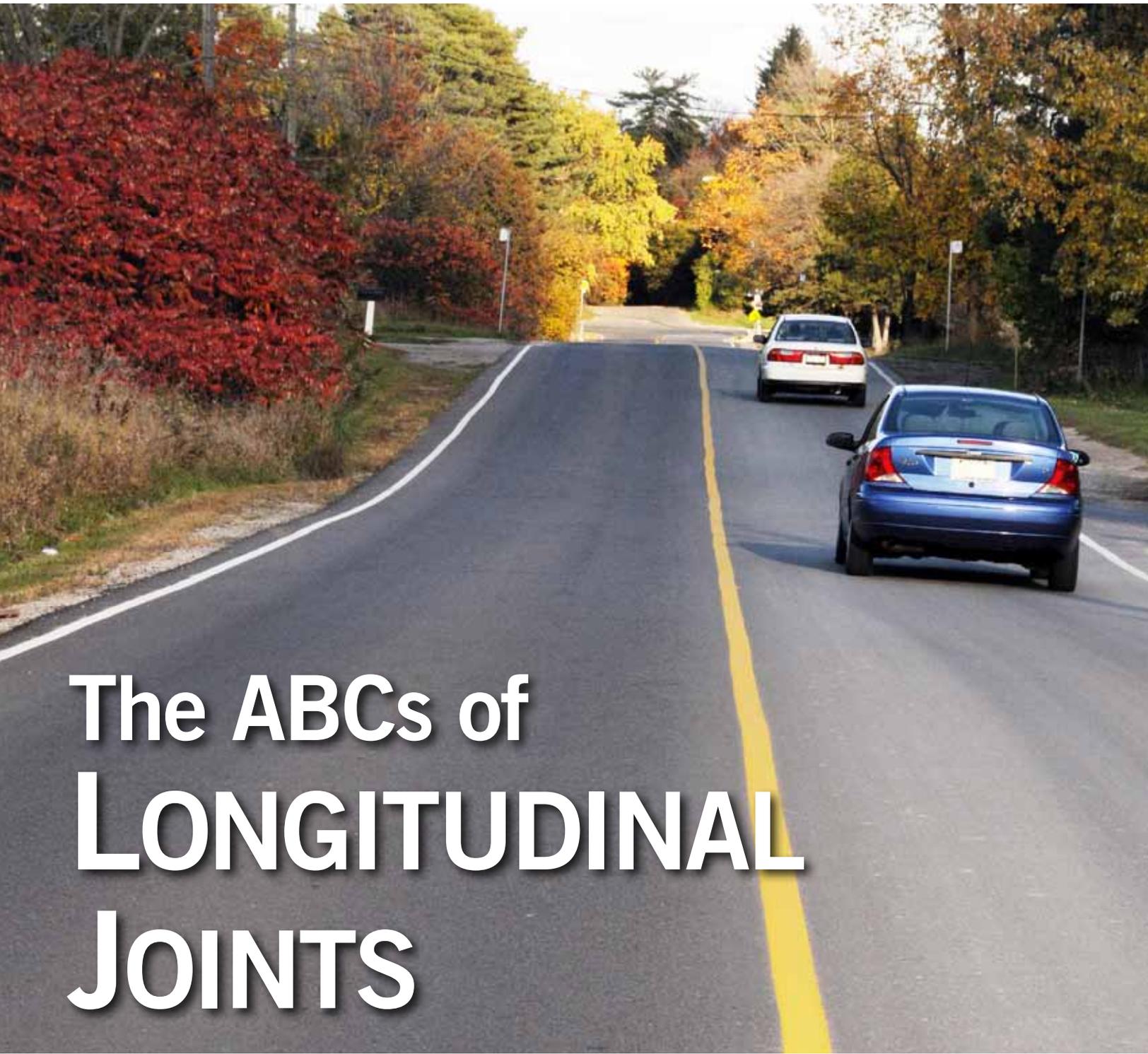




Ontario Hot Mix Producers Association



The ABCs of LONGITUDINAL JOINTS

Asphalt.

ONTARIO RIDES ON US

INTRODUCTION

Asphalt pavement is durable and long lasting but poor performing longitudinal joints can compromise the performance of the pavement structure and lead to earlier than normal rehabilitation. Properly constructed longitudinal joints are necessary to ensure acceptable long term performance. “In recent years, it has become evident how critical longitudinal joint construction is to the life of the pavement structure..... Many pavements have been, or are in the process of being, resurfaced as a direct or indirect result of longitudinal joint deterioration” according to College of Engineering at the Kentucky Transportation Center.

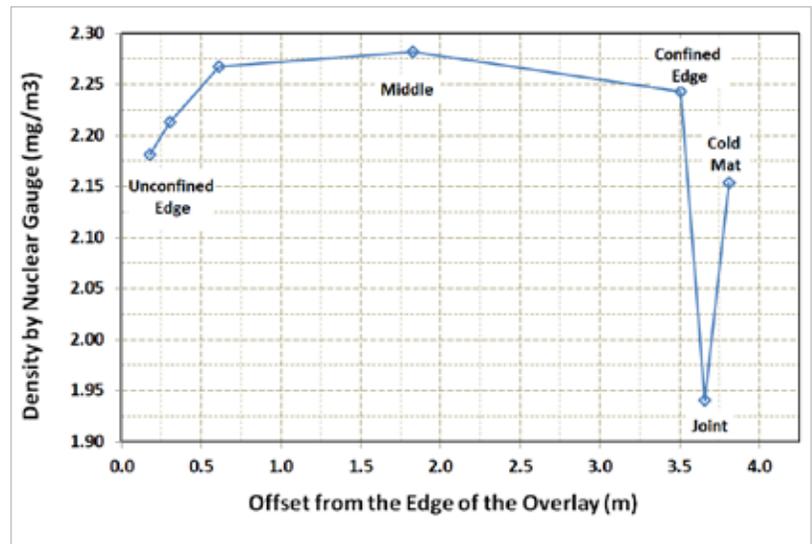
This issue is so critical that the Asphalt Institute carried out a two year study on the construction and performance of longitudinal joints for the Federal Highway Authority (FHWA) in the United States. The results of this study, *Best Practices for Constructing and Specifying HMA Longitudinal Joints*, were released in a report in May of 2012. Based on this report, the Asphalt Institute and the FHWA have been carrying out a cooperative training program for state agencies in 2013 and 2014.

Longitudinal joints continue to be the most difficult aspect of construction practice to get right, but research has shown that we can improve performance with some changes from typical practice.

ECHELON PAVING

The best way to eliminate joints is not to have them in the first place. Echelon paving places adjacent mats at the same time (pavers generally within 20 m) so that the two mats can be compacted as one operation. When this practice is used, cold joints and their inherent problems are avoided. However, echelon paving has operation issues as outlined in *Construction of Longitudinal Joints in Flexible Pavements - Design Guidelines MERO 033*, published by The Ontario Ministry of Transportation (MTO) in November 2008. Echelon paving requires preparation and commitment from the owner (i.e. full lane closure of the roadway is required).

If echelon paving is not used, the owner must accept that they are designing an area of potential weakness into the pavement and that this area will require maintenance. Having said that, there are design and construction practices that can result in improved performance for cold joints.



Density at the edges of the mat is lower if proper compaction techniques are not used.

CONSTRUCTING THE COLD JOINT

There are many methods to construct cold joints. The FHWA recently conducted a study of pavement practice across the US to determine what methodology was most effective. The study included talking to FHWA regional officers, acknowledged pavement experts, and also the recent National Asphalt Pavement Association (NAPA) Sheldon G. Hayes Award winners of Highest Quality in Asphalt Pavements. These experts did not always agree; however, FHWA is recommending the following:

- Follow all the recommendations given in the callouts ***Pavement Design Issues and Inspection*** and ***Basic Pavement Construction Practice***. These are necessary for both the overall quality of the mat and for good joints.
- Ensure that the substrate surface, either granular or milled, is sufficiently level.

**Cover photo: Excellent performance of the longitudinal joint six years after paving with warm mix asphalt.*

PAVEMENT DESIGN ISSUES AND INSPECTION

Design will profoundly affect the performance of both the mat and longitudinal joint. Some basic design issues to be addressed to ensure good longitudinal joints are as follows.

- **Appropriate compacted lift thickness** - For Superpave mixes, the minimum lift thickness should be three times the Nominal Maximum Aggregate Size (NMAS) for fine graded mixes (refer to OPSS.PROV 1151) and four times NMAS for coarse graded mixes. Marshall mixes are generally fine graded. Use a minimum compacted lift thickness of 40 mm for surface course mixes (HL 1 and HL 3) and 60 mm for binder course mixes (HL 8). HL 4 mixes should have a minimum compacted lift of 50 mm.
- **Use the smallest NMAS that will do the job** - This is more applicable to Superpave mixes where 4.75 mm, 9.5 mm, 12.5 mm and 19 mm mixes can all be designed to meet the necessary structural requirements.
- **Allow space for equipment to work** - In order to construct a good joint, there must be space for the equipment and crew to work. A minimum 1.5 m on each side of the mat is required. Where this cannot be provided, alternative solutions will need to be applied.
- **Tack coat is required between all lifts of HMA or WMA** - Tack coat acts to bond the layers together and thus let the stresses of traffic be passed to lower pavement layers. Tack coat is always required, even if the existing lift has not been exposed to traffic.
- **Send out tender calls early** - Where possible, paving jobs should be sent out for tender calls early enough in the year to allow projects to be constructed in times of favourable weather. Late season construction may result in pavements with lower durability and this will affect the longitudinal joints as well.
- **Inspection is essential** - Inspection of the work is essential to ensure performance. The owner's representative should be present during paving to inspect the work as it progresses. In many cases there are operational issues that arise during the course of the day's work that require timely direction from the owner to ensure that the project proceeds smoothly.



Paving in echelon with warm mix asphalt on an MTO project.

BASIC PAVEMENT CONSTRUCTION PRACTICE

It is very difficult to produce well performing longitudinal joints if the basics of good hot mix paving are not followed. Simple things like keeping the paver in motion at all times will improve both mat and joint durability. This requires coordination of all aspects of the work to ensure consistency in all aspects of the work. The plant must be coordinated with the trucking to ensure consistent properties for the mix and a steady supply of material to the paver. In addition, there should be sufficient compaction equipment on site to compact the mat to adequate density before it has cooled.

There are many aspects involved in good pavement practice. Some issues that directly affect the performance of the longitudinal joint include the following.

- **Use a stringline to lay out the first pass** – It is very difficult to achieve good joint density if the edge that the paver is trying to match is not straight. On curves, the stringline must be laid out to make a smooth curve that does not abruptly transition at either end.
- **Vibration should always be turned on** – A vibratory screen should be used. The screed is the first step in densification of the mix.
- **A heated screed should be used** – This is particularly important at the start up every day. A cold screed will affect both mat and joint density.
- **End gates of the screed should always be down** – The end gates should always be in contact with the substrate layer. The end gates provide confinement to the mix and aid in densification at the edges of the mat.
- **End gates no more than 450 mm from the end of the augers** – Augers and auger tunnels (including extensions) should never be further than 450 mm from the end gates. The auger must carry the mix out to the end gates to avoid segregation.
- **Use automatic controls** – Set and adjust the automatics to control thickness and crossfall. Constant manual adjustment of the screed is detrimental to both the mat and the joint.
- **Avoid handwork whenever possible.**



Paving with vibratory screen on.



End gate no more than 450 mm from the end of the auger and auger tunnel.

Laying and compacting the first pass.

- A straight and uniform edge is necessary. Use a stringline and skip paint over it in case the stringline is moved accidentally. The paver must be equipped with a device to allow the line to be followed.
- The breakdown roller should overlap the edge of the mat by 50 to 150 mm to allow the edge of the mat to be compacted. This is sometimes a concern with certain Marshall mixes as the edge may tend to squeeze out but most Superpave mixes Category C and higher should not have an issue. If rubber tired rollers are used, they should be held back about 100 mm from the edge unless experience shows that the mix can support the roller.

Laying and compacting the second pass.

- All joints should be properly tack coated prior to paving the adjacent lane. An application of tack will improve the adhesion at the joint.
- It is necessary to ensure that there is enough material at the joint to result in adequate density. To avoid staving the joint, the following practices should be used.
- Place a sufficient loose thickness of the new mat to ensure that the compacted mat will be at 2 to 5 mm above the first mat. This is the only way to be certain that there is sufficient material at the joint.
- Set the end gate to overlap the existing mat by 10 mm to 30 mm. Less overlap is required with coarse graded Category D or E Superpave mixes.
- Do not lute the joint if at all possible. Compaction of the joint will leave a small amount of crushed aggregate at the joint which will disappear over the first winter.
- First pass with the breakdown roller should be 150 mm away from the joint on the hot side. This partially compacts the loose mat and leaves a ridge of material beside the joint.
- The second and all subsequent passes of the breakdown roller should overlap the cold mat by 150 mm.
- Be sure to continue the overlap of 150 mm for all passes of the rubber tired roller and finish roller.

ADDITIONAL DESIGN ISSUES TO CONSIDER

In multiple lift pavements, the location of the longitudinal joint should be staggered between lifts by 150 mm to 300 mm. It is unwise to construct the joints directly over one another. The location of the joints in the lower lifts will depend on the planned location of the joint in the surface lift.

In typical practice, the longitudinal joint in the surface course has been placed on the centerline of the pavement and subsequently covered with the lane demarcation. Given that the cold joint is a location of known weakness in the pavement, it will require maintenance. Line painting materials and joint sealing compounds do not have good compatibility. Consequently, consideration should be given to displacing the location of the cold joint in the surface course by 150 mm to allow the lane demarcation to be placed on the centerline but not on the cold joint. This allows subsequent maintenance activities (i.e. joint sealing or reapplication of lane demarcation) to be carried out without interference.



End gate all the way down and proper overlap.

INNOVATIVE APPROACHES FOR POTENTIALLY INCREASING JOINT DENSITY

The procedures outlined up to this point are considered to be the existing standard for cold joint construction. There are alternatives that have the potential to increase the performance of the cold joint but not without additional cost and logistical support.

JOINT HEATERS

Joint heaters can be used to improve joint density and bonding. The technology involves infrared heating of the previously placed mat to allow better bonding and the possibility for additional densification. The heaters can be stand-alone units that are towed in front of the paver or can be attached directly to the paver. The stand-alone unit typically use propane as a heat source. Units mounted on the paver may use either propane or electric heat. Care must be taken in use to ensure that the existing mat does not become overheated as this would tend to locally decrease the life of the pavement. If the joint has been sufficiently heated to allow for additional densification (about 110°C), tack coat may not be required.



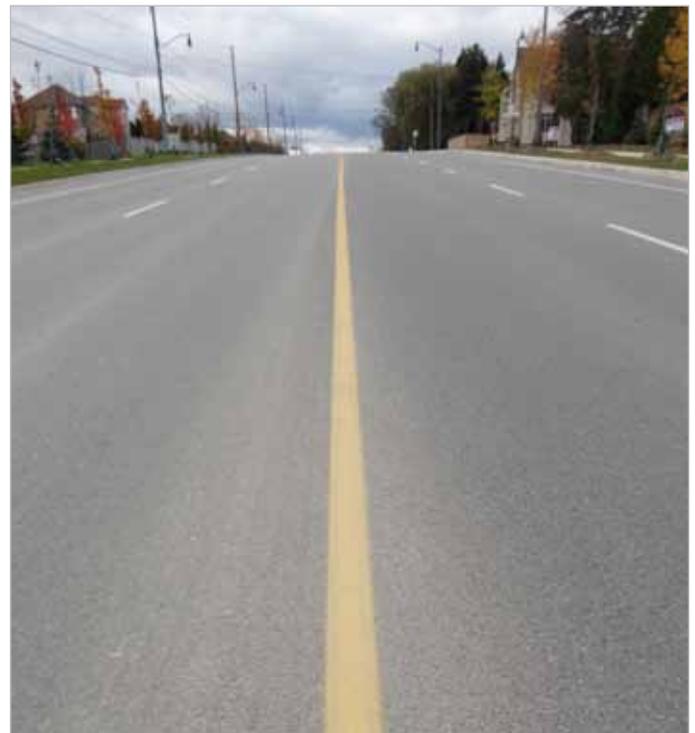
Joint heaters improve joint performance.

There are logistical issues associated with heaters. Stand-alone heaters must be reasonably close to the paver or the benefit to the joint density and bonding are not realized. However, this proximity can lead to conflicts with transfer of mix to the paver from trucks. In addition, truck traffic over

a warmed joint can collapse the edge of the joint. Paver mounted units have logistical issues with training and safety (propane tanks on the paver).

PAVEMENT RAMP DOWNS

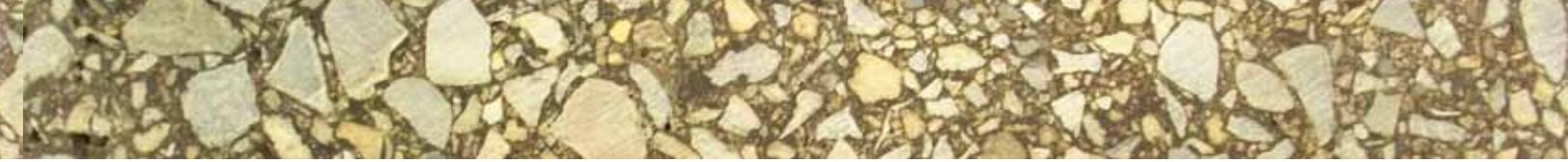
Working together with the industry, MTO has recently approved the longitudinal ramping down of the mat onto the adjacent mat. This has the potential to improve paving efficiency by allowing the paving operations to proceed for the full shift without having to stop and move equipment back to the start of the day's operations so that the paving ends at the same station. The ramp is installed at a 10:1 slope for traffic safety. Prior to paving the second pass in the adjacent lane, the ramp is milled out to remove the lower density material at the edge of the mat and to provide a vertical surface for the longitudinal joint. Care must be taken to ensure that precipitation events do not produce unsafe conditions resulting from ponded water in the adjacent lane prior to paving the adjacent lane.



Properly constructed cold joint five years after paving.

WARM MIX ASPHALT

Warm mix asphalt (WMA) has the potential to improve the performance of a cold longitudinal joint. There is no theory for why this might work but observation of WMA projects shows very good performance from the longitudinal joints. It could



be that the ease of compaction for these materials raises the density of the joint. It also could be that the differential in temperature between the mix being placed and the temperature at which the previously placed mat regains a bit of workability is sufficient to provide higher joint density and better adhesion between the mats.

The use of WMA should be considered when there is insufficient space to allow for a properly compacted joint. In addition, WMA may allow for placement in marginal temperature conditions provided that the substrate is not frozen.

PROPRIETARY PRE-APPLIED JOINT SEALANTS

There are methodologies for applying a sealant to the exposed surface of the cold joint prior to paving. Preformed joint tape can be rolled onto the joint. There are other hot applied joint compounds that are applied with an insulated wand that may also be used. All of these materials soften and penetrate voids in the existing mat when heated by the application of hot mix in the adjacent lanes. While these compounds do not improve joint density, they significantly reduce the permeability of the joint and also increase adhesion, thus enhancing the durability of the joint.

The use of pre-applied joint sealants should be considered when there is insufficient space to allow for a properly compacted joint.

INLAY PAVING

Better joint performance might be accomplished by a change in paving procedures. The existing surface is milled for one lane only to the extent of the day's paving and then inlayed against the vertical longitudinal faces. When the adjacent lane is paved, the lane is again milled to the extent of one day's paving but in this case, the lane is milled wider than necessary to remove some of the new HMA placed in an earlier operation.

The use of inlay paving should be considered when there is insufficient space to allow for a properly compacted joint.

SEALING THE LONGITUDINAL JOINT

In some jurisdictions, the longitudinal joints are sealed at the time of construction as a precaution for long term performance. Bituminous and non-bituminous penetrant type sealing materials have been used. In all cases, the sealant is applied to overband the joint. If this option is used, the longitudinal joint is usually offset from the centreline as the materials are not always

compatible with paint demarcation materials.

Sealing the joint at the time of construction should be considered when there is insufficient space to allow for a properly compacted joint.

MAINTENANCE OPTIONS

If echelon paving is not allowed, then maintenance of the longitudinal joint will be required before the life of the mat has expired. There are several options for longitudinal joint maintenance depending on when the maintenance is performed. Routing and sealing using OPSS 341 (Hot Air Lance procedure) provides durable sealed joints.

If the maintenance has been delayed, and the longitudinal joint has opened up too much to allow for routing and sealing, micro-surfacing can be applied using a rut box to confine the application to a width of about 300 mm. The fine aggregate in the micro-surfacing will fill the open joint and restore the surface profile.

Another option for seriously distressed joints where routine maintenance has not been carried out or where multiple cracks are present is to saw cut through the surface course to a depth of 50 mm. The edges and base of the slot repair are tack coated and then patched with an approved surface course material. The disadvantage of this method is that, in essence, two joints are produced and both will need maintenance.



Patching of the longitudinal joint extends pavement life.



Excellent performance of the longitudinal joint six years after paving with warm mix asphalt.



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The Fine Print: This brochure is designed as a general guide to pavement design. It is not a design manual. Professional engineers should be consulted to ensure that pavements are not only designed functionally but also economically to fit your budget requirements.

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