

The ABCs of

POTHOLES



Ontario Hot Mix
Producers Association



ABCs of Potholes

People put up with a lot of things but potholes are personal. Like the flowers that bloom in the spring, potholes come to life after a hard winter, lurking in the pavement, ready to reach up and grab the unwary motorist. But when drivers call city hall to bemoan the state of the roads, they're probably blaming the wrong person.

It's not the decisions that were made this year that created the problem. It was the decisions made five to ten years earlier.

Potholes

How Potholes Form:

Water gets into the pavement base, creating a small cavity. The unsupported pavement falls away creating a pothole.

How to Prevent Potholes:

Stop water getting in under the pavement.

- Step 1: Build a durable road with good drainage, adequate pavement thickness and tight joints
- Step 2: Maintain the road by sealing cracks.

How to Patch Potholes:

"Throw and go" – a temporary fix in which you throw in mix and then head to the next one.

"Throw and roll" – same as above but using the utility truck to compact the patch.

Best Practice:

- Clean the hole
- Square up the edges
- Use a tack coat on the edges
- Use hot mix (if available) for a better bond
- Add the asphalt in layers
- Compact the patch with a hand held vibratory compactor

The Birth of a Pothole

There are only three things that can kill a road – water, water, and water. And just like the flowers that bloom in the spring, it takes a good sprinkling of water to bring potholes to life.

For thin pavements (less than 100 mm), the majority of municipal roads, potholes start to form when water seeps into the gravel subbase and undermines the pavement. The weight of vehicles going over the unsupported pavement flexes the asphalt, which weakens, cracks, and then falls away leaving a pothole. The more traffic there is, the more damage there will be. Heavily travelled roads or roads with a lot of truck traffic are more prone to potholes.

For major arterial roads with two or more layers of asphalt (thicker than 150 mm), the mechanism is slightly different. With spring conditions, the top layer debonds and breaks up under the

repeated loading of the traffic leaving a pothole and exposing the lower layer of pavement. With the surface lift gone, the water ponds in the hole, leading to further infiltration of water into the pavement and ultimately into the subbase. Since this takes a bit of time to develop, timely filling of potholes in the surface layer, even in the winter, is critical.

Potholes bloom in the spring because the winter freeze thaw cycles open up the cracks in the asphalt, allowing more water to penetrate. When the water in the subbase freezes, it expands, pushing up the pavement and further weakening it. Spring temperatures warm the cold pavement, melting the ice, creating air pockets that leave the pavement unsupported. A winter of heavy snow or rain and repeated freeze-thaw cycles means a big pothole season ahead.

Where There's a Crack, There's a Way

There are two ways that water can get underneath a pavement – through breaks in the asphalt mat or by penetrating through porous pavements.

Asphalt pavement starts out life as a smooth continuous surface but time takes its toll. Inevitably with the pounding from cars and trucks, the scraping of snowplows, and weathering from the sun, rain, and ice, cracks start to appear.

Cracks can also form along another type of discontinuity in the mat, the longitudinal joints, which are formed between lanes when a mat of fresh hot-mix is placed alongside an existing cooler mat.

Utility cuts in the pavement for underground cables and pipes also create discontinuities in the mat.

Even if there are no cracks or discontinuities in the pavement, water can still get into the subbase. With the exception of some special types of asphalt that are designed to be porous, most asphalt is relatively impermeable and watertight. However, if the asphalt pavement is too thin, inadequately compacted, or badly worn along the wheel path, it becomes more porous and water can make its way through the pavement into the underlying base.

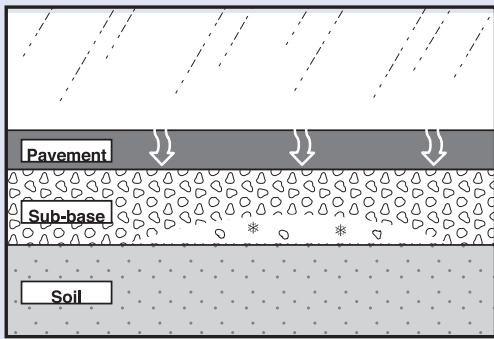
Build It Right in the First Place

You cannot prevent potholes by making decisions this year. The decisions needed to be made years earlier. A well-designed, well-built road lasts longer, has fewer cracks and discontinuities, and prevents water from undermining the pavement in the first place.

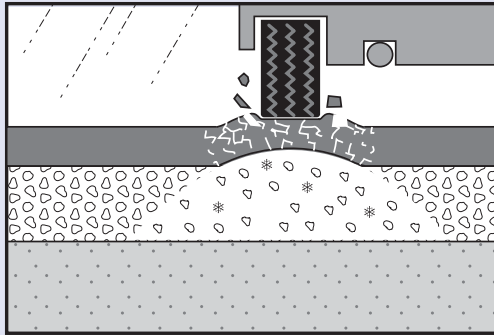
Good Drainage: Every pavement engineer will tell you that good drainage is essential for good roads. A properly crowned road sheds water to gutters, drains and ditches. A well-designed granular subbase provides good drainage as well as solid structural support. In some situations, subsurface drains should be installed for additional drainage.

Good Thickness: Do not skimp on the asphalt pavement. The pavement needs to be thick enough so that the contractor can compact it properly. Air voids (typically 5 to 6 percent) are normal in asphalt pavements but a poorly compacted pavement will have a much higher air void content and as a result will be more porous and more prone to cracking.

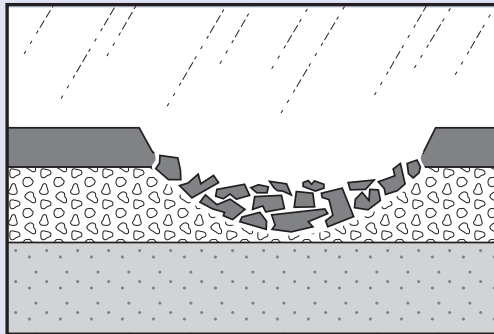
The thickness of the asphalt pavement should be 3 to 4 times the nominal aggregate size, typically 50 millimetres for most road surface courses, to provide the strength needed to resist deformation and cracking.



Water from melting snow and ice seeps into the pavement and softens it. During repeated cold spells, the water in the pavement refreezes and expands, breaking up the pavement, on and below the surface.



When the ice melts, it leaves gaps inside the pavement, and the moisture further softens it. The soft, fractured asphalt cannot support the weight of passing vehicles, and begins to break up.



As vehicles continue to pass over the weakened spot, pieces of roadway are kicked out, creating the hole in the highway.

diagram courtesy of Virginia Department of Transportation

Cutting back from, say, 50 millimetres of hot mix to 40 millimetres will not cut costs by 20 percent. The incremental cost of a few extra millimetres of asphalt is minimal.

Good Bond:

A tack coat is a light application of asphalt emulsion between hot mix asphalt layers that helps bond them together, maintain the road’s structural integrity and helps keep water from penetrating through the pavement. Tack coat is inexpensive insurance against early de-bonding of the layers. If you want to cut down on road construction costs, eliminating the tack coat is one way to do it but be prepared to increase your maintenance costs in a few years time.

Good Joints:

Since a longitudinal joint is the most vulnerable point of failure for asphalt pavements, if you want a really strong durable road, avoid longitudinal joints in the first place. There is, however, only one way to do that and that is by paving in echelon – paving multiple lanes side-by-side with two or three pavers – which usually

requires shutting down the road completely for a day or two.

If echelon paving is not practical, then proper construction techniques, such as correct joint overlap and rolling techniques, joint heating, and joint adhesives, can create tighter, more durable seams.

The Best Defence

Since cracks in the pavement are inevitable, preventive maintenance to repair the cracks and keep the water out of the pavement structure is the best defence against potholes.

Most roads will need some preventive maintenance after about three years of service.

Crack Sealing:

You don’t want to fill the cracks. You want to seal them so that water cannot penetrate into the pavement structure. Cracks should be routed and then cleaned with a jet of hot air to get rid of any dust or debris. Warm the asphalt sealer to ensure that it bonds well to the sides of the crack.

Crack sealing should be done either in the spring or the fall. In the summer, the pavement expands, closing up the crack, so less crack sealant is used. When the winter arrives, the crack opens up pulling the crack sealant apart. Conversely, if you fill cracks in the winter when they are at their widest, they close up in the summer and the sealant is pushed out.

A good crack seal should last for about seven years.

Seals and Overlays:

Seals and overlays can provide a new surface for roads with a large number of surface cracks. A new thin surface for the pavement will restore the surface with a continuous layer and fill and seal most small cracks. Overlays will not correct deep structural cracks. Deep cracks will simply reflect through the new surface.

There are a number of treatments such as chip seals, microsurfacing, and slurry seals that can restore the surface of the pavement, seal small cracks, and prevent water getting into the pavement. A surface treatment will extend the life of the road by about five years. A hot mix overlay, known as shave and pave, should be used for roads with severe cracks and surface distress but are still structurally adequate. In this technique the surface is removed and re-profiled by milling equipment and then paved with a new hot mix overlay. This treatment is much more permanent and should last from 14 to 20 years depending on the traffic and thickness of the overlay. Microsurfacing, a thin cold mix, can be used to seal longitudinal joints.

Manholes and Catchbasins:

Sealing around "ironwork" is difficult and often requires handwork. If there is not good compaction at the edges, the asphalt can sink leaving standing water that can eventually work its way into the pavement.

A well sealed compacted edge to the pavement around manholes and catchbasins is essential to prevent deterioration. One technique is to use a core rig that is larger than the cover to remove the asphalt around the perimeter and then fill it with a preformed resilient rubber ring gasket that resists shock loading.

Patches

The time-honoured practice of patching potholes has developed its own unique vocabulary.

For "throw and go", the most basic of repairs, the crew throws some asphalt in the hole leaving it slightly higher than the pavement and lets the traffic compact the material. It is a temporary solution at best but useful for emergency repairs.

With "throw and roll", the crew drives the utility truck back and forth over the patch to provide some initial compaction. Some crews will come back later, soften the patch with infrared heaters and then do another roll for more compaction.

There are two types of patches that can be used: a cold mix asphalt, which is kept pliable with solvents and emulsions, and the traditional hot mix asphalt. Hot mix is preferable because it bonds better to the existing pavement but unless you have enough volume (Toronto, for example, keeps a hot mix plant open all year), hot mix may be difficult to obtain in the winter and really shouldn't be used when temperatures are below freezing.

Using a hot box, a small trailer hauled behind the utility truck, is a practical way to get small quantities of hot mix from the yard to the road, without having to constantly go back to reload. The crew loads the hot box with previously prepared plugs of asphalt. Some municipalities are using reclaimed asphalt pavement (better known as RAP). However, since RAP is stiff, it takes a lot of heating and only results in a temporary patch. A propane heater in the box maintains the temperature of the hot mix, which can then be used to fill the potholes.

High performance cold mix is best used as a temporary patch in the winter. It should be warmed before use. Care must be taken not to overheat the cold mix which will result in a loss of solvents making the cold mix stiff and unusable.

Regardless of which type of material is used, the best way to ensure a good patch is to do the necessary preparatory work first, rather like a dentist filling a cavity.

Clean out the water, ice and debris first (a leaf blower is cheap, quick, and surprisingly efficient). For large pothole repairs in the summer, square up the hole using a jackhammer to make a more vertical edge. Use a bonding compound or tack coat on the edges for a tighter seal. Add the asphalt in layers. Finish the job with a hand held vibratory compactor or small steel wheeled roller to get good compaction.

Avoid rushing. Try to ignore the outcries demanding that every pothole should be fixed within hours after it has formed. Do the worst first and make sure they are repaired properly.



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