Evaluation of the Use of Green Pavement Technologies in the Region of Waterloo, Ontario

Ludomir Uzarowski, Ph.D., P.Eng., Principal, Golder Associates Ltd., Mississauga, Ontario
Michael Halloran, C.E.T., Region of Waterloo, Ontario
Jim Ellerman, A.Sc.T., Region of Waterloo, Ontario
Vimy Henderson, Ph.D., P.Eng., Golder Associates Ltd. Mississauga, Ontario

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ABSTRACT

The Region of Waterloo (Region) has a long history of applying innovative pavement technologies. The engineering staff at the Region realized that the conventionally used pavement resurfacing, reconstruction or mill and overlay are often not cost effective and environmentally friendly solutions and decided to use innovative, green technologies. The following pavement rehabilitation technologies are commonly used by the Region now: Cold In-place Recycling (CIR); Full Depth Reclamation (FDR) using expanded asphalt; pulverizing the existing pavement and resurfacing; and Cold In-Place Recycling with Expanded Asphalt Material (CIREAM). The Region is also looking forward to the application of Hot In-place Recycling (HIR) that is coming back to Ontario. Pavement preservation technologies have also been used and include crack sealing, microsurfacing, bonded wearing course and thin overlays. The Region has used reclaimed RAP in the HMA mixes for a long time. Warm Mix Asphalt has been tried and is being considered in future works. Being aware that the most sustainable pavements are the ones that last the longest, the Region has focused on proper longitudinal joint construction using echelon paving, infrared heaters and are planning the use WMA in the future.

1.0 INTRODUCTION

The Region of Waterloo (Region) is located in Southwestern Ontario. The Region's history of applying innovative pavement technologies goes back to the early 90s. The engineering staff at the Region realized that the conventionally used pavement resurfacing, reconstruction or mill and overlay are not always the most cost effective and environmentally friendly solutions and decided to use innovative, green technologies. The following pavement rehabilitation technologies are commonly used by the Region now: Cold In-place Recycling (CIR); Full Depth Reclamation (FDR) using expanded asphalt; pulverizing the existing pavement and resurfacing; and Cold In-Place Recycling with Expanded Asphalt Material (CIREAM). The Region is also looking forward to the application of Hot In-place Recycling (HIR) that is coming back to Ontario. Pavement preservation technologies have also been used and include crack sealing, microsurfacing, bonded wearing course and thin overlays. The Region has used reclaimed RAP in the HMA mixes for a long time. The Region moved to Superpave asphalt mix technology in 2010 and has used reclaimed RAP in the HMA mixes for a long time. Warm Mix Asphalt (WMA) has been tried and is being considered in future works. Being aware that the most sustainable pavements are the ones that last the longest the Region has focused on proper longitudinal joint construction using echelon paving, infrared heaters and are planning the use of WMA in the future. This paper particularly focuses on the use of the green pavement rehabilitation technologies in which the Region is considered to be one of the leaders in Ontario.

2.0 PAVEMENT RECYCLING

The Region has been using recycling technologies for rural roads since the mid 1990's. During this time, on average, approximately 10 to 15 kilometers of roads (20 to 30 lane kilometers) were recycled annually. Examples of recycled roads including their current condition are provided in Section 4. The pavement recycling technologies used by the Region are as follows:

a. Cold in Place Recycling (CIR) – the pavement is typically milled to a depth of 75 to 100 mm and asphalt emulsion is applied to coat the millings; after spreading and compaction and after a minimum of two weeks of curing the CIR layer is typically covered with a HMA overlay;
b. Full Depth Reclamation with Expanded (foamed) Asphalt Stabilization – the asphalt layers are pulverized, the material is typically mixed 50/50 with the underlying granular material and stabilized with expanded (foamed) asphalt, spread and compacted. After about two days the foamed asphalt layer is typically covered with HMA overlay;
c. Full Depth Reclamation with Hot-Mix Asphalt Overlay – the existing asphalt is pulverized, the material is mixed with underlying granular material, compacted and covered with HMA overlay; and
d. Cold In-Place Reclamation with Expanded Asphalt Material (CIREAM) – the existing asphalt is partially milled, stabilized with expanded (foamed) asphalt, spread and compacted. After two days the CIREAM layer is typically covered with HMA overlay.

The following aspects are considered when the pavement rehabilitation alternative is selected:

a. Pavement type and structure;
b. Pavement condition including the type, extent and severity of distresses;
c. Geotechnical conditions (soil type, water conditions, frost susceptibility);
d. Available budget;
e. Roadway classification;
f. Traffic volume and composition;

g. Geometric constraints (curbs and gutters, elevation restrictions, and others);
h. Drainage conditions;
i. Local experience with proposed technology;
j. Availability of experienced contractors; and
k. Sustainability aspects (economical, environmental and social).

The overall performance of CIR treated pavements is considered to be good to very good. By the mid 2000's the Region started to migrate from CIR to FDR using foamed asphalt which is currently the most commonly used pavement rehabilitation technique. One of the main reasons for this switch in pavement recycling technique was the long curing period required for the CIR treatment. The required period of two weeks of good weather significantly shortened the construction season. It was observed that if due to adverse weather condition the CIR was not properly cured a significant amount of layer repair was required.

The Region was the pioneer in using foamed asphalt stabilization of the pulverized pavement consisting of up to 100 percent RAP. This allowed huge financial savings as this type of material requires only about 1.2 percent of foamed asphalt cement compared to typical 50/50 mixes of RAP and granular material that requires about 2.8 to 3.0 percent of foamed asphalt cement. The performance of 100 percent RAP foamed stabilized pavements on low to medium traffic volume roads has been very good with no significant amount of rutting observed.

The sustainability benefits of using green technologies in the Region have been tremendous; in particular financial (reduced cost of construction), environmental (significantly lower green house gas emissions, reusing of limited resources, mainly aggregates and reduced materials hauling) and social (mainly public acceptance). The fact that the Region is open to innovations has drawn a number of contractors to the area which has significantly increased the competition resulting in reduced costs and improved quality.

3.0 PAVEMENT PRESERVATION

Pavement preservation treatments have been described in a number of previous TAC papers including TAC 2009 "Pavement Preservation – Effective Way of Dealing with Scarce Maintenance Budget" by Ludomir Uzarowski, Gary Farrington and Wilson Chung. This paper provides examples of the recent pavement preservation technology used by the Region: bonded wearing course; and thin asphalt overlay. These treatments include the following:

a. Bonded wearing course – includes the application of high quality polymer modified asphalt emulsion followed immediately by a thin layer (a single aggregate thickness) of high quality gap graded hot mix asphalt;
b. Thin asphalt overlay – includes placement of a single lift of HMA typically 25 to maximum 40 mm in thickness. Thin overlays provide a new surface course without significant increase of the pavement structural capacity.

4.0 EXAMPLES OF PAVEMENT RECYCLING

The current condition of a total of eight selected Regional Road (RR) sections where pavement recycling was carried out were evaluated for this paper. They cover the time span from 1995 to 2013. Generally, the condition of recycled pavements is considered to be good to very good.

4.1 RR 16 (Hergott Road) from North of Heidelberg to RR 17

CIR was carried on the RR 16 from North of Heidelberg to RR 17 in 1996. It included CIR to a depth of
75 mm and a 40 to 50 mm thick asphalt overlay using a standard Ontario surface course Marshall HL 3 mix. The centreline construction joint has multiple cracks. The pavement also exhibits low to medium severity intermittent alligator cracking. Low to medium severity transverse cracking was observed in about 25 percent of the section. Generally, the condition of this 18 years old pavement is considered to be fair to good. Photograph 1 shows a typical pavement condition on this section.

Photograph 1 Joint and transverse cracking on 18 years old Cold In-place Recycled pavement on RR 16.

4.2 RR 15 (Lobsinger Line) from Three Bridges to RR 8

CIR was carried on RR 15 in 2004. It included CIR to a depth of 75 mm and a 60 mm thick HL 3 mix overlay. The centerline construction joint exhibits very low severity crack in about 50 percent of the length. The pavement also exhibits very low severity localized alligator cracking. Generally, the condition of this 10 years old pavement is considered to be good. Photograph 2 shows a typical pavement condition on this section.

Photograph 2 Good current condition of 10 years old Cold In-place Recycled pavement on RR 15 section between Three Bridges and RR 8.

4.3 RR 15 (Lobsinger Line) from Martin Creek to East Limit of Heidelberg

CIR was carried on the RR 15 from Martin Creek to East Limit of Heidelberg in 1995. It included CIR to a depth of 75 mm and a 40 mm thick HL 3 mix overlay. The centerline construction joint exhibits medium to high severity crack throughout. Also, medium to high severity edge cracking was observed almost throughout. The pavement also exhibits low to medium severity intermittent alligator cracking. Patching has been done in less than 10 percent of the section. Generally, the condition of this 19 years old pavement is considered to be fair. Photograph 3 shows a typical pavement condition on this section.

Photograph 3 Centerline, edge and localized alligator cracking in 19 years old pavement on RR 15 section from Martin Creek Road to East Limit of Heidelberg.

4.4 RR 22 (Northfield Drive) from North of RR 86 to Regional Boundary

CIR was carried on the RR 22 from North of RR 86 to the Regional boundary in very early 1990s. In 2009 was re-recycled using foamed asphalt stabilization, to a depth of 150 mm over the entire length of the section. Then, 50 mm of asphalt HL 8 binder course mix and 40 mm of HL 3 surface course mix were placed. Only low severity edge cracking was observed in less than 20 percent of the length. Generally, the condition of this 5 year old pavement is considered to be excellent. Photograph 4 shows a typical pavement condition on this section.

Photograph 4 Excellent current condition of 5 years old re-recycled with foamed asphalt stabilization pavement on RR 22.

4.5 RR 8 (King Street) from RR 15 to Printery Road

FDR with expanded asphalt stabilization was carried on the RR 8 section from RR 15 to Printery Road in 2010. The stabilization was to a depth of 125 mm and included partially underlying granular layers. Then, 50 mm of asphalt HL 8 binder course mix and 40 mm of high quality HL 1 surface course mix was placed. The pavement is in excellent condition with no distresses observed. Photograph 5 shows a typical pavement condition on this section.

Photograph 5 Excellent current condition of 4 years old foamed asphalt stabilized pavement on RR 8.

4.6 RR 6 (Snyders Road) from RR 12 to RR 1

FDR with expanded asphalt stabilization was carried on the RR 6 section from RR 12 to RR 1 in 2009. The stabilization was to a depth of 150 mm and then, 50 mm of asphalt HL 8 binder course mix and 40 mm of HL 3 High Stability (HS) surface course mix was placed. The foamed asphalt stabilized layer incorporated 100 percent of Reclaimed Asphalt Pavement (RAP) material. This allowed a drastic reduction in the amount of added foamed asphalt cement from about 3.0 percent to just 1.2 percent. The pavement is in good to very good condition. It exhibits only very low severity localized alligator cracking (in less than 10 percent of the length) and very low severity localized centreline joint crack. No rutting was observed on this section. Photograph 6 shows a typical pavement condition on this section.

Photograph 6 Low severity localized alligator cracking in 5 years old foamed asphalt stabilized pavement on RR 6.

4.7 RR 86 (Line 86) from Sloman Lane to Perth County Boundary

CIREAM stabilization was carried on the RR 86 section from Sloman Road to Perth County boundary in 2010. The CIREAM stabilization was to a depth of 100 mm and then, 50 mm of asphalt HL 8 binder course mix and 40 mm of HL 3 HS surface course mix was placed. The pavement is in very good condition with only very low severity localized (less than 10 percent of the length) alligator cracking observed. Photograph 7 shows a typical pavement condition on this section.

Photograph 7 Very good condition of 5 years old CIREAM stabilized pavement on RR 86.

4.8 RR 4 (Bleams Road) RR 12 to RR 51

The pavement on the RR 4 section from RR 12 to RR 51 was pulverized to a depth of 250 mm in 2013. Then, 70 mm of asphalt Superpave SP 19 binder course mix and 40 mm of SP 12.5 surface course mix was placed. The pavement is in excellent condition with no distresses observed. Photograph 8 shows a typical pavement condition on this section.

Photograph 8 Excellent condition of new pavement pulverized and asphalt overlaid in 2013 on RR 4.

5.0 EXAMPLES OF PAVEMENT PRESERVATION

The two examples in this section present the application of bonded wearing course; and thin asphalt overlay as preventive treatments by the Region. Both treatments were placed on RR 4 (Bleams Road) from RR 12 to Manheim Bridge.

5.1 RR 4 (Bleams Road) from RR 12 to Manheim Bridge

The Bonded Wearing Course (BWC) was applied on the RR 4 section from RR 12 to Manheim Bridge in 2013 in order to address premature cracking in the pavement that had foamed asphalt stabilized and overlaid with HMA. The BWC Type A included asphalt cement graded as PGAC 64-28. Although the condition of the pavement is good to very good some of the cracks have already reflected through the thin layer of BWC after the severe 2013/2014 winter. Photograph 9 shows a typical pavement condition on this section.

Photograph 9 Some of the cracks in the underlying asphalt pavement have reflected through the bonded wearing course after one winter on RR 4.

5.2 RR 4 (Bleams Road) from RR 12 to Manheim Bridge

Thin asphalt overlay on RR 4 (Bleams Road) was applied in 2013 to address some surface distresses including low to medium severity early cracking. In this treatment 40 mm of Superpave SP 12.5 FC1 surface course mix was placed. The pavement is in excellent condition with no distresses observed. Photograph 10 shows a typical pavement condition on this section.

Photograph 10 Excellent pavement condition of a section of RR 4 after application of thin asphalt overlay in 2013.

6.0 CONCLUSIONS

The Region of Waterloo in Ontario can be considered one of the leaders in the province in using green technologies including pavement recycling and preventive treatments. Recycling has been used since the mid 1990's. It includes cold in-place recycling (CIR), full depth reclamations (FDR) using foamed asphalt stabilization, cold in-place recycling with expanded asphalt material (CIREAM) and full depth reclamation with asphalt overlay. The Region was the pioneer in using foamed asphalt stabilization of the pulverized pavement consisting of up to 100 percent RAP. On average 10 to 15 km of roads were recycled annually. The performance of the recycled pavements has been good to very good. The sustainability benefits of the green technologies in the Region in terms of economical, environmental and social aspects have been tremendous. It has become a routine in the Region to consider pavement recycling wherever feasible. Also the fact that the Region is open to innovations has dawn a number of contractors to the area which has significantly increased the competition resulting in reduced costs and improved quality.

REFERENCES

1. ARRA “Basic Asphalt Recycling Manual”, US Department of Transportation, Federal Highway Administration, Asphalt Recycling and Reclaiming Association, 2001

2. MTO “Pavement Design and Rehabilitation Manual”, Second Edition, Ontario Ministry of Transportation, 2013.

3. TAC “Pavement Asset Design and Management Guide”, Transportation Association of Canada, 2013.