11.0 CRACK MAINTENANCE

11.1 INTRODUCTION

Preventative maintenance for pavement surfaces is essential if you wish to delay the deterioration and extend the service life of the structure. Cracking is one of the most common distress that occurs in asphalt concrete pavements. The presence of cracks on a pavement surface allows moisture to penetrate into the base material, which can cause premature failure of the pavement structure. In order to maximize life expectancy of a pavement it is desirable to minimize the detrimental effects of the cracks. This can be accomplished by treating the cracks prior to extensive deterioration, repairing cracks, or in extreme cases overlaying the pavement.

Not treating cracks can lead to increased maintenance costs as the crack deteriorates. Spalling and potholes are common secondary distresses for untreated cracks. Maintenance treatments to fix these distresses can be much more expensive than treatments used to fix the crack initially.

In an effort to provide a consistent approach to crack maintenance activities, the following guidelines have been developed.

11.2 MAINTENANCE TREATMENTS - CRACKING

The main purpose of a crack treatment is to seal or fill the crack in order to prevent moisture from penetrating the base and subgrade thereby preventing the weakening of the roadway structure. The secondary purpose is to prevent the loss of aggregate from the edges of the cracks. Moisture entering the crack can lead to accelerated fatigue, stripping, pumping and other pavement damage. Crack maintenance encompasses many treatment options ranging from the basic maintenance application of crack filling to more drastic measure of overlaying the pavement.

Crack Treatment

A Crack Treatment involves either sealing or filling the crack. Besides preventing moisture from penetrating the base and subgrade thereby weakening the roadway structure, it also slows crack deterioration caused by material spalling from the edges of the cracks. Cracks should be treated as early as possible in the spring. The earlier this function can be completed, the more successful it will be in minimizing moisture penetration and damage.

Surface Treatment

Although preventative in nature, surface treatments such as seal coats, slurry seals, fog seals, etc., generally seal the entire surface and are most appropriate on pavements with minor hairline cracks having little or no associated edge deterioration. A surface treatment can also be used in conjunction with individual repairs of selected cracks. They are used to treat surfaces which have segregated areas and porus surfaces due to loss of aggregate.

Crack Repair

The purpose of crack repair is corrective in nature and removes or repairs extreme depressed or tented (cupping or lipping) transverse cracks. Crack repairs reduce or

eliminate roughness in pavements and may be performed in order to delay rehabilitation. Typically pavements that exhibit few other surface distresses are good candidates for crack repair strategies. Repairs are generally made with asphalt concrete pavement mix for Mill & Fill, spray patching or a sand/sulphur slurry mix.

Rehabilitation

Pavement rehabilitation is corrective in nature and is used to cover over all surface distresses and used to strengthen the pavement structure. Surface rehabilitation strategies include Hot In-place Recycling (HIR), Cold Mill and Inlay and overlay. Individual repairs of selected cracks such as, reinforcement, Mill & Fill, spray patching, etc. can be done in conjunction with and prior to rehabilitation.

In general, rehabilitation with or without a crack treatment/repair will improve the resistance to reflective cracking for non-working cracks. However, rehabilitation on working cracks will experience reflective cracking within 1-3 years without crack repair and 2-5 years with crack repair.

Non-working cracks are defined as cracks that have less than 2.5 mm movement during a given year. These are typically longidutindinal cracks. Working cracks are defined as cracks that have 2.5 mm movement or greater in a given year. These are typically transverse cracks.

11.3 EFFECT OF PAVEMENT CONDITION

Careful consideration must be given to existing pavement condition to ensure a successful treatment. Crack density and edge deterioration are two major factors in deciding what treatments to apply. If a pavement is badly deteriorated, and has significant cracking, crack filling or crack sealing may not be the most effective treatment on a life cycle cost basis.

Crack Density

Crack density is a measure as to how closely spaced the transverse cracks are on a given length of roadway. The following table was developed by the Michigan Department of Transportation to determine crack density.

Linear Crack Length per 100 m Pavement Section	Density
< 10 meter	Low
10 meter to 135 meter	Moderate
> 135 meter	High

Table 1.1 – Crack Density (MDOT)

Crack Edge Deterioration

Edge deterioration is a measure of how much the crack edge has deteriorated. The following table from the Surface Condition Rating Manual for Alberta Transportation can be used to determine severity of Edge Deterioration.

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Edge Deterioration	Severity
Crack width < 3mm	Slight
Crack width 3 to 10 mm or Secondary Cracking	Moderate
Crack width > 10 mm or Block Cracking	Extreme

Table 11.2 Edge Severity (Surface Condition Rating Manual)

11.4 DETERMINING THE APPROPRIATE CRACK MAINTENANCE APPLICATION

When the Surface Condition Rating indicates that there is cracking in an asphalt pavement, the complete circumstances of the pavement should be carefully assessed prior to taking action. The type and orientation of the cracks to be treated should be established, along with the climatic conditions, pavement structure composition, traffic characteristics, and future rehabilitation plans. This will help determine the frequency and amount of annual crack movement that can be expected, and consequently the quality of the material required, and whether a short, medium, or long term treatment of the cracks is most appropriate.

Crack Density	Average Level of Edge Deterioration (percent of crack length)		
	Slight (0 to 25)	Moderate (26 to 50)	Extreme (51 to 100)
Low	Monitor or Crack Treatment	Crack Treatment	Crack Treatment or Crack Repair
Moderate	Crack Treatment	Crack Treatment	Crack Repair
High	Surface treatment	Surface Treatment	Rehabilitation

Table 11.3 Guidelines for Determining Crack Maintenance Activities

11.5 CRACK TREATMENT OPTIONS – SEALING VERSUS FILLING

Crack sealing and crack filling are two distinct activities and it is important to understand the differences between the two treatments to effectively treat the cracks.

"Crack sealing" is a more intensive operation that is intended to prevent water from entering the pavement structure. The treatment involves routing the crack to a specific configuration and placing a high-quality sealant in it.

"Crack filling" is a less intensive operation and is intended to reduce the amount of water infiltration into the pavement and reinforce the adjacent pavement. This treatment involves placing a crack filler, generally a cold-pour bituminous emulsion, into the crack without affecting the crack geometry.

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Crack Sealing is carried out to seal ordinary working cracks (greater than 2.5 mm of horizontal crack movement).

- For cost-effective, short-term crack treatment performance (between 1 and 3 years) in pavement with ordinary working cracks and moderate traffic levels (5000 AADT or less), a crack sealant applied as a filler (i.e. an overband or flush-fill configuration) is considered most appropriate.
- For cost-effective medium-term crack treatment performance (between 3 and 5 years) under the above conditions, a modified rubberized sealant placed in a shallow (40X10 mm) or standard (19X19 mm) reservoir with overband configuration (Rout & Seal) is considered most appropriate.
- For cost-effective, long-term crack treatment performance (say, between 5 and 8 years) under the above conditions, a modified low modulus rubberized asphalt sealant installed in a standard or shallow reservoir with overband configuration should be used. These materials provide a high level of flexibility and adhesiveness, so that annual crack movements can be accommodated. Moreover, the combination of a reservoir and an overband helps to maximize sealant performance.

Crack Sealing (Rout and Seal) is recommended if:

- Crack opening between 3-12 mm and pavement is less than five year old. Pavements with crack opening between 12-20 mm should be evaluated to determine whether or not routing is appropriate. Pavements with crack openings greater than 19 mm should be cleaned and filled without routing. Types of cracks considered for routing and sealing are:
  - Transverse cracks.
  - Edge cracks.
  - Longitudinal cracks on low volume roads. (Avoid wheel path cracking, unless treatment is followed up with a chip seal that year)

Crack Sealing (Rout and Seal) is not recommended if:

- Crack opening is less than 3 mm.
- Cracks are alligator (or map) type.
- Crack is severe in density. It is assumed that rout and seal would be ineffective in delaying further deterioration.
- Pavement is more than 10 years old, or is being considered for rehabilitation.
- Longitudinal cracks with moderate to high traffic unless treatment is followed up with a chip seal that same year (centre line, midlane, wheel track single crack, and meandering cracks).

Crack Filling is carried out to fill non-working cracks (less than 2.5 mm of horizontal movement).

- For cost-effective, short-term crack filler performance (1 to 3 years) in pavements with non-working cracks and low to moderate traffic levels, asphalt

cement, cold pour or hot pour sealant placed in a flush-fill or overband configuration is considered most appropriate.

- For cost-effective, long-term crack filler performance (say, between 5 and 8 years) under the above conditions, an asphalt rubber or rubberized asphalt placed in either a flush-fill or overband configuration is considered most appropriate. The higher quality of these materials and the added life provided by the overband make for the most cost effective options in this scenario.

The following Table provides recommended Crack Treatment Criteria for determining which cracks to seal and which to fill, given various crack characteristics. In comparison to crack filling, crack sealing involves much more planning and uses specially formulated materials and more sophisticated equipment.

Crack Characteristics	Crack Treatment Activity	
	Crack Sealing	Crack Filling
Width, mm	5 to 25	5 to 25
Edge Deterioration (i.e., spalls, secondary	Minimal to None (≤ 25% of crack length)	Moderate to None (≤50% of crack length)
Annual Horizontal Movement, mm	≥2.5	<2.5
Type of Cracks	Transverse thermal cracks Transverse reflective cracks Diagonal/meandering cracks	Longitudinal reflective cracks Longitudinal cold-joint cracks Longitudinal edge cracks Distantly spaced blocked crack

Table 11.4 – Crack Sealing Versus Crack Filling

11.6 CRACK PERFORMANCE

Central and Northern Alberta can experience horizontal crack movements in excess of 20 mm. This extreme amount of crack movement requires a high level of workmanship to ensure that the crack is located in the centre of the rout and the use of high quality modified rubberized asphalt materials.

Performance of the crack treatment is dependent on three factors: initial pavement condition, product selection, and production installation. It is very important that the crack/rout be as clean and dry as possible. Sealant should be applied soon after the crack has been routed and cleaned with the hot-air lance. Air temperature, AC surface temperature and humidity all need to be considered during the product installation. Route and seal should not be applied following a rain event. The pavement must be as dry as possible. In addition to that, the selection of what time of the season the crack sealant should be applied is often a compromise between the effect of crack movement on sealant performance and sealant installation.

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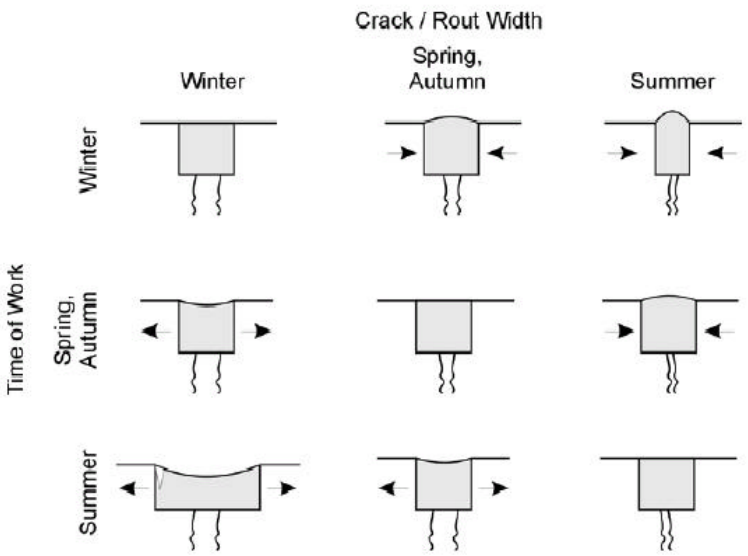


Figure 11 –1 Effect of Crack opening and time of work of sealant strain (National Guide to Sustainable Municipal Infrastructure.

On the basis of crack movement spring and autumn would appear to be the most effective time to do crack sealing. However in the spring, frost is usually coming out of the ground and pavement moisture is normally high.

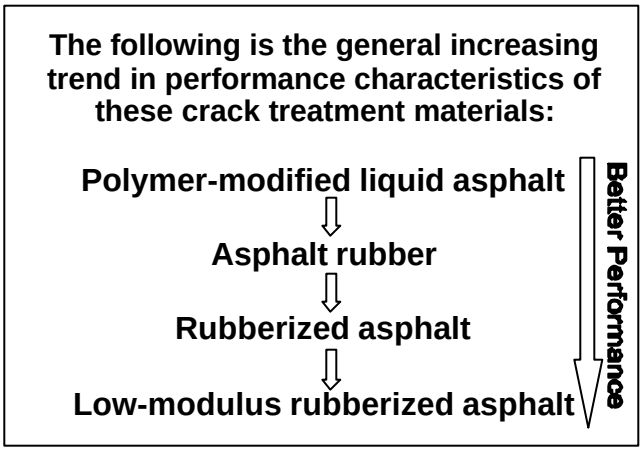
Cool air temperatures can reduce the temperature of the pavement surface thus causing a hot-pour sealant to gel more quickly. As a result of this, sealant penetration is reduced which can then lead to lower than expected adhesion and performance. Crack sealant should not be applied when the pavement temperature is below 10 ^{o} Celsius. Crack sealing in the summer months reduces the effect of air temperature.

Crack filling with cold-pour bituminous emulsions should be applied in late spring when the air temperature is 10 ^{o} Celsius or higher. This will permit sufficient time for the emulsion to shed its residual water. Low temperatures and high relative humidity will extend curing time. In addition, a filler that experiences freezing temperatures or rain within 24 hours of application will be adversely effective. Crack filling can be done on non-working cracks during the summer months.

Material

There are many different crack sealing/filling materials, each with distinct characteristics. The principal material families and types are as follows:

- Cold-applied thermoplastic materials
  - Liquid asphalt (emulsion, cutback)[1]
  - Polymer-modified liquid asphalt
- Hot-applied thermoplastic materials
  - Asphalt cement[1]
  - Mineral-filled asphalt cement[1]
  - Fiberized asphalt
  - Asphalt rubber
  - Rubberized asphalt
  - Low-modulus rubberized asphalt
- Chemically cured thermosetting materials
  - Self-leveling silicone



In order to provide for proper accommodation of traffic, crack maintenance must be carried out on one lane at a time with signs and properly attired flagpersons directing traffic. Signing must be in place in accordance with the appropriate signing diagram in the Traffic Accommodation manual.

11.7 SURFACE TREATMENT OPTIONS

Surface treatments are used to eliminate hairline cracking.

- For cost-effective, long-term performance (8+ years) seal coating, micro surfacing or slurry sealing are considered most appropriate.
- Fogging of slight deteriorated cracks is also an very effective treatment.

11.8 CRACK REPAIR OPTIONS

Crack repair is carried out on cracks with extreme edge deterioration (cupping or lipping). Spray Patching and Mill & Fill are two treatments that can be considered for crack repair.

- For cost-effective, medium-term crack repair performance (3 to 4 years) with low to moderate traffic levels, spray patch and sand/sulphur slurry patch (thermo patch) are considered most appropriate. Spray patching should only be considered if cracks are depressed more than 10 mm. It can be used as a pre-overlay treatment.
- For cost-effective, long-term crack repair performance (5 to 8 years) with low

[1] Crack Filling only

to moderate traffic levels, Mill & Fill is considered most appropriate. Mill & Fill should be used at locations were tented, or failed transverse cracks exist. This treatment will improve the ride and restore structural integrity at the repaired locations. Note, Mill & Fill can be used as a pre-overlay repair. It should not be considered if the base of the structure is weak. A more extensive repair is required.

11.9 REFERENCES

Alberta Transportation and Utilities "Failures Definition" Handbook.

- Crack Sealing; Hot and Cold Pour Emulsion (Code 1680)
- Crack Sealing; Rubberized Asphalt Crack (Code 1690)
- Spray Patch (Code 1790)
- Transverse Crack Repair Mill and Fill (Code 1870)
- Transverse Crack Repair Spray Patch (Code 1880)
- Transverse Crack Repair Sand (Sulphur Slurry Patch) (Code 1890)

SHRP-H-348 "Asphalt Pavement Repair Manuals and Practice".

FHWA-RD-99-143 "LTPP Pavement Maintenance Materials: SHRP Crack Treatment Experiment, Final Report".

“Sealing and Filling of Crack For Bituminous Concrete Pavements – Selection and Installation Procedures”, Michigan Department of Transportation, 1999.

“Guidelines for Sealing and Filling Cracks in Asphalt Concrete Pavement”, Issue No. 10, National Guide to Sustainable Municipal Infrastructure, March 2003

“Guidelines for Assessing Pavement Preservation Strategies”, Alberta Transportation, June 2002