WHY AREN'T ALL PAVEMENTS CONCRETE?

In Ontario, there are approximately 905 lane kilometres of exposed concrete pavement highways, 2,129 lane kilometres of asphalt over concrete pavement, and 29,544 lane kilometres of asphalt pavement.

Asphalt has a long history with road construction; 2500 years ago, Babylonians began applying asphalt, which was a common waterproofing agent, to stone paths thereby waterproofing them and creating a better travel experience. Around that time, people first started applying asphalt as a mortar between stone bricks. Little innovation occurred in asphalt pavements until the 18th Century, when two Scots, John Metcalfe and Thomas Telford, independent of each other paved more than 1,700 kilometres of asphalt roads; Metcalfe accomplished his part despite being blind. Then John Loudon McAdam created a better version of asphalt pavements that consists of stones and asphalt. Called "tarmacadam" pavements, the term and method are still in use today. A few decades later, asphalt pavements made its way to North America. Columbia University professor and Belgian immigrant, Edward De Smedt,created a "well-graded, maximum-density" asphalt, which he called "sheet asphalt pavements". Roadbuilders used that mix design in 1872 to pave the streets Battery Park and Fifth Avenue in New York City and again in 1877 on Pennsylvania Avenue, Washington D.C. In 1891, 2500 years after the first use of asphalt in road construction, George Bartholemew convinced the City Council of Bellefontaine, Ohio, to use his concrete mix design as a paving material. He guaranteed it would last at least five years. The city paved Court Avenue with concrete. When the street turned 100 years old, the city erected a statue of Bartholemew and a plaque that reads: "Here started the better roads movement." The greatest benefits to concrete roads are durability, safety, sustainability, and long life," says Lori Tiefenthaler, Sr. Director of Marketing of Lehigh Hanson, Inc. and past Chair of the American Concrete Paving Association "Concrete provides a 50-year life-cycle and it can be optimized to meet so many conditions, with the increasing focus on resilience of pavements, I believe concrete will

become the go-to building material for pavements." Even though, concrete pavements are on the rise, especially with the growth of concrete overlays on existing pavements, the majority of pavements are still asphalt.

Canada's largest driver of asphalt

Asphalt is nearly synonymous with road construction. In Ontario, there are approximately 29,544 lane kilometres of asphalt pavement, 2,129 lane kilometres of asphalt over concrete pavement and about 905 lane kilometres of exposed concrete pavement highways. The Ministry of Transportation Ontario (MTO) awards approximately 200 highway construction contracts per year, and the ministry is the single largest owner of road and highway infrastructure in Canada. "A majority of those contracts include various asphalt items," says Stephen Lee, P. Eng. Head, Pavements Section, MTO. The MTO also carry out about 100 kilometres of in-place recycling each year. An Alternative Bid contract is one that allows for bidders to prepare their construction bid based on either a concrete or asphalt pavement design. MTO initiated the Alternative Bid process for freeway reconstruction contracts in the year 2001. And, just like all other construction projects, the lowest bid wins. "Concrete is often competitive in upfront costs verses an equivalent asphalt structure; however you have

Lori Tiefenthaler
Sr. Director of Marketing of Lehigh Hanson, Inc.

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Concrete pavements have many benefits over asphalt pavements, including durability, longevity, sustainability and versatility, but asphalt has a longer history of road construction.

lower costs over the life of a concrete asset" says Tiefenthaler. Fortunately, the MTO considers life cycle costs over a 50-year period, so the higher upfront costs of using concrete can be offset by the lower maintenance costs of concrete. The 50-year life cycle costs, including maintenance strategies and schedules, were developed based on MTO's experience with concrete and asphalt pavements and in consultation with both the asphalt and concrete industries. "Our life cycle costing analysis (LCCA) takes into consideration the initial construction cost as well as estimated future maintenance costs over a 50-year life cycle analysis period. A bid adjustment factor is applied to the contract tender prices to account for the 50-year maintenance cost; the lowest final bid wins the contract," says Lee.

One in a hundred

In 2017, Aecon was awarded a contract to tear out and replace approximately 10 kilometres of Highway 401 near London, Ontario. According to Joe Tomlinson, contracts manager for concrete specialties with Aecon, the company chose to use concrete instead of asphalt, because it was a new opportunity that they believed "is a more reoccurring item on many MTO contracts". The MTO says based on the scope of the project, constructability, service life and life-cycle costs, they determined that both rigid and flexible pavement design options were feasible alternatives. Aecon completed the work in 2018 and Tom Linson admitted working with concrete can be a little unforgiving. You have only a limited window in which to use it and if you place it incorrectly, you have to wait for it to harden and then you have to remove it. That's when concrete's durability works against you.

A concrete for every occasion

Concrete pavements are versatile, because they can be placed in many applications, including airports, highways, municipal streets, county roads/highways, industrial facilities (such as large parking areas, test tracks, truck stops, toll plazas), and more," says Tiefenthaler. "They are also versatile because of the various forms of cementitious materials that can be used

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Aecon paves approximately 10 kilometres of concrete on Ontario's 401 Highway in a Ministry of Transportation Ontario Alternative Bid project.

to construct new slipform concrete pavements or rehabilitate existing ones." Solutions, in addition to traditional full depth concrete pavements include 1) roller compacted concrete, 2) concrete overlays (the placement of concrete over asphalt, concrete or composite pavements), 3) TCP and even 4) full-depth reclamation of asphalt pavements using cement.

1. Roller compacted concrete is a zero-slump concrete placed with standard or high-density (asphalt) paving equipment equipped with a tamper bar, which provides initial compaction. Then a large roller is used to compact the pavement to achieve final density. Developed in the 1970's for stabilization of logging roads in North America, its use has diversified into log handling yards, intermodal terminals, freight depots, and roads and highways.Over 400 miles of highway shoulders have been reconstructed using RCC since 2005 in the USA.

2. Concrete overlays, also known as white topping, can be used on existing asphalt, concrete or composite pavements and are a sustainable, cost-effective solution to improve the overall performance of a pavement. "Concrete Overlays are a great repair alternative to repaving failed asphalt pavements. There is a long and successful history in the use of concrete overlays – more than a century of progress!" says Sherry Sullivan, MASc, P.Eng, LEED AP, Business Development and Pavement Engineer, Forta Concrete Fiber. "Concrete overlays can be done over asphalt or over concrete. There is no need to tear up what is underneath; we can design the pavements as a monolithic structure."

3. Thin concrete pavements (TCP), also known as short-slab design, is a method that has demonstrated it can often cost less than asphalt designs for the same service life. "TCP has proven to compete against asphalt in most applications including parking lots, but really illustrates the most savings in any facility with over the road truck traffic such as distribution centers, industrial facilities, highways and county roads," says Sullivan. "TCP pavements curl less, provide a smoother ride and require less thick-

ness (and therefore less material) than traditional designs. Also, the addition of a macrosynthetic fiber into TCP gives better performance over its lifetime in the post-cracking stage and also controls cracking settlements due to possible inhomogeneities in the supporting surface of the concrete slab."

4. Full depth reclamation (FDR) with cement is the final concrete innovation that has advantages over asphalt; it is a rehabilitation method that recycles the existing asphalt pavement and the subbase (between six and ten inches in total) into a new base layer that has been mixed with cement. Its benefits include a stronger, more uniform, and more moisture-resistant base that is capable of withstanding greater weights. It's also a less costly pavement rehabilitation method. "The benefits of using concrete pavements are well known," says Sullivan. "And, although it's widely recognized that traditionally designed concrete pavements can often outlast asphalt, they have also (generally) been more expensive up front. Newer mechanistic-empirical pavement design methods are demonstrating concrete can now compete on a first cost basis, and provide better performing concrete pavements at the same time."

Sherry Sullivan
MASc, P.Eng, LEED AP, Business Development and Pavement Engineer, Forta Concrete Fiber

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