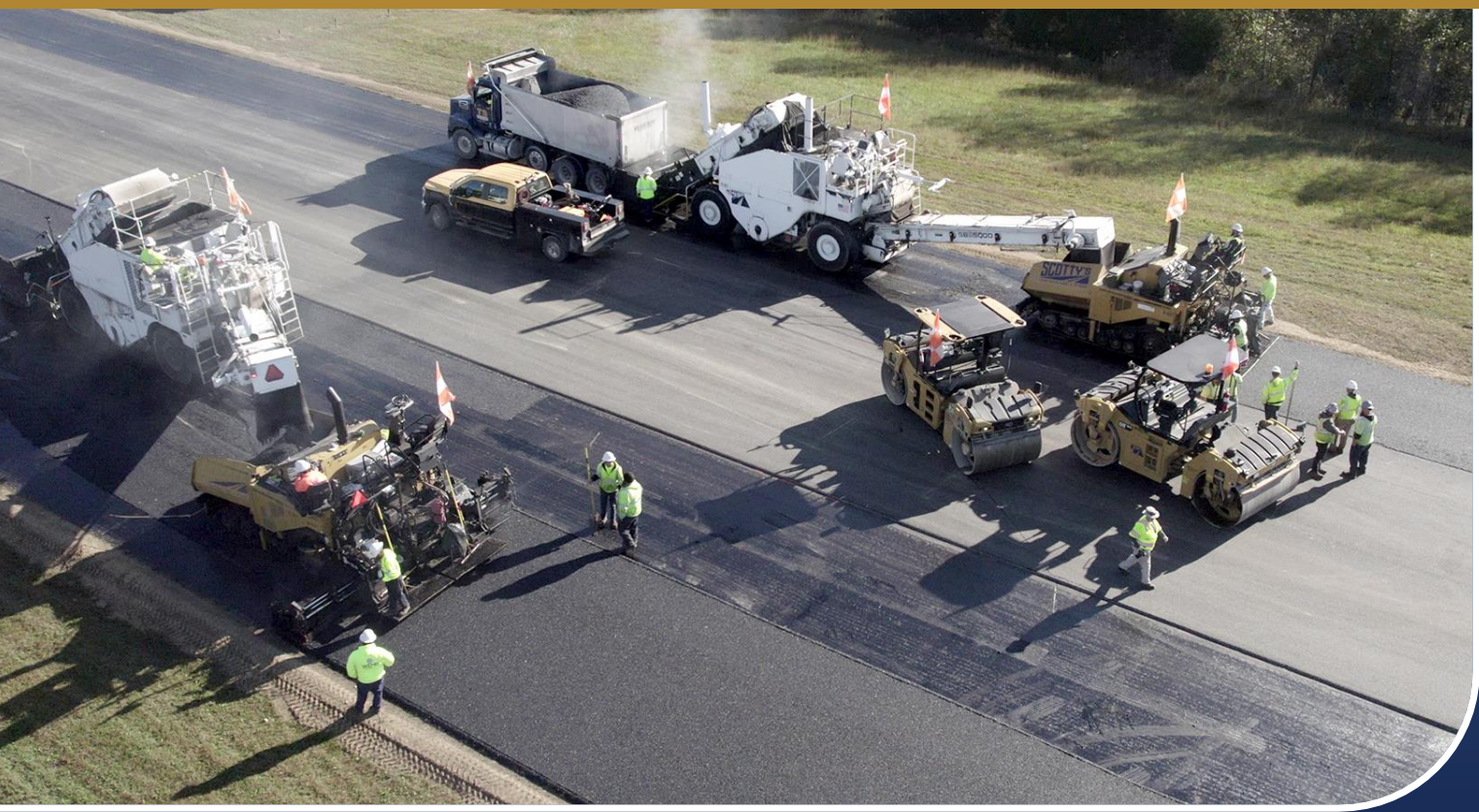
AAPTP
Airport Asphalt Pavement Technology Program

Improving Performance of Longitudinal Joints in Airfield Asphalt Pavements

Volume 3: Best Practices Manual for Longitudinal Joint Maintenance

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Credit: NAPA

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The Airport Asphalt Pavement Technology Program (AAPTP) is a cooperative agreement effort between the **National Asphalt Pavement Association** (NAPA) and the **Federal Aviation Administration** (FAA) to advance asphalt pavements and pavement materials. The AAPTP advances solutions for asphalt pavement design, construction, and materials deemed important to airfield reliability, efficiency, and safety. The program leverages NAPA's unique technology implementation capabilities with assistance from the FAA and industry to advance deployment and adoption of innovative asphalt material technologies.

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Credit: NAPA

Foreword

The Federal Aviation Administration (FAA) advisory circular (AC) 150/5370-10H (2018), *Standards for Specifying Construction of Airports*, requires that longitudinal joints be cut back and an asphalt tack coat or other approved product be applied to the cut face prior to placing an adjacent lane. Contractors may also be permitted to use joint heaters to aid in constructing longitudinal joints. However, despite the FAA's requirement to cut back longitudinal joints and the additional, rigorous joint density acceptance requirement, which have been in place for nearly two decades, longitudinal joint cracking and raveling continue to be leading causes of deterioration for airfield asphalt pavements. While FAA AC 150/5380-6C (2014), *Guidelines and Procedures for Maintenance of Airport Pavements*, provides guidance on sealing cracks at joints, there remains a need to evaluate improved materials and methods.

A new method with potential for preserving joint integrity in flexible highway pavements is the use of a void-reducing asphalt membrane (VRAM). VRAM products are typically a hot-applied, highly polymer-modified liquid asphalt membrane that is applied prior to paving, directly beneath the future location of the longitudinal joint. As the hot asphalt mat is paved, the heat causes the highly polymer-modified membrane to migrate upward into the mat at the joint, filling air voids and reducing permeability from the bottom up.

Another relatively recent innovation with potential to reduce longitudinal joint deterioration is the use of rapid-penetrating emulsions (RPEs). RPEs are asphalt emulsions specially formulated to penetrate quickly into low-density asphalt pavements, where they fill interconnected air voids, reduce permeability, and fill small cracks. RPE products can be applied using distributor trucks equipped with fog nozzles, either immediately after construction or later in the pavement's service life. Application rates can be adjusted based on permeability, texture, amount of air voids, and pavement age. Therefore, both VRAM and RPE technologies may improve pavement performance at longitudinal joints.

This study examined VRAM, RPE, and other approaches to reducing the deterioration of longitudinal joints based on experiences and field trials on highway pavements. The project deliverables are presented in three volumes:

- Volume 1—A literature review of VRAM, RPE, and other techniques to improve longitudinal Joint performance, as well as a literature review of longitudinal joint maintenance for airfield pavements.
- Volume 2—Project reports on inspections of existing VRAM installations and documentation of new applications of VRAM and RPE at airports.
- Volume 3—A *Best Practices Manual for Longitudinal Joint Maintenance*.

This document corresponds to Volume 3.

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List of Acronyms and Abbreviations

AAPTP	Airport Asphalt Pavement Technology Program
AASHTO	American Association of State Highway and Transportation Officials
AC	Advisory Circular
ACRP	Airport Cooperative Research Program
ASTM	ASTM International
FAA	Federal Aviation Administration
FOD	Foreign object debris
HMA	Hot-mix asphalt
L&T	Longitudinal and transverse
MOS	Modification of Standards
NAPA	National Asphalt Pavement Association
NCAT	National Center for Asphalt Technology
PCI	Pavement Condition Index
PWL	Percent within limits
RPE	Rapid-penetrating emulsion
UFC	Unified Facilities Criteria
VRAM	Void-reducing asphalt membrane

Introduction

A longitudinal joint in asphalt pavement is formed when a new lane of asphalt mixture is placed adjacent to a previously placed lane. If the first lane is placed more than 4 hrs prior to the new lane or its surface temperature has cooled below 175 ºF, it is considered a "cold" joint. Conversely, if the first lane was placed less than 4 hrs prior to the new lane and its surface temperature exceeds 175 ºF, it is considered a "hot" joint. Longitudinal joints in asphalt pavement—especially cold joints—typically exhibit lower density compared to the mat areas [1], making them more susceptible to earlier deterioration due to increased permeability and premature aging. Lower density also translates to lower pavement strength and less bond at the interface between the existing cold hot-mix asphalt (HMA) pavement lane and a subsequently constructed lane. The formation of longitudinal cracks at these joints is among the most common early distresses in asphalt airfield pavements, sometimes occurring within the first year after construction, as higher air voids allow more water infiltration and accelerate the aging process of the asphalt binder [2].

Figure 1 shows a recently constructed runway on which the three longitudinal paving joints are clearly visible. The moisture present on the longitudinal joint on the left edge of the pavement in this photo highlights the tendency for these joints to accumulate excess water after precipitation events.



Source: APTech

Figure 1. Visible Longitudinal Joints on a Recently Paved Runway

Achieving desired longitudinal joint performance requires applying good construction techniques to overcome common issues that occur during paving. When the first lane is placed, the unconfined edge tends to deform laterally instead of compacting properly (see Figure 2) due to the lack of lateral support or restraint. When the adjacent lane is paved, that side of the joint is restrained and can be compacted to a higher density as long as the paver supplies sufficient material on the hot side of the joint to ensure adequate density is obtained when rolled smooth with the cold side. If the edge of the mat cools before the next adjacent pass of the paver, it becomes much more difficult to compact the joint area to obtain adequate density without additional compaction efforts at the joint.

Additionally, longitudinal joints have a lower density than the surrounding pavement due to factors such as lack of edge confinement, reduced compaction effort by rollers, and normal variations in materials [3]. Even under optimal conditions, achieving joint density that is equivalent to the density obtained in the mat remains difficult.



Source: APTech

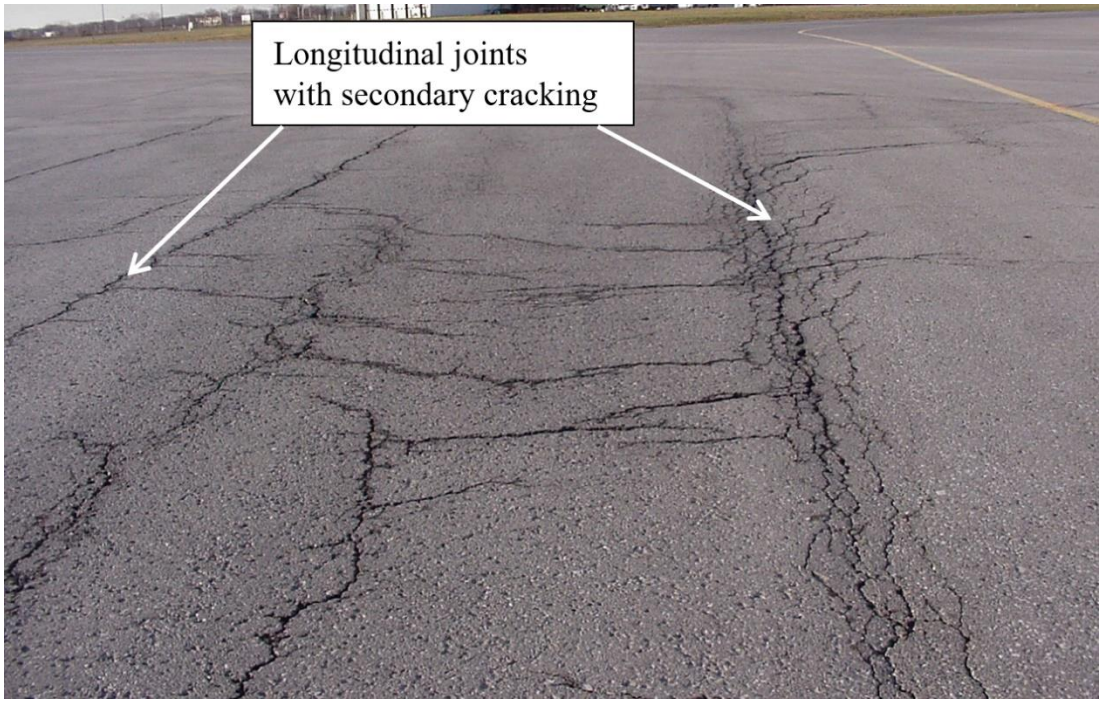
Figure 2. HMA Compaction Near the Free Edge

Figure 3 shows an example of low-severity cracking along the longitudinal joint (a straight crack between paving lanes). Figure 4 shows medium- to high-severity cracking along the longitudinal joint, including the presence of an alligator-cracking pattern.



Source: APTech

Figure 3. Low-Severity Cracking at Longitudinal Joints



Source: APTech

Figure 4. Medium- to High-Severity Cracking on Longitudinal Joint

Specific procedures are prescribed for the construction of longitudinal joints in airport pavements, and specific density requirements must be met for these joints.

Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5370-10, *Standard Specifications for Construction of Airports*, Item P-401, Asphalt Mix Pavement [4], addresses many key components and considerations for asphalt joint construction but stops short of providing specific construction aspects to consider. Similarly, AC 150/5380-6, *Guidelines and Procedures for Maintenance of Airport Pavements* [5], discusses traditional repair methods (patching and sealing) but does not consider potential alternative preservation and repair techniques.

The purpose of this manual is to enhance the understanding by airport personnel and engineering consultants regarding the construction and maintenance of asphalt pavement longitudinal joints. The manual covers the overall joint construction process, with detailed emphasis on construction considerations, materials, specifications, and practices that build on the information provided in FAA ACs 150/5370-10 and 150/5380-6. Additionally, the manual references supplementary technical resources for the construction and maintenance of asphalt longitudinal joints to improve performance.

Longitudinal Joint Performance

A well-constructed longitudinal joint should be difficult to distinguish from the overall mat, as shown in Figure 5. However, distresses at longitudinal joints in airport asphalt pavements are usually one of the first signs of deterioration, occurring even as soon as the first year of service [6].

As noted previously, several factors contribute to this phenomenon. One cause of premature deterioration is that the paving joint has significantly higher permeability than adjacent mat areas [7, 8]. This effect is typically associated with the difficulty of achieving sufficient compaction effort at the joints, combined with potentially cooler temperatures than the rest of the mat and increased chances of thermal and material segregation.

A study by the American Association of State Highway and Transportation Officials (AASHTO) concluded that the areas immediately adjoining a longitudinal joint present the highest probability of experiencing segregation [9]. This segregation is largely attributed to improper paving equipment operation that allows coarser material to run to the end of the auger line while the finer portions remain in the middle of the paver. Permeability develops because areas with higher coarse aggregate concentrations have larger and more interconnected air voids, which allow water and air to penetrate the pavement surface.



Source: APTech

Figure 5. Well-Constructed Longitudinal Joint (Difficult to Differentiate from the Mat)

Longitudinal paving joints that exhibit higher voids and segregation can be more susceptible to premature aging, excess water infiltration, raveling, and cracking [10]. In the context of airfield pavements, a damaged and deteriorated longitudinal joint represents an area that can create foreign object debris (FOD), which can result in damage to aircraft, leading to potential equipment loss and costly emergency repairs. A poorly constructed longitudinal joint can sometimes exhibit distress in as little as 1 year. Longitudinal joint cracking is not a load-associated distress, but if not properly maintained, aircraft loadings can contribute to the accelerated deterioration of longitudinal joints. Pavement failure typically occurs when low-density areas allow water filtration, which can generate additional pore pressure to the surrounding area and can expand during freezing periods, creating additional damage. This seasonal effect can create openings at the longitudinal joint that develop into cracking and dislodge individual aggregate that manifests as raveling [11]. Loadings over the deteriorating crack further crack deterioration.

FAA Longitudinal Joint Construction Requirements

To understand strategies for maintaining airport pavement longitudinal joints, it is helpful to understand how these joints are constructed with the intent to mitigate these construction defects. Airport pavements tend to be much wider than their highway counterparts: widths of commercial airport runways range from 150 to 200 ft (45 to 60 m), taxiways are typically 75 ft (22 m) wide, and apron pavements can be many times larger than taxiways and runways. As such, when paving asphalt, it is inevitable that the pavement surface will include multiple longitudinal paving joints. The FAA guidance for the construction of airport pavements is found in AC 150-5370-10H [4]. Asphalt pavement construction, and longitudinal paving joints in particular, are found in the P-401 specification that is part of that AC.

Relevant portions of the P-401 specification cover elements of asphalt paving intended to enhance the performance of longitudinal paving joints. Paragraph 401-4.12, for example, states that the production laydown plan should follow a sequence of paving that minimizes the number of cold joints, and that the longitudinal joint in one course shall offset the joint from the course immediately below it by at least 1 ft (0.3 m) to avoid creating low-density areas on the pavement that go through more than one layer.

The portion of the specification that has the greatest impact on longitudinal joint density is found in paragraph 401-4.14, which states:

> *Longitudinal joints that have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. Asphalt tack coat in accordance with P-603 shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint.* [4]

In short, the FAA requires complete removal of the asphalt mixture that is typically of the lowest density and is more segregated than the rest of the mat.

When the longitudinal joint is properly constructed, it should not be visibly different from the asphalt in the rest of the mat. Paragraph 401-4.14 states that all joints shall have the same texture as other parts of the mat and meet the same requirements for smoothness and grade. This portion of the specification addresses the tendency for aggregate segregation and inconsistent compaction to occur at longitudinal joints. Paragraph 401-4.12 states:

> *Areas of segregation in the surface course, as determined by the RPR, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraphs 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.* [4]

Minimizing segregation starts with having haul trucks properly loaded. Using a self–powered material transfer vehicle that remixes the mixture can substantially reduce segregation. Segregation can also be minimized by keeping the paver hopper half full between trucks and using cutoff plates in the hopper to eliminate raising the wings.

A P-401 specification note in section 401-4.14 provides an additional option for improving the performance of cold longitudinal joints beyond cutting the joint back. The note states that the contractor may improve joint density by using joint heaters, which are either electrically powered or propane-powered infrared heating equipment. Joint heaters should be configured to heat an area of the joint up to 18 inches (45 cm) wide and 3 inches (7 cm) deep. To accomplish this, the joint heater shall be positioned no more than 1 inch (2.5 cm) above the pavement to be heated, be positioned in front of the paver screed, and be fully adjustable. Special care should be given to avoid producing excessive heat that could damage or prematurely age the in-place pavement. Figure 6 shows a joint heater attached to a paver.



Source: Heat Design Equipment, Inc.

Figure 6. Infrared Joint Heater Attached to a Paver

Paving in echelon also helps to reduce the number of cold joints during construction, as a hot joint is created when pavers operate side by side. However, echelon paving requires additional labor and equipment and may not be feasible for other operational reasons.

Regarding quality control, the FAA requires that at least one core be centered over the longitudinal joint for each sublot that has a joint during density checks. Since joint density quality is an important part of quality asphalt paving, it is evaluated using the percent within limits (PWL) approach for acceptance with a target density of 92.5 percent of the theoretical maximum density, with a maximum variability of 1.55 percent. This joint density range is consistent with requirements supported by research [3]. If contractors are unable to provide adequate quality control on their joints, they risk pay reductions for the paving lots.

A previous study examined the construction of longitudinal joints on airfield pavements and addressed techniques to improve the performance of longitudinal joints [6]. That study identified the following as preferred practices for longitudinal joint construction, listed in order of preference:

1. Notched wedge joint, rubberized asphalt tack coat (joint adhesive), and minimum joint density requirements.
2. Joint adhesive and minimum joint density requirements.
3. Notched wedge joint and minimum joint density requirements.
4. Cutting back edge and minimum joint density requirements.

Longitudinal Joint Deterioration

The progression of longitudinal joint deterioration is documented in Figure 1, Figure 3, and Figure 4. A shadow may become visible as the longitudinal joint ages, followed by hairline cracks at the joint. Those cracks then begin to open up or widen. As the pavement ages further and moisture enters the pavement structure through the surface, the cracks further deteriorate in the following sequence:

- Development of secondary parallel cracks.
- Development of a pattern of interconnecting cracks resembling fatigue cracking.
- If left without treatment, raveling and loss of weakened material.

Observations of longitudinal joint deterioration and the subsequent need to perform maintenance occur during one of the many different pavement inspections airports are required to perform. The most common inspections, however, are those performed as part of a pavement maintenance and management program as required by the FAA, either annually or every 3 years when the Pavement Condition Index (PCI) procedure is followed in accordance with ASTM D5340-20 *Standard Test Method for Airport Pavement Condition Index Surveys* [12].

Focusing on the PCI procedure in particular and the 17 distresses that are defined for asphalt pavements, it is important to note that there is no distress that is specific to longitudinal joint cracking. Rather, longitudinal joint cracking is rated under "Longitudinal and Transverse Cracking," sometimes abbreviated as L&T cracking. The description of this distress states: "Longitudinal cracks are parallel to the pavement's center line or laydown direction. They may be caused by (1) a poorly constructed paving lane joint, (2) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or (3) a reflective crack caused by cracks beneath the surface, including cracks in PCC slabs (but not at PCC joints)." As part of this distress, the description includes defining characteristics and causes of transverse cracks. The significance of how the PCI procedure approaches L&T cracks lies in the fact that this distress includes all types of directional cracking. During a typical PCI inspection, the total quantity (and severity level) of L&T cracking is recorded without consideration of crack orientation or location. As such, a PCI survey alone may not identify whether there is a problem with longitudinal paving joints, even though longitudinal paving joints can have a significant impact on reported pavement conditions. The PCI procedure identifies three severity levels for L&T cracks. Note that in the following quoted content, the ASTM standard's use of the term "spalling" refers to raveling of the asphalt pavement [12]:

- L – "Cracks have only light spalling (little or no FOD potential) or no spalling and can be filled or nonfilled. If nonfilled, the cracks have a mean width of 0.25 inch or less; filled cracks are of any width, but their filler material is in satisfactory condition." (This describes the conditions visible in Figure 1 and Figure 3.)
- M – "One of the following conditions exists: (1) cracks are moderately spalled (some FOD potential) and can be either filled or nonfilled of any width; (2) filled cracks are not spalled or are lightly spalled, but filler is in unsatisfactory condition; (3) nonfilled cracks are not spalled or are only lightly spalled, but the mean crack width is greater than 0.25 inch, or (4) light random cracking exists near the crack or at the corners of intersection cracks. (This may describe conditions seen in Figure 4.)
- H – "Cracks are severely spalled, and pieces are loose or missing, causing definite FOD potential. Cracks can be either filled or nonfilled of any width."

Consider the following three examples for a 5,000-ft^2 (464-m^2) sample unit that is 50 ft (15 m) wide and 100 ft (30 m) long. If that sample unit is part of a pavement placed in 15-ft (4 m)-wide passes, it could have as many as three 100-ft (30 m)-long paving joints. If longitudinal joint cracking is the only distress in this sample unit, the following lists what the resulting PCI would be for 300 ft (91 m) of cracks at severity levels of Low, Medium, or High:

- 300 ft (91 m) of L severity L&T cracking is a PCI of 83.
- 300 ft (91 m) of M severity L&T cracking is a PCI of 72.
- 300 ft (91 m) of H severity L&T cracking is a PCI of 56.

The potential impact of longitudinal joint cracking on maintenance and rehabilitation decisions should be carefully considered. A significant amount of such cracking could easily lead to an overall PCI of 55 or lower, identifying the pavement as a candidate for rehabilitation or reconstruction. However, longitudinal joint deterioration is not a structural distress, and if the other distresses contributing to a low PCI are not indications of structural distress either, then corrective maintenance may be a more appropriate strategy.

Longitudinal Joint Repair Methods

As noted in the preceding discussion of the layout and construction of airfield asphalt pavements and the longitudinal paving joints that result, concerns about the performance of these joints have led to the implementation of several requirements regarding their construction, including an emphasis on constructing hot joints and the requirement to cut back a maximum of 3 inches (7 cm) of a cold joint before paving an adjacent lane. Despite these requirements, deterioration of the joint and the pavement surrounding the joint is one of the primary performance problems associated with airfield asphalt pavement surfaces. This is likely attributed to the failure to meet specification requirements for joint density at all locations.

When pavement failure occurs along a longitudinal joint, the appropriate repair method depends on the type and severity of the distress. The FAA's guidelines for maintenance of airport pavement in AC 150/5380-6C [5] can be applied to the repair of deteriorating joints, even though these repair methods were not specifically envisioned for addressing longitudinal joint issues. Additional details regarding these treatments can be found in the Airport Cooperative Research Program (ACRP) Synthesis No. 22 [13] and in the U.S. Department of Defense (DoD) Unified Facilities Criteria (UFC) Manual 3-270-01 [14]. However, neither publication focuses specifically on longitudinal joints.

Crack Sealing

In the simplest of cases, when a longitudinal joint develops into a low-severity longitudinal crack without secondary deterioration, crack sealing is an appropriate repair technique. Crack sealing slows down or prevents water filtration into the cracks and can slow down the development of additional damage. Good candidates for longitudinal crack sealing are cracks between 0.25 and 1.0 inch (0.6 and 2.5 cm) wide with little to no secondary cracking or raveling, as shown in Figure 7. A poor candidate for longitudinal crack sealing is shown in Figure 8. Although that crack is already sealed and patched, significant secondary cracking extends to either side of the longitudinal joint. It is marked for a patch repair.



Source: APTech

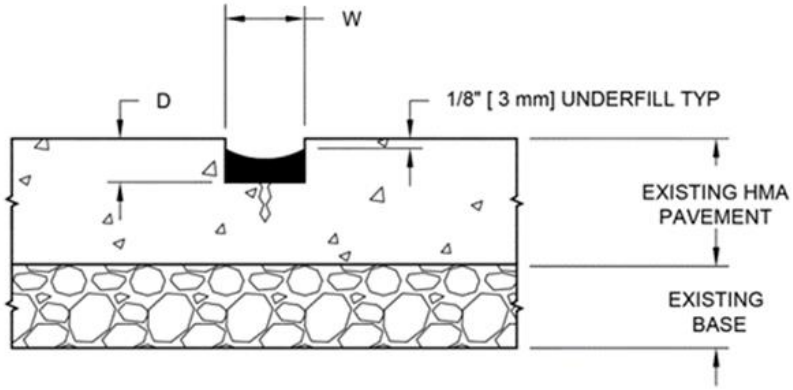
Figure 7. Good Candidate for Longitudinal Crack Sealing



Source: APTech

Figure 8. Poor Longitudinal Joint Candidate for Crack Sealing

Crack sealing repair steps include cleaning the area that will be repaired, routing the crack to create a sealant reservoir, if needed, and placing hot sealant into the cracks. Figure 9 presents a schematic of crack sealant repair. ACRP Synthesis 22 and the DoD UFC Manual 3-270-01 provide greater detail on crack sealing techniques.



NOTES:

1. DEPENDENT ON SEALANT TYPE. USE MANUFACTURER'S RECOMMENDATIONS FOR RESERVOIR DIMENSIONS (W×D) AND FOR BACKER ROD MATERIAL WHEN REQUIRED.

Source: Federal Aviation Administration

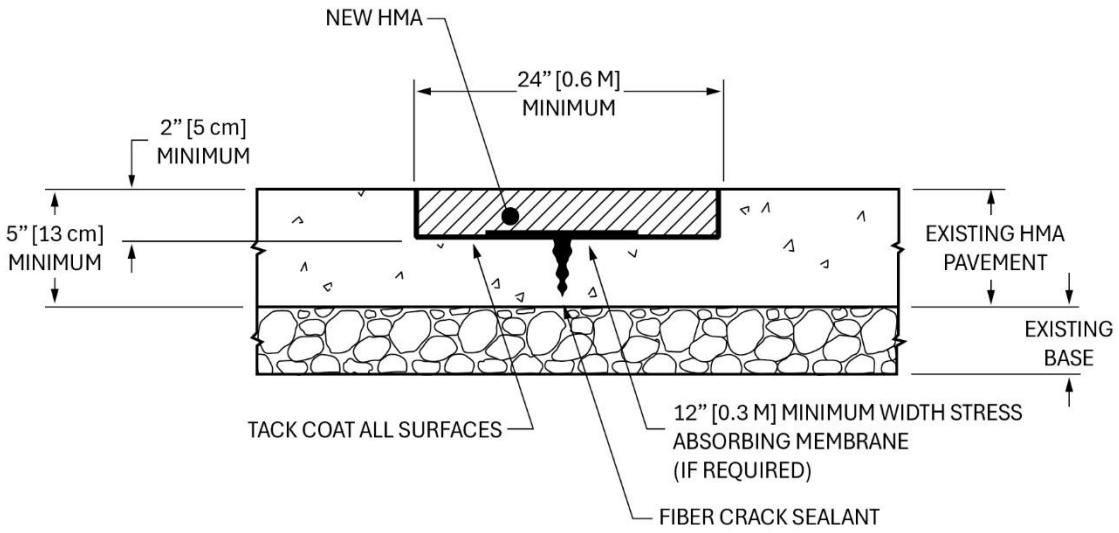
Figure 9. Crack Sealing Cross-Section [5]

Partial-Depth Crack Repair

In cases where the longitudinal joint has started to exhibit secondary cracking, and possibly low-severity pattern cracking has developed, or when the joint has opened too far, simple crack sealing may not adequately address the problem. In these cases, performing a partial-depth crack repair is more appropriate.

Partial-depth crack repair is only viable on pavements thicker than 5 inches (13 cm) and requires removing at least a 2-ft (0.6-m)-wide area centered along the crack to a depth of 2 to 3 inches (5 to 7 cm). This process will remove the top-most deteriorated part of the pavement and expose a narrower and shallower crack at the bottom. Next, the crack is repaired following the standard crack sealing procedure, but without routing, then the whole area is filled with HMA of an equivalent or better quality than the existing pavement. The final surface elevation of the patch must be even with the adjacent pavement to avoid leaving either a sag or a bump.

Figure 10 shows a cross-section schematic for a partial-depth crack repair. The process of matching elevations involves both over-filling the repair area by about 25 percent and achieving adequate compaction of the asphalt in the repair area. Further information on partial-depth patching is also found in ACRP Synthesis 22 and the DoD UFC Manual 3-270-01.

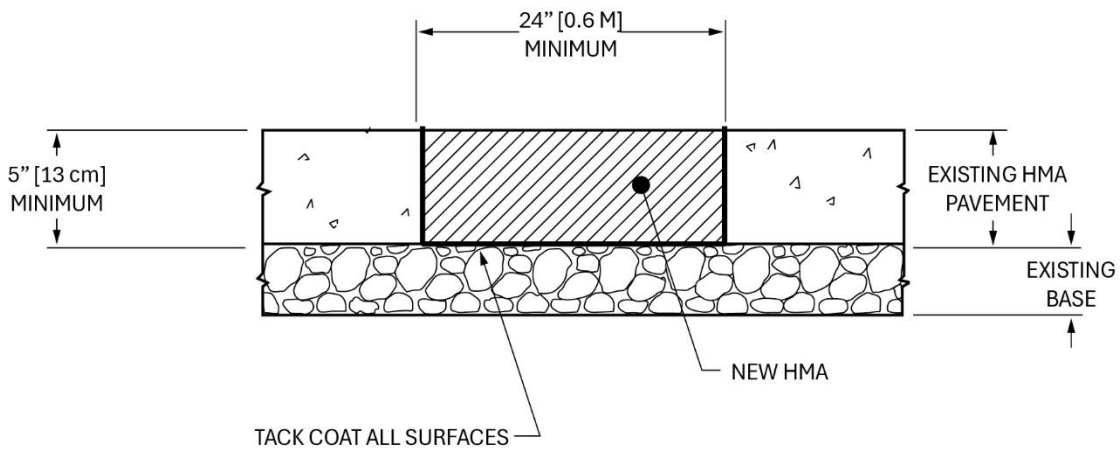


Source: Federal Aviation Administration

Figure 10. Partial-Depth Crack Repair Cross-Section [5]

Full-Depth Repair of Cracks

When cracks have deteriorated to the point that they are wider than 1 inch (2.5 cm), exhibit medium or severe alligator cracking, contain potholes, or present other structural-related distress, a partial-depth patch may not be sufficient to correct the damage. A full-depth repair may be needed to remove all the failed areas of the pavement. Also, a partial-depth repair is not recommended if the pavement is less than 5 inches (12 cm) thick. Instead, a full-depth repair should be used to repair deteriorated cracks. A full-depth repair requires the complete removal of the asphalt layer in an area at least 2 ft (0.6 m) wide centered around the crack. Once exposed, the base should be re-compacted as needed, and a tack coat should be applied before filling the patch with asphalt pavement of equivalent or better quality than the surrounding pavement. Asphalt in the full-depth repairs should be placed in lifts no thicker than 3 inches (7 cm); as such, multiple lifts may be required to properly complete these repairs. A straightedge should be used to verify that the patch is flush with the adjacent pavement. Figure 11 is a cross-section view of the full-depth crack repair technique.



Source: Federal Aviation Administration

Figure 11. Full-Depth Crack Repair Cross-Section [5]

Slot Paving

When longer sections of construction joints are deteriorated and need patching, such as the joint shown in Figure 12, "slot paving" may be more efficient. Slot paving refers to milling a narrow band, typically 2 ft (0.6 m) wide, following the path of a deteriorated longitudinal joint to a depth of 2 to 4 inches (5 to 10 cm). This type of repair removes the top portion of the pavement that is severely damaged and exposes a clean slot that can be treated with a tack coat and filled with an asphalt mixture similar to that of the rest of the mat [15]. The end product will resemble a partial-depth repair, as shown in Figure 10, but is more commonly applied to longitudinal cracks, as shown in Figure 13.

One notable issue with this technique is achieving proper density on such a narrow paving area. If good density is not achieved, it could lead to issues similar to those encountered with poorly constructed longitudinal joints—except now with two joints instead of one. Additionally, the amount of mix required for this type of repair may be considered a low production volume mix. Low volume mixes may not be subject to the same quality control measures as regular asphalt paving, and that may impair the future performance of the slot repair.



Source: APTech

Figure 12. Longitudinal Joint Repaired by Slot Paving



Source: APTech

Figure 13. Longitudinal Crack Marked for Slot Paving

Mastic Sealants

Guidance on crack sealant use typically sets a limit on the crack width—usually from 1 to 1.5 inches (2.5 to 4 cm)—beyond which the sealants are ineffective. For cracks wider than that limit, mastic asphalt sealants offer a more suitable solution. A mastic asphalt crack sealing technique can be used to repair medium- or high-severity cracks on longitudinal joints wider than 1.5 inches (4 cm). Mastic asphalt is a form of pourable asphalt mixture that does not require compaction to achieve consolidation. It is considered more durable than typical crack sealants and has proven very helpful in repairing wide cracks [16, 17].

The application starts by cleaning the crack area, heating the pre-mixed and pre-packaged product to the specified temperature, pouring material into the crack using a shoebox spreader, and leveling the excess material with a flat hot rod. Mastic material requirements are detailed in ASTM standard specification D8620 [18].

Figure 14 shows mastic being applied in a milled-out crack and a completed application of a mastic sealant over an underlying longitudinal crack. This material is currently not included in FAA's AC 150/5370-10H specification. While this is subject to change in future versions, its current use on a federally funded airfield pavement project would require an FAA-approved Modification of Standards (MOS) in accordance with FAA Order 5300.1.



Source: Crafco, Inc.

Figure 14. Asphalt Mastic Application

Additional Crack Repair Options

Some maintenance treatments that are not directly targeted to treat cracks may still provide some benefit by retarding the appearance or deterioration of surface cracking. Two such treatments are emulsified asphalt seal coats (P-608) and emulsified asphalt spray seal coats (P-623).

These two treatments apply an asphalt emulsion on the pavement that seals the surface and protects the pavement from water filtration and excessive oxidation, which slow down the pavement's deterioration rate [19]. If these treatments are applied to areas with low-severity longitudinal joint deterioration, they may function similarly to crack sealing and slow further deterioration (see Figure 15).

These treatments are typically applied over the entire airfield pavement surface and are not specifically designed to target longitudinal joint deterioration; their potential to improve the performance of the longitudinal joint is a beneficial side effect. These and other surface treatments are included in FAA AC/1505370-10H, which contains guidance on where they can and cannot be used.



Source: APTech

(a) Surface with a hairline crack prior to seal coat application.



Source: APTech

(b) Surface after seal coat application.

Figure 15. Taxiway Surface Condition Before (a) and After (b) Asphalt Seal Coat

Emerging Technologies to Improve Longitudinal Joint Performance

In addition to the repair and maintenance techniques currently documented by the FAA, there are other promising techniques and products that may prove beneficial for mitigating the occurrence of distress on longitudinal joints. Examples include joint adhesives, void-reducing asphalt membranes (VRAM), and penetrating sealers. While these products may offer benefits for use on airport pavements, further evaluation is needed to confirm their effectiveness.

As with crack mastics, the use of any of these emerging technologies on federally funded airport projects requires an FAA-approved MOS in accordance with FAA Order 5300.1 prior to use, since they are not currently included in FAA's AC 150/5370-10H specification. However, it should be noted that FAA does update specifications. Airport sponsors and engineers are highly encouraged to check the most recent FAA AC prior to initiating a new project.

Joint Adhesives

A joint adhesive is a hot-applied, modified asphalt used to adhere longitudinal joints on asphalt pavement. Its purpose is to increase the durability of the joint by sealing the edge of the pavement before paving the adjoining lane. This creates a waterproof joint with better bonding between the two layers [20].

Using a proprietary rubberized tack coat in longitudinal joint construction was one of the recommendations made in the 2007 Airport Asphalt Pavement Technology Program (AAPTP) report on longitudinal joints in airfield asphalt pavements [6]. While proprietary joint adhesives are commercially available, generic asphalt emulsions can also be used for the same purpose.

Joint adhesives are not expected to significantly reduce the air voids around the longitudinal joint area but rather to improve the adhesion between the cold and hot lanes and seal the area against water penetration [2]. The joint adhesive is applied directly on the cold joint before the adjacent lane is paved, in a process similar to crack sealing or tack coat application. Figure 16 shows an example of joint adhesive application to the cold open edge of a paved lane.



Source: Tennessee Department of Transportation

Figure 16. Joint Adhesive Application on an Exposed Cold Edge Before Paving Adjacent Lane [2]

Void-Reducing Asphalt Membranes

A void-reducing asphalt membrane (VRAM) is a hot-applied, polymer-modified asphalt used under longitudinal joints. VRAM is applied on top of the tack coat at the planned location of the longitudinal joint. During paving, the membrane material migrates upward into the HMA to fill voids, reduce water intrusion, and protect the underlying layers of the pavement structure [21].

A recent study [1] concluded that pavement samples treated with VRAM exhibited higher surface and joint bond energy values compared to untreated control samples, indicating that using a VRAM on longitudinal joints can delay the appearance and progression of cracks. Figure 17 shows an example of a VRAM application on top of the base layer at the intended location of the longitudinal joint, prior to paving the surface course.



Source: APTech

Figure 17. VRAM Application Before Paving Surface Course and Beneath the Future Location of the Longitudinal Joint

Penetrating Sealers

Penetrating sealers are applied as a maintenance product on existing pavements to longitudinal paving joints having a high air void content. Functioning as a localized sealant and rejuvenator, these materials are applied from 1 to 1.5 ft (0.3 to 0.5 m) on either side of the joint and are reported to penetrate up to 0.5 inches (1.3 cm) into the pavement [22]. They work by combining with the existing asphalt binder and providing a seal at depth to the joint. Manufacturers propose they be applied within several years of construction.

Summary

Deterioration of longitudinal joints remains a persistent problem in airport asphalt pavements. The development of longitudinal cracks at these joints is often one of the first distresses that develop in a newly constructed asphalt surface. Good construction practices can mitigate the development of cracks at longitudinal joints. However, once longitudinal cracks begin to form, their further deterioration can accelerate the need for pavement maintenance and rehabilitation.

A range of accepted techniques are available to slow the deterioration of longitudinal joints, including crack sealing, partial-depth repairs, and full-depth repairs. Placing a surface treatment on the pavement can also slow the development and widening of longitudinal joint cracking.

Several emerging techniques may also be considered for maintaining longitudinal joint cracks. Slot paving repair, a continuous partial- or full-depth patching method, may perform better than a localized patch on a longitudinal crack. Mastics are also used to patch deteriorating longitudinal cracks, while penetrating sealers—applied to longitudinal joints before they develop into cracks—also show promise in slowing deterioration. However, these techniques are not currently included in an FAA technical specification for use on airfield pavement projects. Therefore, an FAA-approved MOS, in accordance with FAA Order 5300.1, is required prior to use on a federally funded project. As noted in this document, FAA specifications are subject to change, therefore airport sponsors and engineers should reference the latest FAA AC prior to initiating a project.

Widespread longitudinal joint cracking can lower a pavement's PCI to a point where major rehabilitation or reconstruction is recommended, even though such cracking does not indicate a structural problem. Pavement owners and engineers are encouraged to consider whether maintenance techniques other than major rehabilitation or reconstruction may be more appropriate and cost-effective when longitudinal joint cracking is the primary distress driving down the pavement condition rating.

References

[1] J. Kamau, J. Podolsky and R. C. Williams, "Performance Evaluation of a HMA Pavement Longitudinal Joint Containing a Void Reducing Asphalt Membrane (VRAM)," *Frontiers in Materials,* vol. 10, 2023.

[2] B. Huang and X. Shu, "Evaluation of Longitudinal Joints of HMA Pavements in Tennessee," Tennessee Department of Transportation, 2010.

[3] C. Chen, R. C. Williams, T. A. EI, H. D. Lee and S. Schram, "Quality Control/Quality Assurance Testing for Longitudinal Joint Density and Segregation of Asphalt Mixtures," *Construction and Building Materials,* vol. 47, p. 80–85, 2013.

[4] FAA, "Advisory Circular: Standard Specifications for Construction of Airports," Federal Aviation Administration (updated by errata 19 August 2020), 2018.

[5] FAA, "Advisory Circular: Guidelines and Procedures for Maintenance of Airport Pavements," Federal Aviation Administration, 2014.

[6] R. B. Mallick, P. S. Kandhal, R. Ahlrich and S. Parker, "Project 04-05: Improved Performance of Longitudinal Joints on Asphalt Airfield," Airport Asphalt Pavement Technology Program (AAPTP), 2007.

[7] R. B. Mallick and J. S. Daniel, "Development and Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator," *International Journal of Pavement Engineering,* vol. 7, no. 1, p. 11–21, 2006.

[8] S. G. Williams, A. Pervis, L. S. Bhupathiraju and A. Porter, "Methods for Evaluating Longitudinal Joint Quality in Asphalt Pavements," *Transportation Research Record,* vol. 2098, no. 1, p. 113–123, 2009.

[9] AASHTO, "Segregation: Causes and Cures for Hot Mix Asphalt," Joint publication of the American Association of State Highway and Transportation Officials (AASHTO) and National Asphalt Pavement Association (NAPA), Washington, DC, 1997.

[10] P. S. Kandhal and R. B. Mallick, *Evaluation of Various Longitudinal Joint Construction Techniques for Asphalt Airfield Pavements,* Paper presented at the 2007 FAA Worldwide Airport Technology Transfer Conference, Atlantic City, NJ, 2007.

[11] J. Lund, *Hot Mix Asphalt Longitudinal Joint Deterioration,* Master's dissertation. Madison, WI: University of Wisconsin-Madison, 2012.

[12] ASTM, Standard Test Method for Airport Pavement Condition Index Surveys, ASTM D5340-20 ed., West Conshohocken, PA: ASTM International, 2023.

[13] J. J. Hajek, "Airport Cooperative Research Program (ACRP) Synthesis 22: Common Airport Pavement Maintenance Practices," Transportation Research Board, Washington, DC, 2011.

[14] DoD, UFC 3-270-01 O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair, with Change 1, Washington, DC: U.S. Department of Defense (DoD) Unified Facilities Criteria (UFC), 2022.

[15] G. M. Duncan, L. Sibaja Vargas, S. B. Seeds, D. Peshkin, M. Sminchak and S. Sophocleous, "Longitudinal Joint Repair Best Practices for the Ohio Department of Transportation," Ohio Department of Transportation, Columbus, OH, 2017.

[16] E. Tons and M. F. Khuri, "Mastic Asphalt for Maintenance," Michigan Department of Transportation, Lansing, MI, 1987.

[17] K. Ksaibati and S. D. Carter, "Evaluating the Effectiveness of Hot-Poured Crack Surfacing Material," University of Wyoming, Laramie, WY, 2006.

[18] ASTM, Standard Specification for Hot-Applied Asphalt Filled Mastic, ASTM D8620-20 ed., West Conshohocken, PA: ASTM International, 2020.

[19] P. Dzwilewski, A. Espinoza, D. Peshkin, C. Trejos, S. M. Dunn and R. Ashburn, "Airport Pavement Surface Treatment: A Literature Review," Federal Aviation Administration, Washington, DC, 2022.

[20] Crafco, "Product Data Sheet–Pavement Joint Adhesive, Part No. 34524," Crafco, Inc. Preservation Products, 2017.

[21] Indiana DOT, "401-R-750 Void Reducing Asphalt Membrane for HMA 220901," Indiana Department of Transportation, 2022.

[22] Transportation Research Board, "TRB Webinar: Centering Seams – Maintaining Centerline Joints in Asphalt Pavements," 2021. [Online]. Available: https://www.nationalacademies.org/event/02-17-2021/trb-webinar-centering-seams-maintaining-centerline-joints-in-asphalt-pavements.