SUSTAINABLE PAVEMENT DESIGN: DOING MORE WITH LESS

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The Regional Municipality of Halton has long since recognized the inherent environmental issues associated with construction projects, such as pollution, disruption to the local communities, traffic interruptions, and high resource consumption. To help address these concerns, the Region has adopted a Green Procurement Policy that integrates sustainability considerations into the decision process at all phases of a project's (and product's) lifecycle.

For three recent road resurfacing projects, this forward-thinking approach allowed the Region to realize improved environmental net benefits, as well as cost-savings—through implementing more sustainable technologies, and more importantly, getting them to work in the "real world."

Traditional road resurfacing projects involve pavement removal and production, transportation and placement of asphalt. These activities consume considerable energy and resources, as well as disrupt the local community. Recognizing this, efforts were made during the planning stage to find "greener" methods.

Detailed pavement condition assessments undertaken at the planning stage found that three innovative, "green" solutions could be used: CIREAM (cold-in-place recycling with expanded asphalt mix), SAMI (stress absorbing membrane interlayer), and pulverized asphalt.

These technologies are not new, but the Ontario engineering and construction industry has been relatively slow to adopt their regular use, mostly due to general unfamiliarity and uncertainty about their historical track records.

For the rehabilitation of Trafalgar Road, Steeles Avenue, and Campbellville Road, implementing these solutions—along with the use of "warm asphalt"—resulted in significant sustainability-related benefits including:

- Material re-use and reduced resource consumption.
- Reduced carbon footprint.
- Reduced energy consumption.
- Minimized social disruption and decreased construction duration.
- Increased worker safety during construction.

THE TOP 5 SIGNIFICANT BENEFITS

Implementing "green" solutions for Trafalgar Road, Steeles Avenue, and Campbellville Road resulted in significant benefits:

KEY BENEFITS INCLUDED:

1 Material re-used and reduced resource consumption

The use of CIREAM technology eliminated the need to haul and dispose of existing milled asphalt on- and off-site at Trafalgar Road (totalling 4.6 km).

For Steeles Avenue (totalling 3.6 km), SAMI technology was used in a trial section to significantly reduce the disposal of materials off-site. The SAMI technology used a product called Fibremat, which comprises fibreglass strands sandwiched between two layers of asphalt emulsion, covered by a thin layer of stone, for a thickness of 10 mm.

The SAMI layer provides tensile strength and inhibits cracks from reflecting through to the surface.

In total, 15,000 m^2 of SAMI was used in lieu of additional asphalt removal, which would have required an additional 2,700 tonnes of asphalt removal and replacement. On this section of the project, 60 mm of the 240 mm of existing asphalt was removed, followed by the placement of the SAMI layer and then the top asphalt.

The pavement rehabilitation of Campbellville Road (4.3 km) utilized a majority of the existing asphalt on site by pulverizing and re-using it as a granular base. Approximately 6,300 tonnes of existing asphalt was reused.

SAMI technology was also used between the base and top asphalt in an area pulverized. This approach eliminated the need for full-depth pavement structure removal and replacement, as well as the associated carbon emissions and additional resources. It also acted as a water barrier in a low-lying marsh area.

2 Reduced carbon footprint

The project approach resulted in a significantly reduced carbon footprint in comparison to a more traditional resurfacing approach.

The use of the CIREAM technology at Trafalgar Road helped to minimize construction duration, which reduced hydrocarbon emissions and resulted in lower construction costs when compared with conventional full depth removal and replacement.

The use of SAMI technology along Steeles Avenue and Campbellville Road minimized the amount of required asphalt removal. It also reduced the amount of new material that needed to be produced and trucked to site.

Pulverizing asphalt on Campbellville Road also eliminated trucking of 6,300 tonnes of milled asphalt off site, as well as the need for new material to be trucked to site.

3 Reduced energy consumption

For the top asphalt layer of Trafalgar Road, approximately 4,000 tonnes of warm mix asphalt was placed on half of the project on a trial basis. Warm mix asphalt requires a lower mix temperature than the standard hot mix asphalt, reducing the average production energy consumption from 7.38 Kj to 5.8 Kj per tonne (an average savings of approximately 20%).

Using SAMI technology along Steeles Avenue resulted in less energy consumption for removal of the existing pavement, as well as less energy consumption in the production, transportation, and placement of additional asphalt.

4 Minimized social disruption

The use of the SAMI technology at Steeles Avenue and Campbellville Road reduced overall noise and pollution – a general inconvenience to the public. It also significantly reduced the construction duration when compared with conventional methods of pavement structure removal and replacement.

SAMI allows traffic to drive on the new surface almost immediately. Four metre sections can be placed at jogging speed. The technology then offers significantly less traffic disruption and lower impacts on local businesses and residents.

5 Increased worker safety during construction

Warm-mix asphalt placed on Trafalgar Road produced lower emissions. This provided a safer environment for workers and allowed for placement in lower temperatures, which was a constraint when implementing the project in autumn.

The technologies reduced the overall construction duration, which allowed the road conditions to return to normal more quickly. This improves general safety for the public and workers.

DESIGN

INNOVATION

Led through green procurement practices and real-world construction expertise

Halton Region recognizes its responsibility to demonstrate leadership in minimizing the negative impacts on human health and the environment while supporting a diverse and prosperous sustainable community.

To this end, the Region's Green Procurement Policy was developed. The policy requires that environmental issues be considered in all purchasing decisions, which are in turn integrated into the overall project lifecycle.

This approach is in line with Transportation Association of Canada's own "Green Guide for Roads."

Lifecycle costs are not the only factor that Halton Region considers when constructing and maintaining its roadways. Instead, the Region lets the road and its surrounding environment choose the best solution.

A cost / benefit analysis was undertaken during the planning and design stages to compare the typical lifecycle cost to the potential benefits.

All key decisions on this project, such as the technology and material choices, were made with a high weighting placed upon overall project sustainability.

Innovation during Design & Construction

R.V. Anderson Associates Limited (RVA) was retained by the Region to design and oversee the actual implementation of the technologies.

The firm has provided engineering and construction services on transportation projects for over 65 years—giving the project the "real-world" experience needed to take the green initiatives from concept to implementation.

As previously identified, the technologies have limited track records within the Ontario engineering and construction industry. The Region and RVA worked together to overcome the lack of historical information through research, consultation with suppliers, and review of information with geotechnical consultants.

Throughout all stages of the project, the team's geotechnical consultants were requested to consider material re-use and greener technologies. A key project goal was to limit use of non-renewable resources, such as virgin aggregate.

Lessons Learned

The Region / RVA team took a collaborative approach to the project, working together to address issues as they arose. This approach was critical to the project's success since the lack of historical information meant the team had to be flexible.

Key lessons learned to apply to a future project involving these sustainable pavement design:

- Incorporate timing windows related to the technology usage into the contract documents. CIREAM, for example, is better suited for construction in the summer months.

- Require all major cracks in the road to be repaired prior to using SAMI technology.

- Consider night construction for busy areas to allow technology application at lower traffic flow times.

FINANCIAL IMPLICATIONS

The sustainable pavement design options offered significant financial benefits in comparison to the traditional approach to resurfacing projects:

For Trafalgar Road, CIREAM technology with 50 mm surface asphalt overlay's construction costs were 40% lower than the conventional reconstruction approach. The estimated 30 year lifecycle cost was also 30% lower. When combined with associated benefit of allowing extensive material re-use, the technology was the preferred choice.

For Campbellville Road, a significant portion of the road traverses a marsh area, which makes full-depth reconstruction even more lengthy and costly due to water-related issues. Pulverization with a hot-mix asphalt overlay was found to be 70% less expensive than a conventional approach. It also offered the lowest lifecycle costs, and allowed the majority of the material to be reused.

Using SAMI on Campbellville Road provided additional tensile strength and prevented water migration to the surface. This approach increased overall project costs, but was offset by the increased tensile strength and projected savings over the life of the pavement.

For Steeles Avenue, costs associated with the SAMI trial section was found to be comparable to the removal and replacement of 25 mm of asphalt. However, the construction duration was minimized, as well as general traffic disruption, offering increased benefits in comparison to a conventional approach.

INDUSTRY APPLICATION

Sustainable pavement design is directly applicable to the transportation industry, especially for municipalities.

Given the huge growth occurring within Halton Region and the Greater Toronto Area in general, the demand for virgin materials is increasing. However, at the same time, there is a push to reduce the environmental impacts associated with using these virgin materials. For example, there is a reluctance to approve new quarries or to expand them.

It is important then to investigate and apply new technologies that allow better material re-use.

As shown on three road resurfacing projects in Halton Region, using these "greener" technologies offered significant environmental benefits, while limiting social disruption. The projects were constructed more quickly with less material, noise and pollution.

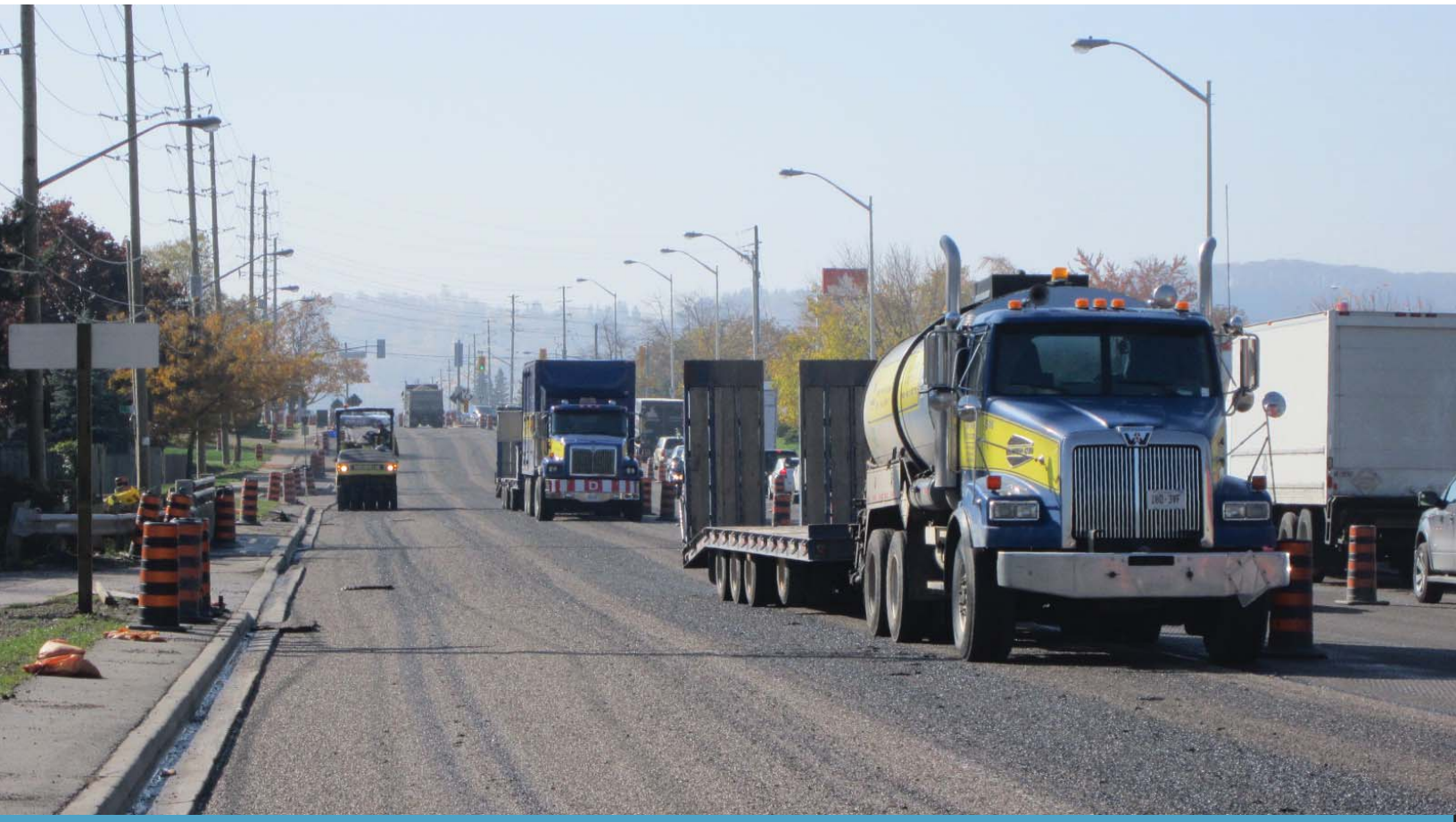
Non-traditional approaches to transportation projects can offer significant benefits to all municipalities and the communities within them.

APPENDIX

PHOTOGRAPHS

Above & Below: SAMI application on Campbellville Road

Above: SAMI application and top asphalt on Campbellville Road
Below: SAMI application on Steeles Avenue



Above: SAMI application on Steeles Avenue
Below: Completed resurfacing of Steeles Avenue

Above & Below: CIREAM operations along Trafalgar Road

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