average thickness in use 3 to 4 cm, minimum thickness at any point 2cm.

On the use of other specific products, reference may be made to technical opinions or other documents outside the official standards.

Recommendations

Many other products are available on the market. However, given the poor fit between their characteristics and airport pavement applications, their use in airport surface courses is strongly discouraged, and in many cases forbidden :

Nailed bituminous concrete - (risk of stripping, and of scattering nails).

Porous bituminous concrete - (risk of over-rapid silting up in low-traffic areas and of stripping due to shearing effect).

Ultra-thin bituminous concrete – (risk of stripping due to shearing effect).

Flexible bituminous concrete – (use must take account of its particular characteristics : fairly low geometric roughness, strong sensitivity to permanent deformation).

Airport bituminous concrete 0/10 C – (not to be used for surface courses of runways because of the difficulty of achieving sufficient geometric roughness).

2.3 –French standards for bituminous products and mixtures

The European standards series NF EN defines the composition, performance characteristics and test conditions for bituminous products and mixtures.

The standards do not provide information on the transport or application of these materials - the prescriptions of standard NF P 98 150-1 apply.

NF EN 12 271 :	Surface dressings - requirements
NF EN 12 591 :	Bitumens and bituminous binders - Specifications for paving grade binders
NF EN 13 043 :	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
NF EN 13 108-1 :	Bituminous mixtures - Material specifications - Part 1 : asphalt concrete
NF EN 13 108-2 :	Bituminous mixtures - Material specifications - Part 2 : asphalt concrete for very thin layers
NF EN 13 108-4 :	Bituminous mixtures - Material specifications - Part 4 : hot rolled asphalt - Annex B (only for the natural asphalts defined in this annex)
NF EN 13 108-5 :	Bituminous mixtures - Material specifications - Part 5: stone mastic asphalt
NF EN 13 108-8 :	Bituminous mixtures - Material specifications - Part 8: reclaimed asphalt
NF EN 13 108-20 :	Bituminous mixtures - Materials specifications - Part 20: type testing
NF EN 13 108-21:	Bituminous mixtures - Material specifications - Part 21: factory production
NF EN 13 924 :	Bitumen and bituminous binders - Specifications for hard paving grade bitumens
NF EN 14 023 :	Bitumen and bituminous binders - Framework specification for polymer- modified bitumens
XP P 18 545 :	Aggregates - Defining elements, conformity and coding
NF P 98 150-1 :	Bituminous asphalt. Laying of base, binder and surface courses. Components. Mix contents. Performance and checks.

2.4 – Decisions on which product to use – Determining stress levels

Specifications relating to the choice of products are guided by a concept which we shall call the "stress level". For a given airport this results from the combination of two factors : class of traffic and type of climate.

2.4.1 - Defining the traffic class

The method used to define the traffic class is to establish a realistic order of magnitude for the various stresses applied on the courses of a pavement by the passage of an aircraft.

Several criteria are liable to influence determination of the traffic class : the weight of the aircraft, number of landing wheels and their tyre pressures, area of tyre/runway contact, tyre pressures, etc.

In the earlier edition of this guide (2003), traffic class was determined by two parameters : total weight of the aircraft or weight per main landing gear assembly, and number of passages per day of this load. Practice has shown that this method tends to discriminate against certain aircraft types with the same weight but a different landing gear configuration (e.g. a greater number of landing wheels reduces the load per landing wheel and therefore the stress applied on the pavement).

To remedy this situation, the present edition introduces the idea of an "aircraft group" based on two variables to represent the impact of an aircraft on a pavement : tyre pressure (P) and the number of wheels (R) of the main landing gear assembly. Table 5 presents five aircraft groups based on the product of P x R.

Table 25 in Annex A places the main aircraft types currently in service into their respective groups (column 8).

2.4.1.1 Determining the traffic class

A traffic class is determined for the aircraft representing the greatest constraint using any part of the airport. Thus, different traffic classes can be defined for different parts of the airport (runways, taxiways, parking areas, etc.) and for homogeneous stresses (same aircraft type and frequency).

The method for determining the traffic class is as follows :

a) calculate the product of P x R or find the aircraft group from Table 25 in Annex A.

b) using Table 5 below, read off the traffic class at the intersection of the column giving the relevant product of P x R and the row giving the frequency (number of movements of the aircraft per day).

Table 5 – Determining the traffic class

Tyre pressure x no. of wheels (MPa) / Frequency (F)*	Light aircraft - total aircraft weight < 5 700 kg	P x R <2	2≤ P x R< 4,1	4,1 ≤ P x R< 5,5	5,5 ≤ P x R
	Group 1	Group 2	Group 3	Group 4	Group 5
F < 10 mvts/day**	CT1	CT2	CT2	CT3	CT4
10 mvts/d ≤ F ≤ 100 mvts/d	CT1	CT2	CT3	CT4	CT5
F > 100 mvts/day	CT1	CT2	CT4	CT5	CT5

* *One movement corresponds to a takeoff or landing*

** *If F > movement per day, the traffic class so determined is adopted for all areas of the airport*
If F ≤ 1 movement per day, the traffic class so determined is only recognized for that particular part of the airport. The traffic class is determined by reference to the other aircraft using the airport.

Two case studies are given as examples here.
In the first case, the airport has aircraft traffic in groups 2 and 3.

Aircraft type	Total weight (kg)	Aircraft group	Frequency (mvts/day)	Traffic Class
Fokker 27	20 400	2	0,8	**CT2**
BAe 146-100	38 300	2	4	**CT2**
B 737-200	52 600	3	2	**CT2**
MD 80-83	72 500	3	2	**CT2**

In this example, the airport is placed in traffic class CT2.

In the second case, an airport has aircraft traffic in groups 3, 4 and 5.

Aircraft type	Total weight (kg)	Aircraft group	Frequency (mvts/day)	Traffic Class
B 737-200	52 600	3	20	**CT3**
A 320-200 Jumbo	75 900	3	25	**CT3**
B 767-200	143 800	4	4	**CT3**
B 747-400 type 4	395 600	5	0,5	**CT4**

In this second example, two traffic classes might be envisaged : CT3 or CT4. However, since the frequency of the B 737-200 is less than 1 movement per day, the airport is placed in traffic class CT3 for the aircraft movement areas (runways and taxiways), and traffic class CT4 for the ramp or apron.

2.4.2 - Types of climate

Four types of climate have been defined for France, on the basis of temperature readings taken over a period of several years (Météo France, the national meteorological office, has calculated so-called "standard values" from daily maximum temperature readings taken in the two hottest months and the two coldest months of the year) :

- type 1 – predominantly oceanic
- type 2 – predominantly Mediterranean
- type 3 – predominantly continental or mountainous
- type 4 – predominantly tropical

Table 6 – Definition of types of climate

		Average of daily maximum temperatures in the hottest two months of the year	
		T° ≤ 27 °C	T° > 27 °C
Average of daily minimum temperatures in the coldest two months of the year	T° > 14 °C	Type 4 : predominantly tropical	
	0 °C ≤ T° ≤ 14 °C	Type 1 : predominantly oceanic	Type 2 : predominantly Mediterranean
	T° < 0 °C	Type 3 : predominantly continental or mountainous	Not relevant

Tables 26, 27 and 28 in Annex B show the climate types of the main airports of metropolitan France and its overseas territories.

2.4.3 – Stress levels

Stress levels are determined with the aid of Table 7, on the basis of the traffic class and type of climate.

Table 7 – Determination of stress levels

Traffic class / Climate	CT1	CT2	CT3	CT4	CT5
Oceanic	NS1	NS1	NS2	NS3	NS4
Continental	NS1	NS1	NS2	NS3	NS4
Mediterranean	NS1	NS2	NS3	NS4	NS4
Tropical	NS1	NS2	NS3	NS4	NS4

2.5 – Determining product choices as a function of stress levels

Table 8 - Products which can be used in the construction of airport pavements

	Products
Surface courses	EB-BBA, EB-BBSG, EB-BBME, EB-BBM, BBTM, SMA, ESU, ECF, EP
Binder course	EB-BBA, EB-BBME, EB-BBM, EB-BBSG
Pavement base or foundation	EB-GB, EB-EME
Anti-cracking layer	EB-Sand mix

2.5.1 – Surface course

The products that can be used for surface courses are :

EB-BBA class 0, 1, 2 and 3

EB-BBME class 1, 2, 3

EB-BBSG class 0, 1, 2, 3

EB-BBM A, B or C of class 0, 1, 2, 3

BBTM class 1, 2

ECF

ESU

EP : Porous asphalt (Annex F below provides a technical note describing the main characteristics of its manufacture and application)

SMA

Products of class 0 can be used for parts of pavements which experience low traffic levels, and only for stress level NS1.

To enable road builders to respond as fully as possible to the objectives and regulatory requirements in terms of resistance and surface condition, in normal operating conditions, Table 9 lists products which can be used for surface courses, subject to application of the recommendations given on page 15, according to certain stress levels.

Table 9 – Products that can be used for surface courses

<table>
<tr><th colspan="2">Area of airport</th><th>NS 1</th><th>NS 2</th><th>NS 3</th><th>NS 4</th></tr>
<tr><td colspan="2">Parking areas</td><td>EB-BBA 2,
ESU, ECF, EP,
EB-BBM 1</td><td>EB-BBA 3,
EB-BBM 2
EB-BBME 1,
EP</td><td>(***)
EP (1)</td><td>(***)
EP (1)</td></tr>
<tr><td rowspan="4">Runways(*)</td><td>Main part</td><td rowspan="4">EB-BBA 1,
EB-BBM A1,
EB-BBM B1,
BBTM</td><td>EB-BBA 1,
EB-BBM A2,
BBTM</td><td>EB-BBA 2</td><td>EB-BBA 2</td></tr>
<tr><td>Turning area</td><td>EB-BBA 2,
EB-BBME 1</td><td>EB-BBME 2 (2)</td><td>EB-BBME 3 (2)</td></tr>
<tr><td>Exit</td><td>EB-BBA 2,
EB-BBM A2</td><td>EB-BBA 3
EB-BBME 2</td><td>EB-BBA 3</td></tr>
<tr><td>Threshold (**)</td><td>EB-BBA 2,
EB-BBM A2</td><td>EB-BBA 3 (2)</td><td>EB-BBA 3 (2)</td></tr>
<tr><td rowspan="2">Taxiways</td><td>Main part</td><td rowspan="2">EB-BBA 1,
ECF,
EB-BBM B2,
BBTM</td><td>EB-BBA 2,
EB-BBM B3,
BBTM</td><td>EB-BBA 2,
EB-BBME 1</td><td>EB-BBA 3,
EB-BBME 2</td></tr>
<tr><td>Intersections</td><td>EB-BBA 2,
EB-BBM B3</td><td>EB-BBA 3,
EB-BBME 2</td><td>EB-BBA 3,
EB-BBME 2</td></tr>
<tr><td colspan="2">Apron or holding area</td><td>EB-BBA 1,
ECF,
EB-BBM B2,
BBTM</td><td>EB-BBA 3,
EB-BBM B3</td><td>EB-BBME 3</td><td>EB-BBME 3</td></tr>
</table>

(*) Use of EB10-BBA C is not recommended (inadequate geometric roughness)
(**) On military airfields, where fighter planes can cause deterioration of pavements constructed with bituminous mixtures (surface burning, oil spills, etc.) concrete pavements are recommended
(***) On traffic areas with a high risk of punching, cement concrete pavements are highly recommended.
(1) Use of this material is related to the pavement base which must possess a high stiffness modulus (for example, a semi-rigid or bituminous structure). In general, the pavement base consists either of graded aggregate bound with cementitious binders, or of a high-modulus bituminous mixture, or bitumen-bound graded aggregate.
(2) For better resistance to shearing strains, use of a modified binder is recommended.

All products shown can be used without any one having any kind of priority over the others. However, for new construction projects, use of BBA is favoured.

NB : The rutting resistance of EB-BBME and EB-BBSG of the same class is equivalent. Therefore, if a high-modulus product is not required, EB-BBSG can be used instead of EB-BBME.

Products of a superior performance class can always be preferred, provided that the economic assessment remains satisfactory. Similarly, in practice, to satisfy the general economic constraints of the project, it is possible to specify the use of one and the same product on all areas

When choosing a product for pavement maintenance, it should be remembered that ESU, ECF, BBTM and EB-BBM all display diminishing sensitivity to the risk of stripping or slippage of the surface layer by virtue of their extreme roughness and thinness.

The specifier should take account of these remarks in order to choose the product most appropriate to the objectives to be achieved.

For other parts of the airport, such as hard shoulders, widened pavements and anti-engine blast lanes, the following products are used : ESU, ECF, EB-BBS, EB-BBM (A, B or C of Class 1), BBTM. In the case of ESU, a sealing using 2/4 chippings should be provided for.

2.5.1.1 Resistance to aviation fuel

Parking areas built as lightweight pavement structures need special protection against attack by aviation fuel, often known as anti-kerosene protection. This protection is achieved :

- **either on the surface** in this case, a filler is spread over the surface to be treated after the bituminous mixture has been applied, in order to prevent the petroleum products from seeping into the ground. Application of this product must be carried out in accordance with the manufacturer's instructions.

- **or in the material itself** : in this case, the bituminous mixture must be aviation-fuel-resistant. This resistance is determined in accordance with Annex D.11 of French standard NF EN 13 108-20. The test method is described in standard NF EN 12 697-43.

A special binder is generally used; this binder endues the mixture with a particular resistance to hydrocarbons (aviation fuel, lubricating and other oils) and good rutting resistance.

In the context of an RFQ, if it is desired to specify that a bituminous mixture should be aviation-fuel-resistant, the following requirements should be stated :

- good resistance to aviation fuel, with the following objectives A ≤ 5% and B < 1%.

2.5.1.2 Resistance to de-icing products

In regions subject to black ice, the surface course must be resistant to de-icing products. This resistance is determined in accordance with Annex 12 of French standard 13 108-20. The test method is described in French standard NF EN 12 697-41.

If no standard is indicated, in the framework of an RFQ the following criterion may be adopted : β75 or β100

2.5.2 - Binder courses and reshaping operations

The following products may be used :

EB-BBA of type C *,

EB-BBM,

EB-BBSG,

EB-BBME.

* Aggregate specifications being stricter for EB-BBA than those for other bituminous products, it is recommended that EB-BBA products should be avoided for economic reasons.

The nature and performance classes of usable products are shown in Table 10 below.

NB : in the case of new construction projects, it should be remembered that binder courses are not recommended. Instead, the pavement base or foundation should be made thicker.

Table 10 – Products which can be used for binder or levelling (regulating) course

<table>
<tr><th colspan="2">Area of airport</th><th>NS 1</th><th>NS 2</th><th>NS 3</th><th>NS 4</th></tr>
<tr><td colspan="2">Parking areas</td><td>EB-BBM 1
EB-BBSG 1</td><td>EB-BBM 3
EB-BBSG 1</td><td>(1)</td><td>(1)</td></tr>
<tr><td rowspan="4">Runways</td><td>Main part</td><td rowspan="4">EB-BBM 1
EB-BBSG 1</td><td>EB-BBM 1
EB-BBSG 1</td><td>EB-BBM 2
EB-BBSG 1
EB-BBME 1</td><td>EB-BBSG1
EB-BBME1</td></tr>
<tr><td>Turning area</td><td rowspan="3">EB-BBM 2
EB-BBSG 1</td><td rowspan="3">EB-BBM 3
EB-BBSG 1
EB-BBME 1</td><td>EB-BBSG 2
EB-BBME 2</td></tr>
<tr><td>Exit</td><td rowspan="2">EB-BBSG 2
EB-BBME 2</td></tr>
<tr><td>Threshold</td></tr>
<tr><td rowspan="2">Taxiways</td><td>Main part</td><td rowspan="2">EB-BBM 1
EB-BBSG 1</td><td rowspan="2">EB-BBM 2
EB-BBSG 1</td><td>EB-BBM 2
EB-BBSG 1
EB-BBME 1</td><td rowspan="2">EB-BBSG 1
EB-BBME 1</td></tr>
<tr><td>Intersections</td><td>EB-BBM 3
EB-BBSG 1
EB-BBME 1</td></tr>
<tr><td colspan="2">Apron or holding area</td><td>EB-BBM 1
EB-BBSG 1</td><td>EB-BBM 2
EB-BBSG 1</td><td>EB-BBM 3
EB-BBSG 1
EB-BBME 1</td><td>EB-BBSG 2
EB-BBME 2</td></tr>
</table>

(1) Not relevant. For parking areas where there is a high risk of punching occurring, cement concrete pavements are strongly recommended.
NB : Products of a superior performance class can always be preferred, provided that the economic assessment remains satisfactory. The products used do not generally contain bitumen polymers.

2.5.3 - Pavement base or foundation

Products which may be used for pavement bases are the following :

EB-GB class 2, 3 or 4,

EB-EME class 1 or 2.

The nature and performances classes of products which may be used for pavement bases are shown in table 11 below.

Table 11 – Products which can be used for pavement bases.

<table>
<tr><th colspan="2">Airport area</th><th>NS 1</th><th>NS 2</th><th>NS 3</th><th>NS 4</th></tr>
<tr><td colspan="2">Parking areas</td><td>EB-GB 2</td><td>EB-GB 2</td><td>(1)</td><td>(1)</td></tr>
<tr><td rowspan="4">Runways</td><td>Main part</td><td rowspan="4">EB-GB 2</td><td rowspan="4">EB-GB 2</td><td>EB-GB 2
EB-EME 1</td><td rowspan="4">EB-GB 3
EB-EME 2</td></tr>
<tr><td>Turning area</td><td rowspan="3">EB-GB 3
EB-EME 1</td></tr>
<tr><td>Exit</td></tr>
<tr><td>Threshold (**)</td></tr>
<tr><td>Taxiways</td><td>Main part
Intersections</td><td>EB-GB 2</td><td>EB-GB 2</td><td>EB-GB 3
EB-EME 1</td><td>EB-GB 3
EB-EME 2</td></tr>
<tr><td colspan="2">Apron or holding areas</td><td>EB-GB 2</td><td>EB-GB 2</td><td>EB-GB 3
EB-EME 1</td><td>EB-GB 3
EB-EME 2</td></tr>
</table>

(1) Not relevant. For parking areas where there is a high risk of punching occurring, cement concrete pavements are strongly recommended

3 - Characteristics of product components

3.1 –Characteristics of aggregates

3.1.1 – Grading

Aggregates for coating of grading 0/6, 0/10, 0/14 and 0/20 are made from

- sand 0/2 or as-dug coarse gravel 0/4 (0/6 possible for EB-GB and EB-EME)
- 2/6-4/6-4/10-6/10-6/14-10/14-10/20 (6/20 and 14/20 possible for EB-GB and EB-EME)
- 2/4 for ESU.

To comply as closely as possible with the grading curve of the mixture, at least three aggregate sizes should always be used (not counting any added fillers).

It should be noted that the use of 0/6, 6/14 or 6/20 can lead to a risk of segregation.

3.1.2 – Aggregates

Sand and chippings must conform to French standard NF EN 13 043.

Aggregates must possess minimum characteristics according to traffic class, type of coated material or bituminous product, and the nature of the pavement, as described in Tables 12 to 19 below.

Table 12 – Surface courses – Minimum characteristics for aggregates to be used in EB-BBA

Product	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
EB-BBA	Intrinsic characteristics of chippings	Fragmentation	**LA_{25}** (1)			**LA_{20}** (1)	
		Wear	**$M_{DE}20$** (1)			**$M_{DE}15$** (1)	
		Polishing	**PSV_{50}**			**PSV_{50}**	
	Manufacturing characteristics of chippings	General grading d/D	**G_C 85/20 (G_C 85/15** – discontinuous formulations)				
		Grading tolerance, intermediate sieve	**$G_{20/15}$**				
		Cleanness	**f_1**				
		Flakiness	**FI_{25}**				
	Manufacturing characteristics of sands and gravels	General grading d/D	**G_F85 ou G_A85 si $2 < D \leq 6{,}3$ mm**				
		Grading tolerance, intermediate sieve	**$G_{TC}10$**				
	Fines and fillers	Quality of fines	**MB_F10**				
		Porosity of fillers	**$V_{28/38}$**				
		ΔRBTT of fillers	**$\Delta_{R\&B}$ 8/16**				
	Angularity of chippings	% of broken surfaces	**$C_{95/1}$**	**$C_{95/1}$**			
	Flow time . or sands	Flow time for sands	**$E_{CS}35$**	**$E_{CS}38$**			

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the Los Angeles (LA) test and the Micro-Deval (MDE) test characteristics may be applied (article 8.1 of French standard XP P 18 545)
- an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10
- an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15
an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

Table 13 – Surface courses – Minimum characteristics for aggregates to be used in EB-BBSG, EB-BBM and EB-BBME

<table>
<tr><th rowspan="2">Products</th><th rowspan="2" colspan="2">Characteristics</th><th colspan="5">Traffic class</th></tr>
<tr><th>CT1</th><th>CT2</th><th>CT3</th><th>CT4</th><th>CT5</th></tr>
<tr><td rowspan="17">EB-BBSG
EB-BBM
EB-BBME</td><td rowspan="3">Intrinsic characteristics of aggregate</td><td>Fragmentation</td><td colspan="5">LA_{25} (1)</td></tr>
<tr><td>Wear</td><td colspan="5">$M_{DE}20$ (1)</td></tr>
<tr><td>Polishing</td><td colspan="5">PSV_{50}</td></tr>
<tr><td rowspan="4">Manufacturing characteristics of aggregate</td><td>General grading d/D</td><td colspan="5">G_C 85/20 (G_C 85/15 – discontinuous formulations)</td></tr>
<tr><td>Grading tolerance, intermediate sieve</td><td colspan="5">$G_{20/15}$ or $G_{25/15}$</td></tr>
<tr><td>Cleanness</td><td colspan="5">f_1</td></tr>
<tr><td>Flakiness</td><td colspan="5">FI_{25}</td></tr>
<tr><td rowspan="2">Manufacturing characteristics of sands and gravels</td><td>General grading d/D</td><td colspan="5">G_F85 or G_A85 si $2 < D \leq 6{,}3$ mm</td></tr>
<tr><td>Grading tolerance, intermediate sieve</td><td colspan="5">$G_{TC}10$</td></tr>
<tr><td rowspan="3">Fines and fillers</td><td>Quality of fines</td><td colspan="5">MB_F10</td></tr>
<tr><td>Porosity of fillers</td><td colspan="5">$V_{28/38}$</td></tr>
<tr><td>ΔRBTT of fillers</td><td colspan="5">$\Delta_{R\&B}$ 8/16</td></tr>
<tr><td>Angularity of chippings</td><td>% of broken surfaces</td><td colspan="5">$C_{95/1}$</td></tr>
<tr><td>Flow time for sands</td><td>Flow time for sands</td><td colspan="5">$E_{CS}38$</td></tr>
</table>

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545) For example :
- *an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10*
- *an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15*

an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

table 14 – Surface courses – Minimum characteristics for aggregates to be used in BBTM

<table>
<tr><th rowspan="2">Products</th><th rowspan="2" colspan="2">Characteristics</th><th colspan="5">Traffic class</th></tr>
<tr><th>CT1</th><th>CT2</th><th>CT3</th><th>CT4</th><th>CT5</th></tr>
<tr><td rowspan="14">BBTM</td><td rowspan="3">Intrinsic characteristics of aggregate</td><td>Fragmentation</td><td colspan="5">LA_{20} (1)</td></tr>
<tr><td>Wear</td><td colspan="5">$M_{DE}15$ (1)</td></tr>
<tr><td>Polishing</td><td colspan="5">PSV_{50}</td></tr>
<tr><td rowspan="4">Manufacturing characteristics of aggregate</td><td>General grading d/D</td><td colspan="5">G_C 85/15</td></tr>
<tr><td>Grading tolerance, intermediate sieve</td><td colspan="5">$G_{20/15}$ or $G_{25/15}$</td></tr>
<tr><td>Cleanness</td><td colspan="5">f_1</td></tr>
<tr><td>Flakiness</td><td colspan="5">FI_{25}</td></tr>
<tr><td rowspan="2">Manufacturing characteristics of sands and gravels</td><td>General grading d/D</td><td colspan="5">G_F85 or G_A85 si $2 < D \leq 6{,}3$ mm</td></tr>
<tr><td>Grading tolerance, intermediate sieve</td><td colspan="5">$G_{TC}10$</td></tr>
<tr><td rowspan="3">Fines and fillers</td><td>Quality of fines</td><td colspan="5">MB_F10</td></tr>
<tr><td>Porosity of fillers</td><td colspan="5">$V_{28/38}$</td></tr>
<tr><td>ΔRBTT of fillers</td><td colspan="5">$\Delta_{R\&B}$ 8/16</td></tr>
<tr><td>Angularity of chippings</td><td>% of broken surfaces</td><td colspan="5">$C_{95/1}$</td></tr>
<tr><td>Flow time for sands</td><td>Flow time for sands</td><td colspan="5">$E_{CS}35$</td></tr>
</table>

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :
- *an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10*
- *an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15*

an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

Table 15 – Surface courses – Minimum characteristics for aggregates to be used in ECF

Products	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
ECF	Intrinsic characteristics of aggregate	Fragmentation	LA_{20} (1)	not recommended			
		Wear	$M_{DE}20$ (1)				
		Polishing	PSV_{50}				
	Manufacturing characteristics of aggregate	General grading d/D	G_C 85/15				
		Grading tolerance, intermediate sieve	$G_{20/15}$				
		Cleanness	f_1				
		Flakiness	FI_{25}				
	Manufacturing characteristics of sands and gravels	General grading d/D	G_F85 or G_A85 si $2 < D \leq 6{,}3$ mm				
		Grading tolerance, intermediat sieve	$G_{TC}10$				
	Fines and fillers	Quality of fines	MB_F10				
		Porosity of fillers	$V_{28/38}$				
		ΔRBTT of fillers	$\Delta_{R\&B}$ 8/16				
	Angularity of chippings	% of broken surfaces	$C_{50/10}$				
	Flow time . for sands	Flow time for sands	$E_{CS}30$				

(1)If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :
- an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10
- an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15
an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

table 16 – Surface courses – minimum characteristics for aggregates to be used in EP

Product	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
EP	Intrinsic characteristic of aggregate	Fragmentation	LA_{25} (1)		LA_{20} (1)		
		Wear	$M_{DE}20$ (1)		$M_{DE}15$ (1)		
		Polishing	PSV_{50}		PSV_{50}		
	Manufacturing characteristics of aggregate	General grading d/D	G_C 85/20				
		Grading tolerance, intermediate sieve	$G_{20/15}$				
		Cleanness	f_1				
		Flakiness	FI_{25}				
	Manufacturing characteristics of sands and gravels	General grading d/D	G_F85 or G_A85 si $2 < D \leq 6{,}3$ mm				
		Grading tolerance, intermediate sieve	$G_{TC}10$				
	Fines and fillers	Quality of fines	MB_F10				
		Porosity of fillers	$V_{28/38}$				
		ΔRBTT of fillers	$\Delta_{R\&B}$ 8/16				
	Angularity of chippings	% of broken surfaces	$C_{50/10}$				
	Flow timel. for sands	Flow time for sands	$E_{CS}30$				

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :
- an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10
- an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15
an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

Table 17 – Surface courses –Minimum characteristics for aggregates to be used in ESU

Product	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
ESU	Intrinsic characteristics of aggregate	Fragmentation	LA_{20} (1)		not recommended		
		Wear	$M_{DE}15$ (1)				
		Polishing	PSV_{50}				
	Manufacturing characteristics of aggregate	General grading d/D	G_C 85/20	GC 85/15			
		Grading tolerance, intermediate sieve	$G_{20/15}$	$G_{20/15}$			
		Cleanness	f_1	f_1			
		Flakiness	FI_{20}	FI_{20}			
	Angularity of chippings	% of broken surfaces	$C_{95/1}$				

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :

- *an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10*
- *an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15*

an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

Table 18 – Binder courses – Minimum characteristics for aggregates to be used in EB-BBA, EB-BBSG, EB-BBME and EB-BBM

Product	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
EB-BBA EB-BBSG EB-BBME EB-BBM	Intrinsic characteristics of aggregate	Fragmentation	not recommended		LA_{30} (1)		LA_{25} (1)
		Wear			$M_{DE}25$ (1)		$M_{DE}20$ (1)
	Manufacturing characteristics of aggregate	General grading d/D			G_C 85/20		
		Grading tolerance, intermediate sieve			$G_{20/15}$ or $G_{25/15}$		
		Cleanness			f_1		
		Flakiness			FI_{25}		
	Manufacturing characteristics of sands and gravels	General grading d/D			G_F85 or G_A85		
		Grading tolerance, intermediate sieve			$G_{TC}10$		
	Fines et fillers	Quality of fines			MB_F10		
		Porosity of fillers			$V_{28/38}$		
		ΔRBTT of fillers			$\Delta_{R\&B}$ 8/16		

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :

- *an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10*
- *an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15*

an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

Table 19 – Base courses – Minimum characteristics for aggregates to be used in EB-GB and EB-EME

Product	Characteristics		Traffic class				
			CT1	CT2	CT3	CT4	CT5
EB-GB EB-EME	Intrinsic characteristics of aggregate	Fragmentation Wear	not recommended	LA_{30} (1) $M_{DE}25$ (1)		LA_{25} (1) $M_{DE}20$ (1)	
	Manufacturing characteristics of aggregate	General grading d/D		G_C 85/20			
		Grading tolerance, intermediate sieve		$G_{25/15}$			
		Cleanness		f_1			
		Flakiness		FI_{25}			
	Manufacturing characteristics of sands and gravels	General grading d/D		G_F85 or G_A85			
		Grading tolerance, intermediate sieve		$G_{TC}10$			
	Fines and fillers	Quality of fines		MB_F10			
		Porosity of fillers		$V_{28/38}$			
		ΔRBTT of fillers		$\Delta_{R\&B}$ 8/16			

(1) If explicitly justified by the contractual documentation, a maximum compensation of 5 points between the LA and MDE characteristics may be applied (article 8.1 of French standard XP P 18 545). For example :
- *an aggregate with LA = 25 is deemed to comply with [LA20 MDE15] if it has MDE = 10*
- *an aggregate with MDE = 20 is deemed to comply with [LA20 MDE15] if it has LA = 15*
an aggregate with MDE = 18 is deemed to comply with [LA20 MDE15] if it has LA = 17

3.1.3 Aggregates for bituminous mixtures

The requirements for the description and classification of aggregates for bituminous mixtures must as a minimum comply with categories F1, P15 or S70 of French standard NF EN 13 108-8. Table 20 below provides further information, and specifies the possible uses of different aggregates for bituminous mixtures in the mix design of new mixtures according to their composition and characterization.

Table 20 - Maximum percentage of aggregates to be used in bituminous mixtures

Components of the bituminous mixture							
	Bituminous binder	Content	TL_{NS}	TL_2	TL_1		
		Penetration or RBTT	B_{NS}	B_2	B_1		
	Aggregate	Grading	G_{NS}	G_2		G_1	
		Intrinsic characteristics	R_{NS}		R_1	R_{NS}	R_1
	CT1 and CT2	Surface course	0 %		20 %	0 %	20 %
		Binder course	0 %	30 %			
		Base	10 %	20 %	30 %	40 %	
	CT3 and CT4	Surface course	0 %		10 %	0 %	10 %
		Binder course		10 %		20 %	
		Base	10 %	20 %		40 %	
	CT5	Surface course	0 %		0 %	0 %	10 %
		Binder course	0 %		10 %	0 %	10 %
		Base	0 %		20 %	0 %	20 %

Comment :The polishing resistance characteristics of aggregates for bituminous mixtures correspond to those for new aggregates.

3.2 –Bituminous binders

French product standards allow the designer a wide choice of binders : pure bitumen, polymer-modified bitumen, or bitumen to which an additive has been added in the factory, guaranteeing the result by means of :

- the actual behaviour of the material after one year's service, for surface dressings and slurry seals,

- observance of the specifications of the type-testing sample, for hot-applied mixtures.

These recommendations alone cannot guarantee a durable result. No type-testing procedure for a bituminous mixture can make it possible to forecast accurately how a mixture, once applied, will age, or hence how long its life will be. It is therefore very important that designers think carefully about the choice of the binder they intend to propose, bearing in mind that this choice has a considerable influence on the cost of the techniques employed.

3.2.1 - Types of binders

The binders for bituminous mixtures currently available on the market are :

● *"Traditional" pure bitumens*

These comply with French standard NF EN 12 591 and are classified according to the penetration test at 25°C. Suitable binders range from Class 20/30 (the hardest) to Class 160/220 (the least hard).

● *"Hard" bitumens*

These binders comply with the NF EN 12 591 standard, and are classified according to the penetration test at 25°C. Two classes are widely used : Class 10/20 and Class 15/25.

● *"Multigrade" bitumens*

They are pure bitumens whose thermal sensitivity has been lowered by means of a special treatment during their manufacture. Multigrade binders were developed to combat the occurrence of rutting in road pavements; the most widely used class is 35/50. There also exists a Class 20/30, but the use of these products is rarely justified for airport pavements..

● *Bitumens "with additives"*

These binders are not considered to be modified binders.

The additives concerned are employed essentially in order to improve resistance to rutting, and even to increase resistance to fatigue, when fibres are added.

The additives are injected during the mixing stage of the manufacture of the bituminous mixture.

● *Polymer-modified bitumens (PMBs)*

The standard governing the specification for this kind of bitumen is NF EN 14 023

These bitumens are mainly used for mixtures applied in thin or very thin layers for surface courses, and for surface dressings, when the requirement is for :

- an improvement in mechanical performance, in terms of

- elasticity and flexibility

- greater resistance to rutting

- reduced sensitivity to surface ripping and shearing efforts,

- greater resistance to hydrocarbons

- enhanced durability (due to the thicker coating of binder), with properties unchanged (resistance to rutting, macrotexture maintained, etc.)

- greater surface cohesion

- reduced sensitivity to high and low temperatures.

These binders are also recommended for tack coats applied to thin or very thin layers of coated materials, and for taxiways where tangential (shearing) stresses are considerable.

The quantity of polymers in the mixture varies according to the use for which the pavement is designed.

These binders can be divided into two categories, defined as "slightly modified" or "strongly modified".

The classification criterion for distinguishing between a "slightly modified" and a "strongly modified" binder is the plasticity interval, i.e. the difference between the ring-and-ball test softening point temperature (standard NF EN 1427) and the breaking-point temperature (standard NF EN 12 593).

- for a "slightly modified" binder, the plasticity interval lies between 65°C and 75°C

- for a "strongly modified" binder, the interval exceeds 75°C.

Modification of the binder is not significant below 65°C.

For use in an airport pavement, the essential minimum requirements are PMB 45/80-60[1] or PMB 40/100-65[1]

[1] *The first term (45/80) expresses penetration and the second (60) the ring-and-ball softening test temperature.*

Further technical requirements to be satisfied are :

- an elastic recovery equal to or greater than 70, at 25°C,
- a plasticity interval of between 65 et 75 ("slightly modified") or equal to or greater than 75 ("strongly modified").

● *Recycled binders*

These are significantly more fluid than the bitumens traditionally used in bituminous mixtures. Their consistency and composition are suited to the objective pursued, so that the mixture of recycled and new binders will have the same properties as a new binder.

● *Other uses of binders*

- Slurry seals

These are manufactured from cationic emulsions with a slow break rate. The basic binder is either a fairly soft pure bitumen (generally 70/100),or a bitumen modified by adding polymers (very similar to the polymer-modified bitumens used in hot-applied mixtures) or a pure bitumen with added latex (bi-phase emulsion). Polymers, or the bi-phase emulsion with added latex are added at the liquid stage, rather than being premixed with hot bitumen.

- Surface dressings

These are made with cationic emulsions with a high break rate, in which the basic binder is very similar to that of slurry seals, or they may be fluxed bitumens in which the basic binder is mixed with a more or less volatile flux.

- Tack coats

Tack coats usually consist of a cationic bituminous emulsion with a high break rate and a high residual bitumen content (> 60 %).

The binder is either a pure bitumen, or a polymer-modified bitumen, or a bi-phase emulsion with latex added at the aqueous stage of the emulsion.

Tack coats based on modified bitumens (polymers or latex emulsions) are used in areas subjected to significant tangential (shearing) stresses, such as turning areas, runway entrances and thresholds, and, to a lesser extent, parking areas.

Bitumen dosage should be, as a minimum, 250g/m² of residual bitumen for all bituminous concretes, except for BBTM, for which minimum dosage should be 300g/m². In the case of mixtures for thin layers (EB-BBM and BBTM), bitumen dosage will be set according to the roughness and/or porosity of the substrate.

It should be noted that there are on the market, alongside the traditional products, so-called "clean" products which avoid the soiling of the pavement by passing heavy goods vehicles.

- Anti-aviation-fuel mixtures.»

This type of mixture is usually applied on parking areas. The binder used is a modified binder to which an additive may be added to improve resistance to punching.

3.2.2 - Recommendations for use

Type testing does not take account of the ageing of a bituminous mixture over the life of the pavement. Therefore, the specifier will want to consider both minimum performance characteristics when the pavement is new (type testing) and the desired durability of the pavement. For example, the use of too hard bitumen on a site where ageing is likely to be rapid, and where there exist heavy thermal constraints, will result in much higher long-term maintenance costs compared with the use of polymer-modified bitumen, despite the higher application costs of the latter.

Given the above, it seems undesirable to allow the contractor free choice of type and class of binder in the context of an RFQ. This choice should be guided by the criteria discussed below.

● *binders for pavement bases*

The rule is to use pure bitumens with additives, or polymer-modified bitumens. For EB-GB, the bitumens are usually of Class 35/50, or even in some cases of Class 50/70.

For EB-EME, the bitumens used are usually of Class 20/30, 15/25 or 10/20. .

● *binders for binder courses*

These courses are not particularly subject to ageing, and consequently the products used may contain a hard binder if resistance to rutting requires this, and if the temperature range experienced by the site is moderate.

EB-BBME is formulated with 20/30 bitumens. Use of a harder binder (10/20) is not usually justified, and using a 35/50 bitumen often leads to less rigidity than is required for this type of material.

EB-BBM and EB-BBSG are generally formulated with pure 35/50 or 50/70 bitumen, and when the level of rutting resistance requires it, a multigrade 35/50 bitumen or a 35/50 with an additive such as cable scrap can be used

- *binders for surface courses*

Surface courses must be simultaneously resistant to rutting, shearing and ageing. The level of rutting resistance being determined at the type testing stage, the choice of a binder therefore directly affects the other two parameters.

Ultra-thin layers (< 2cm)

The products used for these are ESU and ECF, and are suitable for very light traffic only. The binders used are either pure bitumen emulsions (for use only in geographical areas where pavements are not subject to excessive ageing, because their temperature amplitude is small), or polymer-modified bitumen emulsions or bi-phase bitumen emulsions with added latex, in other cases.

Intermediate layers (2 to 4 cm)

For these, BBTM, EB-BBM and EB-BBA with discontinuous grading are used.

Courses of this kind are not recommended in areas where shearing strains are large under heavy traffic conditions. Consequently, these materials should be formulated with pure bitumen, of Class 50/70 or even Class 70/100. To be on the safe side, the tack coat should be made using a polymer-modified bitumen emulsion or bi-phase bitumen emulsion with added latex. The use of an EB-BBA with discontinuous grading on heavy traffic pavements can in certain cases necessitate the use of a polymer-modified bitumen to reduce the incidence of ageing of the binder, and thus to prolong the life of the mixture.

Thick layers (to 8 cm)

In these cases a far wider choice of binders is available because of the variety of mechanical and climatic stresses which may be encountered.

In the case of EB-BBA, the binder can be either pure 50/70 or 35/50 bitumen, a bitumen with additive, a multigrade 35/50 bitumen or a polymer-modified bitumen. The latter is to be preferred in the case of pavements subjected simultaneously to intense shearing and ageing stresses.

For EB-BBME, the choice is limited to pure 20/30 bitumen or 35/50 bitumen with additive or, for extreme cases, polymer-modified bitumen (intense shearing and ageing).

3.2.3 –Choice of binder

Binders are chosen according to the performance they achieve in laboratory tests. As a guide, Table 21 recommends the type and category of binder to be used according to the type of bituminous mixture selected and the performance class required.

Table 21 – Choice of binder according to the type of bituminous mixture selected and the performance class required.

BINDER		PURE BITUMEN						POLYMER-MODIFIED BITUMEN		
Mixture	**Class**	**70/100**	**50/70**	**35/50**	**20/30**	**15/25 or 10/20**	**Multigrade***	slightly modified**	strongly modified**	Anti-K
EB-BBSG	1		x	x						x(4)
	2		x	x						x(4)
	3			x	x		x	x (1)	x(2)	x(4)
EB-BBA	1	x	x							x(4)
	2		x	x						x(4)
	3			x			x	x (1)	x(2)	x(4)
EB-BBME	1			x	x					x(4)
	2				x	x(3)	x (1)	x (1)		x(4)
	3				x	x(3)	x (1)	x (1)		x(4)
BBTM	1	x	x					x		
	2	x	x							
EB-BBM	1	x	x							
	2		x	x						
	3			x			x	x (1)		
EB-GB	1		x	x						
	2		x	x						
	3			x						
EB-EME	1					x				
	2					x				
EB-SAF* **									x	

**   binder with improved sensitivity*
***   For this selection criterion, see article 3.2.1 "polymer-modified bitumens (PMBs)"*
**** Anti-crack sand*
(1) : in surface course
(2) : if NS 4 and in surface course
(3) : avoid 10/12 in surface course
(4) : if anti-crack performance is required

4 – Characteristics in the laboratory

4.1 – Type testing

Type testing is carried out in order to prove that the mix design complies with the relevant specifications of the product standard. It must be carried out in accordance with standard NF EN13 108-20; verification of the formula is carried out in the laboratory using materials from the site.

4.2 –Mix design levels

In line with the European approach, 5 levels of mix design have been defined in France, known as levels 0 to 4.

- *Level 0 :* this consists in drawing a grading curve and determining a binder content. This level may be required for mixtures used for low-traffic areas of pavements (hard shoulders, for example).
- *Level 1 :* gyratory shear press test and water-resistance test
- *Level 2 :* gyratory shear press test, water-resistance test and rutting test
- *Level 3 :* gyratory shear press test, water-resistance test, rutting test and modulus test (not relevant for EB-BBM et BBTM)
- *Level 4 :* gyratory shear press test, water-resistance test, rutting test, modulus test and fatigue test.

The mix design level of a bituminous mixture depends on the course of the pavement for which it is to be used (surface course, binder course or base) and the level of stress to which the pavement will be exposed. Table 22 below defines mix design levels as a function of these two criteria.

When choosing whether to use earlier test results or to carry out a new test, the scope of the project, its volume, the age and representativeness of the earlier test must be taken into consideration. A test result should be not older than 5 years for stress levels NS1 and NS2, and not older than 2 years for stress levels NS3 and NS4.

Table 22 - Mix design levels according to stress

		NS1	NS2	NS3	NS4
Area of airport		1	2 / 1	*	*
Runways	**Main part**	1	1 / 1	2 / 4	2 / 4
	Turning area	1	2 / 3	3 / 4	3 / 4
	Exit	1	2 / 1	3 / 4	3 / 4
	Threshold	1	2 / 1	3 / 4	3 / 4
Taxiways	**Main part**	1	2 / 1	3 / 4	3 / 4
	Intersections	1	2 / 3	3 / 4	3 / 4
Apron or holding area **		1	2 / 1	2 / 4	2+P / 4

* *Structure made of hydraulic concrete or porous asphalt*
** *See definitions given in Chapter 1*
P : *Resistance to static loads test (see Annex E)*

Surface courses / Base courses

4.3 – Characteristics of mixtures

The NF EN 13 108 series of French standards defines the formula of a bituminous mixture in terms firstly of its general characteristics, then its empirical or fundamental characteristics, and hence determines two approaches : the empirical approach and the fundamental approach.

4.3.1 General characteristics

These are generally grading, the percentage of voids, sensitivity to water and resistance to permanent strains (rut meter test).

4.3.2 Additional characteristics

- Empirical characteristics : these are principally the minimum bitumen content of the mixture (expressed as a percentage of the total mass of the mixture), the nature of the binder used and the extent of the grading envelope at characteristic sieve settings.
- Fundamental characteristics : these are principally the rigidity modulus and resistance to fatigue

A choice has to be made between these two sets of characteristics : it is not possible to work with empirical characteristics and fundamental characteristics at the same time.

In most cases, specifications are characterized by the empirical approach (in all cases, where BBTM and EB-BBM are concerned).

The fundamental approach corresponds to mix design levels 3 or 4. Essentially, it applies to materials used for structural purposes, such as high-modulus mixtures, bitumen-bound graded aggregates in the case of variants, and high-modulus bituminous concrete.

Tables 29 to 54 in the Annexes present an overview of the performance of bituminous mixtures, comparing cases of mix design by means of the empirical approach and the fundamental approach.

5 –Manufacture and application

5.1 - Production of bituminous mixtures

5.1.1 - Mixing plants

Mixing plant characteristics must comply with one of the French standards NF P 98 728-1 (continuous bituminous mixing plants) or NF P 98 728-2 (discontinuous bituminous mixing plants).

5.1.2 - Percentage of recycled aggregates

In the case of discontinuous bituminous mixing plants, as in continuous bituminous mixing plants which are not equipped with a specific recycling system, recycled aggregates must not represent more than 15% of the total weight of the mixture.

5.1.3 – Mixing temperature

When road bitumen is used, the temperature of the mixture must be measured in accordance with French standard NF EN 12 697-13, and must fall within the limits prescribed in table 23 below.

Compliance with these limits guarantees normal behaviour of the binder during coating, and ensures satisfactory compaction, provided of course that weather conditions and the compaction equipment are appropriate.

Transportation of the mixture from the production plant to the application site is carried out using vehicles equipped with a metal body, which must be fitted with a tarpaulin to protect the mixture and avoid its cooling. However, in particular cases, heat-insulated bodies may be specified.

The minimum temperatures at which the product may be delivered to the production plant must be documented and declared by the supplier.

Table 23 - Production temperature of bituminous mixtures according to bitumen grade (NF P 98 150-1)

Grade of pure bitumen	Normal production temperature (C°)*	Maximum temperature (C°)*
10/20 – 15/25	160 to 180	190
20/30	160 to 180	190
35/50	150 to 170	190
50/70	140 to 160	180
70/100	140 to 160	180
160/220	130 to 150	170

** For specific binders (modified bitumens, hard bitumen, bitumens with additives), different temperatures may apply. In these cases, they must be documented and declared by the supplier in the course of normal regulatory product markings. The same applies to techniques enabling the coating temperature to be reduced (warm mixtures).*

5.2.- Laying and spreading

5.2.1. - Tack coat

When a layer of bituminous material is applied to a pavement for reinforcement or renovation purposes, a tack coat is applied to ensure good adhesion to the substrate.

For this purpose, the use of binders with polymer additives is recommended, particularly in areas where tangential stresses are considerable : turning areas, runway exits, touchdown areas and to a lesser extent parking areas and taxiways. This method is also recommended for all thin and very thin layers whenever traffic exceeds level CT3.

Tack coats must be laid with a mechanical spreading device; use of a hose is prohibited. The equipment used is usually an ordinary spreader, as used for surface dressing. Integrated spray bars also exist on continuous feeders.

When an ordinary spreader is used, it is important to set the operating parameters of the device so as to ensure that spreading of the product is homogeneous across the pavement profile, avoiding any kind of streaking effect.

In this particular case, and especially when mud or soil deposits on the tack coat caused by passing vehicle wheels cannot be tolerated, free-standing spreaders can only be used if they spread a special emulsion which does not adhere to vehicle tyres. For the same reasons, the tack coat can be replaced by a single-application surface dressing, with appropriately calculated quantities of binder and chippings.

Applications of sand or chippings to a tack coat should be avoided.

The minimum rate of spread of residual binder is

- 300 g per m² for a BBTM
- 250 g per m² for other mixtures.

These rates of spread should be adapted to the condition of the substrate.

5.2.2 - Execution

To guarantee the surface quality objectives of a pavement, it is important to ensure that construction equipment and methods are suited to the constraints of the project, and that they comply with the construction rules given below :

- limit cold joints to the minimum possible, as these make for notorious weak points in an airport runway
- stagger spreading joints and overlaps as far as possible, by at least 20 centimetres for longitudinal joints and by at least 1 metre in the case of transversal joints
- keep the paver operating at sufficient speed to guarantee an acceptable surface evenness. An operating speed of less than 2 metres per minute is insufficient to reach the objectives
- recommend the use of a continuous feeder to avoid the effects of the paver stopping at the end of each truckload of mixture.

When reinforcing the entire width of a runway, two methods may be envisaged

- runways with a straight crossfall: movements of the paver should preferably be made in a downward direction, from the top edge to the bottom
- runways with crossfalls which are symmetrical with respect to the axis : movements of the paver should be executed from the centre line towards the edges.

5.2.3 - Paver guiding methods

The methods for guiding the paver must be indicated in the particular technical clauses section of the contract, and the contractor must state them clearly in his Quality Assurance Plan.

5.2.3.1 Longitudinal evenness

These methods for guiding the paver are determined according to the degree of surface evenness sought.

It is particularly important to note that the correction of long-wavelength defects generally necessitates the application of very thick layers of material.

To find the paver guiding method which best fits the works envisaged, the specifier should refer to French standard NF P 98 150-1 and Circular No. 2000-36 of 22 May 2000 on the longitudinal evenness of new surface courses.

5.2.3.2 Uni transversal evenness

Compliance with the specifications for transversal evenness (slope, depressions) when the spreading width exceeds 5 metres requires guiding the paver by means of two lateral references.

5.2.4. Guiding the paver using a non-linked reference

When a wire is used to guide the paver, particular care must be taken, especially regarding the spacing of brackets, and the pressure of the sensor. As a guide, a 4 mm arrow made with the guiding wire results in a rating of 6 for a medium wavelength.

It should be noted that the topography of airport areas lends itself particularly well to the use of non-material reference systems such as lasers and GPS.

5.2.5 Joining a new surface course to an existing pavement

Two ways of doing this are possible, according to the constraints of the project.

5.2.5.1 A definitive tapered lane on the old pavement

During reinforcement operations, the join with the existing pavement should be made over a certain distance, which will depend on the thickness of the new course and the slope, which must comply with current recommendations (1% to 1.5 %). To ensure the continuity of the surfacing, a cut joint of 4 to 5 cm is dug in the mixture of the old pavement, then a layer of bituminous emulsion is laid to bring about perfect adhesion (see Diagram A).

5.2.5.2 Temporary tapered lane

This type of joint is executed whenever air traffic must be restarted following halting of site operations. The joint lies transversally across the pavement, and the slope of the joint varies according to the thickness of the course applied (see Diagram B for the principle of this operation).

While executing these works, it will be found that guiding the paver by means of mobile references is the most appropriate method : the length of the beam should be at least 1 metre.

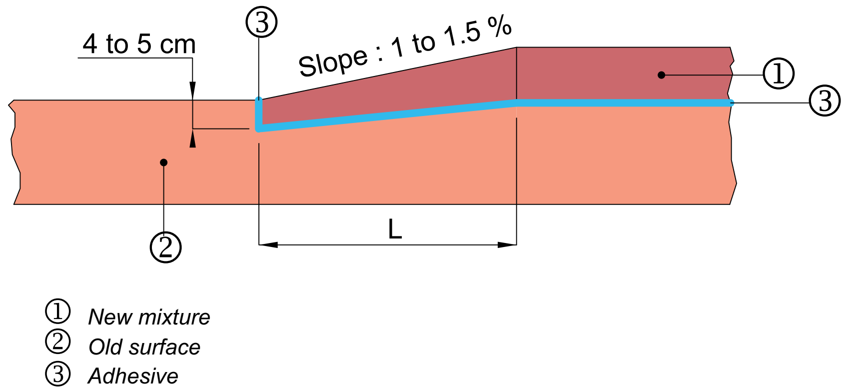


Diagram A – Definitive tapered lane on the old pavement, executed with a bituminous mixture

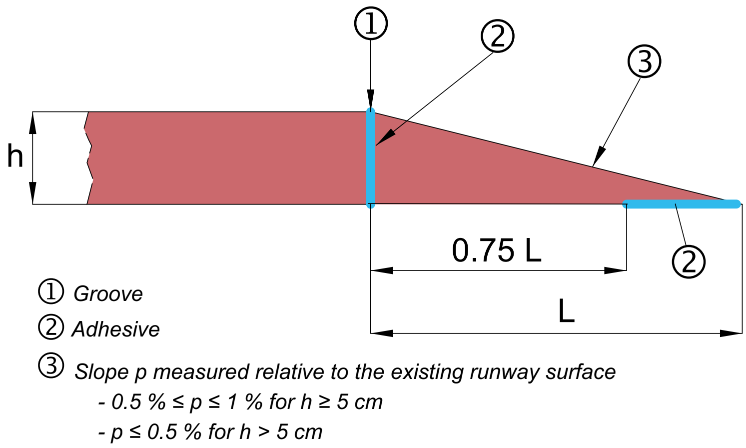


Diagram B –Temporary tapered lane executed with a bituminous mixture

5.3 - Laying - Compaction

5.3.1 Compaction

Compaction of a bituminous mixture on an airport pavement is very similar to the same operation on a road construction site. The only difference is that particular care is needed for compaction of the edges of the wearing course lanes.

5.3.2 Execution of longitudinal joints

The designer should refer to standard NF P 98 150-1 for the definition of execution methods according to the composition of the spreading equipment.

Obtaining satisfactory results in longitudinal joints (between two spread lanes) depends on the execution method selected. Sawing is prohibited, as this would cause too rapid opening of the joint. So is the use of "joint warmers" which are sometimes fitted to pavers; these are not very effective.

To remedy problems of this type, the mixture can be applied using two pavers or more, working in parallel. The distance between two pavers must never be greater than 20 metres. This method is recommended only if it does not prejudice the overall economics of the project.

5.3.3. Line validation

This expression refers to all operations intended to ensure that the equipment and methods used enable the intended characteristics to be attained.

Verification and reference areas form part of the line validation system, and determine compaction methods.

Use of reference areas is especially recommended in the case of projects in which application of a given product lasts more than one week

6 – On-site characteristics– Verification

The project manager's monitoring and progress-chasing role in on-site operations includes constantly verifying that the work is being carried out according to the requirements of the project owner. This applies to each phase of the works, and particularly to the need to verify that the characteristics prescribed in the technical clauses of the contract are indeed being observed. This verification mission concerns the following points in particular :

6.1 Supplies

As they are delivered, incoming products such as aggregate, fillers, binders, additives and bituminous mixtures are checked and tested, according to the detailed procedures laid out in the quality plan, for compliance with the requirements of standard NF EN 13 108-21 (tables 3, 4, 5, 6 and 7).

Additives must comply with a European standard, or a European technical approval, or materials specifications which have been proved by past experience to give satisfaction as components for a bituminous mixture.

6.2 Type testing samples

Documentation concerning type testing samples supplied by the contractor must be approved by the project manager (with or without verification tests).

6.3 Production of the bituminous mixture

The project manager must satisfy himself as to the conformity of the characteristics of the mixture. This is done with reference to standard NF EN 13 108-21 for the conformity of the mixture, and standard NF 98 150-1 for on-site checks.

6.4 Application

The nature of airport operations imposes strict requirements on pavement characteristics in terms of skid resistance and longitudinal evenness. The width and minimal slope of airport pavements imply very strict altimetric constraints to respect the correct values for slopes and the depth of depressions in particular. It should be noted that good skid resistance in rainy conditions can only be achieved by associating the properties of the surfacing with good surface geometry.

Lastly, the width of airport pavements requires a large number of joints, which are notoriously weak points of these pavements. Their execution must therefore be carefully verified.

6.4.1 Geometry

To satisfy these requirements, several frames of reference are in force : ICAO Annex 14, the French ministerial decree on airport approvals and operating procedures of 25 August 2003, Annex 1 of the French ministerial decree on the technical characteristics of certain land-based airports used by fixed-wing aircraft dated 10 July 2006, and ITAC (Instruction Technique sur les Aérodromes Civils, the French technical instructions for civil airports).

6.4.2 Verification of evenness

The evenness of the surface course is verified according to standard NF P 98 218-3 and LPC method no. 46. Ratings are evaluated according to the specifications defined in the information note published by the LCPC and STAC.

These specifications are defined in Annex F of this document.

6.4.3 Verification of skid resistance

Two types of in situ test can be carried out to characterize skid resistance : measurement of the macrotexture, and measurement of the longitudinal friction coefficient.

6.4.3.1 Macrotexture

This is assessed by measuring the average texture depth according to standard NF EN 13 036-1. The on-site measurement should be taken as soon as possible after application and in any case within two weeks. The minimum acceptable values are shown in Table 24 below.

6.4.3.2 Longitudinal friction coefficient

Measurements of the longitudinal friction coefficient should be carried out on the surface courses of airport pavements as soon as the work has been accepted, and within 3 to 12 months of the commissioning of the pavement (standard NF P 98 150-1). They should be taken at two speeds : 65 km/h and 95 km/h.

On acceptance of the work, the longitudinal friction coefficient values measured must be at least equal to those indicated in paragraph 3 of Annex 1 of the decree on the technical characteristics certain land-based airports used by fixed-wing aircraft dated 10 July 2006.

When drawing up the technical clauses of the contract, the designer may suggest other values, as long as these are not less than those defined in Annex 1 of the decree.

In the case of measurements carried out within 3 to 12 months, the values to be achieved are those specified for new pavements. For example, in the case of measurements carried out with an IMAG (a French skid resistance measurement trailer), the following values are acceptable :

- 0.51 at a speed of 65 km/h
- 0.43 at a speed of 95 km/h.

Table 24 – Average texture depth values

Products	Minimum values observed on site (in mm)	Minimum values required by standard NF P 98 150-1 (in mm)
ESU (MCO 2/4)	No data	0,6
ECF (0/6)	0,6	-
BBTM 0/6 type 1	0,6	0,7
BBTM 0/10 type 1	0,9	0,9
EB-BBMA 0/10	0,6	0,7
EB-BBMA 0/14	No data	0,7
EB-BBMB 0/10	No data	0,5
EB-BBMB 0/14	No data	0,7
EB-BBMC 0/10	No data	0,5
EB-BBA 0/10C	0,4	0,4 on airport ramp or apron and 0.6 on runways
EB-BBA 0/10 D	0,5	
EB-BBA 0/14 C	0,4	
EB-BBA 0/14 D	0,6	
EB-BBME 0/10	0,4	0,4
EB-BBME 0/14	0,4	0,5
EB-BBSG 0/10	No data	0,4
EB-BBSG 0/14	No data	0,5

Note : In surface courses of airport pavements, the minimum values required at 90% of control points are :
- 0.6 mm on runways, and
- 0.4 mm on taxiways

ANNEXES

Annex A : Determining the aircraft group of an aircraft

Table 25 below gives for each aircraft and helicopter type currently in service the "aircraft group" to which it belongs.

If an aircraft is not listed in the table, its group can be determined by comparing the product of P x R ("number of landing wheels in its main landing gear assembly multiplied by tyre pressure") to the following values :

Group 1 : No value. Includes all light aircraft weighing less than 5 700 kg and with tyre pressure of less than 0.9 MPa.

group 2 : (PxR) < 2

group 3 : 2 ≤ (PxR) < 4,1

group 4 : 4,1 ≤ (PxR) < 5,5

group 5 : 5,5 ≤ (PxR)

Table 25 – Definition of the aircraft group of a given aircraft

Manufacturer	Type	Series	Maximum weight (kg)	Landing gear tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of wheels/main landing gear	« Aircraft » Group
AIRBUS	A 300	600 R	171 400	1,34	4	5,36	group 4
AIRBUS	A 300	600 ST BELUGA	156 500	1,24	4	4,96	group 4
AIRBUS	A 300	B2	142 900	1,28	4	5,12	group 4
AIRBUS	A 300	B4/C4/600	165 900	1,28	4	5,12	group 4
AIRBUS	A 310	200	153 900	1,46	4	5,84	group 5
AIRBUS	A 310	200 BASIC	139 900	1,30	4	5,20	group 4
AIRBUS	A 310	200 C/DEV	142 900	1,33	4	5,32	group 4
AIRBUS	A 310	300	164 900	1,29	4	5,16	group 4
AIRBUS	A 318		68 400	1,24	2	2,48	group 3
AIRBUS	A 319	100 BOG	70 400	1,13	2	2,26	group 3
AIRBUS	A 319	100 JUM	75 900	1,38	2	2,76	group 3
AIRBUS	A 320	100	68 400	1,28	2	2,56	group 3
AIRBUS	A 320	200 BOG	75 900	1,22	2	2,44	group 3
AIRBUS	A 320	200 JUM	77 400	1,44	2	2,88	group 3
AIRBUS	A 321	100	85 400	1,39	2	2,78	group 3
AIRBUS	A 321	200	93 400	1,50	2	3,00	group 3
AIRBUS	A 330	200	233 900	1,42	4	5,68	group 5
AIRBUS	A 330	300	233 900	1,45	4	5,80	group 5
AIRBUS	A 340	200 AILE	275 900	1,42	4	5,68	group 5
AIRBUS	A 340	200 FUSEL	275 900	1,09	2	2,18	group 3
AIRBUS	A 340	300 AILE	277 400	1,42	4	5,68	group 5
AIRBUS	A 340	300 FUSEL	277 400	1,09	2	2,18	group 3
AIRBUS	A 340	500 AILE	381 200	1,61	4	6,44	group 5
AIRBUS	A 340	500 FUSEL	381 200	1,61	4	6,44	group 5
AIRBUS	A 340	600 AILE	381 200	1,61	4	6,44	group 5
AIRBUS	A 340	600 FUSEL	381 200	1,61	4	6,44	group 5
AIRBUS	A 380	800 AILE	571 000	1,50	4	6,00	group 5
AIRBUS	A 380	800 FUSEL	571 000	1,50	6	9,00	group 5
AIRBUS	A 380	800 F AILE	602 000	1,50	4	6,00	group 5
AIRBUS	A 380	800 F FUSEL	602 000	1,50	6	9,00	group 5
ANTONOV	AN-12		61 200	1,20	4	4,80	group 4
ANTONOV	AN-124		406 500	1,25	10	12,50	group 5
ANTONOV	AN-225		588 400	1,13	14	15,82	group 5

Manufacturer	Type	Series	Maximum weight (kg)	Landing gear tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of wheels/main landing gear	« Aircraft » Group
ATR	ATR 42	200	15 750	0,74	2	1,48	group 2
ATR	ATR 42	320	16 720	0,75	2	1,50	group 2
ATR	ATR 42	500	18 770	0,83	2	1,66	group 2
ATR	ATR 72	101/102	20 020	0,79	2	1,58	group 2
ATR	ATR 72	201/202/212	21 530	0,79	2	1,58	group 2
ATR	ATR 72	212A	22 670	0,84	2	1,68	group 2
ATR	ATR 72	500	22 670	0,84	2	1,68	group 2
BOEING	B 377	Super Guppy	77 500	1,25	2	2.50	group 3
BOEING	B 737	400	68 250	1,28	2	2,56	group 3
BOEING	B 737	500	60 800	1,34	2	2,68	group 3
BOEING	B 737	600	65 771	1,41	2	2,82	group 3
BOEING	B 737	700	70 307	1,41	2	2,82	group 3
BOEING	B 737	800	79 243	1,41	2	2,82	group 3
BOEING	B 737	900	79 243	1,41	2	2,82	group 3
BOEING	B 737	BBJ	77 791	1,41	2	2,82	group 3
BOEING	B 737	BBJ2	79 245	1,41	2	2,82	group 3
BOEING	B 747	100 SF	334 700	1,60	4	6,40	group 5
BOEING	B 747	100/100B	341 500	1,32	4	5,28	group 4
BOEING	B 747	100B SR	273 500	1,12	4	4,48	group 4
BOEING	B 747	100B 300	341 500	1,32	4	5,28	group 4
BOEING	B 747	100B 300 SR	273 500	1,12	4	4,48	group 4
BOEING	B 747	200B COMBI 300	379 100	1,31	4	5,24	group 4
BOEING	B 747	200B/200B COMBI	379 100	1,31	4	5,24	group 4
BOEING	B 747	200B 300	379 100	1,31	4	5,24	group 4
BOEING	B 747	200C	379 100	1,38	4	5,52	group 5
BOEING	B 747	200F	379 100	1,38	4	5,52	group 5
BOEING	B 747	400	397 801	1,38	4	5,52	group 5
BOEING	B 747	400 COMBI	397 801	1,38	4	5,52	group 5
BOEING	B 747	400 DOMESTIC	278 279	1,03	4	4,12	group 4
BOEING	B 747	400 FREIGHTER	397 801	1,38	4	5,52	group 5
BOEING	B 747	400ER	414 130	1,57	4	6,28	group 5
BOEING	B 747	400ER FREIGHTER	414 130	1,59	4	6,36	group 5
BOEING	B 747	SP	318 800	1,41	4	5,64	group 5
BOEING	B 757	200	116 100	1,26	4	5,04	group 4
BOEING	B 757	200 PF	116 100	1,26	4	5,04	group 4
BOEING	B 757	300	122 930	1,38	4	5,52	group 5
BOEING	B 767	200	143 800	1,31	4	5,24	group 4
BOEING	B 767	200 ER	179 623	1,31	4	5,24	group 4
BOEING	B 767	300	159 650	1,25	4	5,00	group 4
BOEING	B 767	300 ER	187 334	1,38	4	5,52	group 5
BOEING	B 767	300 FREIGHTER	187 334	1,38	4	5,52	group 5
BOEING	B 767	400 ER	204 630	1,50	4	6,00	group 5
BOEING	B 777	200	243 500	1,25	6	7,50	group 5
BOEING	B 777	200 ER	287 800	1,41	6	8,46	group 5
BOEING	B 777	200 LR	348 721	1,50	6	9,00	group 5
BOEING	B 777	300	300 280	1,48	6	8,88	group 5
BOEING	B 777	300 ER	352 441	1,52	6	9,12	group 5
BOEING	B 777	300 FREIGHTER	348 721	1,52	6	9,12	group 5
BOMBARDIER	BD700	Global 5000	39 894	1,15	2	2,30	group 3
BOMBARDIER	BD700	Global express	44 565	1,15	2	2,30	group 3
BOMBARDIER	CHALLENGER	300 (BD100)	17 671	1,04	2	2,08	group 3
BOMBARDIER	CHALLENGER	600	18 758	1,53	2	3,06	group 3

Manufacturer	Type	Series	Maximum weight (kg)	Landing gear tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of. wheels/main landing gear	« Aircraft » Group
BOMBARDIER	CHALLENGER	601	20 503	1,42	2	2,84	group 3
BOMBARDIER	CHALLENGER	604	21 885	1,27	2	2,54	group 3
BOMBARDIER	CHALLENGER	800, 850	24 154	1,26	2	2,52	group 3
BOMBARDIER	CHALLENGER	870	35 115	1,05	2	2,10	group 3
BOMBARDIER	CHALLENGER	890	38 555	1,16	2	2,32	group 3
BOMBARDIER	CRJ	100, 200, 440	24 154	1,26	2	2,52	group 3
BOMBARDIER	CRJ	700	35 115	1,05	2	2,10	group 3
BOMBARDIER	CRJ	705, 900	38 555	1,16	2	2,32	group 3
BOMBARDIER	DASH8	Q100	16 740	0,53	2	1,06	group 2
BOMBARDIER	DASH8	Q200	16 556	0,63	2	1,26	group 2
BOMBARDIER	DASH8	Q300	19 600	0,70	2	1,40	group 2
BOMBARDIER	DASH8	Q400	29 347	1,56	2	3,12	group 3
BRITISH AEROSPACE	BAE 146	100 Ser	38 330	0,90	2	1,80	group 2
BRITISH AEROSPACE	BAE 146	200 Ser	43 100	1,14	2	2,28	group 3
BRITISH AIRCRAFT	BAC 01	nov 400	39 690	0,96	2	1,92	group 2
BRITISH AIRCRAFT	BAC 01	nov 475	44 680	0,58	2	1,16	group 2
BRITISH AIRCRAFT	BAC 01	nov 500	47 400	1,10	2	2,20	group 3
BRITISH AIRCRAFT	BAC 111		47 600	0,90	2	1,80	group 2
CANADAIR	CANADAIR CL-44		95 710	1,62	4	6,48	group 5
CONVAIR	CONVAIR 880 M		87 700	1,03	4	4,12	group 4
CONVAIR	CONVAIR 900		115 670	1,28	4	5,12	group 4
DASSAULT	FALCON 20		12 800	0,92	2	1,84	group 2
DASSAULT	FALCON 2000		16 300	1,43	2	2,86	group 3
DASSAULT	FALCON 50		17 600	1,43	2	2,86	group 3
DASSAULT	FALCON 900		20 640	1,30	2	2,60	group 3
DASSAULT	FALCON 7X		31 300	1,43	2	2,86	group 3
DEHAVILLAND	DHC 7 DASH 7		20 000	0,74	2	1,48	group 2
EMBRAER	EMB120	ER	12 070	0,94	2	1,88	group 2
EMBRAER	EMB120	RT	11 580	0,83	2	1,66	group 2
EMBRAER	EMB135	ER	19 100	0,95	2	1,90	group 2
EMBRAER	EMB135	LEGACY (BJ)	22 570	1,13	2	2,26	group 3
EMBRAER	EMB135	LR	20 100	1,04	2	2,08	group 3
EMBRAER	EMB145	EP	21 090	1,05	2	2,10	group 3
EMBRAER	EMB145	ER	20 700	1,03	2	2,06	group 3
EMBRAER	EMB145	EU	20 090	1,03	2	2,06	group 3
EMBRAER	EMB145	LR/LU/MR	22 100	1,15	2	2,30	group 3
EMBRAER	EMB145	MK	20 090	1,08	2	2,16	group 3
EMBRAER	EMB145	MP	21 090	1,08	2	2,16	group 3
EMBRAER	EMB145	XR	24 200	1,26	2	2,52	group 3
EMBRAER	EMB170	LR/SU	37 360	0,97	2	1,94	group 2
EMBRAER	EMB170	STD	36 150	0,97	2	1,94	group 2
EMBRAER	EMB175	STD/LR	38 950	1,00	2	2,00	group 3
EMBRAER	EMB190	LR/AR	51 960	1,08	2	2,16	group 3
EMBRAER	EMB190	STD	47 950	1,08	2	2,16	group 3
EMBRAER	EMB195	IGW	52 450	1,13	2	2,26	group 3
EMBRAER	EMB195	LR	50 950	1,13	2	2,26	group 3
EMBRAER	EMB195	STD	48 950	1,13	2	2,26	group 3
EMBRAER	ERJ140	KE	20 200	1,02	2	2,04	group 3
EMBRAER	ERJ140	KL	21 200	1,08	2	2,16	group 3
FOKKER	FOKKER 70	OPT	41 800	0,81	2	1,62	group 2
FOKKER	FOKKER 100	OPT	43 320	0,92	2	1,84	group 2
FOKKER	FOKKER 100	STD	41 730	0,89	2	1,78	group 2

Manufacturer	Type	Series	Maximum weight (kg)	Landing gear tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of wheels/main landing gear	« Aircraft » Group
FOKKER	FOKKER 27	200/500	20 410	0,54	2	1,08	group 2
FOKKER	FOKKER F-28	1000	29 480	0,58	2	1,16	group 2
FOKKER	FOKKER F-28	2000	29 480	0,70	2	1,40	group 2
FOKKER	FOKKER F-28	4000	32 210	0,70	2	1,40	group 2
FOKKER	FOKKER F-29		59 780	1,02	2	2,04	group 3
HAWKER SIDDELEY	HS 121	2E	65 950	1,09	4	4,36	group 4
HAWKER SIDDELEY	HS 121	3	68 270	1,16	4	4,64	group 4
HAWKER SIDDELEY	HS 748		21 180	0,65	2	1,30	group 2
HAWKER SIDDELEY	TRIDENT	1E	61 160	1,03	4	4,12	group 4
HAWKER SIDDELEY	TRIDENT	2E	66 000	1,07	4	4,28	group 4
ILYUSHIN	IL 62		166 570	0,93	4	3,72	group 3
ILYUSHIN	IL 76	TD	191 500	0,64	8	5,12	group 4
ILYUSHIN	IL 78	M	211 000	0,64	8	5,12	group 4
LOCKHEED	L 1011	1	195 960	1,24	4	4,96	group 4
LOCKHEED	L 1011	100/200	212 290	1,21	4	4,84	group 4
LOCKHEED	L 1011	500	225 890	1,27	4	5,08	group 4
Mc DONNEL DOUGLAS	DC-6	PC	46 200	0,90	2	1,80	group 2
Mc DONNEL DOUGLAS	DC-8	43	144 245	1,22	4	4,88	group 4
Mc DONNEL DOUGLAS	DC-8	55	148 781	1,28	4	5,12	group 4
Mc DONNEL DOUGLAS	DC-8	55F	148 781	1,28	4	5,12	group 4
Mc DONNEL DOUGLAS	DC-8	61	148 780	1,30	4	5,20	group 4
Mc DONNEL DOUGLAS	DC-8	61F	150 142	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	62	160 121	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	62F	160 121	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	63	162 389	1,35	4	5,40	group 4
Mc DONNEL DOUGLAS	DC-8	63F	162 389	1,35	4	5,40	group 4
Mc DONNEL DOUGLAS	DC-8	71	148 781	1,30	4	5,20	group 4
Mc DONNEL DOUGLAS	DC-8	71F	150 142	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	72	153 317	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	72F	153 317	1,31	4	5,24	group 4
Mc DONNEL DOUGLAS	DC-8	73	162 389	1,35	4	5,40	group 4
Mc DONNEL DOUGLAS	DC-8	73F	162 389	1,35	4	5,40	group 4
Mc DONNEL DOUGLAS	DC-9	15	41 504	0,89	2	1,78	group 2
Mc DONNEL DOUGLAS	DC-9	15F	41 504	0,89	2	1,78	group 2
Mc DONNEL DOUGLAS	DC-9	21	45 813	0,99	2	1,98	group 2
Mc DONNEL DOUGLAS	DC-9	32F	49 442	1,07	2	2,14	group 3
Mc DONNEL DOUGLAS	DC-9	33	49 442	1,07	2	2,14	group 3
Mc DONNEL DOUGLAS	DC-9	41	52 163	1,11	2	2,22	group 3
Mc DONNEL DOUGLAS	DC-9	51	55 338	1,19	2	2,38	group 3
Mc DONNEL DOUGLAS	DC-9	80/81	63 958	1,18	2	2,36	group 3
Mc DONNEL DOUGLAS	DC-10	10	207 750	1,34	4	5,36	group 4
Mc DONNEL DOUGLAS	DC-10	10CF	207 750	1,34	4	5,36	group 4
Mc DONNEL DOUGLAS	DC-10	30 AILE	264 445	1,22	4	4,88	group 4
Mc DONNEL DOUGLAS	DC-10	30 FUSEL	264 445	1,06	4	4,24	group 4
Mc DONNEL DOUGLAS	DC-10	30CF AILE	264 445	1,22	4	4,88	group 4
Mc DONNEL DOUGLAS	DC-10	30CF FUSEL	264 445	1,06	4	4,24	group 4

Manufacturer	Type	Series	Maximum weight (kg)	Landing gear tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of wheels/main landing gear	« Aircraft» Group
Mc DONNEL DOUGLAS	DC-10	40 AILE	264 445	1,22	4	4,88	group 4
Mc DONNEL DOUGLAS	DC-10	40 FUSEL	264 445	1,06	4	4,24	group 4
Mc DONNEL DOUGLAS	DC-10	40CF AILE	264 445	1,22	4	4,88	group 4
Mc DONNEL DOUGLAS	DC-10	40CF FUSEL	264 445	1,06	4	4,24	group 4
Mc DONNEL DOUGLAS	MD-10	10	207 750	1,07	4	4,28	group 4
Mc DONNEL DOUGLAS	MD-10	30F AILE	264 444	1,21	4	4,84	group 4
Mc DONNEL DOUGLAS	MD-10	30F FUSEL	264 444	1,00	4	4,00	group 3
Mc DONNEL DOUGLAS	MD-11	AILE	287 120	1,42	4	5,68	group 5
Mc DONNEL DOUGLAS	MD-11	FUSEL	287 120	1,25	4	5,00	group 4
Mc DONNEL DOUGLAS	MD-80	81	63 958	1,18	2	2,36	group 3
Mc DONNEL DOUGLAS	MD-80	82/88	68 266	1,27	2	2,54	group 3
Mc DONNEL DOUGLAS	MD-80	83	73 028	1,34	2	2,68	group 3
Mc DONNEL DOUGLAS	MD-80	87	68 266	1,27	2	2,54	group 3
Mc DONNEL DOUGLAS	MD-90	30	71 214	1,31	2	2,62	group 3
Mc DONNEL DOUGLAS	MD-90	30ER	76 430	1,33	2	2,66	group 3
SAAB	SAAB 2000		23 200	1,14	2	2,28	group 3
SAAB	SAAB 340		13 290	0,79	2	1,58	group 2
TUPOLEV	TU 134		45 200	0,59	4	2,36	group 3
TUPOLEV	TU 134	A	47 200	0,59	4	2,36	group 3
TUPOLEV	TU 154		90 300	0,79	6	4,74	group 4
TUPOLEV	TU 154	A	94 300	0,79	6	4,74	group 4
TUPOLEV	TU 154	B	96 300	0,79	6	4,74	group 4
TUPOLEV	TU 154	M	100 500	0,79	6	4,74	group 4
MILITARY AIRCRAFT							
AEROSPATIALE-MBB	TRANSALL C 160		49 100	0,40	4	1,60	group 2
AEROSPATIALE-MBB	TRANSALL C 160	F	51 000	0,40	4	1,60	group 2
AEROSPATIALE-MBB	TRANSALL C 160	G - GABRIEL	51 000	0,40	4	1,60	group 2
AEROSPATIALE-MBB	TRANSALL C 160	H - ASTARTE	51 000	0,40	4	1,60	group 2
AEROSPATIALE-MBB	TRANSALL C 160	NG	51 000	0,40	4	1,60	group 2
AIRBUS	A400M		137 000	0,88	6	5,28	group 4
BRITISH AEROSPACE	BAE NIMROD		104 500	1,20	4	4,80	group 4
BRITISH AEROSPACE	BAE SUPER-VC10		153 000	1,01	4	4,04	group 3
BOEING	C17A		265 800	0,95	6	5,70	group 5
BOEING	KC135		152 500	1,24	4	4,96	group 4
CASA	CN 235	100	16 000	0,80	2	1,60	group 2
CASA	CN 235	300	16 700	0,80	2	1,60	group 2
DASSAULT/DORNIER	ALPHAJET		7 250	1,40	1	1,40	group 2
DASSAULT	MIRAGE 2000		15 200	1,04	1	1,04	group 2
DASSAULT	MIRAGE 2000	5F	17 000	1,04	1	1,04	group 2
DASSAULT	MIRAGE 2000	B	16 500	1,04	1	1,04	group 2
DASSAULT	MIRAGE 2000	C	16 500	1,04	1	1,04	group 2
DASSAULT	MIRAGE F1	B	16 200	1,32	1	1,32	group 2
DASSAULT	MIRAGE F1	C	15 200	1,32	1	1,32	group 2
DASSAULT	MIRAGE F1	CT	16 270	1,32	1	1,32	group 2
DASSAULT	MIRAGE III	B	11 400	1,32	1	1,32	group 2
DASSAULT	MIRAGE III	C	11 600	1,32	1	1,32	group 2

Manufacturer	Type	Série	Maximum weight (kg)	Pression pneu tyre pressure (MPa)	No. of wheels on main landing gear	Tyre pressure x no. of. wheels/main landing gear	« Aircraft » Group
DASSAULT	MIRAGE III	E	13 500	1,32	1	1,32	group 2
DASSAULT	MIRAGE IV	P	33 800	1,32	1	1,32	group 2
DASSAULT	RAFALE		24 600	1,66	1	1,66	group 2
EMBRAER	EMB 121 XINGU		5 700	1,40	1	1,40	group 2
EMBRAER	EMB 312 TUCANO		3 200	1,40	1	1,40	group 2
LOCKHEED	F16	D	17 010	1,97	1	1,97	group 2
LOCKHEED	HERCULES C 130	H	79 200	0,54	2	1,08	group 2
LOCKHEED	HERCULES C 130	H 30	79 200	0,54	2	1,08	group 2
LOCKHEED	HERCULES C 130	L382	70 760	0,74	2	1,48	group 2
LOCKHEED	HERCULES C 130		79 380	0,54	2	1,08	group 2
LOCKHEED-MARTIN	C5A GALAXY		349 000	0,84	6	5,04	group 4
LOCKHEED-MARTIN	ORION P3C		63 500	0,90	2	1,80	group 2
MAURANE-SAULNIER	MS-760 PARIS		4 000	0,40	1	0,40	group 2
PANAVIA	TORNADO		27 985	1,60	1	1,60	group 2
SEPECAT	JAGUAR		15 800	1,60	2	3,20	group 3
SOCATA	EPSILON TB 30		1 300	1,40	1	1,40	group 2
HELICOPTERS							
AEROSPATIALE	DAUPHIN/ PANTHERAS	365/AS 565	4 300	0,86	1	0,86	group 2
AEROSPATIALE	DAUPHIN	EC 155	4 850	0,86	1	0,86	group 2
AEROSPATIALE	PUMA		7 400	0,48	2	0,96	group 2
AEROSPATIALE	SUPER FRELON		13 000	0,69	2	1,38	group 2
AEROSPATIALE	SUPER PUMA/ COUGAR	AS 332 L2	9 300	0,90	1	0,90	group 2
AEROSPATIALE	SUPER PUMA/ COUGAR	AS 532 A2	11 200	0,90	1	0,90	group 2
AEROSPATIALE	SUPER PUMA/ COUGAR	AS 532 U2	9 750	0,90	1	0,90	group 2
EHI	EHI	EH 101	14 600	0,70	1	0,70	group 2
EUROCOPTER	NH 90		10 600	0,93	1	0,93	group 2
EUROCOPTER	SUPER PUMA/ COUGAR	EC 225	10 400	0,90	1	0,90	group 2
EUROCOPTER	SUPER PUMA/ COUGAR	EC 725	11 000	0,90	1	0,90	group 2
MIL	MIL	MI 26	56 500	0,60	2	1,20	group 2

Annex B : Climate type of france's main airports

Average of minimum and maximum daily temperatures, by month (source Météo France)

type 1
type 2
type 3
type 4

Table 26 –Definition of climate type of the main airports situated in metropolitan France

Weather station	Minimum daily temperature		Maximum daily temperature		Climate type
	January	February	July	August	
Agen La Garenne	2,8	2,7	27,5	28,2	2
Ajaccio	4,5	4	28	29	2
Alençon	2,1	2,1	23,5	25	1
Amiens Glisy	1,4	1,9	22,9	24,6	1
Aurillac	-0,1	-0,7	23,7	24,5	3
Auxerre	1,2	1,5	25,3	26,6	1
Bastia	5,6	5	28,9	29,6	2
Besançon	-0,1	0,1	24,6	25,6	3
Biarritz Anglet	5,2	5	23,6	25,1	1
Bordeaux Mérignac	3,9	3,6	26,4	27,8	2
Brest-Guipavas	4,6	4,7	20,4	21,5	1
Châteauroux Déols	1,6	1,7	25,4	26,5	1
Clermont-Ferrand	0,6	0,9	26	26,8	1
Dijon Longvic	-0,4	0	25,7	26,4	3
Lannaero	4,3	4,4	20,1	21,4	1
Lille - Lesquin	1,5	2,3	22,5	24	1
Limoges	2	1,8	25,7	26,9	1
Lorient	4,1	4,1	22,3	23,3	1
Lyon Saint-Exupéry	0,9	1,3	26,6	27,3	2
Marseille Marignane	3,8	3,6	30	30,1	2
Megève	-5,4	-5,4	9,7	10,2	3
Metz Frescaty	-0,5	0,2	24,6	25,7	3
Mont-de-Marsan	1,9	1,9	27,2	28	2
Montpellier	3,7	3,4	28,9	28,9	2
Bâle Mulhouse	-1	-0,5	25,1	26,1	3
Nantes	3,4	3,2	24,4	25,7	1
Nevers-Marzy	0,7	0,4	24,9	26,1	1
Nice	5,5	5,8	27,1	28	2
Nîmes-Garons	3,5	3,5	30	29,9	2
Paris-le-Bourget	1,9	2,3	24,5	25,9	1
Perpignan Rivesaltes	4,7	5,3	28,8	29,2	2
Poitiers Biard	2	1,5	25,3	26,5	1
Le Puy en Velay	-0,6	-0,4	26,5	27	3
Reims Champagne	0,2	0,9	24	25,1	1
Rennes Saint Jacques	3,5	3,4	24,2	25,2	1
Albi	2,2	2	28,3	28,9	2
Rouen	1,4	1,8	22,3	23,8	1
Strasbourg	-0,7	0	25	26,2	3
Tarbes-Ossun	1,3	1,7	24,6	25,5	1
Toulouse-Blagnac	3,2	3,3	27,6	28,2	2
Tours	2,2	2,4	25	26,2	1
Montélimar	2,3	2,5	28,9	29,5	2

Overseas Territories

Northern hemisphere

Table 27 –Definition of climate type of the main airports of French overseas territories situated in the northern hemisphere

Weather station	Minimum daily temperature		Maximum daily temperature		Climate type
	January	February	July	August	
Cayenne-Suzini (Guyane)	24,5	25,6	30,7	31,1	4
Fort de France Desaix (Martinique)	22,2	21,9	29,5	30,2	4
Basse-Terre (Guadeloupe)	22,0	21,7	30,8	31,2	4
St Pierre et Miquelon	-4,8	-5,6	16,8	18,2	3

Southern hemisphere

Table 28 – Definition of climate type of the main airports of French overseas territories situated in the southern hemisphere

Weather station	Minimum daily temperature		Maximum daily temperature		Climate type
	January	February	July	August	
Dzoudzi - Pamandzi (Mayotte)	30,3	30,4	21,5	20,4	4
Nouméa - La Tontouta (Nouvelle-Calédonie)	29,3	29,4	17,4	17,2	4
St-Denis-Gillot (La Réunion)	29,7	29,8	17,6	17,3	4
St-Pierre (La Réunion)	30,9	30,3	17,1	17,0	4
Tahiti - Faa'a (Tahiti)	31,1	30,3	21,8	21,6	4

Annex C : Definition of requirements for reclaimed asphalt pavement (Rap)

The requirements for describing and classifying reclaimed asphalt pavements are those given in French standard NF EN 13 108-8.

Reclaimed asphalt pavement is designated by the abbreviation AE, preceded by the diameter of the aggregate and followed by the diameter of the particle when coated.

The category of maximum size is 35 AE 0/D, where D is less than the diameter of the reclaimed particle.

Specifications for reclaimed asphalt pavements must comply as a minimum with categories F1, P15 or S70.

● Reclaimed asphalt may be categorized according to its average binder content :

Binder content	Category
≤ 1 %	TL_1
≤ 2 %	TL_2
> 2 % or non specified	TL_{NS}

● Minimum penetration or maximum ring-and-ball temperature (RBT) for a binder extracted from recycled asphalt for one sample and for the mean of n samples.

Sampling must be carried out in accordance with French standard EN 932-1

Penetration (1/10 mm)	RBT (°C)	Frequency of test	Category
Minimum=5 and extended ≤ 15	Maximum=77 and extended≤ 8	n1 (*)	B_1
Minimum =5	Maximum=77	n2 (**)	B_2
To be declared	To be declared	Not specified	B_{NS}

(*) n1= 1 sample per 1000 tonnes with a minimum of 5 tests
(**) n2= 1 sample per 1000 tonnes with no minimum number of tests

● Grading uniformity (G) of reclaimed asphalt

Passant to 1,4 D	Passant to D	% passing a 2 mm sieve	% passing a 0.063 mm sieve	Category
Vsi 99	Li 85 Ls 99 e 10	e 15	e 4	G_1
Vsi 99	Li 80 Ls 99 e 15	e 20	e 6	G_2
Not specified	Not specified	Not specified	Not specified	G_{NS}

Note : The symbols D, Vsi, Li, , s, and e are defined in French standard XP P 18-545.

● Classification of aggregates extracted from reclaimed asphalt in terms of uniformity of their intrinsic characteristics, and their angularity

Category of aggregates according to article 8 of French standard XP P 18-545	Frequency of tests	Category of aggregate
Code A or B and code Ang1 or chippings and sand (flow test)	1 per 2000 tonnes (*)	R_1
Category C or not characterized	Not specified	R_{NS}

(*) Declared value, in the case of residues from a single batch (homogeneous, and with D ≤ 31,5 mm).

Annex D : Performance comparisons for bituminous mixtures

Performance comparison table – Empirical approach

Table 29 – Surfacing – Performance of EB10-BBSG – Empirical approach

			General characteristics							Empirical characteristics					
Designation	**Application**	**Reference standard (NF EN)**	**Binder grade**	**D (max) in mm**	**Water sensitivity ITSR (I/C) method B (by compression)**	**Percentage of voids GSP**			**Rutting test at 60 °C No. of cycles (% voids of sample) Class**	**% scope according to sieve**					**Minimum binder content**
						Class	**No. of gyrations**	**at 10 gyrations**		**0,063**	**0,250**	**2,00**	**6,3**	**D**	
										%	**%**	**%**	**%**	**%**	
EB10-BBSG class 0	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,2}$
EB10-BBSG class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	NR	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,2}$
EB10-BBSG class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	NR	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,2}$
EB10-BBSG class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	NR	30 000 cycles (Vi = 5 % Vs = 8 %) P_5	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,2}$

** For binder types and grades, see Table 21*
NR : Not required

Table 30 – Surfacing – Performance of EB14-BBSG – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	General characteristics: Percentage of voids GSP			Rutting test at 60 °C No. of cycles (% voids of sample) Class	Empirical characteristics: % scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	6,3 %	D %	
EB14-BBSG class 0	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,0}$
EB14-BBSG class 1	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	NR	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,0}$
EB14-BBSG class 2	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	NR	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,0}$
EB14-BBSG class 3	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	NR	30 000 cycles (Vi = 5 % Vs = 8 %) P_5	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min5,0}$

For binder types and grades, see Table 21
NR : Not required

Table 31 – Surfacing – Performance of type C EB10-BBA – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP: class	Percentage of voids GSP: No. of gyrations	Percentage of voids GSP: at 10 gyrations	Rutting test at 60°C No. of cycles (% voids of sample) Class	Empirical characteristics: % scope according to sieve 0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	Minimum binder content
EB10-BBA type C class 0	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\,3}$ $V_{max\,7}$	60	$V10G_{min11}$	NR	6 to 9	10 to 25	35 to 45	-	65 to 80	90 to 100	$TL_{min5,4}$
	Binder course				$ITSR_{70}$	$V_{min\,4}$ $V_{max\,8}$				5 to 8	10 to 25	32 to 42	-	62 to 77	90 to 100	
EB10-BBA type C class 1	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\,3}$ $V_{max\,7}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	6 to 9	10 to 25	35 to 45	-	65 to 80	90 to 100	$TL_{min5,4}$
	Binder course				$ITSR_{70}$	$V_{min\,4}$ $V_{max\,8}$				5 to 8	10 to 25	32 to 42	-	62 to 77	90 to 100	
EB10-BBA type C class 2	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\,3}$ $V_{max\,7}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	6 to 9	10 to 25	35 to 45	-	65 to 80	90 to 100	$TL_{min5,4}$
	Binder course				$ITSR_{70}$	$V_{min\,4}$ $V_{max\,8}$				5 to 8	10 to 25	32 to 42	-	62 to 77	90 to 100	
EB10-BBA type C class 3	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\,3}$ $V_{max\,7}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	6 to 9	10 to 25	35 to 45	-	65 to 80	90 to 100	$TL_{min5,4}$
	Binder course				$ITSR_{70}$	$V_{min\,4}$ $V_{max\,8}$				5 to 8	10 to 25	32 to 42	-	62 to 77	90 to 100	

** For binder types and grades, see Table 21*
NR : Not required

Table 32 –Surfacing – Performance of type C EB14-BBA – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP: class	Percentage of voids GSP: No. of gyrations	Percentage of voids GSP: at 10 gyrations	Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve: 0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	Minimum binder content
EB14-BBA type C class 0	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	$V10G_{min11}$	NR	6 to 9	10 to 25	32 to 45	-	54 to 69	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 0	Binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$	80	$V10G_{min11}$	NR	5 to 8	10 to 25	30 to 40	- -	50 to 65	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 1	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	6 to 9	10 to 25	32 to 42	-	54 to 69	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 1	Binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$	80	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	5 to 8	10 to 25	30 to 40	-	50 to 65	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 2	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	6 to 9	10 to 25	32 to 42	-	54 to 69	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 2	Binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$	80	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	5 to 8	10 to 25	30 to 40	-	50 to 65	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 3	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	NR	10 000 cycles (Vi = 4% Vs = 7 %) $P_{7,5}$	6 to 9	10 to 25	32 to 42	-	54 to 69	90 to 100	$TL_{min5,2}$
EB14-BBA type C class 3	Binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$	80	NR	10 000 cycles (Vi = 4% Vs = 7 %) $P_{7,5}$	5 to 8	10 to 25	30 to 40	-	50 to 65	90 to 100	$TL_{min5,2}$

** For binder types and grades, see Table 21*
NR : Not required

Table 33 –Surfacing – Performance of type D EB10-BBA – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve						Minimum binder content
			General characteristics							Empirical characteristics						
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	
EB10-BBA type D class 0 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*		$ITSR_{80}$	$V_{min\,5}$ $V_{max\,9}$	40	$V10G_{min11}$	NR	6 to 9	10 to 25	35 to 45	47 to 57	53 to 63	90 to 100	$TL_{min5,2}$
EB10-BBA type D class 1 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*		$ITSR_{80}$	$V_{min\,5}$ $V_{max\,9}$	40	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	6 to 9	10 to 25	35 to 45	47 to 57	53 to 63	90 to 100	$TL_{min5,2}$
EB10-BBA type D class 2 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*		$ITSR_{80}$	$V_{min\,5}$ $V_{max\,9}$	40	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	6 to 9	10 to 25	35 to 45	47 to 57	53 to 63	90 to 100	$TL_{min5,2}$
EB10-BBA type D class 3 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*		$ITSR_{80}$	$V_{min\,5}$ $V_{max\,9}$	40	NR	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	6 to 9	10 to 25	35 to 45	47 to 57	53 to 63	90 to 100	$TL_{min5,2}$

** For binder types and grades, see Table 21*
NR : Not required

Table 34 –Surfacing – Performance of type D EB14-BBA – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristicss: Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	Empirical characteristics: % scope according to sieve						Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	
EB14-BBA type D class 0 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	$V10G_{min11}$	NR	6 to 9	10 to 25	33 to 43	36 to 46	37 to 47	90 to 100	$TL_{min5,0}$
EB14-BBA type D class 1 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	6 to 9	10 to 25	33 to 43	36 to 46	37 to 47	90 to 100	$TL_{min5,0}$
EB14-BBA type D class 2 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	6 to 9	10 to 25	33 to 43	36 to 46	37 to 47	90 to 100	$TL_{min5,0}$
EB14-BBA type D class 3 (D 4/6) (D 2/6)	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	NR	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	6 to 9	10 to 25	33 to 43	36 to 46	37 to 47	90 to 100	$TL_{min5,0}$

** For binder types and grades, see Table 21*
NR : Not required

Table 35 – Surfacing – Performance of type A EB10-BBA – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	6,3 %	D %	
EB10-BBM type A class 0	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\,5}$ $V_{max\,10}$	40	$V10G_{min11}$	NR	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type A class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	3 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type A class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	10 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type A class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	30 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$

General characteristics: columns Binder grade to Rutting test; Empirical characteristics: % scope according to sieve and Minimum binder content.

** For binder types and grades, see Table 21*
NR : Not required

Table 36 –Surfacing – Performance of type A EB14-BBM – Empirical approach

Désignation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	6,3 %	D %	
EB14-BBM type A class 0	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,5}$ $V_{max\,10}$	40	$V10G_{min11}$	NR	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type A class 1	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	3 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type A class 2	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	10 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type A class 3	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	NR	30 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$

General characteristics: columns Binder grade to Rutting test; Empirical characteristics: % scope according to sieve and Minimum binder content.

** For binder types and grades, see Table 21*
NR : Not required

Table 37 – Surfacing – Performance of type B EB10-BBA – Empirical approach

			General characteristics							Empirical characteristics					
Designation	**Application**	**Reference standard (NF EN)**	**Binder grade**	**D (max) in mm**	**Water sensibility ITSR (I/C) method B (by compression)**	**Percentage of voids GSP**			**Rutting test at 60°C No. of cycles (% voids of sample) Class**	**% scope according to sieve**					**Minimum binder content**
						class	**No. of gyrations**	**at 10 gyrations**		**0,063 %**	**0,250 %**	**2,00 %**	**6,3 %**	**D %**	
EB10-BBM type B class 0	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	$V10G_{min11}$	NR	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type B class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	V_{min7} $V_{max\,12}$	40	NR	3 000 cycles (Vi = 8 % Vs = 11 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type B class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	V_{min7} $V_{max\,12}$	40	NR	10 000 cycles (Vi = 8 % Vs = 11 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type B class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	V_{min7} $V_{max\,12}$	40	NR	30 000 cycles (Vi = 8 % Vs = 11%) P_{10}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$

** For binder types and grades, see Table 21*
NR : Not required

Table 38 – Surfacing – Performance of type B EB14-BBA – Empirical approach

			General characteristics							Empirical characteristics					
Designation	**Application**	**Reference standard (NF EN)**	**Binder grade**	**D (max) in mm**	**Water sensibility ITSR (I/C) method B (by compression)**	**Percentage of voids GSP**			**Rutting test at 60°C No. of cycles (% voids of sample) Class**	**% scope according to sieve**					**Minimum binder content**
						class	**No. of gyrations**	**at 10 gyrations**		**0,063 %**	**0,250 %**	**2,00 %**	**6,3 %**	**D %**	
EB14-BBM type B class 0	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,6}$ $V_{max\,11}$	40	$V10G_{min11}$	NR	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type B class 1	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,7}$ $V_{max\,12}$	40	NR	3 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type B class 2	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,7}$ $V_{max\,12}$	40	NR	10 000 cycles (Vi = 7 % Vs = 10 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB14-BBM type B class 3	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\,7}$ $V_{max\,12}$	40	NR	30 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$

** For binder types and grades, see Table 21*
NR : Not required

Table 39 –Surfacing – Performance of type C EB10-BBA – Empirical approach

			General characteristics							Empirical characteristics					
Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	6,3 %	D %	
EB10-BBM type C class 0	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 6}$ $V_{max\ 11}$	40	$V10G_{min11}$	NR	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type C class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 8}$ $V_{max\ 13}$	40	NR	3 000 cycles (Vi = 8 % Vs = 11 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type C class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 8}$ $V_{max\ 13}$	40	NR	10 000 cycles (Vi = 8 % Vs = 11 %) P_{15}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min5,0}$
EB10-BBM type C class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 8}$ $V_{max\ 13}$	40	NR	30 000 cycles (Vi = 8 % Vs = 11 %) P_{10}	5 to 8	10 to 23	27 to 37	30 to 40	90 to 100	$TL_{min4,8}$

** For binder types and grades, see Table 21*
NR : Not required

Table 40 –Surfacing – Performance of BBTM 10 – Empirical approach

			General characteristics							Empirical characteristics						
Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve						Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	
BBTM 10 class A ou B	Surface course	NF EN 13108-2	*	10	$ITSR_{75}$	$V_{min\ 10}$ $V_{max\ 17}$	25	NR	NR	4,5 to 6,5	15 to 25	27 to 33	-	28 to 45	90 to 100	$TL_{min5,0}$
BBTM 10 class A ou B Level 2**	Surface course	NF EN 13108-2	*	10	$ITSR_{75}$	$V_{min\ 10}$ $V_{max\ 17}$	25	NR	Mechanical stability 3 000 cycles (Vi = 11 % Vs = 14 % thickness 5 cm) P_{15}	4,5 to 6,5	15 to 25	27 to 33	-	28 to 45	90 to 100	$TL_{min5,0}$
BBTM 10 class B	Surface course	NF EN 13108-2	*	10	$ITSR_{75}$	$V_{min\ 18}$ $V_{max\ 25}$	25	NR	NR	4 to 6	10 to 20	15 to 25	-	28 to 45	90 to 100	$TL_{min5,0}$
BBTM 10 class B Level 2**	Surface course	NF EN 13108-2	*	10	$ITSR_{75}$	$V_{min\ 18}$ $V_{max\ 25}$	25	NR	Mechanical stability 3 000 cycles (Vi = 11 % Vs = 14 % thickness 5 cm) P_{15}	4 to 6	10 to 20	15 to 25	-	28 to 45	90 to 100	$TL_{min5,0}$

** For binder types and grades, see Table 21*
NR : Not required
*** Level 2 mixture*

Table 41 – Surfacing – Performance of BBTM 6 – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	General characteristics						Empirical characteristics						
				D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve						Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	4,00 %	6,3 %	D %	
BBTM 6 class A	Surface course	NF EN 13108-2	*	6,3	$ITSR_{75}$	$V_{min\ 12}$ $V_{max\ 19}$	25	NR	NR	7 to 9	15 to 25	20 to 30	25 to 35	-	90 to 100	$TL_{min5,0}$
BBTM 6 class B Level 2**	Surface course	NF EN 13108-2	*	6,3	$ITSR_{75}$	$V_{min\ 20}$ $V_{max\ 25}$	25	NR	Mechanical stability 3000 cycles (Vi = 17 % Vs = 20 % thickness 5 cm) P_{20}	4 to 6	10 to 20	15 to 25	20 to 30	-	90 to 100	$TL_{min5,0}$

** For binder types and grades, see Table 21*
NR : Not required
*** Level 2 mixture*

Table 42 – Bases courses – Performance of EB14-GB – Empirical approach

Designation	Application	Reference standard (NF EN)	Binder grade	General characteristics						Empirical characteristics					
				D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063 %	0,250 %	2,00 %	6,3 %	D %	
EB14-GB class 2	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 11}$	100	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min3,8}$
EB14-GB class 2 Level 2**	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 11}$	100	NR	10 000 cycles (Vi = 8 % Vs = 11 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min3,8}$
EB14-GB class 3	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 10}$	100	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min4,2}$
EB14-GB class 3 Level 2**	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 10}$	100	NR	10 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min4,2}$

For binder types and grades, see Table 21
NR : Not required
*** Level 2 mixture*

Table 43 – Bases courses – Performance of EB20-GB – Empirical approach

					General characteristics					Empirical characteristics					
Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP			Rutting test at 60°C No. of cycles (% voids of sample) Class	% scope according to sieve					Minimum binder content
						class	No. of gyrations	at 10 gyrations		0,063	0,250	2,00	6,3	D	
										%	%	%	%	%	
EB20-GB class 2	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,11}$	120	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min3,8}$
EB20-GB class 2 Niv. 2**	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,11}$	120	NR	10 000 cycles (Vi = 8 % Vs = 11 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min3,8}$
EB20-GB class 3	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,10}$	120	$V10G_{min11}$	NR	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min4,2}$
EB20-GB class 3 Level 2**	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,10}$	120	NR	10 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	5 to 8	10 to 25	28 to 38	50 to 65	90 to 100	$TL_{min4,2}$

** For binder types and grades, see Table 21*
NR : Not required

Performance comparison table – Fundamental approach

Table 44 – Surfacing – Performance of EB10-BBSG – Fundamental approach

					General characteristics				Fundamental characteristics	
Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP class	 Nb girations	Rutting test at 60°C No. of cycles (% voids of sample) Class	Modulus test at 15°C 0.02s or 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB10-BBSG class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min5500}$	(Vi = 5 % Vs = 8 %) ε_{6-100}
EB10-BBSG class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	(Vi = 5 % Vs = 8 %) $S_{min7000}$	(Vi = 5 % Vs = 8 %) ε_{6-100}
EB10-BBSG class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) P_{5}	(Vi = 5 % Vs = 8 %) $S_{min7000}$	(Vi=5 % Vs= 8 %) ε_{6-100}

** For binder types and grades, see Table 21*

Table 45 – Surfacing – Performance of EB14-BBSG – Fundamental approach

					General characteristics				Fundamental characteristics	
Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP class	 No. of gyrations	Rutting test at 60°C No. of cycles (% voids of sample) Class	Modulus test at 15°C 0.02s or 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB14-BBSG class 1	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min5500}$	(Vi = 5 % Vs = 8 %) ε_{6-100}
EB14-BBSG class 2	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	(Vi = 5 % Vs = 8 %) $S_{min7000}$	(Vi = 5 % Vs = 8 %) ε_{6-100}
EB14-BBSG class 3	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) P_{5}	(Vi = 5 % Vs = 8 %) $S_{min7000}$	(Vi = 5 % Vs = 8 %) ε_{6-100}

** For binder types and grades, see Table 21*

Table 46 – Surfacing – Performance of EB10-BBME – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensitivity ITSR (I/C) method B (by compression)	Percentage of voids GSP		Rutting test at 60°C No. of cycles (% voids of sample) Class	Modulus test at 15°C 0.02s or 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
			General characteristics						Fundamental characteristics	
						class	No. of gyrations			
EB10-BBME class 1	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min9000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$
EB10-BBME class 2	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$
EB10-BBME class 3	Surface course or binder course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 10}$	60	30 000 cycles (Vi = 5 % Vs = 8 %) P_5	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 47 – Surfacing – Performance of EB14-BBME – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	Water sensitivity ITSR (I/C) method B (by compression)	Percentage of voids GSP		Rutting test at 60°C No. of cycles (% voids of sample) Class	Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
			General characteristics						Fundamental characteristics	
						class	No. of gyrations			
EB14-BBME class 1	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min9000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$
EB14-BBME class 2	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) $P_{7,5}$	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$
EB14-BBME class 3	Surface course or binder course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 4}$ $V_{max\ 9}$	80	30 000 cycles (Vi = 5 % Vs = 8 %) P_5	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 48 –Surfacing – Performance of type C EB10-BBA – Fundamental approach

			General characteristics						Fundamental characteristics	
Designation	**Application**	**Reference standard (NF EN)**	**Binder grade**	**D (max) in mm**	**Water sensitivity ITSR (I/C) méthode B (by compression)**	**Percentage of voids GSP** class	**Percentage of voids GSP** No. of gyrations	**Rutting test at 60°C** No. of cycles (% voids of sample) Class	**Modulus test at 15°C 0.02s or 10 Hz** (% voids of sample) Class	**Fatigue test at 10 °C 25 Hz flex.2** (% voids of sample) Class
EB10-BBA Type C class 1	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}130}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				
EB10-BBA Type C class 2	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				
EB10-BBA Type C class 3	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	(Vi = 4 % Vs = 7 %) $S_{min7000}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				

* *For binder types and grades, see Table 21*

Table 49 – Surfacing – Performance of type C EB14-BBA – Fundamental approach

			General characteristics						Fundamental characteristics	
Designation	**Application**	**Reference standard (NF EN)**	**Binder grade**	**D (max) in mm**	**Water sensitivity ITSR (I/C) method B (by compression)**	**Percentage of voids GSP** class	**Percentage of voids GSP** No. of gyrations	**Rutting test at 60°C** No. of cycles (% voids of sample) Class	**Modulus test at 15°C 0.02s or 10 Hz** (% voids of sample) Class	**Fatigue test at 10 °C 25 Hz flex.2** (% voids of sample) Class
EB14-BBA Type C class 1	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}130}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				
EB14-BBA Type C class 2	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				
EB14-BBA Type C class 3	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 3}$ $V_{max\ 7}$	80	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	(Vi = 4 % Vs = 7 %) $S_{min7000}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
	Binder course				$ITSR_{70}$	$V_{min\ 4}$ $V_{max\ 8}$				

* *For binder types and grades, see Table 21*

Table 50 – Surfacing – Performance of type D EB10-BBA – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	General characteristics: Percentage of voids GSP – class	General characteristics: Percentage of voids GSP – No. of gyrations	General characteristics: Rutting test at 60°C No. of cycles (% voids of sample) Class	Fundamental characteristics: Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fundamental characteristics: Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB10-BBA Type D class 1	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	40	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}130}$
EB10-BBA Type D class 2	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	40	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
EB10-BBA Type D class 3	Surface course	NF EN 13108-1	*	10	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	40	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	(Vi = 4 % Vs = 7 %) $S_{min7000}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 51 –Surfacing – Performance of type D EB14-BBA – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	General characteristics: Percentage of voids GSP – class	General characteristics: Percentage of voids GSP – No. of gyrations	General characteristics: Rutting test at 60°C No. of cycles (% voids of sample) Class	Fundamental characteristics: Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fundamental characteristics: Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB14-BBA Type D class 1	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) P_{15}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}130}$
EB14-BBA Type D class 2	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) P_{10}	(Vi = 4 % Vs = 7 %) $S_{min5500}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$
EB14-BBA Type D class 3	Surface course	NF EN 13108-1	*	14	$ITSR_{80}$	$V_{min\ 5}$ $V_{max\ 9}$	60	10 000 cycles (Vi = 4 % Vs = 7 %) $P_{7,5}$	(Vi = 4 % Vs = 7 %) $S_{min7000}$	(Vi = 4 % Vs = 7 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 52 – Bases courses – Performance of EB14-GB – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP: class	Percentage of voids GSP: No. of gyrations	Rutting test at 60°C No. of cycles (% voids of sample) Class	Fundamental characteristics: Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB14-GB class 2	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 11}$	100	10 000 cycles (Vi = 8 % Vs = 11 %) P_{10}	(Vi = 7 % Vs = 10 %) $S_{min9000}$	(Vi = 7 % Vs = 10 %) $\varepsilon_{6\text{-}80}$
EB14-GB class 3	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 10}$	100	10 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	(Vi = 7 % Vs = 10 %) $S_{min9000}$	(Vi = 7 % Vs = 10 %) $\varepsilon_{6\text{-}90}$
EB14-GB class 4	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\ 9}$	100	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 53 –Bases courses – Performance of EB20-GB – Fundamental approach

Designation	Application	Reference standard (NF EN)	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP: class	Percentage of voids GSP: No. of gyrations	Rutting test at 60°C No. of cycles (% voids of sample) Class	Fundamental characteristics: Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB20-GB class 2	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\ 11}$	120	10 000 cycles (Vi = 8 % Vs = 11 %) P_{10}	(Vi = 7 % Vs = 10 %) $S_{min9000}$	(Vi = 7 % Vs = 10 %) $\varepsilon_{6\text{-}80}$
EB20-GB class 3	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\ 10}$	120	10 000 cycles (Vi = 7 % Vs = 10 %) P_{10}	(Vi = 7 % Vs = 10 %) $S_{min9000}$	(Vi = 7 % Vs = 10 %) $\varepsilon_{6\text{-}90}$
EB20-GB class 4	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\ 9}$	120	30 000 cycles (Vi = 5 % Vs = 8 %) P_{10}	(Vi = 5 % Vs = 8 %) $S_{min11000}$	(Vi = 5 % Vs = 8 %) $\varepsilon_{6\text{-}100}$

** For binder types and grades, see Table 21*

Table 54 – Bases courses – Performance of EB-EME – Fundamental approach

Designation	Application	Reference standard référence	Binder grade	D (max) in mm	General characteristics: Water sensibility ITSR (I/C) method B (by compression)	Percentage of voids GSP: class	Percentage of voids GSP: No. of gyrations	Rutting d'orniérage to 60 °C No. of cycles (% voids of sample) Class	Fundamental characteristics: Modulus test at 15°C 0,02s ou 10 Hz (% voids of sample) Class	Fatigue test at 10 °C 25 Hz flex.2 (% voids of sample) Class
EB10-EME class 1	Base	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{max\,10}$	80	30 000 cycles (Vi = 7 % Vs = 10 %) $P_{7,5}$	(Vi = 7 % Vs = 10 %) $S_{min14000}$	(Vi = 7 % Vs = 10 %) ε_{6-100}
EB10-EME class 2	Base	NF EN 13108-1	*	10	$ITSR_{70}$	$V_{max\,6}$	80	30 000 cycles (Vi = 3 % Vs = 6 %) $P_{7,5}$	(Vi = 3 % Vs = 6 %) $S_{min14000}$	(Vi = 3 % Vs = 6 %) ε_{6-130}
EB14-EME class 1	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\,10}$	100	30 000 cycles (Vi = 7 % Vs = 10 %) $P_{7,5}$	(Vi = 7 % Vs = 10 %) $S_{min14000}$	(Vi = 7 % Vs = 10 %) ε_{6-100}
EB14-EME class 2	Base	NF EN 13108-1	*	14	$ITSR_{70}$	$V_{max\,6}$	100	30 000 cycles (Vi = 3 % Vs = 6 %) $P_{7,5}$	(Vi = 3 % Vs = 6 %) $S_{min14000}$	(Vi = 3 % Vs = 6 %) ε_{6-130}
EB20-EME class 2	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,10}$	120	30 000 cycles (Vi = 7 % Vs = 10 %) $P_{7,5}$	(Vi = 7 % Vs = 10 %) $S_{min14000}$	(Vi = 7 % Vs = 10 %) ε_{6-100}
EB20-EME class 1	Base	NF EN 13108-1	*	20	$ITSR_{70}$	$V_{max\,6}$	120	30 000 cycles (Vi = 3 % Vs = 6 %) $P_{7,5}$	(Vi = 3 % Vs = 6 %) $S_{min14000}$	(Vi = 3 % Vs = 6 %) ε_{6-130}

** For binder types and grades, see Table 21*

Annex E : Resistance to static loads

The resistance to static loads of a bituminous mixture can be characterized by means of one of the two test procedures described below.

Direct traction modulus test – Long load time

According to French standard NF EN 12 697-26 and either of the methods DT-CY or DT-PR. The percentage of voids in the samples tested must comply with the product standard, where one exists. If the product standard does not exist, the test should be specified in the RFQ or in the contractor's proposal.

The test is carried out under the following operating conditions :

- Test temperature : + 30°C
- Relative strain amplitude : 200 microdefs
- Load duration: 300 seconds.

The modulus value must be equal to or greater than 200 MPa

Punching test

According to the operating method described in the ANNALES recommendation of the I.T.B.T.P. (French technical institute for the building and public works industry) no. 465 dated June 1988.

The test consists in measuring the degree of penetration, over time, at given temperatures and under given loads, of a punch of a particular diameter into the product sample being tested

The degree of penetration depends on:

- the duration of the test,
- the load applied,
- the temperature at which the test is carried out.

The values of the latter two parameters are chosen according to the intended use of the product, and the environment in which it is to be used.

For example, for a test using a punch with a cross-sectional area of 5 mm², at a pressure of 5 MPa, at temperatures of 20°C, 40°C and 50°C, the penetration values of Table 55 may be adopted.

Table 55 – Punching test – Penetration values

Test temperature	Duration of test	Maximum penetration
20 °C	24 h	2 mm
40 °C	24 h	3 mm
50 °C	4 h	3 mm

Annex F : Technical note on grouted pervious bituminous mixtures

Field of application

These products offer strong resistance to static punching and the stresses caused by moving loads. They have been used for several years for the aprons of industrial sites where mechanical stresses are considerable.

They may be appropriate solutions for pavements of airport aprons subject to heavy mechanical stresses and chemical attack, especially those where the stress level is NS3 or NS4.

General characteristics

These are manufactured products which have not yet been the subject of a standard.

They consist of a matrix of coated materials, the communicating voids of which are filled with a hydraulic slurry.

The material is laid to an average depth of about 4 cm to 5 cm.

Matrix

This is a bituminous mixture with a high void content, with :

- grading of 0/10 ou 0/14, continuous or discontinuous
- aggregates compliant with French standards NF EN 13 043 and XP P 18 545
- low binder content, of the order of 4%. The binder used is pure bitumen, 70/100 or 50/70 or 35/50, in accordance with French standard NF EN 12 591.
- the percentage of voids to be obtained after compaction is between 15 and 25%

Hydraulic slurry

This consists of

- sands and fines (mineral fillers)
- ordinary cement to French standard NF EN 197-1
- type 2 water corresponding to the specification of French standard NF EN 1008
- additives (resins and polymers) intended to reduce shrinkage, and to stabilize the slurry.

The dosage of these components will vary according to the performance desired.

Manufacture

Bituminous mixture

This can be manufactured in all types of plant, either in continuous process (to French standard NF 98 728-1) or in discontinuous process (to standard NF 98 728-2)

The mixing temperature is between 140°C and 180°C.

Hydraulic slurry

This is produced on site using a mobile cement mixer, or in a manufacturing plant for the needs of large jobs.

It is delivered to site either as an anhydrous pre-mix, or reconstituted.

Its consistency should be chosen to enable it to fill all the communicating voids in the aggregate (fluidity approximately 15 seconds in the Marsh cone test with a 10 mm tube).

Laying

Substrate

Application of a pervious bituminous mixture requires a substrate with a high stiffness modulus, of a semi-rigid or bituminous type. In general, this substrate consists of a cement- or bitumen-bound graded aggregate, or a high-modulus bituminous mixture.

Bituminous mixture

The minimum spreading temperature is135°C

Transportation and application of the product must be carried out in accordance with French standard NF P 98 150-1.

Using a paver, the product is spread over a perfectly even surface, in order to achieve as regular a thickness as possible over the entire area (maximum admissible deformation : 1 cm under a 3-metre rolling straight edge).

A tack coat should be applied to the substrate before the mixture is laid.

Compaction must be carried out using a smooth-wheeled roller. In general, rolling every part of the area four to six times is sufficient.

Before the slurry is applied, no traffic may be allowed to use the matrix, and it must be protected from silting up and pollution of any kind.

Hydraulic slurry

Slurry can only be applied after the bituminous mixture has completely cooled.

The slurry must be spread as soon as it has been produced, using a rubber scraper, and its penetration assisted by the use of a vibrating plate or cylinder until satisfactory.

To ensure that the slurry sets and hardens correctly, there must be no walking or placing of anything on the finished surface for 24 or 48 hours.

Trafficking

The time before trafficking will depend on site constraints and conditions.

After application, the minimum times which must elapse before trafficking are :

- for light loads (e.g. private cars) 7 days
- for heavy loads, 14 days

Optimum performance is only attained after 28 days.

Propriétés

Resistance to aviation fuel

This product offers good resistance to localized attack by petroleum products such as aviation fuel and lubricants.

This resistance can be appraised by means of the test prescribed by French standard NF EN 12 697-43.

Static punching

It is characterized by excellent resistance to static punching.

To date, no minimum values for this have been determined. The level of resistance depends on the stresses to which the pavement is exposed.

Resistance to static punching should be measured according to the punching test described in paragraph 5.2 of the preceding chapter.

This type of test is carried out by all contractors.

The maximum permitted penetration after the slurry has aged 28 days is less than 1 mm.

Annex G – Specifications for longitudinal evenness

Definition

The following specifications concern the evenness of airport pavements in their longitudinal dimension only.

Evenness is a geometric criterion which characterizes all surface defects or irregularities which an aircraft may encounter while taxiing.

Poor evenness can have the following consequences :

- piloting difficulties as a result of : vertical acceleration (which may be as much as 2 G) and excessive vibrations; pitching or yawing phenomena causing the shock absorber pistons to reach their limits of travel, and thus bringing about loss of control of the aircraft; longitudinal resonance, which can make the braking system become ineffective, and make lateral control of the aircraft difficult
- aquaplaning phenomena (a problem which can be accentuated by poor evenness leading to dissymmetrical braking)
- fatigue of the aircraft structure (landing gear wear)
- accelerated local deterioration of the pavement as a result of the imposition of excessive dynamic loads
- passenger discomfort.

The main evenness defects can be divided into three categories :

- isolated defects of limited length, the effects of which are most often felt at low speeds, especially on taxiways. Usually they are easy to identify, and normal maintenance activities are sufficient to keep the pavement in good order.
- isolated defects occurring periodically over the pavement surface and likely to cause resonance phenomena. A typical example is defects in joints every 5 to 7.5 metres in a rigid pavement, leading to subsidence of the centre of the slabs.
- surface undulation or defects of notable length, more or less periodical, which can generate vertical accelerations or pitching and yawing.

Evaluating the quality of longitudinal evenness

According to French standard NF P 98 218-3 – determination of the quantifiers of longitudinal evenness indexes calculated from profilometer data.

The measurements are made according to LPC test method no. 46 of the Laboratoire Central des Ponts et Chaussées (Central Roads and Bridges Laboratory). Their interpretation, and the evaluation of the test results, is carried out in accordance with the characteristics set out in the STBA technical information note of June 2002 – Specifications for longitudinal evenness

The evaluation of the quality of evenness is based on measuring the longitudinal profile of a pavement using an LPC measuring device called a longitudinal profile analyser, and quantifying the data within a rating system classified by wavelength on a scale from 0 (very poor) to 10 (excellent).

Determining the ratings requires prior digital analysis of the signals, filtered according to three wavebands defined as follows :

- Short waves : from 0.707 m to 2.828 m
- Medium waves : from 2.828 m to 11.312 m
- Long waves : from11.312 m to 45.248 m

This method is applicable to all airport pavements, whatever their structure, regardless of whether they are situated on a civil or military airport, and in the context both of taking delivery of new pavements and of reinforcement or maintenance works.

Measurements

When taking these measurements, it should be remembered that tests on airport pavements are strictly regulated, for safety reasons related to air traffic. These rules are described in the annex to LPC test method no. 46.

The test method differentiates between evenness measurements taken on runways and those taken on taxiways. In the case of pavements of less than 1000 metres (for example, high-speed taxiways) it is more important to respect the medium-wave and long-wave requirements.

The attention of contractors and airport operators is drawn to the fact that civil engineering structures may make it difficult locally to attain the stated requirements. In such cases the sections involved should be excluded from the study, and a specific study carried out on those sections.

It is also important to bear in mind that :

- in the case of the construction of new pavements, the quality of evenness is strongly affected by the evenness quality of the underlying layers (binder course and base).
- in the case of pavement refurbishments (reinforcement or restoration of the surface course) with a single course treatment of 5 cm to 7 cm thickness, it is difficult to bring about significant improvement in evenness in long-wave areas.

The technical solutions offered here must be carefully defined, taking due account of the initial condition of the pavement. Consequently, the designer will wish to adopt the principle that, prior to any renovation work on the surface course, evenness should be measured before the work begins. This precaution makes it possible to verify the prior state of the pavement, and to avoid dispute after the work is completed, in the event of non-compliant measurements.

Project managers and pavement owners should also be reminded that a sequencing of the work which provides for an excessive number of starts and stops is not conducive to the achievement of a good, even surface.

When evaluating the longitudinal evenness of a new pavement, the specifications shown in Table 56 below should be applied.

Table 56 – Specifications for rating the longitudinal evenness of an airport pavement*

	Wavebands	New pavements L < 2000 m	New pavements L < 2000 m	Pavements after maintenance works on several courses	Pavements after maintenance works on a single course
Overall requirements for all ratings of all profiles	Short	100 % ≥ 4 95 % ≥ 6 80 % ≥ 7		100 % ≥ 4 95 % ≥ 6 80 % ≥ 7	100 % ≥ 4 Existing maintained *
	Medium	100 % ≥ 5 80 % ≥ 8		100 % ≥ 5 80 % ≥ 8	Existing maintained *
	Long	100 % ≥ 7 80 % = 10	100 % ≥ 7 90 % = 10	Existing maintained *	Existing maintained *
Requirements by profile for the 3 central pairs of profiles	Short	100 % ≥ 6 90 % ≥ 7		100 % ≥ 6 90 % ≥ 7	Existing maintained *
	Medium	100 % ≥ 6 90 % ≥ 8		100 % ≥ 6 90 % ≥ 8	Existing maintained *
	Long	100 % ≥ 8 80 % = 10	100 % ≥ 8 90 % = 10	Existing maintained *	Existing maintained *

** Existing maintained = "average rating after works ≥ average rating before works and minimum rating after works ≥ minimum rating before works"*

REMARKS :

(a)This table applies to the length measured, not the length of the pavement. It should be noted that when taking measurements at a speed of 72 km/h, a non-measured length of 2 x 200 m is necessary before and after the test area, for the approach before and for braking after the test, and to stabilize the digital filters.

(b)The term "overall requirements" refers to the method of verifying these specifications. The overall analysis consists in verifying whether or not the ratings specified for all traces (14 or 18, as described in Module 4 of LPC test method no. 46) are attained.

(c)The term "requirements by profile" also refers to the method of verifying these specifications. The overall analysis consists in verifying whether or not the specifications for each of the three central traces considered individually (centre line and +/- 2.50 m, as described in Module 4 of LPC test method no. 46) are attained. These requirements correspond to particular needs related to the passage of the forward landing gear of the aircraft (nose wheel) situated under the cockpit.

(d)When 80%., 90% and 95% of the ratings calculated do not result in whole numbers, the score is rounded down if the difference is ½ point or less, or rounded up if above ½ point.

(e)These specifications are generally applicable in all cases of renovation of a surface course. However, in cases of maintenance work necessitating only one course, and when localized defects are detected during the taking of evenness measurements before maintenance works begin (short-wave ratings equal to or less than 2), it is necessary to undertake preparatory works such as reshaping or planing to enable these specifications to be applied.

Annex H : – List of tables

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