SPECIAL FEATURE

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ROADBUILDING & HEAVY EQUIPMENT

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William Conway, Progress Photography

Let's Get to Work

Ontario rolls out big plans for road building and maintenance

IAN HARVEY
CORRESPONDENT

Ontario is digging deep to roll out billions in infrastructure while also launching $1.3 billion in road repairs and upgrades this season.

What's more interesting, says Bryan Hocking, chief operating officer of the Ontario Road Builders' Association (ORBA, is that the Ontario budget tabled in April shows there may be more money in the pipeline.

"The recent rehab tenders announcement covered Jan 1, 2019 to June 30, 2019," he says. "There might well be more to come, which would be great news for our industry, particularly in the North. The 2019/20 budget projections are approximately $2.75 billion for 'provincial highways.' We are now waiting for some of the supporting details."

Ontario will pay one third of $30 billion over 10 years with similar contributions from municipal and the federal government as part of the Canada Infrastructure Program but a very small proportion will go to roads.

The three-level infrastructure program is in four streams: Rural and Northern, Public Transit, Green Projects and Community, Culture and Recreation. The vast majority will just go to the $28 million GTA transit expansion however, since Ontario has already committed $11 billion towards that.

"The province and the federal government have agreed to terms regarding the use of Investing in Canada Infrastructure Program (ICIP) funds for these subway projects," says Ontario Ministry of Infrastructure spokesperson Sofia Sousa-Dias.

"The federal government confirms ICIP monies can be used for subway projects, regardless of underlying ownership and has further confirmed that it will invest up to 40 per cent of the cost of eligible projects."

> "We're seeing more extreme weather events and more congestion coupled with a growing population,"
>
> Sofia Sousa-Dias
> Ontario Ministry of Infrastructure

It means the $4.2 billion in provincial funding already allocated under ICIP for transit infrastructure in Toronto could be used for eligible subway projects, in addition to the $660 million already allocated to the Scarborough subway extension by the federal government.

"The 2019 intake targets near-term transportation improvement projects with the objective of supporting improved and/or more reliable road, bridge, air and marine infrastructure assets," says Sousa-Dias noting it targets 500 communities with less than 100,000 populations.

This first intake of the Public Transit stream is open to 85 eligible municipalities outside the Greater Toronto and Hamilton Area, she adds.

"This initial intake (for transit) leverages $1.63 billion of a total of $15.6 billion in federal and provincial funds over 10 years," she says. "Funding is allocated to every municipality that receives provincial Gas Tax funding (and Metrolinx) and has reported ridership data to the Canadian Urban Transit Association for 2015. Projects eligible for the public transit stream will be assessed by a multi-ministry panel."

The criteria is that a project must be financially viable and aligned with one of three improvement outcomes: improved capacity of public transit infrastructure, improved quality and/or safety of existing or future transit systems or improved access to a public transit system. They'll both require Ontario and federal approvals.

"We heard from municipalities that there are many road and bridge projects across Ontario that are in critical need of funding," she says.

The first intake for the Rural and Northern stream will focus on road, bridge, air or marine infrastructure in rural and northern communities with populations of 100,000 or less. Projects will be assessed and prioritized based on critical health and safety aspects of the project, technical merit of the proposed project, and the funding need for the proposed project. In addition, the province will give consideration to joint projects.

The first intake for the Rural and Northern stream will be open for eight weeks, and will focus on road, bridge, air or marine infrastructure in rural and northern communities with populations under 100,000 people.

"The Public Transit stream launched on April 2," says Sousa-Dias. "Further information on the launch timing and priorities for the other streams will be available later this year."

The province has set up the Grants Ontario website to be a "one-window" application channel to process intake, review, nomination, reporting and transfer payment management processes.

Building and maintaining roads is critical to Ontario's economy, says ORBA's Hocking.

"We're seeing more extreme weather events and more congestion coupled with a growing population," he says. "It's vital for Ontario's success as a province to have robust and sustained transportation infrastructure investment, which will, of course, effectively maintain existing assets, plan and build for the future, while at the same time creating jobs and bolstering the economy."

ORBA is please to see the new government "sending a pretty strong signals that this is definitely part of their long-term plan. This would not only be good news for the industry but for Ontarians generally."

The $1.3 billion this year will go to 123 projects across the program with the lion's share targeting $512 million to rebuild and restore 20 highway projects in central Ontario.

Projects range from the rehabilitation of North Shore Blvd, Phase 2 at the QEW in Burlington to similar rehabs on Highway 401 around Neilson Rd. to Whites Rd., Eastbound Express and Collector Lanes, Kingston Rd., HWY 2A, Rouge River, Morningside Ave., Meadowvale Rd., Port Union Rd., Rougemount Dr., Petticoat Creek. at the Toronto-Pickering borders.

The Northeastern region will also see some $291 million to rebuild and restore 32 highway projects many of them along Highway 11.

There's also $195 million to rebuild and restore 30 highway projects in Eastern Ontario. The Thousand Island Parkway section of Gananoque gets some rehab while Highway 7 will see several rehab jobs though the biggest looks to be the

CNR overhead bridge replacement, Lily Lake Rd. to Parkhill Rd. near Peterborough. Highways 401, 416, 417 will see lots of work while there will be shoreline protection at the Howe Island ferry terminal and at the Glenora/Adolphustown ferry.

The Western Region is earmarked for $165 million to rebuild and restore 23 highway projects most involving Highways 3, 7, 401 and 402.

And there's also $103 million for 18 projects in the Northwestern Region, mostly on Highway 17 and 527.

The Northeastern and Northwestern projects are part of the four-year Northern rehabilitation plan launched in 2016 which will see projects past 2010.

Ontario is investing $103 million to rebuild and restore 18 highway projects in Northwestern Ontario.

As part of this, the Namakan River Bailey Bridge on Flanders Road at Lady Rapids, some 50.9 km south of Hwy 11, and the Namakan River Acrow Bridge are to be replaced and structurally rehabilitated. Bids from four companies set the work at between $1.8 million to $4.8 million.

Economic Snapshot

Mid-year outlook – clouded by uncertainty

John Clinkard

World View

Approaching the mid-point of the year, words used to describe the health of the world economy include: "easing", "moderating" or "plateauing". For example, the Organization of Economic Co-operation and Development (OECD)'s composite leading indicators continue to point to easing growth momentum in most major economies.

The International Monetary Fund (IMF)'s *World Economic Outlook* has a similar view. It sees global growth moderating in the near term but picking up slightly in 2020. Beyond 2020, it sees growth set to plateau.

The World Bank in its *Global Monthly* report notes that after losing considerable momentum in late 2018 and early this year, global growth appears to be stabilizing. Closer to home, the Bank of Canada, in its *April Monetary Policy Report*, anticipates that after an economic slowdown in the latter half of 2018, a resolution of the U.S.-China trade dispute and other trade tensions should give global growth a boost in the first (now looking more likely in the second) half of this year.

U.S. View

Against this background of flattening global growth, the Bureau of Economic Analysis reported that the U.S. economy grew by 3.2% in the first quarter, faster than most U.S. economy watchers guesstimated. Further, it suggests that our largest trading partner will provide Canada with a stronger tailwind during the remainder of 2019 than many anticipated.

While the U.S. economy clearly started the year on a stronger note than expected, the key question concerns how long it can be sustained. As noted in the Snapshot titled "We are curbing our enthusiasm about Global, U.S. and Canadian economic prospects in 2019", the current U.S. economic expansion which started in June of 2009 is about to celebrate its tenth anniversary and become the longest period of uninterrupted economic growth on record. Low U.S. inflation (at or below 2% since the beginning of the year) should keep the U.S. Federal Reserve on the sidelines into the second half of this year.

Looking forward, the lingering impact of income and corporate taxes cuts, implemented at the beginning of 2018, and persisting low interest rates should support growth in the near term. This positive outlook is reinforced by a number of forward looking indicators including a recent 1.9% increase in new factory orders, a healthy 0.4% rise in the Conference Board's *Leading Economic Index*, a climb in the Chicago Fed National Activity Index and a jump in U.S. consumer confidence to a 15-year high of 102.4 in April.

Given the advanced age of this expansion and the fact that the unemployment rate is at a 50-year low, it appears increasingly likely that capacity constraints will hobble U.S. growth in the second half of the year and into 2020. Nevertheless, after its strong start and despite the prospect of a second half slowdown, the U.S. economy should see growth in the range of 2.3% to 2.7% this year and 2% to 2.5% in 2020 compared to a gain of 2.9% in 2018.

Canada View

Before looking forward we should look at how the Canadian economy has performed relative to the U.S. economy over the past several quarters. A recent article by Alex Carrick titled "Prolonged Streak of U.S. Beating Canada in Q/Q GDP Growth", indicates that over the past six quarters the U.S. economy has grown, on average, 25% faster than Canada, mostly due to stronger growth of business investment (+15%) and of exports (+7%). In contrast, Canada's investment spending is up by just 3% and our exports have risen by 4.8% on account of a modest 9% increase in energy exports.

Further, Canada's investment prospects remain weak due to the persisting impact of British Columbia's efforts to land lock Alberta oil, by uncertainty about the impact of the federal government's Bill C-69 and by the depressing effect of the recently introduced carbon tax on small businesses in Ontario, Manitoba, Saskatchewan and New Brunswick.

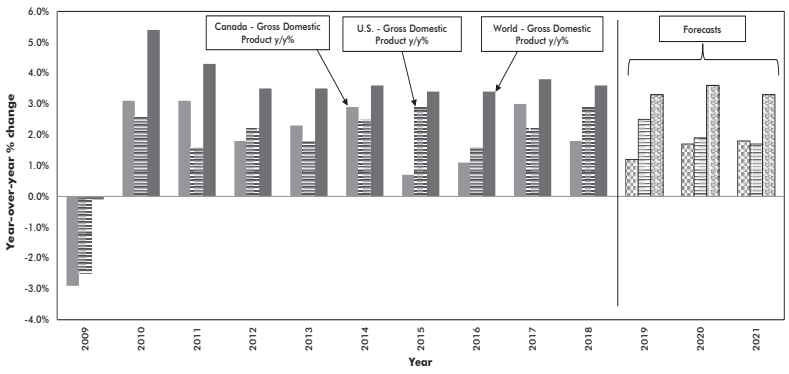
Stronger than expected U.S. growth in Q1 should give a boost to Canada in the second half of the year. This prospect is reinforced by the very strong 102,000 gain in total employment in April. However, a number of recent indicators suggest that it is nothing to get too excited about.

First, the CFIB's *Business Barometer* was essentially unchanged in April. Consumer confidence as measured by the Conference Board in Canada has been trending lower since the beginning of this year. Finally, the IHS Markit Canada Manufacturing PMI fell from 50.5 to 49.7 in April, its lowest print since early 2016.

Given the slow start to the year and the persisting relatively hostile investment climate, we expect the Canadian economy to grow in the range of 1% to 1.5% this year and by 1.5% to 2% in 2020 after posting a gain of 1.8% in 2018.

John Clinkard has over 35 years' experience as an economist in international, national and regional research and analysis with leading financial institutions and media outlets in Canada.

Global, U.S. and Canadian Gross Domestic Product – y/y% change



Data Source: International Monetary Fund, Statistics Canada; Forecasts — CanaData.
Chart: ConstructConnect — CanaData.

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Project Planning

Widening of Highway 11/17 section ahead of schedule, reports MTO

DAN O'REILLY
CORRESPONDENT

Under construction since June 2015, the widening of an approximately 12-kilometre-long (7.4-mile) stretch of Highway 11/17 between Stillwater Creek to Red Rock Road No. 9 just west of Nipigon is expected to be finished this June, two years ahead of the fixed completion date of June 2021.

Designed to improve the movement of goods and services, the $84.8-million project also included the erection of four bridges ranging from 39 to 52 metres (24 to 32 feet). Hatch was the prime design consultant.

An "aggressive schedule and diligence in organizing the work" by Sudbury-based Teranorth Construction & Engineering Ltd. are the factors the Ontario Ministry of Transportation (MTO) is attributing to the early completion date.

Wrapping up a major highway project two years ahead of time in the rugged terrain of northwestern Ontario would seem to be a major accomplishment in itself.

What is even more remarkable about this project is the foundation treatment measures which had to be implemented in several areas of complex soils.

MTO

A 12-kilometre section of Highway 11/17 near Nipigon, Ont. has undergone extensive road work which is running two years ahead of schedule. The $84.8 million project included the erection of four bridges ranging from 39 to 52 metres.

> "The highway embankments constructed on soft soils at the swamp crossing sites posed short-term slope stability and long-term settlement challenges,"
>
> Annemarie Piscopo
> Ontario Ministry of Transportation

Approximately 43 per cent of the construction route was crisscrossed by three swamps underlain with thick deposits of soft soils and another 18 areas with compressed soils.

The three swamp crossings ranged from 200 to 350 metres (124 to 217 feet) in length and the 18 compressed soil areas were anywhere from 30 to 700 metres (18 to 434 feet) long.

"The highway embankments constructed on soft soils at the swamp crossing sites posed short-term slope stability and long-term settlement challenges," says MTO spokesperson Annemarie Piscopo.

It's not that those conditions weren't known ahead of the actual construction.

Geotechnical investigations undertaken in the early stages of a five-year-long detailed design by WSP Canada Group Ltd. (McCormick Rankin Corporation at the time) revealed the presence of those soils and identified solutions, she says.

MTO

What has made the four-laning project on Highway 11/17 a challenge is the foundation treatment measures required in several areas of complex soils.

The design called for approximately 30,000 wick drains to be installed at varying depths at the swamp crossing sites to provide, "positive drainage paths for pore water pressure dissipation and to accelerate settlements in soft compressible soils."

Pore water is the water contained in gaps between soil particles within a soil mass, she explains.

On this project, the procedure started with the removal of the top soil and then the placement of a granular drainage blanket.

Then, in a sequenced operation between August and November 2015, Teranorth installed 339,214 metres of wick drains through the drainage blankets. "If laid end to end they would run 39 kilometres."

To be left permanently in the ground, the drains were installed vertically with one exception where they were placed on an angle into the existing highway embankment.

After the wick drains were inserted, they were covered with rock fill excavated from different areas of the construction route. In three of the soft areas, a geogrid was also placed above the drainage blanket, she says.

As the embankments were being constructed, the pore water was squeezed out from the silty clay soil and drained through the wick drains "upward and downward into the more permeable soil layers."

Four areas also required "surcharging" which is the temporary placement of additional fill — in this case granular material — which accelerated the ground settlement until it reached the desired target level. Then the fill was removed.

Settlement wait periods in the three swamp areas ranged from three to 18 months, distributed over the staged embankment construction periods, while the settlement wait periods for the 18 areas with compressible soils varied between one month and a year. While waiting for the settling to occur, the contractor pushed ahead with construction in other areas, she says.

A geotechnical instrumentation monitoring program was in place to monitor settlement, lateral displacement, and pore water pressure at the three swamp areas as well as at five additional locations, says Piscopo.

Apart from the projected early competition and the complex soil remedies utilized, the project is noteworthy in that the MTO required key personnel to take a three-day erosion and sedimentation control training course. This included the project coordinator, site superintendent, forepersons, quality control and environmental personnel.

"At all times the contractor was required to have three trained personnel on site. These individuals then provided training to all subordinate staff, sub-contractors and suppliers involved in the work adjacent to environmentally sensitive areas."

Asked if the project has been a challenging one, Piscopo says that: "It is more of a unique project in that it was the first in the province with a unique approach to sensitive fisheries locations with an adaptive management approach to minimize environmental impacts."

It was also unique because of the sensitive soils encountered and both the use and amount of wick drains, she says.

During the course of the construction, Teranorth used an estimated 40 workers and operators from its own companies. It also hired a number of subcontractors including a blasting contractor and a specialized crew to install the wick drains.

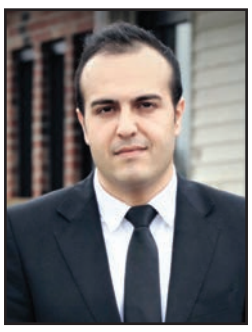
MTO

Approximately 30,000 wick drains were installed at various depths at the swamp crossing sites on the project to assist with settling the soil and increasing soil stability.

Technology

Road quality inspections just a swipe away on your smartphone

GRANT CAMERON
CORRESPONDENT


Amir Alavi

A smartphone is something most Canadians carry in their pocket each and every day. It's used for phone calls, sending texts and emails, taking photographs, playing video games, even keeping track of how many steps you take or how may kilometres you cycle each day

But what if smartphones could help your local transportation department figure out the quality of the roads you drive on?

A pair of researchers at the University of Missouri (MU) have developed smartphone-based technology that can monitor civil infrastructure systems such as crumbing roads and aging bridges — and much more rapidly and more cost efficiently than current methods.

The technology uses sensors such as gyroscopes, accelerometers and cameras that already exist in smartphones to interface with tiny external sensors and infrared devices to gather data that will enable scientists to determine the specific makeup and surface deterioration of roadways in real-time.

Current surface appraisal methods involve shutting down traffic, taking a core sample from the surface and comparing it to a baseline, which can be time-consuming and costly to do on a regular basis, not to mention straining manpower resources since workers must be trained.

However, the researchers say smartphone applications can change all that. With the sensors, they can detect bumpiness and conditions that cause a driver to slow down. The data can then be uploaded to a cloud-hosted database with relative ease, enabling scientists to determine the specific makeup and deterioration of a road's surface in real-time.

"People are looking for smart, cost effective, scalable and user-centred approaches," said Amir Alavi, one of the researchers and an assistant professor of civil and environmental engineering in the MU College of Engineering. "With current advances in technology, people can help monitor or detect problems using their own devices, and smartphone technology allows us to do that with civil infrastructure."

Alavi partnered with Bill Buttlar, the Glen Barton Chair of Flexible Pavement Technology at the university's civil and environmental engineering department, to develop the innovative solution to monitor roads and bridges.

Their study, titled "An overview of smartphone technology for citizen-centered, real-time and scalable civil infrastructure monitoring," was funded by the Missouri Department of Transportation.

"Assessing roads, bridges and airfields with affordable sensors, such as those found in smartphones, really works," said Buttlar. "With a smartphone, we can stitch together many inexpensive measurements to accurately assess things like the roughness or deterioration of a road surface."

Their study outlines how sensors in the smartphones can be used to estimate the quality of a given road, bridge or airport runway surface. Once the sensor is plugged into a smartphone, any person will be able to effortlessly transmit the data wirelessly to a database while riding on a road. As such, the data can be used to make critical decisions on repair in heavily trafficked areas.

"These sensors are potentially useful tools for various civil infrastructure condition assessment purposes in a cost-efficient way with large spatial coverage," said Alavi. "In addition, they provide an opportunity for frequent, comprehensive, and quantitative monitoring of pavement infrastructure."

Alavi said the recent research has demonstrated that the technology can be used to determine the road roughness potentially cost-free.

Recently, in collaboration with a company in Illinois, an Android-based application was deployed to capture the acceleration data and it was then fed into a mechanical model to estimate road roughness in terms of a well-known index called International Roughness Index, or IRI.

An excellent match was obtained with the results from a fully-instrumented, million-dollar van that was used at test sites in Illinois and Missouri, said Alavi.

"This is merely the smartphone accelerometer and there are plenty of other built-in or portable sensors that can be deployed for other monitoring purposes."

The acceleration and GPS data can be collected and stored in a text file using an app and then transferred to a server for further data processing.

Alavi said the technology is important because transportation infrastructure systems are seriously threatened by age-related degradation, deferred maintenance, natural disaster and man-made hazards.

"Day-to-day collection of information on such public assets using existing technologies is extremely costly and requires significant effort," said Alavi.

Moreover, he noted, existing infrastructure assessment technologies are not user-centred, not widely shared, and do not directly solicit and process inputs from users or directly consider human health, comfort and safety.

"Smartphones are clearly a viable tool to tackle these issues and can be feasibly relied upon as centerpiece mobile sensing units for smart transportation infrastructure monitoring," he said.

"Such a technology can lead to an intelligent and connected civil infrastructure system through mobile crowdsourcing where people sense the environment automatically for the agencies."

While the technology is almost free, Alavi said previous research shows that simply providing a software measurement application for individuals to download is not sufficient enough and incentives have to be provided to get signed-up smartphone owners to participate.

While nearly all previous existing studies in the area have used the GPS and accelerometer sensors, Alavi said adding a combination of built-in and external sensors may serve to improve future infrastructure sensing systems.

"Smartphone measurements are affected by many factors, which can be addressed by developing robust calibration procedures and through mobile crowdsourcing platforms," he said.

"Much research is still necessary to explore the power of crowdsourced smartphone-based measurements, and to branch out into new application domains."

Out With the Old

Duchesnay Creek Bridge replacement to utilize timber construction

DAN O'REILLY
CORRESPONDENT

Wooden bridges may be making a coming back of sorts in Ontario.

In a project which interweaves economic opportunities for First Nations, nurtures the enhanced use of timber, and pays tribute to this province's bridge history, a timber girder and arch bridge will be under construction in Northern Ontario by this summer.

To be built by a limited partnership company comprised of majority owner Nipissing First Nation (NFN) and Miller Paving Limited, the $12-million Duchesnay Creek Bridge will be erected over Highway 17B on the Nipissing First Nation–North Bay boundary.

Scheduled for completion in 2020, the 93-metre-long (305-foot) and 12-metre-wide (39-foot) bridge will consist of three spans and 12, 1,710-mm deep and 315-mm wide glue-laminated girders. Other than the girders and arches, the rest of the bridge will be built with reinforced concrete — with some steel piling for the piers.

The project will also include the pavement of the one kilometre of 17B owned by the province and the removal of an abandoned CPR railway bridge.

Lea Consulting Limited was the detailed designer, while Stantec completed the preliminary design.

In a press release issued at the end of March, the provincial government cited the project's overall social, economic, and infrastructure advantages and the specific benefits to the First Nation.

"Through this procurement, Ontario is working with Nipissing First Nation to create opportunities for skills development and job creation while building beneficial infrastructure," said finance minister and Nipissing MPP Vic Fedeli.

Commenting on the contracting arrangement, Chief Scott McLeod noted that "the Nipissing First Nation has built a strong business relationship with Miller over the past 15 years, and this announcement represents the fruits of our relationship-building."

Details of the partnership agreement are still being worked out, says Nipissing First Nation chief executive officer Dwayne Nashkawa.

"Miller has the technical management experience and we will be supplementing that," says Nashkawa, adding the labour force will include a mix of both NFN residents and non-members.

Sourcing aggregates won't be a problem as the First Nation has its own quarry, he points out.

Located only metres from Lake Nipissing, the new structure will replace the original Duchesnay Creek Bridge which was closed by the Ministry of Transportation (MTO) this past January for safety reasons after an inspection determined it was in poor condition.

Constructed in 1937, the timber deck truss bridge is a designated heritage structure and the last one of its kind on Ontario's provincial highway network, says MTO senior project engineer Jim Bucci.

With the exception of a 1930s resurgence in the use of timber spans in Northern Ontario through the application of new methods of preservation, the once common wooden bridge was gradually replaced by steel and concrete ones, a transition which started in the early 20th Century, he says.

And in the preliminary design for the Duchesnay Creek Bridge, concrete or steel bridge girders with a concrete deck covered with asphalt were actively considered.

As design progressed into detailed phase which included an evaluation of materials, however, "the timber girder was selected to address a design that was sympathetic to the heritage significance of the existing timber bridge."

The timber design is "a modern interpretation of the heritage structure."

Advances in timber construction have evolved over the years allowing glue-laminated girders to span longer distances which far exceed conventional dimensional timbers, says Bucci, in explaining why girders are being instead of a truss system which was the old bridge's defining heritage feature.

No specific construction challenges are anticipated. The unique aspects of the bridge have been included in the design, including procurement, fabrication and installation of the timber girders which will be prefabricated, shipped to the site and then lifted into place. Dimensional tolerances have been allowed for in the design to aid in the onsite erection, he says.

The general contractor will determine the source of the timber. But there are at least two companies within a 500-kilometre radius of the site which are capable of fabricating the timber girders, he points out.

First task in the construction schedule will be the dismantling of the 1937 structure as the replacement bridge will be installed in the exact same location, says Bucci.

As a portion of the project near the Duchesnay Creek Bridge goes through Nipissing First Nation reserve land, the First Nation will be providing a shuttle service to connect with transit service in North Bay. Highway 17B was the old commuter route through the city and motorists will be able to use local streets and roads to connect with Highway 17, he says.

Asked if this project will spur the use of timber in bridge construction, Bucci says the ministry will look for opportunities to construct timber bridges at locations where it might be feasible.

"We will have to see how this one goes."

(TOP) LEA CONSULTING, (BOTTOM) DTAH

The original Duchesnay Creek Bridge (top) was closed by the province in January for safety reasons. A new bridge will be built over Highway 17B on the Nippissing First Nation-North Bay boundary using glue-laminated girders and arches, reinforced concrete and steel.

Concrete Plan

Concrete slabs get the nod for quick highway repairs

IAN HARVEY
CORRESPONDENT

The test scores are in and concrete slabs for highway repairs get an A plus grade from the Ministry of Transportation Ontario.

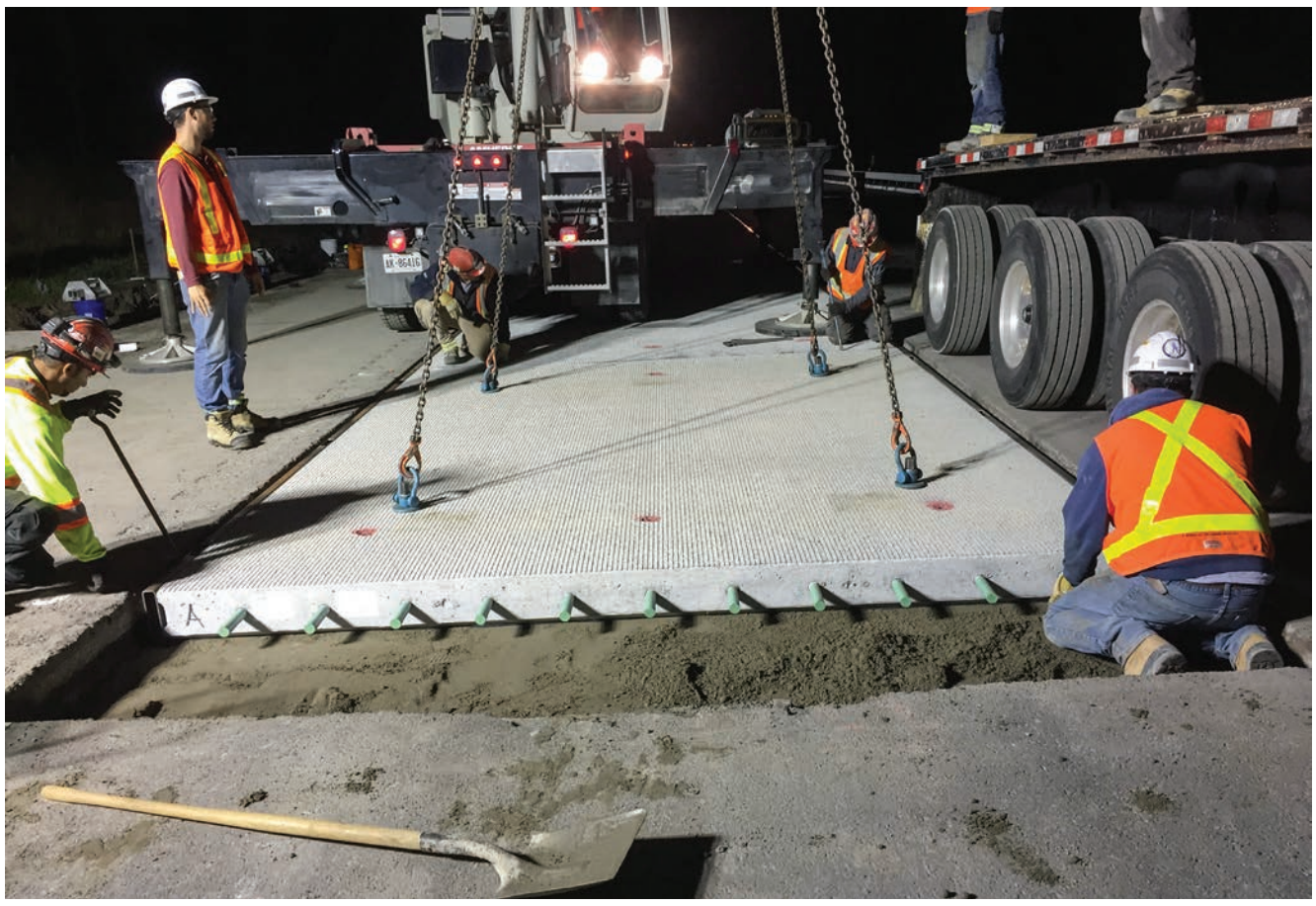
Never one to rush into any new technology, the MTO ran its first test of precast concrete slab repair on concrete pavements in 2004. That trial on Highway 427 in Toronto led to a specification and more precast repair work resulted.

At every step, the slabs have been a success leading to a pilot using precast concrete slabs to repair flexible pavement in a fall 2016 trial.

The results are positive: It costs more but there are savings in reduced traffic disruption and extended pavement life which more than offset the initial installation cost.

"We were not surprised by the findings," says Stephen Lee, head of the MTO's pavements and foundations section, materials engineering and research office. "And we will continue to monitor the long-term performance of this pilot."

> "This technique is suitable where ease and speed of construction is a premium,"
>
> Stephen Lee
> Ministry of Transportation Ontario



MTO

The Ontario Ministry of Transportation has experienced success in its trials where precast concrete slabs were used to repair road pavements. Though the slabs cost more, savings are found in reduced traffic disruption and extended pavement life. A pilot using concrete slabs was done on a northbound section of Highway 400 in 2016.

These slab repairs seem best suited for heavy truck traffic on asphalt pavements with 300 mm or more thickness but with more than 25,000 trucks per day which inevitably lead to rutting and premature deterioration.

Shave and pave, the standard treatment, only extends the pavement lifecycle three to five years. It's far short of the eight to 12 years needed before the rutting, cracking and overall deterioration returns.

That's what drove the MTO to look at literally milling out a section of pavement and dropping in precast slabs of concrete. It would be faster and ultimately more durable but would require precision cutting and high-level skills to get them seated and flush with the existing surfaces, says MTO's Stephen Lee.

He says one of the big advantages is time because this type of rehabilitation work on busy highway sections must be done at night so as not to disrupt traffic flows.

The 2016 pilot project on the northbound section of Highway 400 between the intersections of Highways 88 (to the south) and 89 (to the north) tackled a section with average annual daily traffic in both directions at about 87,300.

They used the Fort Miller Superslab System with fully-cured precast concrete slabs and three different slab support systems for evaluation based on factors like load transfer and ease of construction. Time as also a consideration: could it be done within the overnight eight-hour window? And could horizontal and longitudinal joint details be figured out.

The slabs are just one option among many for pavement repair, Lee stresses and will not replace other options.

"This will be one of tools in the toolbox for the right pavement candidate," he says. "This technique is suitable where ease and speed of construction (product is produced before field work begins) is a premium and where conventional rehabilitation of thick pavement layers cannot be achieved within an eight- hour closure window. The product is manufactured in a controlled environment to ensure enhanced product quality that could equate to longer lifecycle."

The slab support systems were asphalt, grade and grout while instrumentation for long term monitoring came from a partnership with the University of Waterloo, Centre for Pavement and Transportation Technology (CPATT).

Some 22 reinforced precast sections were fabricated in late summer 2016 at the Armtec production facility in Mitchell, Ont. with a specific micro and macro surface texture to ensure friction.

After experimenting, a broom finish was found to be the best option, followed by longitudinal "tining" with constant pressure applied throughout.

Prior to milling out the sections, crews took core samples to ascertain asphalt depths. On the northbound lanes these came back at 355, 375 and 375 mm.

This left enough depth to rout out the asphalt leaving 150 mm of base for the 205 mm slabs which are a lane-width wide at 3.7 m and 4.6 m long. They were bonded with two mats of epoxy-coated dowels at 300 mm centres embedded at the transverse joints. Design strength rating was 30 MPa at 28 days with three-per-cent air void.

MTO

The MTO stresses the use of concrete slab allows for another tool in its road repair toolbox, especially where ease and speed of construction is at a premium.

During installation over three nights, temporary longitudinal slabs were used as sleepers for transition from night to night.

Installation started Sept 20th, 2016 with seven to eight slabs, over three nights, for each of the three methods and it was all kept to a tight schedule, says Lee.

A Wirtgen Model W120 CFI milling machine with a 1.2 m-wide milling head proved to be the right choice for the asphalt supported method which also proved to be the fastest method. It required width with precise tolerances of plus/minus 3 mm.

There were some field adjustments, specifically re-milling an additional 12 mm to achieve the perfect grade. The CPATT instrumentation was installed beneath the fourth and eighth asphalt-supported slabs.

More interestingly was the time factor. Eight asphalt-supported slabs were laid in just over an hour, a rate of nine minutes per slab, followed by the temporary end slab. Fast-setting bedding grout, dowel grout and edge grout for longitudinal joints were applied the next night.

The second method tested were Grade Supported Slabs which also involved milling the asphalt, followed by placement, grading, and wetting the cement-treated bedding material (CTBM) prior to placing the precast concrete slab on top.

According to the report Lee wrote on the project, the CTBM was graded using a manual leveling screed and compacted using the plate tamper to the correct elevation. The material was wetted to begin hydration and the slabs were placed directly on this bedding layer. Installation time was about 13 minutes a slab.

The third test was for Grout Supported Slabs which were embedded with leveling screws. Once in place and level, quick-set bedding grout was then injected. Installation time was about 12 minutes a slab, Lee reports.

The process went well with only one of 22 not meeting the 3mm tolerance and needing diamond grinding.

Falling Weight Deflectometer tests showed the average load transfer efficiency (LTE) for all 23 joints was 80.3 per cent, well above the threshold of 70 per cent. Friction and roughness measurements were equally positive.

The pilot was a learning process with findings to apply to future installations, says Lee.

Milling must be precise, Bobcat-mounted chipping equipment worked faster than manually chipping the edges, slabs should be broom-finished at the plant, then diamond ground or grooved on site, as a post-installation process and saw cutting of longitudinal joints prior to milling is not needed, Lee reports, but transverse end joints should be saw-cut.

To speed things along, he recommends two crews with separate grout mixing equipment for dowel grout and bedding grout as the two grouts have different mixing consistency.

Overall, however reports Lee, the slab trial was a success. Moreover, it's fast: At full production speed, 30 to 40 slabs could be placed in an eight-hour construction window, he says.

While the data suggests the Grout Supported Slab method is slightly better, the ministry prefers the Asphalt Supported Slab based on a cost-benefit analysis.

It was the fastest of the three techniques, precision milling achieves final grading and does not require additional bedding grout. Also, Lee says, the Asphalt Supported method using leveling screws would be a contingency where there are grade issues.

There's still some work to be done, in addition to the monitoring to prove out the lifecycle projections.

"Ongoing monitoring results will be used to monitor the lifecycle cost of this option and the disruption cost will need to be analysed on a project-by-project basis." he says. "Based on pilot project experience, a number of changes will be included in the specification to reduce the construction challenges faced by the crew. As with any new process there will still be a learning curve for a new crew."