THE USE OF FRENCH ASPHALT MATERIALS IN UK AIRFIELD PAVEMENTS

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ABSTRACT

The need to construct more sustainable, durable and low maintenance airfield infrastructures has become very important in recent years due to the environmental pressure and customer expectation. Traffic delay during maintenance and its impact on airport operations has also become a significant issue as airports face increasing pressure to maximise runway availability to meet increasing aircraft utilisation. The paper reviews the use of alternative asphalt surfacing materials in UK airfield pavements to provide a better whole life solution and to address some of the above points. The use of the French BBA (*Béton Bitumineux pour Chaussées Aéronautiques*) surfacing and EME2 (*Enrobé à Module Elévé 2*) base were investigated. The materials' mechanical properties and their impact on pavement thickness design, constructability and maintenance requirements are reviewed. The environmental advantages of constructing thinner stiff pavement and reducing aggregates and asphalt use are also considered. The French material properties are compared with those of typical materials used in the UK. A case study of using the BBA surfacing on the runway resurfacing project at Sumburgh airport in the Shetland Islands is presented. Issues related to material developments, logistics, main construction and practical implementation experienced by Colas during the construction of Sumburgh airport are highlighted.

1. INTRODUCTION

Concerns about the environment and the expectation of increases in air traffic movements around the world in the recent years have increased the pressure to build more sustainable and low maintenance airfield infrastructures. For the least, it is expected any airfield surfacing material should demonstrate the following characteristics:

- The materials (constituents) need to be readily available at reasonable cost, capable of being delivered at reasonable cost and relatively easy to mix on site;
- The laying conditions would need to be as flexible as possible with reasonable tolerance of weather conditions as can be provided without sacrificing quality;
- The laying equipment should be relatively standard without the need for expensive machinery during batching, transporting, laying or compaction;
- The material needs to be easy to lay and immediately ready for trafficking;
- The material needs to be stable (particularly after Petroleum, Oil and Lubricants (POL) spills, de-icer and application of markings etc);
- It should be easily repaired (even in small quantities) and environmentally friendly/recycleable;
- It should provide the necessary strength, durability, rideability and friction characteristics.

In this paper, the use of French airfield pavement materials – specifically BBA (Bétons Bitumineux pour chausées Aeronautiques) surface/binder course and EME2 (Enrobé à Module Elévé 2) base - has been assessed for their potential as viable alternative to the existing UK airfield pavement materials in order to address this new challenge.

2. PAVEMENT STRUCTURAL AND MATERIALS DESIGN PRINCIPLES

Typical UK airfield flexible pavement construction can consist of asphalt layers over cement bound base over the subgrade soil. The cement bound material acts as a construction platform and helps reduce the traffic induced stresses and strains within the asphalt layers by providing a better support compared with unbound materials. Subgrade improvement, such as a capping layer of granular material or stabilised layer, is usually needed for weak subgrade to support traffic loading during construction. The asphalt layers consist of a surface layer to provide good ride quality and skid resistance, typically constructed over two asphalt base layers. The asphalt base is the main structural layer of the pavement which carries aircraft loading and distributes the stresses and strains to acceptable levels during the pavement life. Marshall Asphalt (MA) surface course/binder course and Dense Bitumen Macadam (DBM) base are traditionally specified and used in UK airfield pavements.

In order to design a pavement structure, the future traffic loading and the pavement material properties (stiffness values), including those of the subgrade foundation, should be known. Pavement layer thicknesses are specified and the stresses and strains at critical locations are calculated under aircraft loading employing a structural analysis model. These stresses and strains are compared with allowable values and adjustments are made to thickness and materials until satisfactory design is achieved. Additionally, the pavement materials are specified to resist fatigue cracking and excessive deformation during the pavement life and to provide a long-term durable construction.

Two main factors contribute to flexible pavement deterioration, environmental variations and traffic loading. The environmental variations include temperature, which can cause surface rutting in hot weather and cracking of the age-hardened brittle asphalt surface in cold weather. Additionally, seasonal changes in foundation condition due to moisture and freeze-thaw action can cause cracks in thin pavement constructions. The traffic loading will generate stresses and strains within the asphalt layers causing fatigue and eventually cracks, and surface rutting due the cumulative plastic deformation of the pavement layers including the foundation. Therefore, the classical design approach addresses two forms of pavement failure in flexible pavements; fatigue cracking in the asphalt material and overstressing of the subgrade.

Pavements deteriorate with time and traffic loading, a process that accelerates towards the end of their life. Flexible pavement structural failure is often defined by the level of rutting (typically greater than 25mm) and excessive surface cracking in the trafficked area at the end of the design life. However, various design methods consider different level of defect based on the level of service required and consequential costs (e.g. due to operational restriction during pavement strengthening or reconstruction) [1].

3. FRENCH AIRFIELD PAVEMENT MATERIALS

BBA is the standard airfield asphalt surfacing in France and has been used in almost all airport pavements in France, including the two runways at Paris Charles de Gaulle, and Toulouse (where the A380 is being built and tested), with a track record of over 18 years. Outside France, the BBA has also been used at Bierset airport (Belgium) and more recently in the UK, at Sumburgh airport in the Shetland Islands. Different from grooved MA runway surfacing predominantly used in the UK, surface characteristics inherent to the French BBA negate the need for grooving; therefore, BBA surface course can be ready for trafficking as soon as the material cools down to ambient temperature. Furthermore, ungrooved BBA can also be laid as binder course which is practically an advantage, particularly in cases where aircrafts are expected to land on temporarily exposed binder course during a new runway construction (due to sufficiently good wet skid resistance inherent within ungrooved BBA). In France, BBA surfacing is generally used with EME base in the airfield pavement design. EME which was developed and has been widely used in France for nearly 20 years represents a binder course/base material type with a relatively high content of low penetration bitumen and low air voids content, designed to provide good mechanical properties (load spreading ability, resistance to deformation and cracking), durability and impermeability.

There are four types of BBA material: closed and gap graded, each grade with 0/10 mm and 0/14mm aggregate sizes; each can be used for binder and wearing courses in new construction and overlay. There are three classes of BBA (i.e. BBA1, BBA2 and BBA3) specified under the French specification (NF P 98-131) [2] based on the frequency and weight of aircraft and the airport climatic regions, to give the characteristics of mix constituents, volumetrics and the level of performance tests required. Similarly, there are three EME mix designations in the French specification (NF P 98-140) [3], according to aggregate size: 0/10, 0/14 and 0/20mm; each mix designation can be manufactured as either EME Class 1 (EME1) or EME Class 2 (EME2). EME2 requires significantly a higher content of low penetration binder and is recommended for the most heavily trafficked pavements due to its high stiffness and good resistance to cracking; this material is currently being introduced in the UK highway network. For both BBA and EME2 materials, performance based mixture design is specified under the respective French Normatives [2,3]; this would ensure the material will be workable and have appropriate performance. There are typically four levels of performance assessments as summarised in Table 1.

Table 1 - Four Levels of Testing [2,3]

Description of Tests	**Performance Requirement**	**Level 1**	**Level 2**	**Level 3**	**Level 4**
Gyratory shear compactor (NF P 98-252)	Workability				
Duriez at 18°C (NF P 98-251-1)	Durability				
Rutting test (NF P 98-253-1)	Deformation				
Mechanical characterization tests with stiffness/complex modulus (NF P 98-260-2) or direct tensile (NF P 98-260-1)	Load bearing capacity				
Fatigue test (NF P 98-261-1)	Fatigue cracking				

The production of test results in level 1 is mandatory in every case. The level of mix design will be determined according to the level of loading, environmental circumstances and the requirement for pavement design. Level 2 is applicable for wearing and binder or base courses that will be subjected to high traffic of heavy aircraft and includes a verification of the resistance to rutting with the wheel-tracking rutting tester. Level 3 applies to mixes of base and binder courses when the determination of the stiffness of the mix is required for pavement design purposes. Level 4 is carried out for heavily trafficked pavements, for mixes used in base layers of new pavements or of overlays in relation with pavement design.

Examples of materials selection for runway and/or taxiway applications where particular classes of BBA and EME would be required are shown in Table 2; the respective performance categories are summarised in Table 3. NS3 and NS4 denote traffic stress levels where mass of aircraft landing gear is typically greater than 40 tonnes; the number of aircraft movements and climatic regions under NS4 are much higher and severer than those under NS3 categories. Similarly, BBA3 and EME2 require higher performance levels than BBA2 and EME1 respectively [4]. It is possible to lay BBA surface course immediately on top of EME base. In any case, tack/bond coat is applied between asphalt layers.

Table 2 - Examples of Materials for Runway and/or Taxiway Applications [4]

Area of Application	**NS3**			**NS4**		
	Surface Course	**Binder Course**	**Base**	**Surface Course**	**Binder Course**	**Base**
Link Sections	BBA2	BBA2	EME1	BBA2	BBA2	EME2
Turning Areas, Exit, Apron	BBA3	BBA2	EME1	BBA3*	BBA2*	EME2

Note: *Higher modulus BBA is required for turning area.

Table 3 - Performance Categories and Requirements [4]

Products	**Duriez test (NF P 98-251-1)**		**Rutting test (NF P 98-253-1)**	**Stiffness modulus test (NF P 98-260-2)**	**Fatigue test (NF P 98-261-1)**
	Wearing course	**Binder course**			
BBA class 1	≥ 0.80	≥ 0.75	≤ 15 % (10,000 cycles)	≥ 5,000 MPa	≥ 100 µdef
BBA class 2	≥ 0.80	≥ 0.75	≤ 10 % (10,000 cycles)	≥ 5,000 MPa	≥ 100 µdef
BBA class 3	≥ 0.80	≥ 0.75	≤ 7.5 % (10,000 cycles)	≥ 8,000 MPa	≥ 100 µdef
	Base				
EME class 1	≥ 0.70		≤ 7.5 % (30,000 cycles)	≥ 14,000 MPa	≥ 100 µdef
EME class 2	≥ 0.75		≤ 7.5 % (30,000 cycles)	≥ 14,000 MPa	≥ 130 µdef

Assessment of the mechanical properties of some BBA materials has been carried out by Scott Wilson Pavement Engineering (SWPE) in Nottingham, using UK test methods. In parallel, the same materials were also assessed using French test methods by Colas Central Laboratory in France. These assessments included testing of laboratory manufactured samples and asphalt cores removed from UK Sumburgh airport (field samples). Selected mechanical test results are summarised in Figure 1 and presented as a comparative performance between UK and French airfield materials. In addition, EME2 material can be laid in thicker layers than other dense asphalts (e.g. 0/20mm EME can be laid in 100-150mm thick, whilst 0/20mm MA or DBM is laid in 50-100mm thick), hence reducing the number of pavement layers [5,6,7]. This could mean more homogenous pavement and problems associated with debonding between base layers (in case thicker (>100mm) base layer is required) can be prevented.

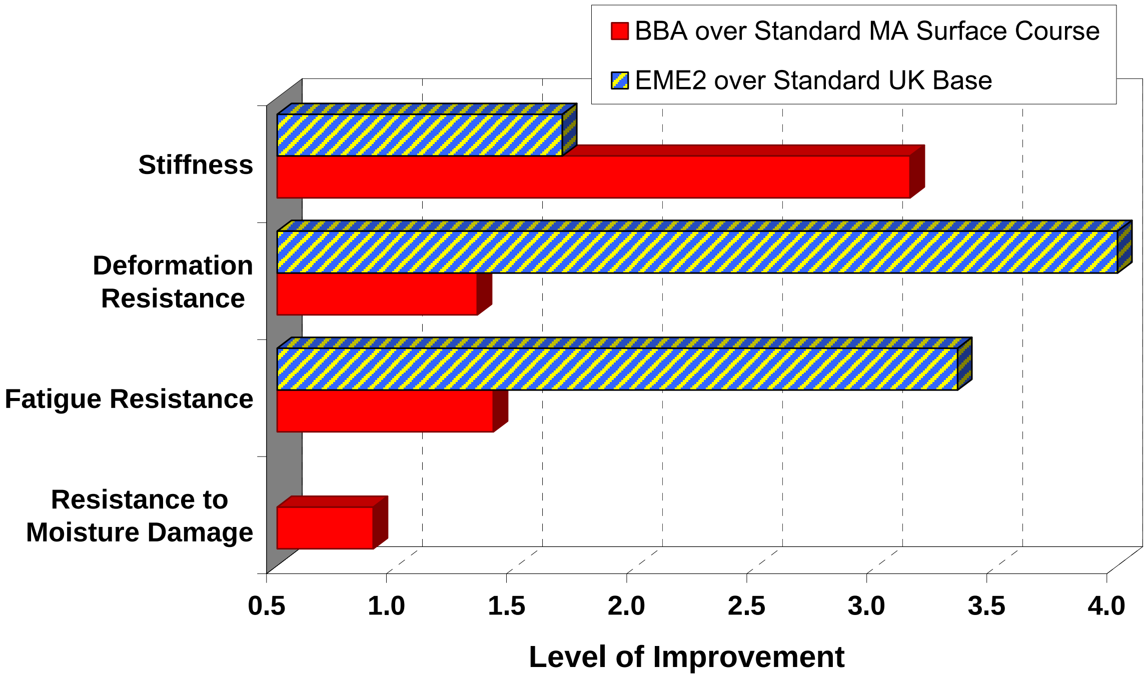

Figure 1 – Performance Comparison between UK and French Airfield Materials

Based upon the above findings, both EME2 and BBA can be considered to have better performance than other asphalt materials currently used in UK airfield pavements, specifically MA surface course and binder course. The potential benefits with respect to the use of both materials in pavement design are presented below.

4. PAVEMENT THICKNESS DESIGN

Review of the pavement thickness design was carried out assuming both EME and a standard DBM/MA asphalt base materials constructed over 150mm of cement bound lower base over four different subgrade conditions. Three aircraft types, BAe146, A320 and A380, representing typical traffic of regional, medium and large international airports and three traffic levels (10000, 100000 and 250000 coverages) which represents low, medium and high traffic levels respectively were considered. Coverages describe the actual number of load applications expected during the pavement life at a point of the pavement surface, considering aircraft wheel configuration and wander about the pavement centreline (details of pass to coverage ratios are presented in PSA and BAA Guides [8,9]. As an example, the landing gear configuration and footprints for A380-800 are illustrated in Figure 2.

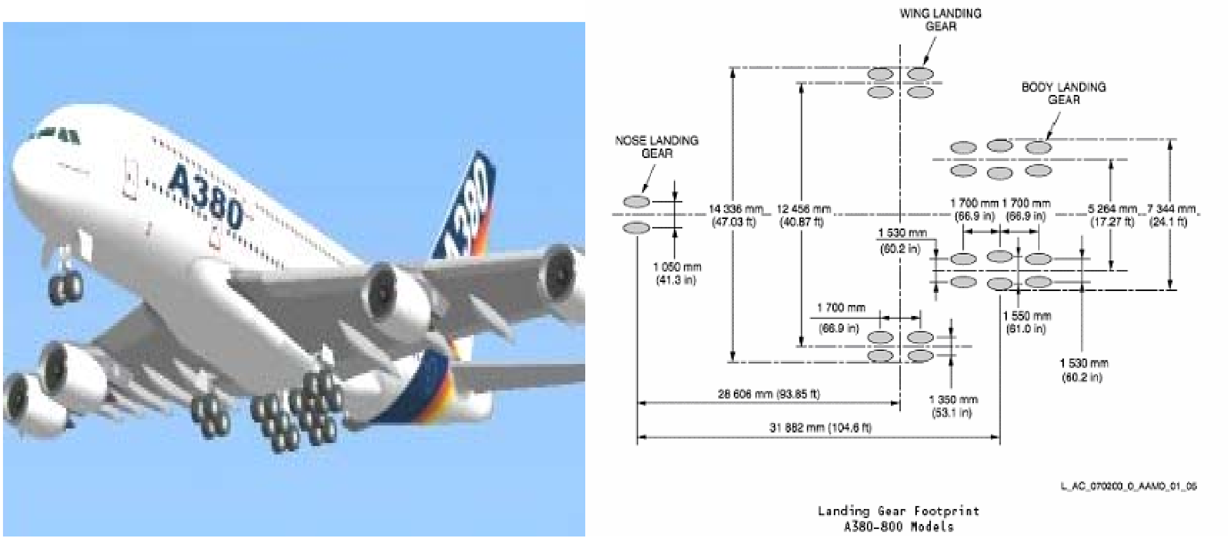

Figure 2 - Landing Gear Footprint for A380-800 [10]

The following design parameters were adopted:

- Design stiffness values of 1,380MPa and 3,100MPa for standard asphalt and EME2 base respectively, to account for slow moving aircraft loading, temperature and long term performance. The BAA design guide [9] assumes a design stiffness of 1,380 MPa for standard asphalt base. However, the design stiffness for EME2 base is not well established for UK airport pavements; the design value (3,100 MPa) was selected based on the ratio of laboratory stiffness values (6,300 MPa for DBM125 and 14,000 MPa for EME2 at 15^{o}C and 10Hz, assessed using the French methods [4])
- The EME2 was assumed to have a similar fatigue and deformation properties to standard asphalt, despite its actual superior laboratory properties. The in situ asphalt fatigue performance is complex and is affected by the pattern of aircraft movements and environmental variations.
- A 150mm thick cement bound material lower base with a stiffness of 1200 MPa (in accordance with BAA assumptions) was used.
- Subgrade California Bearing Ratio (CBR) values of 3, 6, 10 and 15% were considered (corresponding stiffness values are 30, 60, 100 and 150 MPa according to the BAA Guide).

Pavement thickness design from first principles was undertaken for the three aircraft, and four subgrade conditions using a multi-layer system and the BAA performance models. The theoretical thickness values for both standard asphalt and EME2 bases (over 150mm cement bound lower base over various subgrade conditions) are calculated for three traffic levels. The analyses results are summarised in Table 4.

Table 4 - Theoretical Thickness Calculations for both EME2 and Standard Asphalt Bases

Number of Coverages	Subgrade CBR (%)	Total Bound Material Thickness (mm)*					
		BAe-146-300		A320-200		A380-800	
		Standard Base	EME2 Base	Standard Base	EME2 Base	Standard Base	EME2 Base
10 000	3	475	405	605	505	980	775
100 000		610	510	765	630	>1000	>1000
250 000		650	550	845	690	>1000	>1000
10 000	6	400	350	510	430	685	565
100 000		520	440	650	545	965	790
250 000		555	480	720	600	>1000	890
10 000	10	340	300	430	370	535	445
100 000		450	385	565	480	740	615
250 000		490	420	615	525	850	705
10 000	15	295	265	370	325	460	390
100 000		385	340	495	425	610	510
250 000		420	375	540	465	690	575

Note: *the above thicknesses include 150mm cement bound material lower base.

The results indicated an average reduction in bound layer thickness of around 15%, when using EME2 base compared to a standard asphalt base. The number of layers required to construct a thinner pavement using EME2 base is typically less than those of standard asphalt materials. This will result in a more durable homogeneous construction with lower number of layer interfaces. It should be noted that other issues related to material durability, long term performance under heavy slow moving aircraft and UK environmental conditions, have not been included in the analyses and for a full evaluation of pavement life, performance monitoring of this pavement material under UK condition needs to be carried out.

5. SURFACE CHARACTERISTICS

Low skidding resistance at the runway pavement surface represents a major hazard for the aircraft traffic operations in wet weather condition. Friction is the mechanism that allows the aircraft to slow down after landing. Each airport operator will have their own criteria for minimum friction values for their runways; however they generally follow the guidance given by the Civil Aviation Authority (CAA) [11] or International Civil Aviation Organization (ICAO) [12].

One of the most important criteria during licensing and routine maintenance is the requirement for longitudinal wet friction coefficient. The French standard specifies that the longitudinal wet friction coefficient of new ungrooved BBA (measured at 1mm water depth by IMAG, within 3-12 months after laying) shall not be less than 0.53 or 0.44 at speeds of 65 or 95 km/h respectively. French airfield data reported measured values of new ungrooved BBA surfacing typically above 0.60 and 0.50 at speeds of 65 or 95 km/h respectively.

Grooving is generally applied on dense airfield asphalt surface course such as MA, primarily to facilitate rapid surface water dispersal but also generally being perceived as an insurance to prevent wet skidding accidents. The French require adequate surface crossfall to ensure water dispersal and hence negate the need for BBA grooving. There are a number of arguments against grooving of the dense asphalt surface course as it is expensive, reduces the expected life (poor durability), increases the cost of maintenance (e.g. for rubber removal) and has a negative environmental impact in the form of additional noise of grooved surfaces. BBA surfacing on the other hand is normally laid ungrooved.

Rubber deposits are frequently found in the touchdown areas on grooved runways and can be quite extensive, to an extent that may compromise airfield safety. Rubber removal is usually carried out when the friction coefficient has reduced to the specified maintenance planning level (MPL) [14]. Rubber removal operation could take place as often as once in every 8-10 weeks for grooved surfacing in very busy airports (e.g. Hong Kong International Airport with 35 millions passengers per year). In comparison, a major French airport (50 millions passengers per year) where BBA surface course is used reported less frequency for rubber removal (2-3 times a year). This suggests fewer requirements for maintaining skid resistance and hence reduced the maintenance cost.

6. ENVIRONMENTAL BENEFIT

Potential benefits to the environment from using (ungrooved) BBA and EME2 materials can be expected as a result of a number of factors, including long service life, conservation on the use of premium aggregates, potential for recycling, potential for retexturing, and low noise and greenhouse gas (GHG) emission. The main gases which contribute to greenhouse effect are carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4).

The laboratory assessments have indicated improved overall performance of BBA over MA. Furthermore outcomes from the pavement design review suggest that the combined use of BBA and EME2 materials would potentially carry more aircraft movements (hence higher PCN) over that with MA materials for the same design thickness. PCN (Pavement Classification Number) is an indication of the pavement bearing capacity, which is a function of the pavement construction, subgrade strength and future traffic (aircraft movements) [12]; higher PCN means higher pavement bearing capacity. These findings may suggest longer service life and/or less maintenance work; this would help reducing the requirement for premium aggregates used in maintenance or resurfacing works. Reduced construction period would also mean lower fuel consumption and less carbon emission. BBA, in particular, is commonly manufactured in high output continuous mixing plants which are more fuel efficient than batching plants, efficiency that helps reduce energy usage and minimising the effect on air quality. As an illustration, Figure 3 shows the GHG emissions for manufacturing one ton of material, from extraction of the raw materials to laying at the construction site [15]; the GHG emissions are expressed in kilograms per tonne of material. Higher energy consumption will be required to produce EME2 (high modulus asphalt concrete); however, the total GHG emission is actually comparable with other asphalts (bituminous concretes) although remains higher than “leaner” road base asphalt concrete. Due to its higher stiffness and reduced pavement thickness for the same design traffic, the net energy consumption associated with constructing pavements incorporating EME2 will reduce.

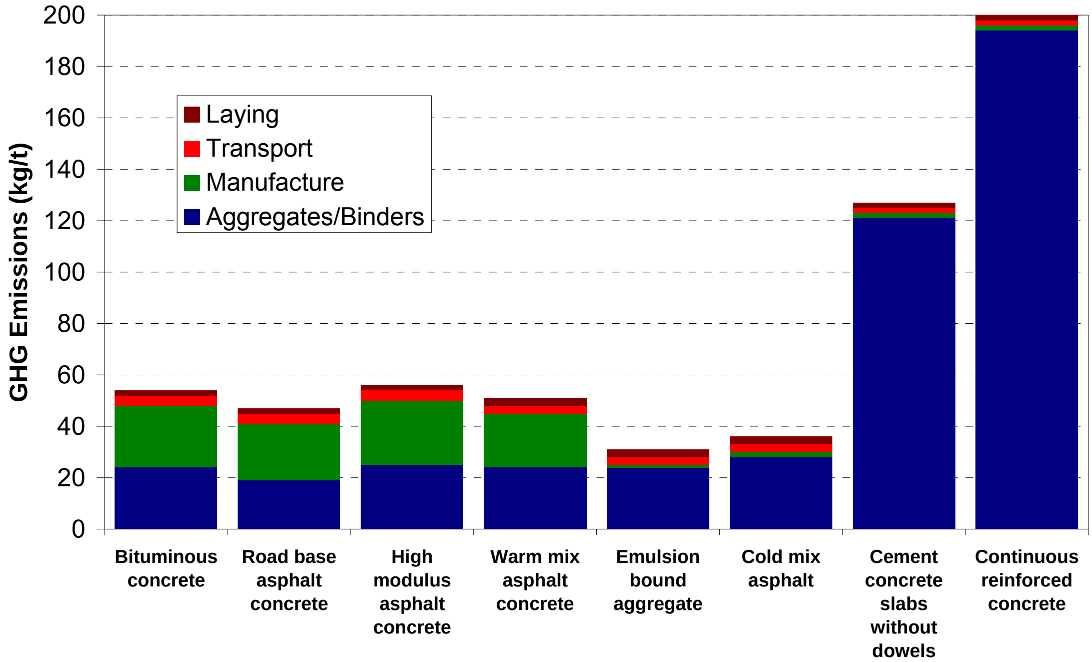

Figure 3 - GHG emission during manufacturing and construction [15]

The fact that there is a tight control to ensure good quality aggregates are used in the BBA surfacing coupled with no requirement for grooving, would also mean that, at the end of design life (which is expected to be longer than the traditional grooved MA surface course), there is the potential to retexture the surface course (to restore skid resistance) and/or recycle this premium material back into the pavement (potentially up to 100% recycleable, but this may be limited by contractual provision to 10% by existing French and UK specifications [2, 16] if recycled for use in a surface course, or 20% if recycled for use in binder course [2]). However, recycling up to 50% in lower asphalt layers has been recently proposed in the UK to conserve the use of virgin aggregates.

The lack of grooving would also mean lower noise generated between aircraft tyres and the surface of runways compared to that generated on grooved surface, which would be of benefit those living near the airport. McNerney et al [17] has carried out a research consisted in field-testing fifteen different road and runway pavements in Texas, in coordination with six other pavement types in South Africa. The test results demonstrated the effect of grooving in increasing noise level up to 10 dB(A). BBA material has a high portion of coarse aggregate with relatively high binder content. If the composition of BBA could be assumed to be similar to that of the coarse matrix binder assessed by McNerney, BBA surface course would be expected to have lower noise emission than grooved asphalt; however, verification of this hypothesis by in situ assessment is required.

7. WHOLE LIFE COST

Whole life cost includes the initial cost of pavement construction or rehabilitation, all the costs of routine maintenance and planned strengthening over the pavement life, and the value of the asset at the end of its service life. Other factors include the engineering cost, traffic management cost during pavement treatment and users cost as a result of delay and increase in aircraft operating cost. Therefore, where the cost of traffic disruption during pavement maintenance and strengthening is high, as the case of majority of busy airports, constructing thick/strong pavement would have a major advantage.

Ungrooved asphalt surfacing such as BBA can be fully operational as soon as the temperature of the laid materials has reached the ambient. For comparison, MA surfacing has to wait from as early as 24 hours to as long as 2 years (in cold/wet climatic countries) after the surfacing material had been laid before grooving operation can be carried out and subsequently opening to traffic. Runway closure in particular would cause a reduction in the movement capacity of the infrastructure; this would have a big impact on the airport operations at all levels and potentially a significant loss of revenue. As an illustration, delay cost for closing a runway at Dallas International Airport was around $110,000 – 131,000 per day in 1990 [18], whilst a recent UK practice suggested that this delay cost could have been as high as £13.5 millions per day. Other savings could be seen from the construction cost (between 15 and 27% less), completion time (26 – 40% shorter) and material quantities (18% less).

8. CASE STUDY: SUMBURG AIRPORT CONSTRUCTION

Resurfacing work at Sumburgh Airport's Runway 09/27 in the Shetland Islands (UK) was started in May 2006, covering a 1500 m long runway plus 2 runway extensions (230m and 90m on the west and east ends). The runway extensions involved reclamation of 4.2 hectares of land from the sea.

The material used for the new runway surfacing was the French BBA 0/10 Class 2. Specifically, the work comprised removal of the existing porous friction course and replacement with a new 45mm thick BBA surface course and, on the extensions, full depth construction incorporating 45mm thick BBA surface course over 85mm thick 0/20mm Dense Bitumen Macadam (DBM) binder course and 165mm thick 0/32 mm DBM base, over granular base.

The raw material (aggregate) used for the resurfacing work was igneous rock with a PSV of 66, locally quarried from Wilsness Hill situated adjacent to the airport. The use of local material and on-site production not only meant greater control over quality and supplies but also minimised airport disruption and environmentally and socially beneficial as it avoided the impact of some 1100 lorry movements on local roads. The bitumen used for the BBA surface and DBM binder courses has penetration grades 40/60 and 70/100 respectively; a total of 1080 tonnes of bitumen was transported in 54 loads, together with the bond coat Colbond 65, by sea from Dundee to the construction site. Colas' mobile asphalt plant, Ermont TSM 225, was transported to the Shetlands from Birmingham.

The transportation routes used by the mobile asphalt plant (from Birmingham), including a 50 tonne capacity weighbridge, and the bitumen loads (from Dundee) are illustrated in Figure 4. Upon arrival on-site, the asphalt plant, which requires no foundation, was erected and commissioned within 10 days.

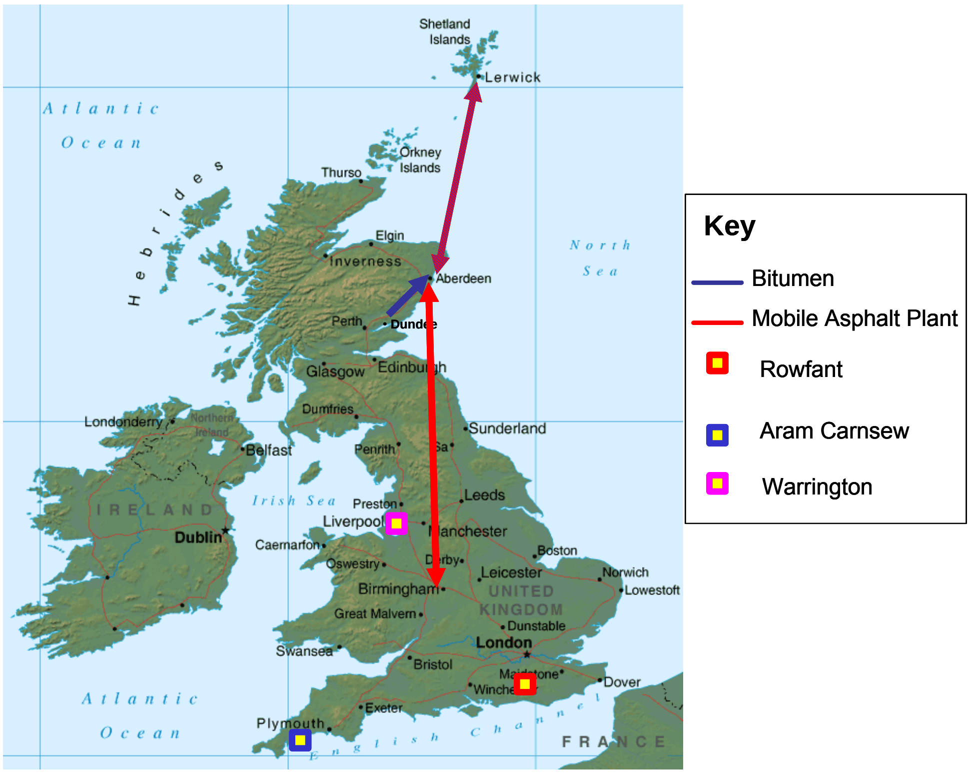

Figure 4 – Movements of logistics for the construction

The asphalt materials used for the resurfacing work were produced by a continuous batching mobile asphalt plant with a capacity rated to 225t/hour; the actual production rate adopted during the work was approximately 120t/hour. The BBA surface course was laid by two Vogelle pavers laying in echelon and compacted by two Bomag 161 rollers with a Hamm HW90 deadweight following each paver. It should be noted here, however that French experience suggested even much higher outputs than (say) conventional MA surfacing and DBM base, for example:

i) During a complete runway closure, up to 14,000 tonnes per day of BBA have been laid by using two on-site plants manufacturing 450 tonnes per hour each.
ii) During restricted runway possession time (between 11pm and 5am), the output was about 1000-1200 tonnes per night; this corresponds to 120-160 m per night runway surfaced using 2 paving machines laying dual layers of 70mm EME base and 50mm surface course, with a width of 8m each.

The high binder content and composition of BBA material has contributed to improved workability and speed of construction of this material. BBA in particular does not require specialist paving equipment such as pneumatic tyres (which are expensive to hire and require specialist operators).

As a part of the project condition, the runway remained operational during daytime throughout the duration of the project. This meant that all equipments had to be withdrawn to safe zones during daytime aircraft movements. Furthermore, the local access road, A970, which runs across the west end of the runway, was to remain open all times. For the final runway surfacing, which involved milling and removing the existing surface, all work was carried out at night. Possession was given to Colas at 22:00, and the work was competed by 04:30 to allow sufficient time before the handover at 07:00 by which time the runway had to be clear and operational. Despite these restrictions, the project was completed in a relatively short time, within 28 days.

Site observation during runway resurfacing project at Sumburgh Airport suggested that the material can be easily laid and compacted. This was also confirmed by the laboratory assessment that the mixture has good when laid and compacted in a laboratory roller compactor – the variations in air void of compacted samples were ± 1% for BBA as opposed to ± 1.5% for MA. Furthermore, the composition and aggregate gradations of BBA appeared to carry a lower risk of segregation during manufacturing and transportation of the asphalt to site (when compared with MAs). This evidenced by the more uniform appearance of the finished BBA surface. These would imply better constructability, workability and quality control for BBA than those for MA.

Despite the normal practice for not grooving BBA surface course in France, however, the BBA surface course used at Sumburgh airport was specifically grooved upon a request of the airport’s owner. This decision to groove the BBA surface course was made considering the proximity of the runway to the North Sea and the Atlantic Ocean, having significantly wet climate with very strong wind capable of blasting sea water on to the runway; this weather condition is illustrated in Plate 1. By grooving runway 09/27 at Sumburgh airport, aircraft are expected to be able to stop in shorter distances when it is wet, allowing the runway extension to be significantly shorter than it would otherwise have been. In this case, the mixture gradation was modified to give closer surface texture to receive grooving. As previously mentioned in Section 3, a number of cores were removed from Sumburgh Airport and were subjected to laboratory mechanical tests. The test results suggest that the performance of the BBA cores removed from site was comparable to that of the laboratory manufactured BBA, and significantly better than that of MA material. The improved performance included the superior groove stability (resistance to closure and/or cracking) of the field (grooved) BBA to that of (grooved) MA material.

Plate 1 – Aerial photograph of Sumburgh Airport and its typical weather condition

The initial friction test carried out on the new laid grooved BBA at Sumburgh airport showed an overall initial Mu-Meter coefficient of 0.66 (at 65 km/h test speed), with variations from 0.63 to 0.70. This value is considered to be typical for new grooved asphalt surfacing and higher than the maintenance planning level (MPL) set out by CAA [13] and ICAO [12]. Generally, this friction value can be expected to increase with age, as the binder coating the aggregate at the surface has been rubbed off by aircraft trafficking [14]. Indeed, four months after opening to traffic, the measured Mu-Meter coefficient of the runway surfacing at Sumburgh airport increased to around 0.74 (variations between 0.72 and 0.77).

9. CONCLUSIONS

Review of the suitability of two French airfield pavement materials, specifically BBA (Bétons Bitumineux pour chausées Aeronautiques) surface course and EME2 (Enrobé à Module Elévé 2) base, for use in UK airfield pavement construction has been presented. The friction characteristics of BBA surfacing are expected to be at least as good as the traditional grooved MA (Marshall Asphalt) surface course. This study has highlighted a number of potential benefits from using French airfield pavement materials as opposed to using the materials currently used in the UK airfields. Specifically, a combined BBA/EME2 layer would be expected to offer greater benefits than the popular MA/DBM layers. Pavement design with combined BBA and EME2 layers would be expected to offer the following benefits:

- better strength and durability leading to at least 15% reduction in layer thickness for airport with the same PCN;
- EME2 base/binder course is practically a durable long life material, therefore maintenance and repair may be limited to surface course only and at longer intervals;
- ease of laying with consequence increased productivity, reduction in construction period and construction cost together with less disruption to airport operations;
- fewer transverse joints in pavements owing to greater runway lengths surfaced each shift;
- potential reduction in noise;
- saving since for grooving is not required and runway closures are shorter;
- longer interval between rubber removals;
- BBA materials lend themselves to easier future maintenance, requiring no specialist paving equipment or mixing plant;
- BBA is more readily recycled than grooved MA resulting in reduced need for primary aggregates and lower levels of greenhouse gas emission.

Based upon the above findings, it is expected that the BBA and/or EME2 materials can offer whole life cost saving whilst providing the critical elements of sustainable construction, namely environmental, social and economic advantages.

A case study presented the success of a runway resurfacing project at Sumburgh Airport in the Shetland Islands, where BBA surface course was used. The case study showed a number of practical issues experienced by Colas in relation to: material use, logistics, main construction and practical implementation.

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