Improving HMA Longitudinal Joints through Construction, Preventive Maintenance and Repair

Introduction
The Minnesota Department of Transportation (Mn/DOT) is currently conducting a research project aimed at reducing longitudinal joint (Ljt) deterioration in hot mixed asphalt (HMA) pavements through improved construction techniques, preventive maintenance practices, and repair treatments. Constructing durable HMA pavements, with adequate Ljt performance, has been well documented and extensively researched, however preventive maintenance and repair treatments specific for Ljt have received little attention in the literature.

It is commonly accepted that adequate density is critically important in achieving a durable HMA pavement. Insufficient density, or high air voids, usually results from the difficulty of compacting an unconfined pavement edge, and the localized area of low density creates a density gradient. Pavements with lower densities can have more interconnected air voids, leaving them more susceptible to moisture and environmental deterioration resulting in distresses such as weathering and raveling.

Premature Ljt deterioration reduces the pavement’s service life and increases agency costs. If the deterioration is severe enough, it can become a significant safety concern for motorcyclists. A review of pavement management data indicated that Ljt deterioration is responsible for more loss of surface rating (SR) than any other distress, even transverse cracking. The data also shows that the distresses are occurring earlier and in greater frequency, meaning that there is a large inventory of pavements expected to develop this deterioration in the near future that could be potentially delayed with PM treatments.

Research Work Plan
The research work plan seeks to address the deterioration through improved construction, targeted preventive maintenance, and repair methods. The work plan outline is:
1. Literature Search – Draft Complete
2. Evaluation of pavements with low & high severity Ljt deterioration
3. Mitigation Techniques
   a. Construction
   b. Preventive Maintenance
   c. Repair
4. Implementation and Long Term Monitoring
5. Final report

Ljt Construction
The literature search revealed a number of different Ljt construction techniques including: echelon paving, various joint geometries, cutting wheels, paver and roller attachments as well as different adhesives, sealants and rejuvenators. Compaction techniques included: rolling from the hot side (6” away), rolling from the hot side, and rolling from the cold side. Many of the studies were relatively short term, evaluating Ljt performance after no more than 6 years and many of the papers did not agree with one another on any particular method for either construction, or compaction. Many
sources stressed the importance of quality construction especially:
1. Pave in a straight line
2. Proper depth and overlap of the second lane
3. Avoid raking and maintain proper auger lengths

**Ljt Construction – Mn/DOT Efforts**

Mn/DOT recently implemented a longitudinal joint density specification (and incentive) which requires the edge of the core barrel to be 6” away from the joint. Field personnel reported that construction contractors were paying more attention to compaction of the joints and initial testing results looked promising. However, a review of paving projects revealed that many of the cores were not extracted in the correct location.

**Mn/DOT Specification**

The Mn/DOT Ljt density specification requires the edge of the core barrel to be no more than 6” from the joint.

Consistently extracting cores from the correct location is critical in assessing the specification, determining proper incentive and disincentive rates and ultimately in assuring that the public receives the highest quality product.

The 2010 construction season saw the limited implementation of two relatively low cost treatments: fog sealing of longitudinal construction joints and joint adhesive (sealant).

Fog sealing products include both diluted emulsions and rejuvenators, both of which should be applied no more than two feet wide over the joint before the application of permanent pavement markings. Traditionally, agencies have been wary of applying fog seals over mainline pavements due to friction concerns; however these concerns are can be mitigated if only a small, lightly traveled area is properly treated. In addition, if the application is diluted, slow setting, and if the application rate is carefully monitored, then most of the treatment can be expected to be absorbed into the pavement.

A diluted Cationic Slow Setting, hard based asphalt emulsion (CSS-1h) was applied over the centerline Ljt at the Minnesota Road Research Project (MnROAD). The slow setting emulsion sealed, and penetrated into the pavement. Field testing indicated that the seal had dramatically reduced permeability of the Ljt; however the sealed Ljt was still much more permeable than the wheel path. This material is an economic choice for fog sealing, as it can also be used as a tack coat. However, caution must be exercised as undiluted emulsion can also be used for tack coats. It is not advised to apply an undiluted emulsion over the centerline joint. Too much emulsion over the joint will severely complicate striping efforts, including grinding. In addition, CSS-1h fog seals must be allowed to cure for at least 14 days before applying epoxy pavement stripes.

Rejuvenators propose to modify and improve the existing chemical properties of the asphalt binder at the Ljt. Typically these products are recommended for aged surfaces, but some, such as clear colored joint stabilizers can be applied as part of the construction or within eighteen months of construction. Mn/DOT laboratory and field studies of one clear colored rejuvenator (JointBond) showed a dramatic reduction in retro-reflectivity of pavement markings when the rejuvenator was applied over the pavement markings. The laboratory study showed a reduction in retro-reflectivity measurements of approximately 50%, and measurements made in the field shortly after application showed a reduction of 30% (30
MCDs. The reduced retro values reduce the service life of the pavement markings. Thus, if the product is applied directly over the stripes, then the retro values should be monitored to ensure that they do not fall below standards.

In 2010 many metro district projects included joint adhesive (sealant) applied during construction (between paving passes). These treatments provide for an initially sealed joint from the time of construction and field personnel reported that this operation did not significantly impact normal paving operations. The performance of these projects will be monitored with time, as the benefits likely will not be fully understood for at least several years as pavement management data shows that Ljt deterioration typically does not become severe until 10 years.

**Ljt Preventive Maintenance**

An analysis of pavement management data showed that PM consisting of ship seals and crack seals reduced the amount of severe longitudinal joint deterioration by about a third at the 10-year old range and about half at the 15-year old range when compared to pavements that did not receive PM treatments. The PM treatments benefited the Ljt; however some treatments can be applied exclusively to the Ljt including crack seals and fog seals.

Fog seals can be applied over the Ljt, if properly coordinated with pavement striping. Sealing the Ljt with crumb rubber or Mn/DOT specified 3723 products should help to limit water infiltration. However, sealants do little to address deterioration in the vicinity of the joint, which usually suffers from low density.

**Ljt Repair**

There are a limited number of options available once Ljt deterioration reaches the medium to high severity level and becomes a safety hazard. Cold mix patching can give temporary relief, but oftentimes the entire pavement must be milled and overlaid. In fact, Pavement Management data shows that the average amount of medium severity Ljt deterioration at the time of a medium overlay is 1.6%, but the average for a medium mill and overlay is 16.3%. Strong evidence that the presence of Ljt deterioration is influencing the decision to mill, increasing project costs. As an alternative, Minnesota has been using micro surface treatments to quickly fill and level badly deteriorated longitudinal joints. This treatment is applied only to the targeted joints and not the whole pavement as shown in the photo below. This treatment has been performing reasonably well and has eliminated the need for patching, for several years. Additional treatments for consideration include mastics, which have the added benefit of being available during offseason months.

**Evaluation of Pavements**

Pavement management data will be searched to reveal differences between pavements with low and high severity Ljt deterioration. Factors such as: as weather/climate, PM, roadway type, and others will be considered. In addition the eight Mn/DOT districts have been asked to nominate pavements that are exhibiting exceptionally low or high severity Ljt deterioration. Selected pavement will be sampled to ascertain density, stripping and segregation at the Ljt.
Conclusions Recommendations

Longitudinal joint deterioration is currently a major problem in Minnesota, with the potential to become much bigger. Fog sealing and joint adhesives have been identified and implemented as low cost construction treatments to improve Ljt performance. PM treatments to address Ljt deterioration include coordinating fog sealing with pavement marking and sealing Ljt with crack sealant materials. Micro surface treatments have been used successfully to repair severely deteriorated Ljt. Mastics have been identified as another potential treatment.

These treatments are part of an ongoing evaluation to assess the long term performance and cost effectiveness.

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Mn/DOT Bituminous Office Specs/Standards and Reports for Longitudinal Joint Treatments:

www.dot.state.mn.us/materials/bituminous

Road Research program at Mn/DOT:

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