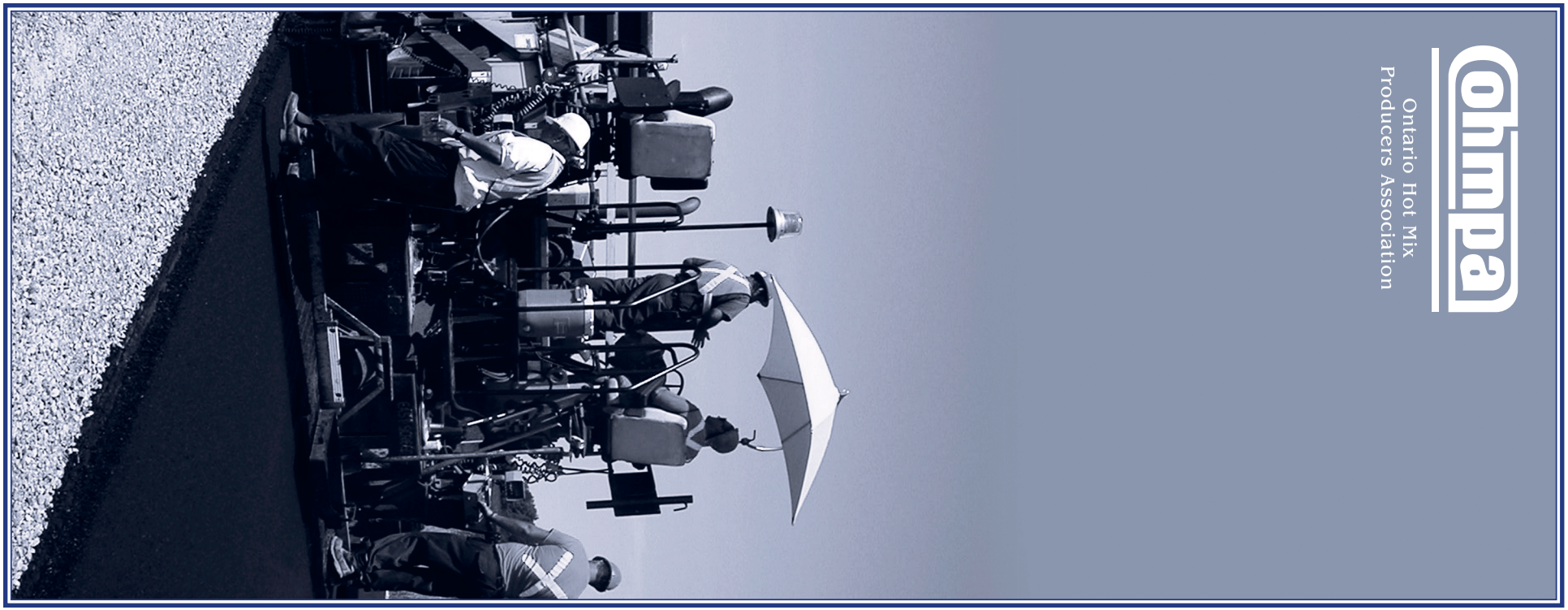
The ABCs of

PAVEMENT REHABILITATION



ohmpa

Ontario Hot Mix Producers Association

The ABCs of Pavement Rehabilitation

Steel rusts. Wood rots. Concrete crumbles. And even hot mix asphalt eventually wears out. The constant pounding of traffic, the scouring of wind and rain, the heat of the summer and the cold of the winter all take their toll.

It may be fifteen years, it may be twenty years, it may even be thirty years after they were first built but eventually all roads will require major rehabilitation as they get close to the end of their useful life.

The most popular method of rehabilitating roads is a hot mix overlay - a new layer of hot mix pavement. Done properly, an overlay should give between 15 and 20 years of extended pavement life - almost as good as a brand new pavement at considerably less expense.

The key word is "properly". And thus the ABCs of pavement preservation:

A. A well prepared stable base

B. The right mix and the right thickness

C. Quality construction

When Do You Start?

Asphalt pavement is amazingly resilient. Most signs of distress (cracks, small potholes, stripping) can be fixed with normal maintenance techniques. Even severe defects, if they are localized, can be repaired relatively quickly and easily. In fact, a well-planned, well-executed preventive maintenance program can extend the life of roads by up to fifteen years.

But when the pavement starts to show extensive structural defects, it is time for a complete pavement rehabilitation. Using a falling weight deflectometer (FWD) can provide an objective assessment of the structural capacity of pavements. Taking core samples can help identify the type of asphalt in the existing pavement, moisture conditions and the condition of the bond between the various pavement layers.

A condition survey should look for:

- Deep structural cracks
- Severe surface distortions
- Heavy rutting

Rehabilitation Basics

Engineers start by selecting the type of overlay that is going to be used - either a typical surface course or a premium mix depending on traffic conditions - and then designing the mix and calculating the pavement thickness. Overlays range in thickness from 25mm (used primarily for preventive maintenance) to 200 mm.

Engineers will also review the condition and performance of the existing road to ensure that any problems are corrected before the new overlay is laid. Drainage problems need to be corrected, the correct road profile restored, and measures put in place to avoid reflective cracking.

The contractor starts the rehabilitation process by preparing the old road surface. Milling ("shave and pave") removes the distressed asphalt. The contractor corrects any local defects, installs any interlayers required (membranes, fabrics or aggregates used to help stop reflective cracking), and then lays the new pavement.

In situations where there is deep cracking or where the cracking is from the bottom up, the contractor can use base stabilization techniques such as cold-in-place recycling and full depth reclamation to remove the entire old asphalt pavement and use it to create a new base.

The entire construction process typically takes two to three days after which the lane can be immediately opened for traffic.

Signs of Distress

Not all signs of distress mean that the entire pavement needs to be rehabilitated. Most problems are minor and can be corrected with normal maintenance. However, when a road starts to show signs of permanent deformation, fatigue cracking, and low temperature cracking - all indications of severe distress and structural failure - pavement rehabilitation is probably going to be needed.

Here are some signs of distress to watch for:

Rutting: longitudinal deformation of the pavement caused by heavy traffic.

Fatigue or alligator cracking: interconnected cracking with a pattern resembling the hide of an alligator. Caused by base failure.

Reflective cracking: cracks in the surface of the pavement due to underlying cracks in the pavement.

Edge cracking: longitudinal or crescent shaped cracks within the first 30 cms of the pavement edge.

Types of Overlays

In Ontario, there are two common procedures for designing HMA mixtures: the Marshall method (AI publication MS-2) and the new Superpave method (AI publication SP-2). While the move is to Superpave, either mix designs procedure can be used to design quality mixtures.

Most Marshall mix overlays will be HL-1, HL-2, HL-3 for single lift overlays, HL-4, or HL-8 mixes as base courses for multi-lift overlays. Which overlay is chosen depends primarily on traffic conditions.

Superpave dense graded mixes are designated by the nominal maximum aggregate size (NMAS). The nominal maximum size is defined as "one sieve size larger than the first sieve to retain more than 10 percent." Dense graded mixtures can be further classified as fine graded or coarse graded mixtures.

For exceptionally heavy traffic conditions or to extend the life of the new overlay, premium mixes can be used:

- High Density Binder Course: A premium base course for multi-lift overlays.
- Dense Friction Course: A premium surface course with high frictional resistance.
- Stone Mastic Asphalt: A premium surface course with excellent pavement performance characteristics and exceptional rutting and fatigue cracking resistance.
- Open Friction Course: An open-graded mix used on roads and highways with heavy traffic where low tire noise is desired. OFC is free draining and has good frictional resistance.

Mix Design: The mix design for an overlay is essentially the same as the mix design for a new pavement. It needs to cover the materials to use, the aggregate structure, the binder content and moisture susceptibility.

Asphalt cement: Specify the correct Performance Graded Asphalt Cement for the temperature and traffic conditions.
Superpave: Engineers should consider using Superpave - a complete system for designing hot mix asphalt pavements that integrates all the mix design requirements.

RAP: As with any other hot mix, Reclaimed Asphalt Pavement can be incorporated into the mix. Check mix design specifications for the amount of RAP that can be used.

Thickness Design

1. AI Design Methods:

The Asphalt Institute provides two design methods for overlays:

(i) Deflection Procedure

(ii) Effective Thickness Procedure

Both methods should be used to design the overlay, the results compared and engineering judgement used to select an appropriate overlay thickness. These methods are described in AI's Manual Series 17 along with a computer program, Asphalt Institute Thickness Design Software SW-1.

(i) Deflection Procedure

The Asphalt Institute's deflection based design method for flexible pavements is an empirical method that has been used successfully for many years.

The deflection procedure for flexible pavements uses an actual Representative Rebound Deflection from the Benkelman Beam device, or an equivalent RRD from dynamic or impulse non-destructive tests such as the Dynaflect and FWD.

The magnitude of the deflection is an indicator of the structural capacity of the existing pavement and its ability to accommodate future traffic loading.

Based on the deflection data, a strengthening overlay is designed to reduce pavement deflections from a measured to a limiting design RRD for varying traffic conditions.

(ii) Effective Thickness Method

The Effective Thickness Method is another empirical design procedure that can be used for flexible pavements.

As pavements deteriorate due to traffic loading and exposure to the environment, their physical characteristics may not change but because their performance has deteriorated they behave as if they are thinner than they really are. The effective thickness of this "thinner" pavement is the thickness of a full depth asphalt pavement with equivalent physical properties.

The overlay thickness is the difference between the full depth asphalt pavement thickness required for future traffic and the effective thickness of the existing pavement.

2. The MTO Method

The Ministry of Transportation of Ontario has a detailed design procedure for pavement overlays similar to the AI method.

The MTO method starts with a determination of the traffic loading in terms of daily ESALs (referred to as Daily Traffic Number (DTN)). The next step is to determine the actual deflection of the road using the Benkelman Beam, Falling Weight Deflectometer or other devices. These numbers are then used to determine either maximum traffic loading or thickness requirements using the Granular Base Equivalency (GBE).

3. AASHTO Method

The AASHTO Method for asphalt overlay design requires the following inputs:

- existing pavement design and construction data
- material types and thickness
- subgrade information
- traffic analysis
- pavement condition survey
- deflection testing, coring and material testing are recommended to investigate the existing conditions.

If the overlay is being placed for the purpose of structural improvement, the required thickness in terms of Structural Number for the overlay is calculated as the difference between the SN required to carry the future traffic and the SN of the existing pavement.

The AASHTO Guide gives the range of layer coefficients for the materials in the existing pavement depending on the pavement condition.

Preparing the Old Pavement:

The old pavement will either be removed by milling or reused with base stabilization techniques.

Milling removes the top layer of asphalt pavement. It not only prepares the surface for the overlay by removing rutting and surface irregularities but also restores the pavement's cross slope and profile. The milled asphalt pavement can be recycled as reclaimed asphalt pavement, or RAP, in other hot mixes.

Cold In Place Recycling turns the existing pavement into an aggregate base. The existing pavement is removed to a depth of between 65 and 125 mm., mixed with an emulsion, re-laid and then compacted to the specified density. After a short curing period for the emulsion, the new base is ready for the overlay. The entire process is carried out in-situ. None of the old pavement is removed from the site.

Full Depth Reclamation processes the entire flexible pavement section and a predetermined portion of the base material. A full depth recycling machine uniformly pulverizes and blends the pavement and base to produce a stabilized base course. Aggregate can be added to improve the base's characteristics as required.

Full depth reclamation can be used for depths up to 300 millimetres. By completely removing the old pavement, full depth reclamation erases all deep cracks thus avoiding any chance of reflective cracking. It also restores the pavement's profile and cross-fall.

Pre-Overlay Treatments:

As with all pavements, durability and performance start from the ground up. It doesn't matter how good the mix design is or how thick you make the overlay, if it is laid over a poorly treated base, it will not perform properly.

Repair Localized Defects. Patch potholes and cracks. Remove defective and distressed materials.

Repairing small defects can save time and money when it comes to placing the overlay but not every defect needs to be fixed. In fact, doing too much preparation can sometimes cost more than it saves. Discuss with your contractor what the optimal balance between repairs and overlay costs should be.

Level the Surface: Fill ruts. Restore the cross slope. Improve the longitudinal profile.

Cold milling will handle most surface improvements but an asphalt levelling course may be needed to correct the profile.

Improve the Drainage: Proper drainage is absolutely essential to maintain a good pavement.

Make sure all drainage problems are identified and corrected before the overlay goes down. Start with a drainage survey paying particular attention to where drainage problems and pavement distress coincide. No sense repeating the same problems.

Avoid Reflective Cracking: The overlay is being laid over pavement that is already cracked. The last thing you need is for the cracks to reappear in the new surface course.

Route and seal cracks to limit deterioration. Consider using an interlayer between the old pavement and the overlay. Aggregate interlayers can be effective when designed properly. Geotextiles and membranes can also be used to control reflective cracking.

Full depth reclamation, when appropriate, is the most effective way to eliminate reflection cracking because it completely eliminates the problem.

Construction Notes:

Density: While the new asphalt mixes are more durable and longer lasting, contractors have to make sure that they achieve the necessary density. The key is to have proper rollers and rolling patterns that are established using good quality control procedures.

Lift Thickness: The old rule of thumb was twice the maximum aggregate size. Today, lift thickness are typically three times nominal maximum aggregate size and four times for coarse-graded mixtures.

Hot mixes with a 12.5mm nominal maximum aggregate size will have a lift thickness between 40 and 75mm; a 19mm NMS lift thickness will be between 60 and 100mm.

Traffic Control: Pavement rehabilitation is a far more time-consuming process than preventive maintenance. Maintaining traffic flow through construction zones may require cross-over detours, night work, and longer construction schedules.

Rubblization:

All roads deteriorate and concrete roads are no exception.

When a concrete road gets to the end of its useful life, rubblization gives you the best of both worlds - a strong granular base topped by a fresh overlay of hot mix asphalt for a smooth, quiet and durable pavement.

Special equipment is used to break up the old concrete pavement into small pieces which when compacted serve as the base for the new hot mix overlay.

The process is quick, inexpensive and because the old road is being reused, environmentally friendly. There is no need to put the concrete into overburdened landfills.

The new asphalt road will perform as well as any asphalt pavement laid over a normal granular base.

Pavement Maintenance:

If you are filling potholes and repairing major cracks, it's probably too late.

Preventive maintenance is an essential tool for extending the life of a pavement. Used early in a pavement's life, preventive maintenance can either eliminate the need for pavement rehabilitation or at least lengthen the pavement's useful life before major rehabilitation is needed.

Preventive maintenance corrects small problems before they become big problems, saves money, reduces delays and improves safety and rideability.

Since preventive maintenance is an organized, systematic approach to maintain the condition of a road and slow future deterioration, it should be used on all pavements including those that have been rehabilitated.

For more information on how preventive maintenance should be a part of every road management system, call the Ontario Hot Mix Producers Association for the ABCs of Pavement Preventive Maintenance.

It's as Easy as ABC

OHMPA's ABC series is a beginner's guide to asphalt and asphalt paving for municipal and consulting engineers, politicians and administrators.

Written in simple, easy-to-understand language, these guides show how good design and the latest technology can produce long lasting durable roads at an affordable cost.

The following publications are available free of charge:

Life-Cycle Costing

Asphalt Pavements in Ontario: When it comes to pavement design, there is one over riding question. Which design is most cost-effective? Life-cycle costing shows you how to find the answer.

The ABCs of PGAC

The Use of Performance Graded Asphalt Cements in Ontario: The definitive guide on how to select, order and test PGACs and how to use them with Superpave design methods.

The ABCs of Pavement Design

This brochure introduces various concepts and design methods for asphalt pavements to make sure that municipalities and agencies get the best value for their money.

The ABCs of Asphalt Pavement Recycling

More than steel. More than plastic. More than paper. Asphalt is North America's most recycled material. This brochure outlines the ABCs of RAP:

A. Good Material
B. Good Design
C. Good Methods

The ABCs of Pavement Preservation

The Right Treatment to the Right Pavement at the Right Time. Preventive maintenance is a strategy – an organized, systematic approach that maintains or improves the condition of a road and slows future deterioration. Learn more in this brochure about doing it right.

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The Fine Print: This brochure is designed as a general guide. 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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