

Using Precast Concrete Inlay Panels for Rut Repair on High Volume Flexible Pavements

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Abstract

The Ministry of Transportation of Ontario (MTO) in Canada has identified that several of their high traffic-volume flexible pavements are experiencing rutting failure early in their design lives. The pavement structures in the areas of premature failure consist of layers of hot mix asphalt (HMA) over granular base/subbase materials and experience significant truck traffic. The MTO has decided to investigate an innovative rapid pavement rehabilitation technique which distributes traffic loads over a larger area in order to avoid future rutting failure. Concrete has been identified as an ideal material to avoid the previously mentioned performance issues. However, conventional cast-in-place concrete is impracticable due to the high traffic volumes on these roads and corresponding short construction windows. Normal and fast-track concrete repairs require periods of strength gain which would extend beyond the 8-hour overnight construction window required by the MTO on these heavily trafficked highways. Precast concrete inlay panels provide a practical solution to this challenging rehabilitation problem. A 100-m test section is planned for construction during the 2016 construction season in Ontario. A new rehabilitation strategy will be employed in which existing HMA is milled to a design depth and precast concrete panels are placed within the 8-hour overnight work window, such that daytime traffic is not impacted. The test section will be instrumented to acquire stress and moisture data in addition to traditional surface testing methods. This paper will summarize the construction process and all data which has been gathered and analyzed up to the time of the 2016 conference. Both foreseen and unforeseen difficulties in the construction process and their solutions will be discussed in order to gain insight into the feasibility of this novel rehabilitation strategy.

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Introduction

The Ministry of Transportation of Ontario (MTO) has responsibility for the maintenance of several high-volume roadways within the province. The most highly travelled of these roadways are generally located in and around the Greater Toronto Area (GTA), which is a metropolitan area with a population of more than six million people (Statistics Canada, 2015). For instance, portions of the King's Highway 401 in the GTA have average annual daily truck traffic levels higher than 26 000 trucks per day (Ministry of Transportation Ontario, 2014).

Highways with traffic levels this high are affected in two major ways by the traffic. Firstly, the high traffic loading increases the rate of pavement degradation in the most heavily travelled lanes. Secondly, the user costs associated with delays on the highway increase greatly. These two effects have a considerable impact on the maintenance and rehabilitation strategies which can be effectively employed on these highways.

The MTO has identified that several of their high volume HMA highways are experiencing deep rutting failure due to the high levels of traffic. This failure has been seen most commonly in the rightmost lanes, which typically see the highest percentage of the overall truck traffic. In the past, the MTO has addressed this issue with shallow (1- or 2-lift) HMA cold-planing and replacement strategies, however these repairs were found to last only 3-4 years, in some cases, before requiring further rehabilitation.

Work zone road user costs are significant considerations for all construction activities on roadways. These user costs are defined as the additional costs incurred by motorists and the larger community as a result of construction activities. The costs can be used as a measure of the impacts that a given roadway construction activity has on people. These costs can be considered to be a combination of several components, not all of which are easily considered as a monetary value. Some of the components which can be monetized include costs associated with travel delay, vehicle operation, crashes, and emissions. Other components of the user cost, including noise, business impacts, and inconvenience to local residents, are more difficult to monetize but are just as important when assessing the effects of a given construction activity (US Department of Transportation Federal Highway Administration, 2015).

In the case of construction activities on Ontario's high volume highways, night construction is often used in order to reduce the number of users which are directly affected by the activity. The user costs are minimized by performing construction activities when the traffic levels are at their lowest point of the day. The construction time window which is often prescribed by the MTO is between the hours of 10 pm and 6 am the following morning.

At the end of this construction window, the MTO typically specifies that all construction equipment and materials need to be removed from the roadway and shoulders to allow for the full reinstatement of unimpeded traffic the following morning.

Even given this method, construction activities can have a significant impact on traffic and not all user costs and worker safety issues can be avoided. Because of this, minimizing the number of required construction activities for a given roadway is a high priority concern for the MTO.

The MTO is interested in studying a new method for rehabilitating the high volume highways in Ontario. They are interested in finding a method which has a longer service life than the current

method of rehabilitation but that can still be installed during overnight construction windows without significantly affecting daytime traffic.

Background

Previously, the MTO has used a traditional HMA cold-planing and replacement strategy for repairing its high volume highways. This method has the benefit of using a paving material which can be exposed to traffic loads relatively soon after its placement. The strategy is also well-known to contractors, which typically makes it relatively attractive from the perspectives of ease of construction and subsequently lower contractor pricing. In addition to familiarity with this construction strategy, there is familiarity with this rehabilitation procedure.

Performance-Graded Asphalt Cements (PGACs) are typically used in Ontario, and are specified using the average 7-day design maximum temperature and minimum design temperature which can be withstood without excessive rutting and low-temperature cracking, respectively. Pavements which are subjected to heavy traffic levels are generally designed with a higher average 7-day design maximum temperature than is warranted by climatic data. This helps to provide improved rutting resistance under the expected traffic loading. The design reliability level of the climatic data is also generally increased for these types of pavements, which further improves the expected performance of the HMA pavement (Ontario Hot Mix Producers Association 1999).

For surface courses of high volume highways, an SP 12.5 FC2 type HMA is typically specified. This type of HMA includes high quality aggregate, such as dolomitic sandstone which has a high resistance to rutting and polishing (Ministry of Transportation Ontario 2004).

Concrete pavement has been identified as being more cost-effective for high-volume roadways (AADTT 7500-10000+). The results indicate that, over the course of 50 years, the costs associated with repair and rehabilitation on top of initial costs would make concrete pavement a more economical option. These results are based on the assumption that the HMA would last an average of 8-12 years before requiring repairs. Even using the previously mentioned design practices and construction materials, the HMA sections often last only 3-4 years before requiring rehabilitation instead of the expected 8-12 years (Applied Research Associates 2011). This indicates that, according to life-cycle cost analysis, concrete may be the better design option, assuming that the 12-year period to first repair is somewhat accurate.

Replacing the current HMA highway pavements with conventional concrete is not an ideal rehabilitation method from the MTO's perspective because of the time restrictions mentioned previously.

The MTO has significant experience with precast concrete for the application of repairing existing concrete and composite pavement highways. Studies beginning in 2004 were undertaken to study the effectiveness of precast concrete as a repair method (Lane and Kazmierowski 2010). The results of these studies were very positive and led to several other projects, including repairs of highways 427, 401, and 400, all major highways in the GTA. This experience led the MTO to consider the use of precast concrete as a rehabilitation option for its high-volume HMA highways.

Precast concrete is well-suited to highway rehabilitation for a number of reasons. It is produced in controlled conditions, that allow for full curing, precise reinforcement detailing and placement, and well-controlled and monitored concrete placement. Because it is produced and cured off-site

prior to placement, precast concrete has sufficient strength to support traffic loads as soon as it is uniformly supported on site.

A drawback of using precast concrete is that it lacks the flowable nature of traditional cast-in-place concrete (CIPC). Because CIPC is placed in a plastic state, it can take the form of whatever space it is being poured into. This allows it to form a full-contact interface between the concrete and its supporting material or the material at its edges. Because precast concrete is produced prior to being brought to site, the supporting and edge materials must be installed to suit the precast slab. This is typically achieved by precision grading of support material and/or pumping flowable, fast-setting grout or urethane beneath and around the precast slabs.

The problems associated with this extra consideration could become magnified when precast slabs are installed under the tight overnight time restrictions imposed by the MTO on highway rehabilitation projects.

This paper outlines the plans which have been developed to investigate whether using precast slabs to rehabilitate existing HMA pavement is a feasible option for the MTO. Descriptions of the slab designs, support conditions, construction plan, and testing plan are included.

The Centre for Pavement and Transportation Technology (CPATT) at the University of Waterloo has been involved in the planning and design of this new rehabilitation strategy. CPATT will be monitoring and collecting data throughout the construction and design life of the trial section, through inspections, instrumentation, and surveys. This data will be used to determine the strategy's feasibility and also to produce design tools and specifications for future applications of the strategy.

Pavement Repair Design

A mill-and-replace strategy with precast concrete slabs was decided upon to rehabilitate HMA sections. The HMA in the lane will be milled to a partial depth and precast slabs will be placed within the milled-out recess. The precast slabs will be supported by the remaining HMA and the surfaces of the slabs will be the riding surface of the roadway. The plan to implement this rehabilitation method consists of the following general steps:

1. **Slab Fabrication-** Fabrication of the precast panels will take place at least two weeks prior to the beginning of construction. This will depend on the delivery of the concrete mixture design and approved fabrication drawings to the precast producers from the contractor.
2. **Surveying-** The lane to be rehabilitated must be surveyed completely prior to the beginning of construction. This survey will provide the elevation details necessary to ensure that asphalt removal is performed to the correct depth and that the proper pavement cross-slope is maintained.
3. **Saw Cutting-** The night before the precast slabs are installed, precise saw cuts will be made in the asphalt delineating the area of asphalt which is to be removed on the following night. The saw cuts will be based on the survey data and must be precise in order that no large gaps remain after asphalt is removed and precast slabs are placed. The depth of the saw-cut will correspond to the specified HMA removal depth. For instance, the total overall depth of the asphalt pavement may be 300 mm $\pm$, but the depth of removal will be approximately 215 mm $\pm$.
4. **HMA Removal-** The HMA within the sawcut-delineated area will be removed to the specified depth using milling equipment. This portion of the construction process is

expected to require a significant proportion of the available time each night. Milled HMA will be trucked off-site as it is removed. At each end of the nightly milling extents, a radiused portion will be left by the cylindrical milling head. This portion will have to be removed by hand in order to provide a vertical face against which the precast slabs can be placed.

5. **Surface Preparation-** Once the HMA has been milled to the proper depth, the surface of the remaining asphalt will be prepared for precast slab placement. The first step in this preparation will be the removal of detritus left by the asphalt milling equipment, using power brooms. When the asphalt surface is free of debris, the support material for the precast slabs can be placed. The support conditions will vary throughout the project but cement-treated bedding material will be used where graded support material is required.
6. **Slab Placement-** The slabs will be lowered into place using the four lifting inserts installed in each slab. Care will be taken to ensure that all dowels and dowel slots align during placement and that the maximum spacing limits between slabs are observed.
7. **Grouting-** Grout will be placed in order to fill any voids around or beneath the precast slabs. Four distinct types of grout will be used for this project:
 - a. Bedding Grout: thin, non-structural grout to be pumped beneath slabs supported by surfaces which are within a ± 3 mm tolerance. Used to fill small voids and provide uniform support.
 - b. Rapid-Setting Bedding Grout: thin, non-structural bedding grout as described above that reaches a compressive strength of 5 MPa in one hour or less. This grout is used to support slabs which incorporate levelling screws and have larger voids between the slab and the underlying asphalt.
 - c. Dowel Grout: a non-shrink, non-expansive structural grout which is pumped into dowel slots to engage dowels in load transfer between slabs. The dowel grout will have a minimum design compressive strength of 30 MPa and must attain a strength of 20 MPa before it is deemed acceptable to carry traffic loads.
 - d. Edge Grout: dowel grout which is typically extended 60% by weight with 9.5 mm pea gravel. This grout is used to fill gaps between the precast slabs and the vertical cut faces of the adjacent asphalt pavement.

*Dowel and edge grout must be installed prior to either type of bedding grout to ensure structural performance of dowel and edge grout

Precast Slab Support Conditions

The support provided to a precast concrete slab is one of the most important factors in determining how well that slab will perform. Non-uniform support can lead to premature cracking, loss of load transfer, and ultimately premature slab failure. The process of preparing the proper slab support has also been identified as a construction activity where potential time savings can be made.

For these reasons, the precast slab support conditions are a primary focus of this research study. Three different slab support conditions will be investigated and seven slabs will be constructed using each support condition. Because this study is designed to assess the feasibility of precast concrete slab rehabilitation of asphalt highways, each support condition will be evaluated based on its constructability and performance. The three support conditions to be evaluated are:

1. Grade-Supported

This condition involves the placement of graded and compacted cement-treated bedding material (CTBM) between the slab and the underlying asphalt. The material is placed on the supporting asphalt and levelled using a large screed, such as the one pictured in Figure 1. After leveling, the material is compacted to a desired density using plate tampers, and this process is repeated until the required surface elevation of the compacted CTBM is met. The final surface of the CTBM must be within a ± 3 mm tolerance prior to placing the slabs.

Once slabs are placed on the CTBM, they can support traffic loads and can be opened to traffic, however dowel, edge, and bedding grout must be installed (in that order) during the next construction shift (typically the following night). Dowel and bedding grout are pumped through the slab through ports in the slab's surface. Adjacent port holes are observed during pumping until grout is observed to come out, which indicates that the dowel chambers or the voids beneath the slab are filled with grout.



Figure 1: Large screed leveling base material (Source: Fort Miller Website (Fort Miller Compancy, Inc.))

This support condition most closely resembles the typical method used with Fort Miller Super Slabs on MTO highway projects. The method has shown good results in full-depth slab repair projects in the past.

2. Grout-Supported

Grout-supported slabs will be fabricated with integrally cast leveling screws for this trial section. The slabs will be placed directly on the asphalt surface following the milling and cleaning operations and then the leveling screws are deployed until the surface of the slab has the correct elevation and cross-slope characteristics.

The slab cannot support traffic loads when it is resting on the leveling screws, so dowel, edge, and rapid-setting bedding grout must be installed the same night the slab is placed. While this has implications for the nightly construction schedule, it is also presumed that time will be saved relative to grade-supported slabs by not requiring the placement, screeding, and compaction of bedding material.

Because there is no base material required for this support condition, the depth of asphalt milling can be slightly reduced in relation to the grade-supported slabs.

3. Asphalt-Supported

The final support condition to be evaluated is asphalt-supported. This condition is a hybrid of the previous two conditions and involves placement of precast slabs directly onto the milled asphalt surface which has been micro-milled to within the ± 3 mm surface tolerance previously specified. If this tolerance can be achieved, then slabs can support traffic as soon as they are placed and grouting can take place on the following night, similar to grade-supported slabs.

It is presumed that this method will provide benefits in terms of time in relation to the other two methods because neither placement of a CTBM layer nor leveling and same-night grouting are required. However, the extra time and cost required for asphalt micro-milling to precise tolerances will be monitored to determine the overall time benefit.

Precast Slab Design

A total of 22 slabs will be installed as part of the trial installation. The concrete used to produce the precast slabs will meet a minimum compressive strength of 30 MPa at an age of 28 days and will have a minimum of 3% entrained air with a maximum spacing factor of 0.230mm. The concrete will be produced to meet the MTO specification outlined in OPSS 350- and OPSS 1350- Prov. The aggregate used in the production of the slabs will have a maximum nominal diameter of 19 mm and will adhere to OPSS 1002-Prov.

The surfaces of the precast slabs will be finished with a burlap drag in the direction of vehicle travel, followed by 3-5 mm wide longitudinal grooving spaced at 19 mm.

The slabs will be 205 mm thick and reinforced with two mats of reinforcement steel spaced at 300 mm centres. The dowels to provide load transfer are 38 mm in diameter and 355 mm long and spaced at 300 mm on centre.

For the purposes of this study, a precast slab of typical plan dimensions 3.66 m by 4.57m was chosen. These dimensions were decided upon based on the design lane width and extensive precast panel experience. The slabs are to be Fort Miller Super Slabs[®]. Figure 2 presents a plan view of the typical slab design.

Several design details can be seen in Figure 2. Super Slabs have patented dovetail dowel slots on the bottoms of the slabs, as shown on the left edge of the slab pictured in Figure 2. The slots are cast such that they align with the embedded dowels shown on the right side of the figure. These slots differ from several other precast slab types which have dowel bar slots that are exposed to the surface of the pavement. The key benefits associated with the bottom-slot design are that it

allows for traffic to pass safely over the ungrouted slots prior to placing dowel bar grout and it protects the dowel grout from de-icing chemicals that are applied to the pavement surface.

Because the dowels and dowel slots are cast integrally into the slabs, greater precision of alignment can be met under the controlled casting conditions. The only drawback to these details is that they require a greater level of precision during the placement of the precast slabs on site to ensure that slots are lowered directly over the dowels. This has typically not been observed to be a problem for experienced construction crews.

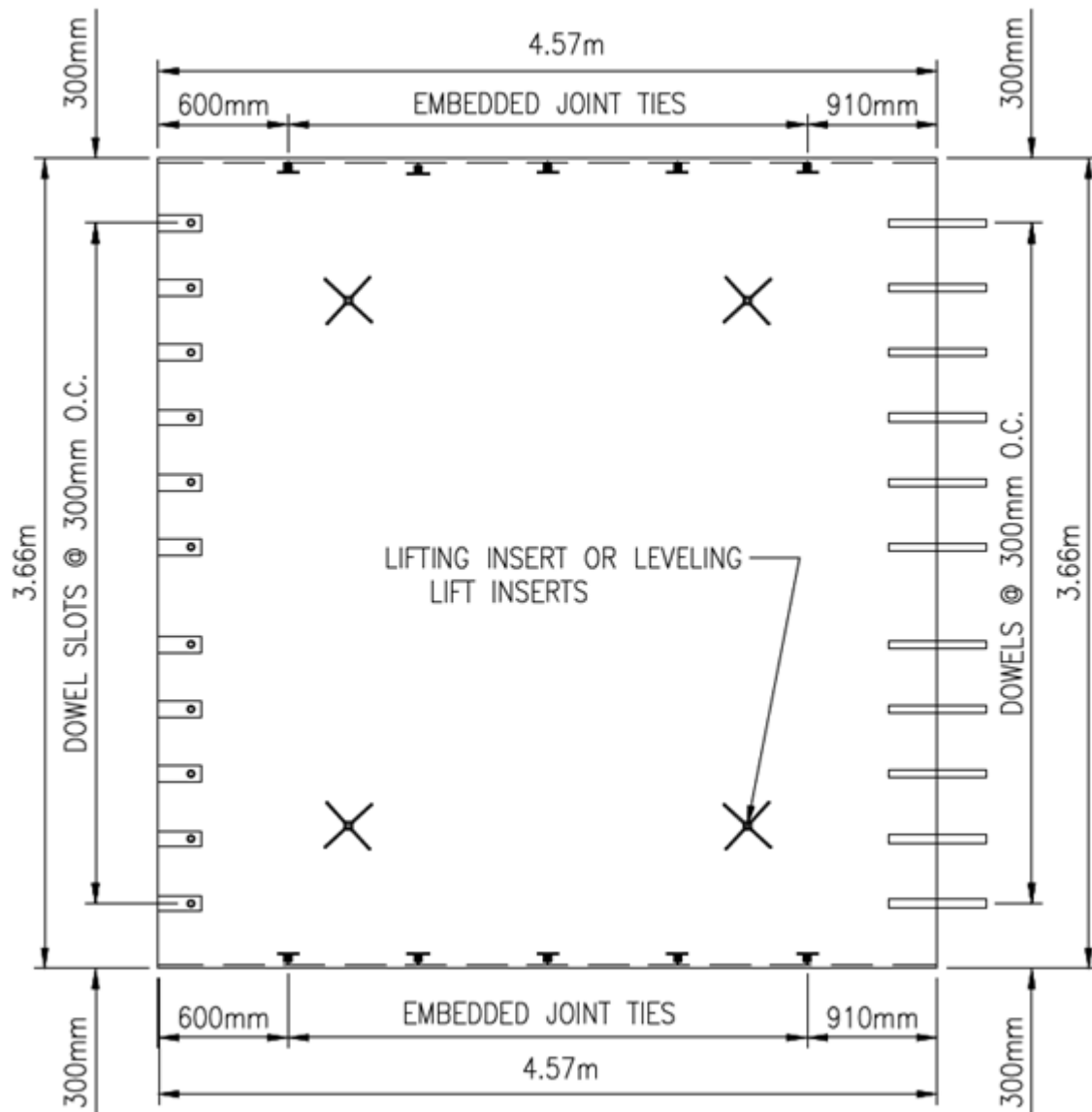


Figure 2: Typical precast slab layout (The Fort Miller Co., Inc. 2015)

The dowel slots are open to the bottom of the slab; therefore, slab-bottom gaskets are required to provide separation between the dowel grout and the much weaker and more flowable bedding

grout, which is pumped beneath the slab. The bedding grout is also not designed for freeze-thaw durability and could result in rapid deterioration of joints, if it is placed therein. In order to ensure that the bedding grout is not installed around the dowels, the dowel grout is pumped into the slots first. The thinner bedding grout is unlikely to displace the dowel grout when it is installed subsequently.

The second slab support option described previously is grout-supported. In order to place this support condition, the precast slabs typically require integrally cast leveling screws. The screws provide the mechanism by which the slab is raised to the desired position (elevation and cross-slope) before the bedding grout is pumped beneath it to provide support. As shown in Figure 2, this support system requires that leveling-lifting inserts be cast integrally within the precast panels, instead of the typical lifting inserts.

At the end of each night of construction, the dowels protruding from the last slab placed will be exposed. While they will be covered by the bottom slots of the first slab placed during the next construction shift, they cannot be left exposed if daytime traffic is to be maintained. In order to maintain the driving surface, a 1 m long temporary end slab with one set of Super Slab inverted dovetail slots (see Figure 3) will be placed over the exposed dowels. This temporary slab will be the same width as the typical precast slabs to fit into the same milled recess in the HMA pavement. The transverse edge of the temporary end slab, which has no cast-in dowels, will be butted against the vertical cut face of the HMA at the nightly terminus of construction. At the beginning of the next night's construction activities, the temporary slab will be removed and typical construction will recommence.

The use of the temporary slab requires that the removal of asphalt be performed with high precision. The length of the removed asphalt requires enough precision that the temporary slab can be installed without leaving a gap larger than 12 mm between the asphalt and the slab.

In order to place precast slabs between the vertical asphalt faces left by saw cutting and removing asphalt, the vertical faces must be spaced far enough apart to allow for placement without risk of damaging the adjacent asphalt. To provide this space, a 75 mm gap will be left along both longitudinal edges of each precast slab.

While this plan allows for safe slab placement, it leaves two edge gaps which cannot be present when traffic resumes. These gaps will be grouted when the dowel and bedding grout is placed, typically on the night following the slab placement. The delay of grouting is due to the restrictive time constraints associated with this project. A temporary longitudinal joint insert, shown in Figure 4, has been designed to fill a portion of this gap and support traffic until grouting takes place. The detail consists of a temporary re-usable hollow steel section which is bolted to the longitudinal edge of the precast slab and secured in place with bolts that will be screwed into threaded inserts embedded in the edges of the precast panels, as shown in Figure 4.

During the next construction shift, the temporary joint insert will be removed, headed studs will be attached to the threaded inserts, and a #5 reinforcing bar will be placed in the longitudinal gap in order to secure the grout within the edge gap as is also shown in Figure 4. The gap will then be filled with the appropriate grouting material.

Figure 5 illustrates the terminal transverse edge detail where the inlay slabs abut the existing HMA pavement. This joint is designed with a keyway cast integrally in the precast slab and is specified

to be placed approximately 12 mm from the vertically cut face of the existing pavement. This 12 mm gap will be filled with the same grout used for the typical transverse joints. This joint represents an area of concern which will be closely monitored throughout the life of the trial section. Unlike the longitudinal joints, this joint will be exposed to high traffic loading. Additionally, the interface being between materials of different moduli could result in differential deformation over time, which in turn could lead to increased stresses and surface water ingress.

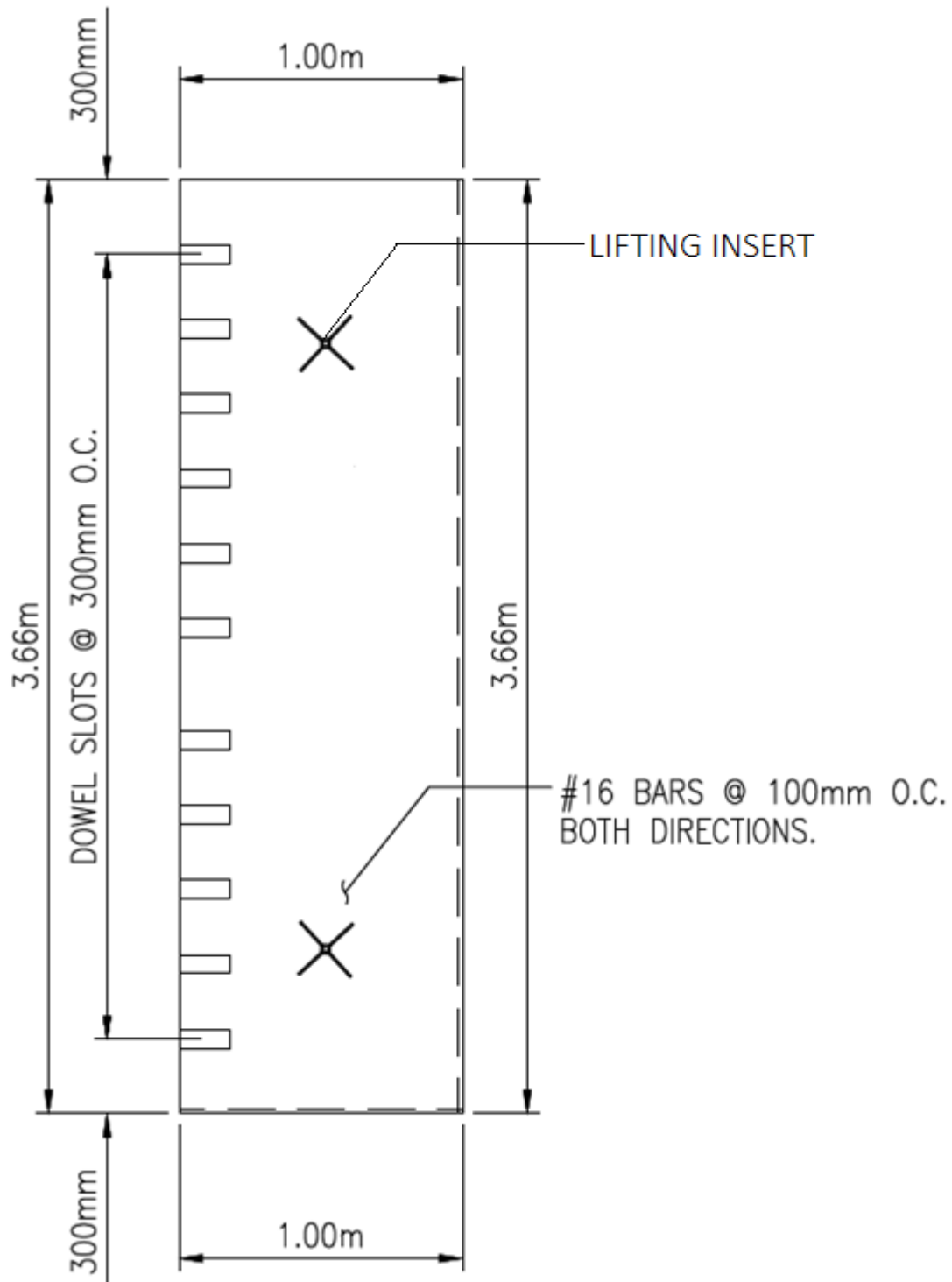


Figure 3: Temporary end slab detail (The Fort Miller Co., Inc. 2015)

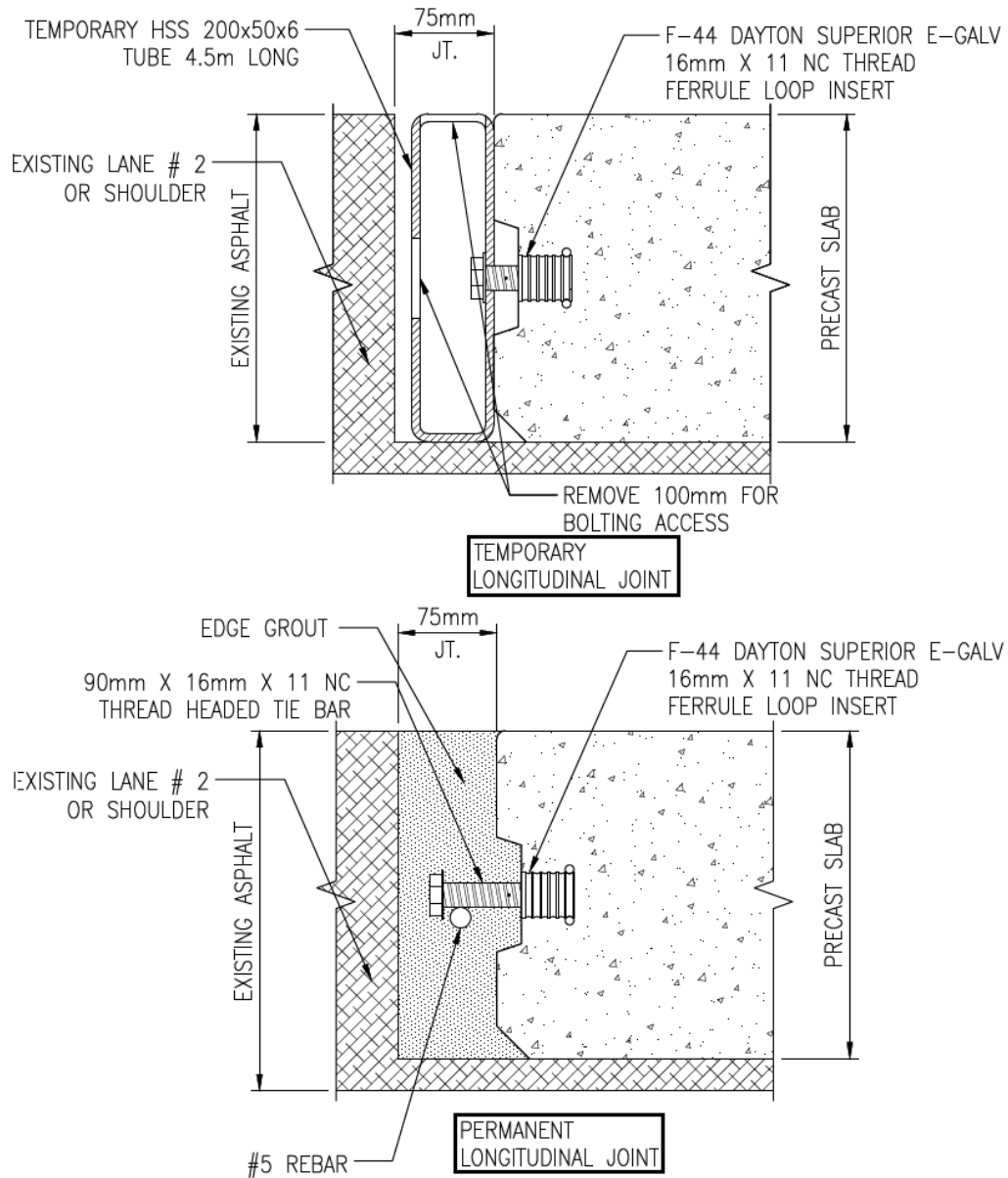


Figure 4: Temporary and permanent longitudinal edge details (The Fort Miller Co., Inc. 2015)

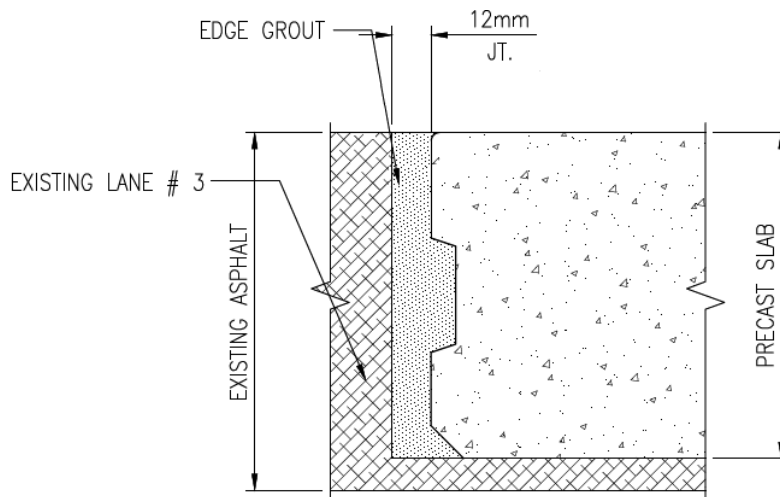


Figure 5: Terminal transverse edge detail (The Fort Miller Co., Inc. 2015)

Evaluation Plan

The evaluation of this rehabilitation method will have many components in order to gain a comprehensive understanding of its feasibility for regular use by the MTO. The evaluation plan will include five broad components, which will be evaluated with regard to each support condition being investigated as well as the overall rehabilitation method, as described below.

Construction Monitoring/ Discussions with Contractor

While construction is on-going, members of CPATT will be on-site monitoring and recording each night's activities. They will time individual construction processes and note any issues which arise throughout the course of the process.

Because this is a new strategy and there is an expected learning curve, consideration will be given to the types of difficulties associated with any new construction practice. Night-to-night improvements in repeated construction practices will be considered to assess each practice's constructability.

On-going discussions will be had with the installation contractor to help determine which activities pose the most difficulties or concerns. A wrap-up meeting will also be scheduled following the completion of the project to give the contractor an opportunity to summarize any concerns and suggestions for future implementation that they wish to provide.

Instrumentation

During the installation of the precast slabs, several pieces of sensing technology will also be installed. This technology will include earth pressure cells and moisture probes.

The earth pressure cells will be installed at the interface between the slabs and the HMA. This will allow for the collection of information relating to the stress being imparted by traffic loads through the precast slabs into the underlying HMA. This information will help to provide insight into the effectiveness of this rehabilitation strategy in extending the pavement life. Each earth pressure cell has a built-in temperature sensor. In combination with surface temperatures, this measurement can

provide information regarding the temperature gradients being experienced by the precast slabs under both day and night conditions.

Moisture probes will also be placed at the slab/HMA interface. Any moisture which permeates this interface could have an adverse effect on the durability of the repair method when it is exposed to freeze-thaw cycles throughout the course of a Canadian winter. The moisture probes will be used to monitor the presence of moisture and, if any is found to reach this level, the slabs will be monitored for signs of freeze-thaw damage.

Falling Weight Deflectometer Testing

The falling weight deflectometer (FWD) is a pavement testing tool which imparts a deflection in the pavement using a mass falling from a prescribed height and then measures the deflections at set distances from the point of impact using sensors. When considering rigid pavements, FWDs can be used to assess the load transfer across joints and cracks and also to detect voids beneath the pavement.

FWD testing will be performed on the test section no more than two weeks after the completion of construction. The testing will be performed using the testing configuration shown in Figure 6, which was taken from the Falling Weight Deflectometer Testing Guideline produced by the MTO (Ministry of Transportation Ontario 2005).

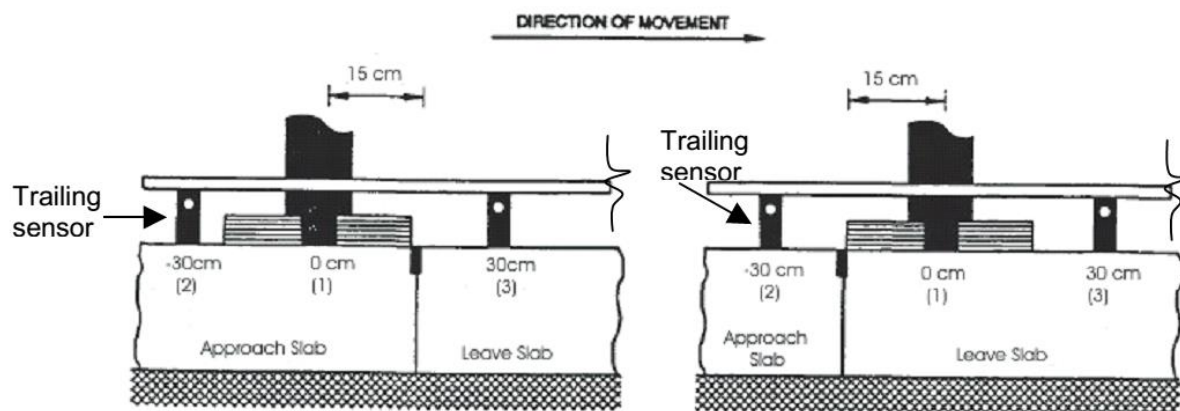


Figure 6: Typical Sensor Configuration for FWD Load Transfer Test (Approach and Leave Slab) (Ministry of Transportation Ontario 2005)

As shown in Figure 6, two sensors are located at an equal distance ahead of and behind the excitation source. A test is performed spanning the joint with each sensor, and the signal loss across the joint is compared to the signal loss measured at the sensor on the same slab as the excitation for each test. These values are then used to calculate the efficiency of load transfer across the joint.

Load transfer efficiency (LTE) above 70% is considered adequate by the MTO, depending on the severity of the joint. Below this threshold value, a full depth repair is generally recommended. LTE considers the ratio of the two deflections, but does not consider the deflection differential between the slabs. This can result in low LTE values at small total joint deflections in joints that are performing well. Conversely, the LTE value of a poorly supported joint can be acceptable even with significant total deflection (Snyder 2011). The LTE provides a component for assessing joint

performance, but the deflection differential will also be considered. This should provide a better indication of overall joint performance.

Testing will be performed at all joints within the extents of the project, according to the testing procedure specified by the MTO. This procedure specifies tests at the outer wheel path, slab centre, and slab edge. Testing will include all dowelled joints between adjacent slabs as well as the transverse joints between asphalt and the precast slabs at the two ends of the test section. The results of the initial FWD test will provide a baseline for future load transfer testing which will be undertaken throughout the test section's life cycle. Remedial action will be considered on any joints found to not meet the 70% threshold for load transfer efficiency and a specified maximum differential deflection value during the initial FWD testing.

If degradation of the slab support is suspected due to freeze thaw cycling, FWD testing will be used to determine if any loss of support can be detected. This testing will also be performed in accordance with the MTO's Falling Weight Deflectometer Testing Guideline (Ministry of Transportation Ontario 2005).

Noise Testing

An often-expressed concern with concrete pavements is the production of noise by the tire/pavement interaction. This concern has been found to be reduced through the use of longitudinal diamond grinding on the surface of the pavement without sacrificing the skid resistance of the pavement (Burgé, Travis, and Rado 2002). Longitudinal tining, turf drags, and exposed aggregate on concrete surfaces have also shown promise in reducing the noise of the tire/pavement interaction.

The placement of this test section will provide an opportunity to assess the noise characteristics of a precast concrete pavement in terms of tire-pavement noise. The panels will have a longitudinally-tined surface when initially constructed. The noise levels will be monitored throughout the pavement's life and will be considered in relation to the pavement condition at the time of testing.

Noise testing will be carried out within a month of construction, prior to and following surface texturizing such as longitudinal diamond grinding, and when any surface defects such as joint deterioration, is observed.

Visual Inspection

Visual inspections will be carried out at regular intervals throughout the course of the pavement lifecycle. Specific attention will be paid to joint condition and slab cracking as these are the most common surface defects associated with precast pavements. Furthermore, the condition of the HMA-to-precast and precast-to-HMA joints at each end of the test section will be closely monitored to assess the performance of this joint type.

Visual inspections will be comprehensive and performed on a slab-by-slab basis. This is feasible due to the relatively small scale of the project. This will help provide insight into the effects of the different slab support conditions.

Conclusions

The MTO is interested in investigating a novel pavement rehabilitation strategy for their high-volume HMA pavements. The HMA pavements are often reaching rutting failure in periods as

little as 3-4 years, which is necessitating relatively frequent highway closures for pavement repair. This issue is particularly prevalent in the rightmost lanes where most truck traffic is found.

The novel pavement rehabilitation strategy includes partial-depth milling of the rutted asphalt followed by installation of precast slabs into the pavement to match the previous pavement surface elevation and cross-slope characteristics. The precast slabs are intended to eliminate pavement surface rutting, thereby extending the pavement service life.

Precast slabs are fabricated and cured offsite prior to placement on site. This avoids the in-place curing period to attain the required concrete compressive strength of 20 MPa which can preclude cast-in-place concrete construction on the high-volume roadways which are associated with short overnight construction windows.

Off-site fabrication makes the concrete support conditions one of the most important design considerations for the concrete pavement. The study will consider three different approaches to providing support to the precast slabs: grade-, grout-, and HMA-supported.

The performance of the slabs under each support condition, as well as the overall pavement performance will be monitored throughout the course of the pavement's life. This monitoring will include documentation of constructability concerns during construction, pressure and moisture monitoring between the slabs and the HMA, falling weight deflectometer testing, noise testing, and visual inspections.

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