Precast Concrete Inlay Panel Installation Method Evaluation

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INTRODUCTION

- In recent years, the Ministry of Transportation of Ontario (MTO) has identified a need for a rehabilitation method that:
  a) has a long service life,
  b) can be installed in 8-hour construction windows, and
  c) can be installed reliably
- Because of good success in past, **PRECAST CONCRETE PANELS** were identified as a promising option
- **Support conditions** beneath panels are typically considered to be one of the primary considerations for a well-performing precast slab
- During detailed design, three different designs differentiated by their support conditions were produced
- A test section was constructed in September 2016 which incorporated each of the three designs
- This study considers and evaluates the support conditions based on their construction, including input from the MTO and Dufferin Construction, who constructed the test section

SUPPORT CONDITIONS

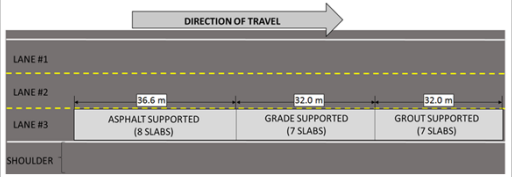
- Support conditions identified as main factor in slab performance
- Support beneath slab must be uniform (±3mm) and strong to provide full and lasting support to slabs
- The conditions affect all of the main evaluation criteria of this project, namely: durability, cost, and constructability
- Three different support conditions will be evaluated
  1. Asphalt Supported:
     - finely-milled asphalt supports slabs directly
  2. Grade Supported
     - Cement-treated bedding material screeded and compacted after milling to support slabs
  3. Grout Supported
     - Slabs are leveled using cast-in lifts and voids are filled using high-early strength grout

Design costs/benefits for support conditions

	Benefits	Costs
Asphalt Supported	· No extra support material required (CTBM, rapid setting grout) · Pavement can open as soon as slab is placed	· Unknown time requirement for precision milling · Requires pre-construction proof of concept · Asphalt surface must be clear of debris
Grade Supported	· Contractor familiarity with method · Pavement opened immediately · High smoothness of asphalt surface not a requirement	· Time/Effort required to place CTBM · Requires extra material (CTBM, water) and machines (laser level, compaction equipment) be brought on site
Grout Supported	· Slabs can be easily · Intensive surface preparation is not required · High smoothness of asphalt surface not a requirement	· Time is required for rapid setting grout to achieve sufficient strength · Cost of leveling lift is approximately 3-4 times higher than standard lifting insert · High cost of rapid setting grout

TEST SECTION CONSTRUCTION

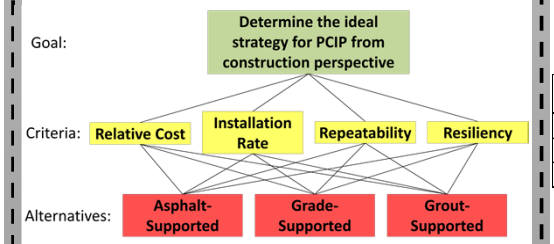
- The test section was constructed during September 2016
- Consisted of three sections, each defined by a different support condition
- Each section was placed during consecutive over-night construction periods and subjected to traffic loading between construction closures
- Lane #2 and Lane #3 were both closed for construction operation
- Grouting of slabs generally took place on subsequent night



Trial section location before (left) and after (right) construction (Google Maps, 2015 & 2016)

RESEARCH METHODOLOGY

- Each support condition design had unique construction-related considerations
- Since constructability is a key consideration in the feasibility of this rehabilitation technique, the relative constructability of each support condition was reviewed
- An analytic hierarchy process (AHP) was employed in order to rank the different support conditions according to a number of criteria, as well as to develop the relative weighting of these criteria
- Members of the Dufferin Construction team that performed the construction were asked to rank the three support conditions



CRITERIA DEFINITION

- **Relative Costs:**
  - The estimated costs associated with each support condition. While cost information was not made public, these costs are based on industry standard values and some unit costs provided by the contractor
- **Installation Rate:**
  - The rate at which the slabs could conceivably be installed. While on-site measurements were taken measuring the times of each support condition, these numbers included steep nightly learning curves. Based on experience, contractor estimates of nightly installation rates were used for comparison
- **Repeatability:**
  - This value reflects the relative ease with which each support condition was installed. Fewer and less difficult steps will result in a more consistently repeatable installation
- **Resiliency:**
  - How easily construction/unforeseen issues can be addressed using the given technique. For instance, adjustable levelling feet and gradable bases provide some resiliency in the case of milling issues.

RESEARCH METHODOLOGY

- The average responses from both MTO and Dufferin personnel are shown below

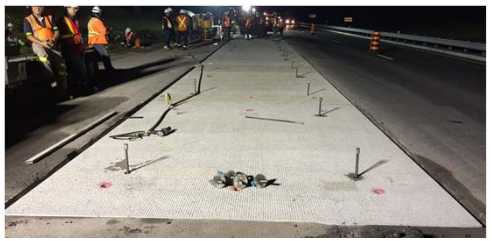
Support Condition	Average Values: Cost ($)	Installation Rate (est. panels/night)	Repeatability (/10)	Resiliency (/10)
Asphalt	106855	40	5.4	6.4
Grade	108621	30	8	5.8
Grout	107072	43	8	6.2
Relative Weighting	0.138	0.338	0.168	0.356

- The values for each criterion were subjected to an AHP to determine relative values (shown below)
- Values were then considered based on the weightings obtained from MTO
- Based on the construction-related criteria, the Grout-Supported slabs were found to be the best method to address the MTO's general criteria

Construction Type	Cost	Installation Rate	Repeatability	Resiliency	Overall Score
Asphalt-Supported	0.046	0.120	0.042	0.124	**0.332**
Grade-Supported	0.045	0.090	0.063	0.112	**0.310**
Grout-Supported	0.046	0.129	0.063	0.120	**0.358**
Σ	0.138	0.338	0.168	0.356	1

CONTRACTOR COMMENTS

- Wider grinding head would improve constructability of all types
- Milling depth and accuracy is limiting factor for Asphalt-supported slabs
- GPS/laser guidance for milling machine to better control milling depths could make this option more feasible
- Since short construction periods are goal of this rehabilitation technique, extra steps in Grade-supported slabs seem counter-productive
- Regardless of technique, built-in lifting jacks should be included in slabs as safety measure in case of over-milling
- Grout-supported option identified as most "stress-free" alternative, due to less stringent milling requirements and forgiving leveling procedure
- Some steps identified as redundant:
  - Saw-cutting longitudinal and transverse joints prior to milling
  - Minimize edge gaps to avoid HSS-tubes, longitudinal reinforcement



CONCLUSIONS/FUTURE

- Based on the criteria and comments from contractors, the grout-supported design was found to be the ideal solution, though all options scored similarly in the AHP
- Grout-supported slabs require curing time and potentially a second grouting crew due to the large amount of grout required in relation to other designs
- Final selection of support condition could be largely dependent on the performance characteristics of the test section
- This performance will be measured using:
  - FWD testing for load transfer efficiency
  - Noise/friction measurements
  - Sub-surface instrumentation monitoring
  - Detailed condition surveys

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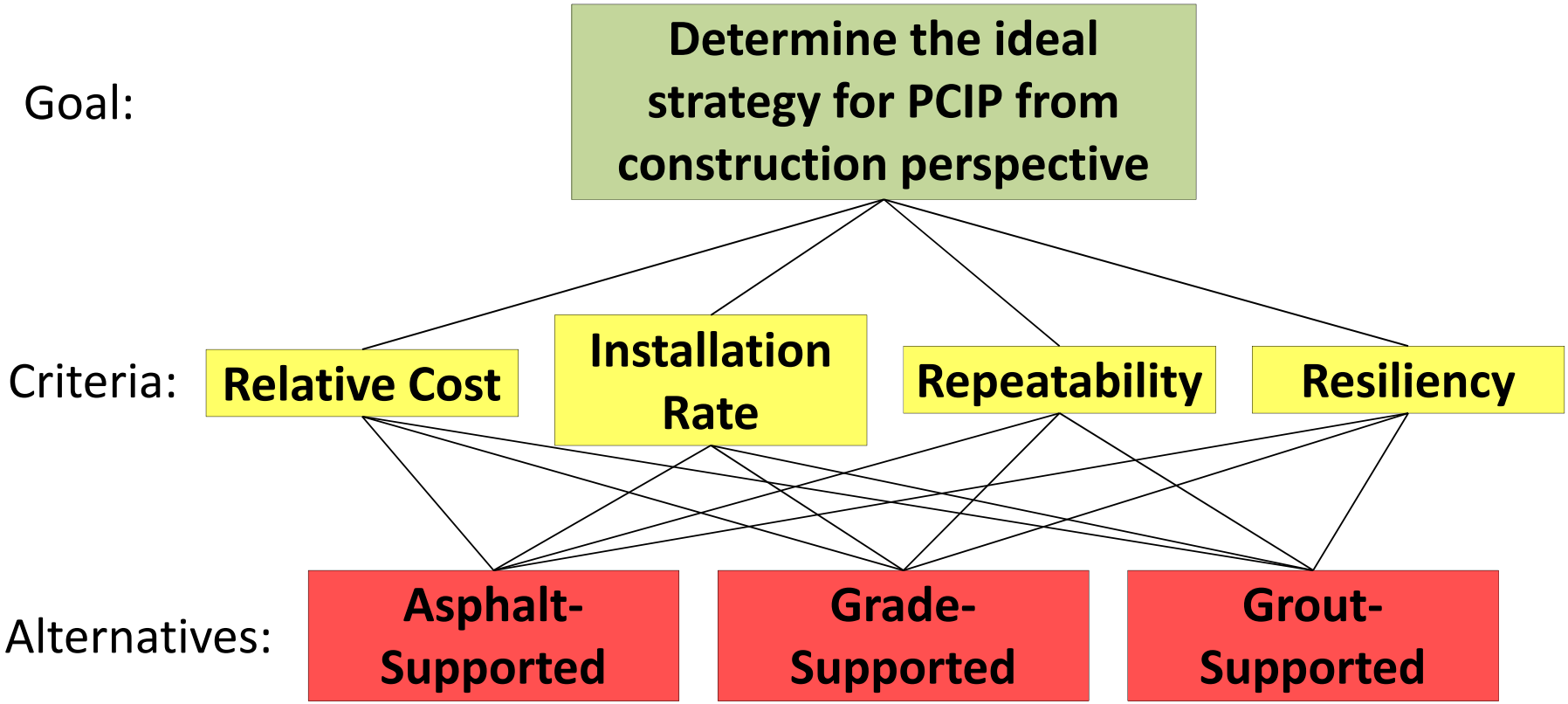
Goal:
Determine the ideal strategy for PCIP from construction perspective
Criteria:
Relative Cost
Installation Rate
Repeatability
Resiliency
Alternatives:
Asphalt-Supported
Grade-Supported
Grout-Supported