PAVEMENTS FOR RURAL AND REMOTE AIRPORTS

SUPPLEMENT TO AIRPORT PRACTICE NOTE 12
ABOUT THE AUTHOR

Dr. Greg White

Dr. Greg White is the Director of Airport Pavement Research at the University of the Sunshine Coast, as well as Director of Airport Pavement Engineering Specialists, an independent consultancy providing high level and specialised advice to the airport industry. Previously Greg worked as Technical Manager for airport projects at one of Australia’s leading asphalt surfacing and construction contractors, and as a Principal Airport and Pavement Engineer with a number of Australia’s largest design firms. Greg’s interests extend to all aspects of airport pavement design, construction, management, evaluation and maintenance, particularly the incorporation of new and innovative technology and practice into real life projects, for the benefit of airport owners. As well as his PhD, Greg holds a Bachelor of Civil Engineering and four Masters degrees, all earned in the pavement engineering and airport pavement disciplines.

Contact details:
T: 0400 218 048
E: gwhite2@usc.edu.au
greg@apes.net.au
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These airport practice notes are prepared on behalf of industry to promote ‘best practice’ across Airport operations.

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1. PREAMBLE

Airport Practice Note Number 12 (APN 12) (AAA 2017) provides guidance to airports relating to the materials, design, construction, management and maintenance of airfield pavements. Chapter 6 of APN 12 provides general guidance specific to rural and remote airports where the aircraft are so small that ground vehicles, like refueling trucks, govern pavement strength requirements. Other sections of APN 12 address many of the issues considered in this Supplement, but in a manner that applies to all airports and only in a general way. This Supplement aims to provide more practical and focused guidance to rural and remote airfields on issues that are considered important for the management of pavements used by small aircraft.

Like APN 12, this Supplement provides general information. It must not be used in lieu of project-specific advice by appropriately skilled professionals.
2. INTRODUCTION

There are around 300 significant airfields in Australia. Around 50 of these are large and major regional airports, while the rest are regional, rural and remote airfields. The pavements at many rural and remote airfields are usually constructed from locally available materials that would not be accepted at major airports, are usually owned and managed by a local government authority and may accommodate aircraft ranging from small General Aviation (GA) planes up to Dash 8 Q-400 or small jets. Because regional, rural and remote airfields are, by definition, generally located away from major cities, they often provide critical community access to medical and other services, including support of bushfire fighting aircraft and access for the Royal Flying Doctor Service (RFDS). Consequently, the operational availability of these airfields is just as important to local communities as that of larger or major airports.

It is important to understand that Manual of Standards Part 139 (MOS 139) requirements relating to pavement surface shape, aircraft skid resistance, ponding of water and freedom from Foreign Object Debris (FOD), apply almost equally to rural and remote airfield pavements as they do to capital city or even international airports. Consequently, despite the thinner pavement and use of local and more economical materials, the aviation safety related outcomes are often similar to those required at larger airports. Airport-experienced professional advice is required to strike a balance between solutions that are suited to rural and remote airports but remain within the limitations of aviation safety. This will allow appropriate and economical solutions to be developed, that are also consistent with the intent of MOS 139 (CASA 2016).

This Supplement addresses issues that are significant or challenging to rural and remote airports, as well as other regional airports that have similar pavements used by small aircraft. The issues described include:

- Pavement thickness design.
- Pavement surfacing materials.
- Pavement strength rating using the ACN-PCN system.
- Surface friction and texture.
- Delivering airfield pavement works.

First, airfield pavements are defined and the important differences between roads and airfield pavements are described. The various issues are then addressed prior to outlining the important considerations when planning and delivering airfield pavement works.
3. DEFINING AIRFIELD PAVEMENTS

APN 12, Section 1.1 defines a pavement as a durable structure or surfacing placed over existing soil or ground materials to improve performance under traffic. This is no different for rural and remote airports as it is for pavements at larger airports. However, lower loads mean that thinner pavements can improve the existing material adequately enough for General Aviation (GA) and other small aircraft to operate. Lower quality materials can also be used to resist the stresses imposed by the smaller aircraft, providing significant economic benefit to the airfield.

APN 12, Section 6.1 defines aircraft pavements as pavements that are structurally designed to accommodate the aircraft that use them. In many rural and remote airports, the aircraft are so small that refuelling trucks impose greater loads than the aircraft, and these ground support vehicles dictate the structure and thickness of the pavement required. These pavements are rarely designed using aircraft pavement design principles and are better termed ‘pavements used by aircraft’ rather than ‘aircraft pavements’. Pavement design is described in more detail below (4 Pavement design).

The differences between roads and airfield pavements are detailed in APN 12, Section 1.4 and Table 1. These differences are less significant for rural and remote airfields because of the lower aircraft loads and because of the use of more economical local materials. However, many of the differences remain important and still require careful consideration. For example, the geometric shape (cross fall and longitudinal grade) of all airport pavements must comply with MOS 139, regardless of the size and location of the airport. Furthermore, providing a surface that is free from ponding water, free from Foreign Object Debris (FOD) and provides adequate friction and texture (refer 7 Surface Friction and Texture) is no less important for rural and remote airports as it is for large and major airports, and is more important than for roads.

The differences between airfield pavements (even rural and remote ones) and roads means that airport-specific solutions are usually required. However, due to their ownership by local government authorities, rural and remote airfield pavement works are often developed by local road engineers that do not necessarily understand the different requirements of aircraft and airfield pavements. In some cases, this has resulted in unsafe solutions or reduced service life of pavements at rural and remote airfields. Consequently, it is important that rural and remote airfield pavements be designed, constructed and maintained to achieve airport-suitable outcomes, even when local materials are used.
4. PAVEMENT DESIGN

As detailed in APN 12, Section 1.1.2, aircraft pavements can be rigid (concrete) or flexible (unbound, granular or bituminous). Because rigid pavements are rarely encountered in rural and remote airfields, this Supplement does not consider rigid pavements. Furthermore, thick asphalt pavements are also rarely used in rural and remote airfields, with flexible pavements comprised of granular (gravel) base and sub-bases courses and a thin bituminous (asphalt of sprayed seal) surface being more common and are the focus of this Supplement.

4.1 Methods

The design of flexible airfield pavements is detailed in APN 12, Section 3.4. In general, the thickness and stiffness of the pavement layers are determined to ensure that the underlying material or soil (usually referred to as the subgrade) is adequately protected from the aircraft that will use the pavement. The stiffer the materials and the thicker the layers, the more protected the subgrade is. It follows that larger aircraft and weaker subgrades require thicker and stiffer pavement layers to achieve acceptable performance.

The calculation of pavement composition and thickness is usually performed using a software application. Different applications provide different results and are more or less suited to different airfield circumstances. The USA’s Federal Aviation Administration’s (FAA) FAARFIELD is best suited to major airports with large aircraft.

The FAA’s simpler COMFAA is well suited to rural and remote airports and is also the international standard for calculating Aircraft Classification Numbers (ACN) (refer 6 The ACN-PCN System). However, COMFAA is limited to considering only one aircraft at a time and calculates the thickness of a standard pavement composition. In contrast, the Australian software Aircraft Pavement Structural Design System (APSDS) can calculate pavement thicknesses for multi-aircraft traffic mixes simultaneously and any pavement composition can be nominated.

Consequently, COMFAA is suited to designs where there is one clear critical aircraft, whereas APSDS is more efficient when multiple aircraft are similarly critical to pavement design.

In Practice

An airfield with occasional Dash 8 Q-400 operations and a range of smaller aircraft, such as the Dash 8-200/300, Challenger 604, Saab 340 and GA operations, can usually ignore all aircraft except for the Q-400 and use COMFAA for thickness calculation. The material equivalence factors detailed in APN 12, Section 2.6, Tables 2 and 3, must be used to convert the standard COMFAA thickness to an equivalent thickness of the proposed pavement compositions, by taking account of the relative stiffness of different materials compared to the standard COMFAA materials.

4.2 Examples

Table 1 gives pavement thicknesses calculated by COMFAA for different aircraft that may use rural and remote airports. A number of larger aircraft are also included to demonstrate the additional pavement thickness required to accommodate these. Three subgrade CBRs (refer 4.3.1 Subgrade) are considered and a typical refuelling tanker is also included for comparison. It is important to note that the thicknesses in Table 1 are standard COMFAA thicknesses and they must be adjusted using the material equivalence factors discussed above.

It is worth noting that pavements that are designed for aircraft smaller than the Dash 8-300 are likely to fail under continuous operation of the typical refuelling truck.

This demonstrates the distinction between ‘airfield pavements’ and ‘pavements used by small aircraft’. Table 1 also demonstrates the high influence of subgrade CBR (4.3.1 Subgrade) on the required pavement thickness, as well as the large difference in thickness required by the different aircraft.
Table 1: Example COMFAA thickness for different subgrades and aircraft

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>CBR 5</th>
<th>CBR 10</th>
<th>CBR 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light aircraft @ 5.7 t and 550 kPa</td>
<td>260 mm</td>
<td>220 mm</td>
<td>115 mm</td>
</tr>
<tr>
<td>Saab 340 @ 13.0 t and 820 kPa</td>
<td>355 mm</td>
<td>220 mm</td>
<td>165 mm</td>
</tr>
<tr>
<td>Dash 8-300 @ 18.6 t and 697 kPa</td>
<td>425 mm</td>
<td>265 mm</td>
<td>195 mm</td>
</tr>
<tr>
<td>Fokker 50 @ 17.6 t and 1,430 kPa</td>
<td>450 mm</td>
<td>290 mm</td>
<td>220 mm</td>
</tr>
<tr>
<td>Challenger 604 @ 21.9 t and 1,000 kPa</td>
<td>490 mm</td>
<td>310 mm</td>
<td>235 mm</td>
</tr>
<tr>
<td>Dash 8 Q-400 @ 28.5 t and 970 kPa</td>
<td>545 mm</td>
<td>340 mm</td>
<td>260 mm</td>
</tr>
<tr>
<td>Embraer 170 @ 37.0 t and 900 kPa</td>
<td>595 mm</td>
<td>370 mm</td>
<td>280 mm</td>
</tr>
<tr>
<td>Embraer 190 @ 52.0 t and 1,034 kPa</td>
<td>700 mm</td>
<td>440 mm</td>
<td>340 mm</td>
</tr>
<tr>
<td>Boeing B737-800 @ 79.0 t and 1,407 kPa</td>
<td>925 mm</td>
<td>585 mm</td>
<td>445 mm</td>
</tr>
<tr>
<td>Refuelling tanker 25.0 t and 750 kPa</td>
<td>420 mm</td>
<td>265 mm</td>
<td>200 mm</td>
</tr>
</tbody>
</table>

4.3 Materials

Pavement materials are described in detail in APN 12, Section 2.3 (subgrades) and Section 2.4 (other materials). For rural and remote airfield pavements, the most important pavement materials are the subgrade, sub-base, base course and bituminous surfacing. Of these, the subgrade has the greatest influence on the pavement thickness required to support a particular aircraft. The subgrade, sub-base and base materials are described below, with the bituminous surfacing detailed later (5 Pavement surfacing).

4.3.1 Subgrade

As detailed in APN 12 Section 2.3, subgrades have a high influence on the pavement thickness required for a certain aircraft loading. Weaker subgrades require greater pavement thicknesses. Subgrades are characterised by their California Bearing Ratio (CBR) which is measured in a soaked condition, when the subgrade is weaker than when it is dry. It is normal to design the thickness of airfield pavements for a range of subgrade CBRs from 3 to 15. Higher strength subgrades are usually assumed to be no stronger than CBR 15, while weaker subgrades are usually stabilised or improved to achieve a minimum strength of CBR 3. Subgrades weaker than CBR 3 are usually not able to support the plant and equipment required to construct the proposed pavement, meaning that stabilisation is often the only practical option.

Subgrade materials are usually sampled and tested in the laboratory to determine an appropriate CBR value. However, Table 2 provides indicate CBR values for different subgrade material types. These materials are described in detailed in APN 12, Sections 2.3.2 (sand), 2.3.3 (silt), 2.3.4 (clay) and 2.3.5 (gravel). Because of their propensity to become weak when wet and to shrink and swell, clays and some silts are usually improved by lime stabilisation.

Table 2: Indicative CBR values for different types of subgrade

<table>
<thead>
<tr>
<th>Subgrade material</th>
<th>Typical CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>15 or more</td>
</tr>
<tr>
<td>Gravel</td>
<td>6 to 15</td>
</tr>
<tr>
<td>Silt</td>
<td>1 to 10</td>
</tr>
<tr>
<td>Clay</td>
<td>1 to 6</td>
</tr>
</tbody>
</table>

4.3.2 Base and Sub-base

Base and sub-base materials provide the majority of the thickness of most rural and remote airfield pavements. In these pavements, processed natural gravel (APN 12, Section 2.4.2) and crushed rock (APN 12, Section 2.4.3) are the most common base and sub-base materials. Crushed rock is generally stiffer than natural gravel because of the higher internal friction between the particles, provided by the fully crushed shape of the aggregate particles, and is therefore more suited to the upper layers of the pavement where the stresses imposed by the aircraft are higher.
In Practice

Base and sub-base courses are often built using the same material. As a guide, a sub-base should have a minimum CBR 30, while base courses should have a minimum CBR 80. Many crushed rock sources have CBR 100 or more.

Large airports usually require an airport-specific crushed rock that is more strictly defined than most local road crushed rock materials, and therefore usually require particular quarry operations to manufacture. For large airports the quality of crushed rock is important because the wheel loads and tyre pressures associated with large aircraft impose high stresses on the upper base layers.

In contrast, aircraft operating at rural and remote airfields place much less stress on the base course and lesser quality materials usually perform adequately well. Locally available crushed rock, that is usually used for roads, is often acceptable and is typically much less expensive. In fact, for many years, at all but the largest airports, natural gravels were the normal base and sub-base materials used successfully in airfield pavement construction.
5 PAVEMENT SURFACING

Following calculation of the required pavement composition and thickness, the selection of the surface material is the most important element of rural and remote airfield pavement design. The most common pavement surface for rural and regional airfields is a bituminous sprayed seal, although some have asphalt surfaces. Microsurfacing has also been used at some rural and remote airfield in recent times.

5.1 Asphalt

Asphalt is the premium flexible pavement surfacing and is described in detail in APN 12, Section 2.4.5. Importantly, airport asphalt is different to road asphalt, with higher bituminous binder content, modified or premium bituminous binders and a tight surface finish to minimise pavement-generated FOD.

However, for rural and remote airfield pavements intended for use by GA and other small aircraft, a heavy duty road asphalt is usually appropriate and is more likely to be locally available at much less cost than airport-quality asphalt.

5.2 Sprayed seals

Sprayed seals are the most common rural and remote airfield pavement surfacing material. They are generally recommended for aircraft up to Dash 8 Q-400 in size but regional jet aircraft and even the B737-800 operate on sprayed sealed runways on a daily basis at airfields across Australia.

As detailed in APN 12, Section 2.4.6, sprayed seals for airports are significantly different to sprayed seals for roads and the construction of a road-style sprayed seal on airfield pavements is unlikely to provide adequate performance. Key differences between aircraft pavement and road sprayed seals include:

- Larger aggregate stone sizes. Airports use 7 mm, 10 mm and 14 mm sized seals. Smaller seals have been used but generally do not perform adequately with unacceptably short life spans, significant FOD generation and significant flushing.

- Higher binder content. More bituminous binder is required to retain the stones and minimise the risk of FOD generation. The bituminous binder content increases with the stone size and typical airport requirements are:
  - 14 mm (not usually the final seal). 2.5 l/m².
  - 10 mm. 2.0 l/m².
  - 7 mm. 1.6 l/m².

- Stiffer bituminous binders. Road seals often use C170 (soft) unmodified bitumen. Stiffer C320 (unmodified) bitumen or a modified binder, such as MS00 or S10E, are better suited to airfield sprayed seals.

- Construction methods. Different construction methods are required to achieve a sprayed seal that is suited to airfield pavements, such as:
  - Shorter run lengths. Usually limited to around 350 m.
  - Increased rolling. To fully push the stones into the bituminous binder film, 4-6 times the rolling effort required by road seals.
  - Increased sweeping. The increased width of runways and the need for a FOD-free surface requires airport seals to be constructed with increased sweeping.
  - Steel drum rolling. To flatten the sharp edges on the top of the stones after rolling, reducing aircraft tyre wear during landing operations.

For new surfaces constructed during pavement construction or reconstruction, a two-coat seal is most appropriate, either a 14/10 mm or a 14/7 mm combination. Depending on the condition of the existing surface, a 10 mm single coat reseal or a two-layer reseal may be appropriate. For airfield pavements supporting jet aircraft operations, a lockdown treatment, such as a sanded-emulsion overspray or a proprietary sand-filled polymer modified emulsion treatment is also added. The lockdown treatment minimises loose stones becoming FOD and damaging jet engines, which are often lower slung and more fragile than turbo props.
It is also important to understand that the designed bituminous binder and aggregate spread rates are only indicative. Even following an inspection of the pavement and review of locally available materials, the determined rates are only for planning and tendering purposes. It is critical that a construction trial be performed to verify or adjust the rates and the sealing operation must be monitored to adjust the rates during the progress of the work. Because of the influence of the weather, materials and existing surface on the optimum solution, an experienced and skilled pavement engineer is required to attend the trials and subsequent construction, to achieve an appropriate outcome.

Furthermore, because of the high sensitivity of sprayed seal construction to prevailing weather conditions, sealing outside of the hottest and driest time of the year is inappropriate and likely to result in poor seal performance. This is probably the most misunderstood limitation of aircraft pavement sprayed sealing and has led to many rural and remote airfield pavements to be resealed in unsuitable conditions, resulting in surface conditions worse than before the work was performed. Similarly, high quality seals can not be constructed in short night shift work periods and any airport that is too busy to be sealed in the daytime, is also too busy to be sealed and should adopt an asphalt surface instead.

As a guide, when planning an airfield pavement sprayed seal project, if the response to any of the following is ‘no’, extreme caution should be raised:

» Is the bituminous binder C320, M500 or S10E?
» Are all seal layers 7 mm or larger?
» Are the bitumen spray rates consistent with the above guidance?
» Is a fully crushed aggregate being provided?
» Is a seal trial to be performed?
» Is the designer going to be present during the seal trial and subsequent work?
» When the area of pavement to be sealed each day is multiplied by the bituminous binder spray rate in the seal coat, is the result less than 50,000?
» Does the number of pneumatic tyred rollers exceed five?
» Will a steel drum roller be provided?
» Is the seal being performed during the day?
» Is the work to be performed during the driest and hottest period of the year?

5.3 Microsurfacing

Microsurfacing is similar to sprayed sealing except it provides increased capability to correct ruts and other geometric imperfections in the existing surface, as detailed in APN 12, Section 2.4.7. Only limited use of microsurfacing has been reported at Australian airports and the first such surfaces were constructed in 2010. The results have been variable and it remains too early to understand the long-term performance.
Almost all airfield pavements are assigned a pavement strength rating using the ACN-PCN system, as detailed in APN 12, Section 3.7. The Aircraft Classification Number (ACN) represents the damage caused to the pavement subgrade by the aircraft. Each aircraft has a unique ACN for the tyre pressure, aircraft weight and the subgrade on which the pavement is constructed. The Pavement Classification Number (PCN) reflects the strength of the pavement to accommodate aircraft. The PCN is not unique and an airport can set its PCN at any level it chooses. However, for a given pavement structure, the higher the PCN that is selected, the more damaging aircraft that will be allowed to operate and the shorter the pavement’s structural life will be. Consequently, most airports set their PCN equal to the highest ACN of the various aircraft that the pavement was designed for.

APN 12, Section 3.7.4 provides a detailed explanation of the various elements of the PCN expression. The practical importance of these elements is outlined below.

**PCN number**

- The numerical expression representing the strength of the pavement and arguably the most important element of the PCN, with a higher PCN number reflecting a stronger pavement that is suited to larger and more damaging aircraft.

**Pavement type**

- Due to the difference in design methods and response of the pavement to loading, ACNs differ for equally strong flexible and rigid pavements. Consequently, the PCN expression includes an indicator of pavement type, with ‘F’ indicating a flexible pavement.

**Subgrade category**

- Many aircraft have multiple wheels on the same landing gear and the thicker the pavement, the more the subgrade ‘feels’ the interaction of the wheels rather than the individual wheel loads. Because the thickness of the pavement is most influenced by the subgrade strength, the level of wheel interaction is represented by the subgrade category, with ‘A’ being a strong subgrade and ‘D’ being a weak subgrade. Importantly, except for single-wheeled aircraft the aircraft’s ACN will differ for each subgrade category.

**Tyre pressure rating**

- To protect the pavement surface (i.e., not the subgrade) from the effects of the aircraft tyre pressure, a tyre pressure limit is provided for comparison to the aircraft’s tyre pressure. The assignment of a tyre pressure limit is subjective and is much less scientific than the PCN number itself. Consequently, if the pavement’s surface is in good condition, airports should be far less concerned about approving tyre pressure related Pavement Concessions (see below) than about pavement strength related Pavement Concessions.

**Assessment type**

- Finally, to record the basis of the PCN determination, an indication of the assessment type as ‘T’ for technical, or design-based, versus being based on prevailing aircraft usage (‘U’) is provided. Both are equally valid.
As indicated above and detailed in APN 12, Section 3.7.5, when an aircraft with a higher ACN than the airfield pavement PCN, or a tyre pressure exceeding the tyre pressure limit in the PCN expression, the aircraft operator must seek a Pavement Concession. The Pavement Concession is explicit permission from the airfield owner to use the pavement in question. Airfield owners will usually grant a Pavement Concession based on the additional revenue offered.

It must be remembered that a Concession operation is an overloading or overstressing of the pavement and will cause more damage than normal operations. As illustrated in Figure 25 of APN 12, the damage caused to the pavement increases exponentially with the ACN. For example, an aircraft with an ACN 50% higher than the pavement’s PCN will damage the pavement 10-30 times as much as an aircraft with an ACN equal to the PCN.

It is important to understand that in this context the term ‘damage’ does not usually mean a visible failing or distress of the pavement. In fact, only at extreme overloads do pavements fail under a single operation of an aircraft. Rather, damage relates to the gradual consumption of the theoretical life of the pavement. In turn, a flexible airfield pavement’s life is generally defined as the time until unrecoverable vertical deformation of the subgrade results in a 25 mm deep rut at the pavement surface.

Life and damage are less well defined with regards to the pavement surface. Consequently, there is no rational basis for the setting of tyre pressure limits for specific pavement surfaces. As a result, the tyre pressure limit in any airfield pavement’s PCN can only be considered to be indicative and airfield owners should not be as concerned about tyre pressure related Pavement Concessions as they are about pavement strength related Pavement Concessions. For example, if an airfield’s PCN traditionally included a tyre pressure limit of 600 kPa (light aircraft) and it is proposed to commence operations with a Dash 8 Q-400 (970 kPa) the airport owner should be far more interested in the pavement strength (PCN number) than exceeding the tyre pressure limit by almost 50%, as long as the surface is in generally sound condition.

If the strength of an existing pavement is not known, or the current strength rating is questioned, a PCN can be determined from first principles. This will normally require:

» Understanding of the existing aircraft traffic, including aircraft types and frequencies.
» Visual assessment of the pavement condition.
» Falling weight deflectometer survey to determine areas of consistent response.
» Intrusive core hole testing to measure pavement layer thicknesses and recover samples for laboratory testing.
» Reverse design of the existing structure to determine the capacity of the pavement to support operations by various aircraft.
» Recommending a PCN equal to the ACN of an aircraft that just fails the pavement over an appropriate period of time.

In recent years, software has been developed to calculate PCN values directly from FWD results. This process is informative, but generally under-rates the strength of the pavement and is not reliable or appropriate unless supported by intrusive testing and reverse engineering.
7. SURFACE FRICTION AND TEXTURE

The International Civil Aviation Organisation (ICAO) provides recommendations regarding runway friction and texture for the minimisation of aircraft skidding risk, as detailed in APN 12, Section 3.9. In Australia, CASA makes many of these recommendations mandatory, with three optional intended approaches to runway skid resistance compliance:

- Surface texture not less than 1.0 mm.
- Grooving full width, nominally 6 mm wide and 6 mm deep, spaced 32 mm apart.
- Friction test results exceeding the minimum levels recommended by ICAO.

With the exception of international airports, an airfield is free to meet any one of these approaches to compliance, but there is increasing interest by CASA in airports periodically verifying that compliance is being maintained over time.

Grooves are the simplest means of compliance to verify as they can readily be visually checked. However, grooves can not be sawn in sprayed seal surface, so are only an option for runways with asphalt surfaces. Grooves can be eroded, contaminated with rubber or filled with maintenance materials, such as asphalt preservers/rejuvenators (refer APN 12, Section 5.6.2). However, in rural and regional airports, the asphalt surface is likely to reach the end of its life before the grooves are compromised, as long as any surface preservation is planned and executed with diligence. For grooved runways, the annual technical inspection usually verifies the adequate condition of the grooves.

A typical 7 mm or 10 mm sprayed seal will usually exceed 1 mm surface texture, as long as it is not flushed or bleeding with free bitumen on the surface. Ongoing compliance may be verified by spot-testing the surface texture with a sand patch or a laser texture scanner, and an annual check is appropriate.

Where runway friction is the selected means of compliance, the friction must be measured using a continuous friction measuring device recommended by ICAO, with self-wetting capability. In Australia, the Griptester is the most common device, although others are available and can be used. The ‘spot tester’ known as the British Pendulum is useful for relative friction measurement before and after surface treatments, such as asphalt preservers, but is not recommended by ICAO or accepted by CASA. Friction testing must be performed periodically, based on the volume of aircraft traffic, with a frequency of every one to five years appropriate for rural and remote airfields.
8. DELIVERING WORKS

Despite adequate understanding and the best of intentions, sometimes airfield pavement projects are not delivered well. Although this can impact larger airports, the small management structures, potential for influence by road engineers and higher reliance on government grant funding, means that rural and remote airports are at higher risk of not achieving the desired outcomes during the delivery phase.

8.1 Site investigations

Regardless of the project scope, some level of site investigation will be required and usually includes:

» Visual inspection.
» Engineering survey.
» Geotechnical.

It is important to understand that the scope and detail, and therefore the cost, of these investigations depends on the scope and type of the work to be delivered.

A visual inspection is necessary to determine the condition of the existing pavement and will usually consist of a walk-over the full pavement area to detect symptoms of both surface distress and structural pavement distress. Because the visual signs of imminent distress are subtle, experience is required to detect and interpret these symptoms.

A three-dimensional engineering survey of the surface and surrounding infrastructure is usually required to allow the geometric design to be complete according to the requirements of MOS 139. The exception being resealing and preservation (or rejuvenation) treatments that cannot correct the existing pavement shape and therefore a simple extent of work is required rather than a detailed engineering survey. Importantly, the required accuracy of the survey differs for different types of work. A pavement that is to be fully reconstructed requires all infrastructure locations to be surveyed but the critical surface levels are at the centreline and the edges of the pavement. In contrast, the survey for an asphalt overlay design must be much more accurate and a close grid of survey points is required at a spacing consistent with the width of asphalt paving. For the reconstruction, a laser survey may provide adequate accuracy but it is unlikely to be detailed enough for an asphalt overlay. Consequently, the engineering survey must be scoped to suit the work that is proposed.

Geotechnical investigations usually include an FWD survey to determine areas of consistent pavement strength and intrusive (core holes) investigation of the existing pavement, supplemented by laboratory testing of representative samples of the various materials encountered. However, the scope of the investigation must be tailored to the scope of work, for example:

» Reseal. Geotechnical investigations are not usually required.
» Asphalt overlay (non-structural). Geotechnical investigations are not usually required.
» Asphalt overlays for structural strengthening. Combination of FWD and intrusive testing to determine layer thicknesses, material properties and the underlying subgrade CBR.
» Pavement reconstruction. Focused on the subgrade CBR because the existing pavement will be removed.
» Pavement stabilisation for structural strengthening. As per the structural overlay requirements, with the addition of testing to determine the most appropriate stabilisation materials and processes.

Some airports have undertaken site investigations prior to fully understanding the pavement upgrade options available and identification of the most effective and efficient solution. Consequently, some site investigation effort has been rendered inadequate and additional investigation undertaken at additional cost. This demonstrates the importance of understanding the likely scope of work prior to briefing and engaging the site investigation services.

8.2 Operational constraints

Unlike roads, one lane or side of a runway cannot be closed while the other side is used to support operations. Consequently, runways and other critical airfield pavements are usually closed for short work periods and then returned to service for aircraft operations. Although many rural and remote airfield do not have Regular Public Transport (RPT) services, the airfield must usually be kept available for medial evacuations and other critical aircraft operations.
Sometimes airfield pavement works are designed without consideration for the operational constraints under which the work will necessarily be delivered. This can lead to inefficient construction methods, solutions that are not consistent with the budget, or solutions that cannot be constructed within the operational restrictions permitted. There is a clear requirement to consider the operational constraints associated with airfield operations, in conjunction with technical needs, when developing airfield pavement works solutions.

8.3 Prevailing weather

Some common pavement surfacing and construction works are more sensitive to weather conditions than others. It is important to understand these constraints and to schedule airfield pavement works to maximise the probability of suitable prevailing weather conditions. Of the works that are commonly delivered at rural and remote airfields, the following constraints generally apply:

» Crushed rock. Insensitive to temperature but requires generally dry conditions for construction.

» Asphalt. Requires completely dry conditions and the best results are achieved in warm or hot weather, especially when using modified binders, but generally constructible through most temperature ranges in Australia.

» Asphalt preservation (rejuvenation). When emulsion (water) based products are used, there is tolerance to moist pavement surfaces, but curing times are sensitive to humidity and temperature conditions. Hotter pavements will result in faster curing times, but very hot conditions can re-soften the cured product the day after application, sticking to aircraft tyres. Non-emulsion-based products are less sensitive to temperature and humidity but require completely dry conditions.

» Sprayed sealing. Requires completely dry conditions and hot conditions to adequately bond and fully embed the aggregate into the bituminous binder film.

The last item and is critically important. In recent years, a number of rural and remote airfields have received grant funding for sprayed sealing their pavements, with a requirement to complete the works by the end of the financial year. Consequently, works have been performed in May and June, sometimes in near freezing conditions. The results have generally been poor, with some pavements rendered unserviceable and requiring more expensive remediation than the cost of the original work.

8.4 Budgets

As described above, many rural and regional airports depend on government grant funding to perform airfield pavement works. In most cases, grants are for fixed values, requiring the cost of the work to be robustly estimated well before the design is complete and the works are tendered. The budgets are often developed by multiplying the area of the pavement by a typical unit cost rate. These rates often make simple assumptions or are based on local road work cost rates. Consequently, when the work is designed and tendered, the true cost is found to significantly exceed the budget allocation. In such circumstances, it would seem logical to reduce the scope of the work by reducing the area of pavement included. However, the grant funding is usually provided based on a minimum set of outcomes that prevents scope from being significantly reduced. This highlights the importance of ensuring that realistic budgets are set early in the planning process and that the work solutions be developed to be consistent with the budget available. This requires reasonable allowances for:

» Airfield suitable solutions and materials.

» Shape correct when planning asphalt overlays.

» The operational airfield constraints.

» Design and construction supervision/management.

» Contingency.
9. REFERENCES

