Bituminous Surfaced Pavement Maintenance for Remote Airfields in Australia
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Abstract
Many smaller airfields in Australia are situated in remote locations. Many of these airfields are now servicing B737 aircraft even though they were designed for the smaller aircraft in operation at the time of their construction. Well planned and executed bituminous pavement maintenance is therefore critical to the ongoing serviceability of these pavements.

Typical remote airfields surfacings include hot mix asphalt and hot sprayed bituminous seals. The operation of aircraft and airfields is such that the outcomes and performance of bituminous surfacings and maintenance for airfields is slightly different to that for roads. Subtle but important differences in the approach to the application and maintenance of these surfacings are therefore essential.

Common bituminous pavement maintenance activities include:

- Asphalt overlay.
- Hot sprayed bitumen resealing.
- Surface enrichment sprayed treatment.
- Routine maintenance tasks.

Whilst the materials, equipment, contractors and construction techniques are generally the same as for road pavements, the operational requirements are significantly different. Experienced aircraft pavement engineering specialists are recommended to ensure that these subtle differences are implemented.

Introduction
There are over 200 regional airports with sealed runway surfaces in Australia. Whilst some of these airports are located in major regional centres, many are located in rural areas. The majority of these airports are provided with bituminous surfacings, either hot bitumen seals or asphalt. Many of these airports are managed and operated by local Councils or private companies. Such Councils are generally not staffed to performed airfield maintenance using Council assets and in many cases the airports are not financially self supporting. In these cases, the ability for airports to maintain operational pavement surfaces in an economical manner is critical to their financial viability.

Common pavement maintenance activities for these airports include:

- Asphalt overlay.
- Hot sprayed bitumen resealing.

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• Surface enrichment sprayed treatment.
• Routine maintenance tasks.

The operation of aircraft and airfields is such that the outcomes and performance of bituminous surfacings and maintenance for airfields is slightly different to that for roads. Subtle but important differences in the approach to the application and maintenance of these surfacings are therefore essential to their success and the financial viability of the Councils and private companies that manage and operate them.

A range of bituminous pavement maintenance activities are described. The subtle but important differences between aircraft pavement and road pavement surfacings and maintenance are detailed and a number of lessons learnt from various projects carried out around Australia are detailed.

**Asphalt Overlay**

Asphalt surfacings are the norm for major airports and are preferred for regional and rural airports carrying jet aircraft. With an expected life of 12 to 15 years, asphalt overlays represent a major investment in any airport’s pavement. Whilst the equipment, personnel and raw materials are generally the same for airport and road pavements, asphalt mix design is significantly different and some of the construction practices have subtle differences designed to optimise the resulting surface for aircraft operations.

**Binder and Binder Content**

In recent years, in response to perceived reductions in performance of conventional bitumen binders, Multigrade binder has become the norm for airport pavement asphalt.

Binder contents for airport asphalt are generally higher than for roads, primarily in an effort to provide surface durability in very lightly trafficked pavements. Also, as asphalt surfaces are generally thin (typically 50-60 mm for new surfaces or asphalt overlays) the asphalt layer contributes relatively little to the pavement’s structural capacity and therefore achieving higher moduli values through lower bitumen contents is not as important as achieving a durable surface. Typical binder contents for airport and road asphalts are:

- Nominal 14 mm sized asphalt. Minimum 5.6% for airports and typically 4.5-4.9% for roads.
- Nominal 10 mm sized asphalt. Minimum 5.8% for airports and typically 5.0-5.4% for roads.

**Aggregates**

Aggregates are generally similar to road asphalt aggregates but the tolerances on grading are slightly more stringent. Whilst parent rock for asphalt aggregates is sometimes available in remote areas, the more stringent grading and processing requirements make the production of airport asphalt difficult.
In very remote areas where asphalt is not an option for road pavements, the provision of asphalt for airport surfacing will usually be problematic. In such areas, mobile batching plants will be required and aggregates may need to be hauled many hundreds of kilometers to the site.

**Construction issues**

From a construction perspective, the equipment, tools and processes for airport asphalt construction are as per road asphalt. However, tolerances are tighter and aim to minimise the risk of loose material being generated on the asphalt surface during service. Due to the operational requirement to completely shut runways when overlays are performed, the requirement to complete works in a timely manner, often during the night when there are no scheduled flights, it common. As a result, two pavers in echelon are commonly used on airfield overlay projects.

**Hot Sprayed Bitumen Resealing**

For many rural airports where asphalt aggregates and plant are prohibitively far away, hot bitumen sprayed seals are common surfacings. These can be applied to existing seals or to asphalt surfaces. Whilst road construction contractors commonly provide such surfaces to roads, they are generally not aware of the subtle but important differences required for aircraft pavements. These important differences generally aim at minimising the risk of loose material being left of the surface and are described as follows.

**Binder application rate**

Binder application rates are much higher than for road applications. For example, a typical road surfacing might have 1.2 l/m$^2$ of residual binder for a 10 mm sized seal. By contrast, the same 10 mm seal in an airport application would typically require 2.0 to 2.4 l/m$^2$ of binder. These high binder rates are required due to the inability to accommodate any loose stones on the surface of the pavement. In a road environment, this is not generally a significant issue and the high number of traffic passes necessitates lower application rates due to concerns with bleeding of the surface in service, which can lead to loss of surface texture. Bleeding of the seal rarely occurs on airfields due to the low traffic frequency, but where it does occur, it is considered preferable to loose aggregate.

**Aggregate spread rate**

Aggregate application rates on roads are generally higher than theoretically required to provide a single layer of aggregate. On aircraft pavements, where loose aggregate on the surface is not tolerated, an application rate that results in a single layer matrix of aggregate on the surface is required. Aggregate spread rates therefore tend to be lighter on airports than on roads.

**Sand-emulsion overspray**

To further ensure that aggregate is locked into the surface, an overspray of bitumen emulsion and sand is commonly applied to the hot bitumen seal. The sand assists in locking the aggregate in place by filling the interstices.
This is not a common practice for road seals. The most commonly encountered risk with sand-emulsion overspray is to adequately dry the cover sand so that it will flow out of the tipper gates. It has commonly been necessary to dry the sand in an asphalt drum to achieve the required level of sand dryness. A seal with the sand-emulsion overspray at Claris Airfield on Great Barrier Island in New Zealand is shown in Figure 1.

**Figure 1  Sand-Emulsion overspray at Claris Airfield.**

*Pneumatic tyred rolling*

Whilst the use of pneumatic tyred rollers is not significantly different for road or aircraft pavement seals, the amount of rolling is significantly greater for the latter. Due to the requirement to hold the aggregate in the surface and because the surface typically receives very low numbers of passes post construction, rolling is typically specified as 1 hour per 800 l of residual bitumen applied. This is two to three times the amount required for road seals, where high traffic numbers continue to roll the seal after construction.

*Steel drum rolling*

When aircraft land on runways, the wheels are not rotating. This means that sharp aggregate in the sealed surface can tear and erode tyres. Steel drum rolling is therefore employed during construction to remove the sharp tops from the aggregate in its final position. Steel drum rolling is performed only on the top aggregate seal coat and is performed prior to the application of the emulsion-sand overspray. Steel drum rolling is not performed on road pavements. A steel drum rolled 10 mm seal from Lockhart River Airport is shown in Figure 2.
Construction issues

In some cases, these differences require the contractor to construct hot bitumen surfaces with materials and equipment they have never used before and using application rates that would create significant problems in a road environment. Convincing contractors to construct these surfacings as specified can therefore be a challenge.

Surface Enrichment Sprayed Treatment

Surface Enrichment Sprayed Treatment (SEST) is a light application of sprayed hot binder to an asphalt surfacing. The low application rate (typically 0.25 to 0.35 l/m$^2$ of residual binder) and absence of cover aggregate allows the binder to penetrate into the voids within the asphalt surface. Within this typical range, SEST should be applied at the maximum rate possible without causing excessive build-up of bitumen on the surface which could lead to a longer term reduction in skid resistance. A typical surface before and after SEST treatment is shown in Figure 3.
The treatment is generally applied to aged asphalt and the aims are to:

- Replace some of the fine aggregate and oxidized binder that has eroded from the surface with age.
- Provide a sacrificial or protective film over the surface to retard further asphalt binder oxidation.
- Seal fine, non-working, cracks.
Construction issues

SEST also provides the aesthetic advantage of returning the asphalt surface to a black condition. It also highlights fine cracks in the underlying asphalt as shown in Figure 4. Whilst SEST application is expected to slightly reduce the skid resistance of an asphalt surfacing, this has generally found to only be temporary, with skid resistance considered to return to normal levels once the binder is rubbed from the top of the aggregate particles, similarly to as occurs for a new asphalt surfacing.

Figure 4  Cracks revealed by SEST at RAAF Scherger.
**Materials**

Two materials have historically been used for SEST treatment. These are:

- Convention 50-50 cutback bitumen with a slower (kerosene) or rapid curing cutter.
- Coal-tar in an emulsion of rapid curing turpentine cutter.

The conventional SEST of bitumen in kerosene cutter is considered to be preferable from an OHS perspective as well as its ability to penetrate the existing asphalt due to its slower curing properties. This product is ideal at airfields where two runways of similar capacity allow one to be closed for a week or more during application and curing, or airfields that have no permanent aircraft that can be closed for the period of work.

Traditionally, the rapid curing nature of the coal-tar product made it popular as it offered the advantage of being able to apply the SEST at night and return the pavement to operational condition the following morning. However, in more recent times, OHS concerns with tar based products has seen coal-tar SESTs become less common.

The cutback bitumen with rapid curing cutter is a recent development that allows the OHS concerns of the coal-tar product to be avoided whilst retaining a rapid curing time. At no significantly greater cost, this product provides some of the advantages of both traditional options and is rapidly gaining favor.

**Programming**

Under a reactive maintenance regime, SEST would be typically expected to be applied when the asphalt surface is aged 10 to 12 years. The SEST application is considered to have an effective life of around two years. Depending on the initial SEST application rate and the condition of the asphalt, second applications are common and a third application has been successful in some circumstances. The use of SEST treatments has been shown to extend the period between asphalt overlays by up to five years. At a cost of $1.00-1.50/m² (asphalt surfacing is typically around $30/m²) this is a very cost effective treatment. Under a preventative maintenance regime, SEST may be applied to the surface earlier in its life (typically 6-8 years of age) to retard the oxidation of the binder prior to any significant erosion of fines and binder.

**Routine Maintenance Tasks**

Routine pavement maintenance tasks are as important at remote airfields as at major airports in capital cities. Common routine maintenance tasks performed on bituminous surfaced airport pavements include:

- **Crack sealing.** Cracks are sealed with a rubberised bitumen banding which leaves a slightly proud bandage over the top of the crack. This has been shown to be a reliable and durable method of preventing water from
entering cracks. Figure 5 shows well treated cracks at Gin Gin airfield in Western Australia.

- **Linemarking.** Linemarking on remote airfield pavements is commonly required at intervals between three and five years, depending on the amount of aircraft traffic and rainfall. Linemarking must be performed with airport paint that powders and erodes rather than thermoplastic paint that flakes, which could present a hazard to aircraft. Glass beads are not used in runway line marking as they result in significant loss of skid resistance when applied to large areas of pavement. Figure 6 shows a newly marked runway at HMAS Albatross.

- **Polymer Modified Bitumen (PMB) Emulsion.** PMB Emulsion is a generic term for a range of proprietary products that are all based on a PMB Emulsion slurry with very fine aggregate. These products include Liquid Road (by Australian Pavement Management System), Jet Black (by PMP Bitumen) and Carbonyte (by Sami Road Services). These products are used to choke the surface of segregated and eroded asphalt with the aim of preventing larger aggregate from becoming loose on the pavement surface. This effectively extends the life of the asphalt overlay and delays future overlay requirements based on aggregate plucking out of the surface. Figure 7 shows asphalt at Townsville Airport before and after the application of liquid road.
Figure 5  Rubber banded crack at Gin Gin Airfield.

Figure 6  Newly marked runway at HMAS Albatross.
Figure 7  Asphalt before and after PMB Emulsion at Townsville.

All these maintenance activities are important and the remoteness of some airfields makes them more challenging. Material supply and damage to equipment in transport add to the challenge of performing such activities in remote areas.
Conclusions

Maintenance of bituminous airfield surfacings is critical to achieving the maximum possible service life for airfield pavements. When airfields are located in remote rural and regional areas, maintaining these assets presents unique challenges that need to be addressed.

Based on ten years of maintenance on airfields located from regional New South Wales and Victoria to the Northern Territory, tropical north Queensland, the Pilbara in Western Australia and remote islands of New Zealand, many lessons have been learnt. Some of these lessons include:

- The preference for asphalt on runways servicing jet aircraft means that overlays will sometimes be required in areas where asphalt is not commonly used for road pavements.
- Whilst airport asphalt uses similar aggregates, binders and equipment to those used in road asphalt, the tolerances, binder contents and construction restrictions make airport asphalt non-standard and therefore it requires special attention.
- Hot bitumen seals commonly provide economical and operationally acceptable surfacings for rural airport pavements, including those accommodating jet aircraft up to B737 sized.
- Hot bitumen seals utilise aggregates and binders that are very similar to those used in road pavements but bitumen application rates, the use of steel drum rollers and the provision of bitumen emulsion-sand oversprays are somewhat unique to airfields and necessitate specialist input during design and construction.
- SEST is a common treatment for asphalt on airport pavements and can extend the period between overlays by five or more years. SEST should be applied at the maximum possible rate that does not compromise the skid resistance of the surface.
- Routine pavement maintenance includes sealing of cracks, treatment of segregated and eroded asphalt and linemarking. All these activities are similar to those performed of road pavements but have subtle differences that require careful consideration.

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