Introduction to Provincial Concrete Pavements

January 28, 2021

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Presentation Overview

- Summarize main changes to MTO's concrete pavement specification.
- Summarize results from MTO contracts where new specification has been used.
- Give overview of alternative bid contracts.

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Concrete Pavement Specification Update (2018)

MTO Concrete Pavement Specification

In early 2018, MTO updated their concrete pavement specification implementing a number of changes resulting in:

- Improved joint durability
- Improved surface friction
- Quieter pavements (longitudinal grooving)
- Smoother pavements

Some minor additional changes were made in early 2019, and another update to the specification will be issued in early 2021.

Premature Joint Deterioration

Changes to address premature joint deterioration:

- Concrete properties
- Joint design

Other Changes

- Smoothness requirements tightened.
- Measurement of smoothness using an inertial profiler replaces use of California profilograph.
- Final surface texturing – longitudinal grooving of hardened concrete replaces transverse tining.
- Owner quality assurance testing replaces contractor quality control testing for acceptance, and referee processes added for measurement of:
  - Dowel Alignment (using MIT Scan)
  - Pavement Smoothness
- Insoluble residue requirements to increase friction (in OPSS 1002 – Aggregates - Concrete).

Joint Deterioration – Hwy 417

- Premature joint deterioration 8 years after construction.
- Many joints visibly deteriorated at the pavement surface.
- Cores revealed that many joints that appear to be intact, actually have signification levels of deterioration below the sealant.


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Are other MTO highways affected?

- Investigation to assess joint performance on other provincial highways.
- Cores taken from two other sections of concrete pavement (on Hwy 401 and Hwy 410).
- The sections examined are not showing any signs of deterioration at the surface, but cores show that some freeze-thaw damage is occurring in the joint, although damage is less severe than Hwy 417.

Hwy 410 (Constructed in 2007) – Core 2A

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Hwy 410 – Core 2A

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Hwy 410 – Core 2A

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Investigation – Cause and Solution

In order to determine the cause(s) of the problem and solutions, MTO carried out a comprehensive investigation in 2014 which included:

- Field investigation (field review, coring and testing)
- Review of literature and practices of other jurisdictions
- Discussions with:
  - Other transportation agencies (e.g. New York DOT)
  - Technical organizations (e.g. American Concrete Pavement Association (ACPA))
  - Technical experts including Dr. Peter Taylor, Director of Concrete Pavement Tech Centre and Prof. at Iowa State and Dr. Shiraz Tayabji, President, Advanced Concrete Pavement Consultancy
  - Ontario industry

Findings

- Deterioration mechanism: freeze-thaw damage of critically saturated joints.

- Level of deterioration varies between contracts, and between stages of the same contract.

Contributing Factors

Marginal Quality of Concrete

- strength
- permeability
- air void system

Saturated Joints

- drainage, water not draining through the joint
- joint design

Changes to Specification to Address Joint Deterioration:

Specified Concrete Material Properties:

- **Compressive Strength** (28 day)
  increased from 30 MPa to 35 MPa (tested on cores).
- **Permeability** (28 day) - introduced requirement for maximum of 2500 coulombs using Rapid Chloride Permeability test (tested on cores).
- **Air Void System** – added requirement for minimum hardened air content of 3% and maximum spacing factor of 0.230 mm (tested on cores).

Slag Content:

- Maximum allowable slag content increased from 25 to 30%.

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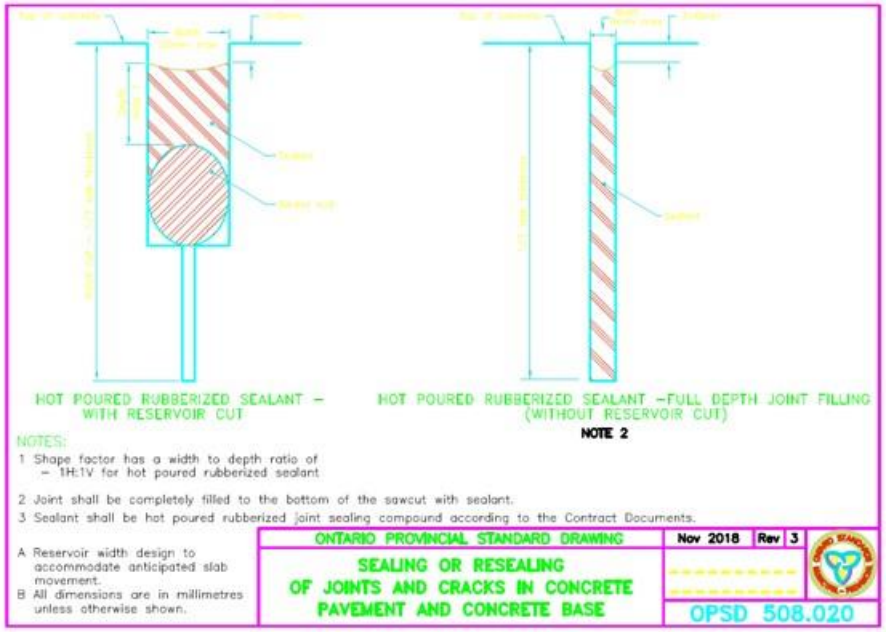
Changes to Specification to Address Joint Deterioration:

Joint Design

- To minimize the amount of water present in the joint:
  - Joint filling is done – the joint sawcuts are completely filled with joint sealant (removed reservoir cut, and backer rod).
  - Joint width is narrowed, maximum sawcut width is 6 mm.
  - A low modulus sealer is specified.
- Joint filling has been used successfully by other agencies (e.g. New York DOT) and is recommended by experts in the field.
- It is also outlined in an American Concrete Pavement Association (ACPA) Technical Bulletin (TB010-2018).

OPSD 508.020



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QC → QA

- Owner Quality Assurance testing replaces Contractor Quality Control testing for acceptance, and referee processes added for measurement of:
  - Pavement Smoothness
  - Dowel Alignment (using MIT Scan)

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Smoothness Measurement Equipment

- High Speed Inertial Profiler Replaces California Profilograph
- MTO Correlation Programme for Inertial Profilers to Measure Concrete Pavement

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Smoother Pavement

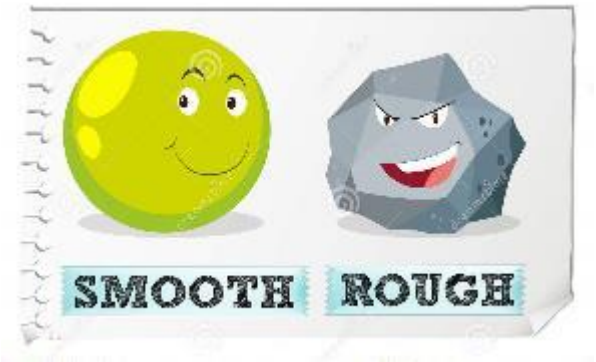


Table 5 : Sublot Payment Factors Based on MRI

(MRI - Mean Roughness Index)

MRI (m/km)	Sublot Payment Factors
≤ 0.500	1.200 (subject to Note 1 & 2 given below)
> 0.500 to 0.650	1.867 - (1.333 x MRI) (subject to Note 1 & 2 given below)
> 0.650 to 1.000	1.000
> 1.000 to 1.250	2.200 - (1.200 x MRI)

Notes:

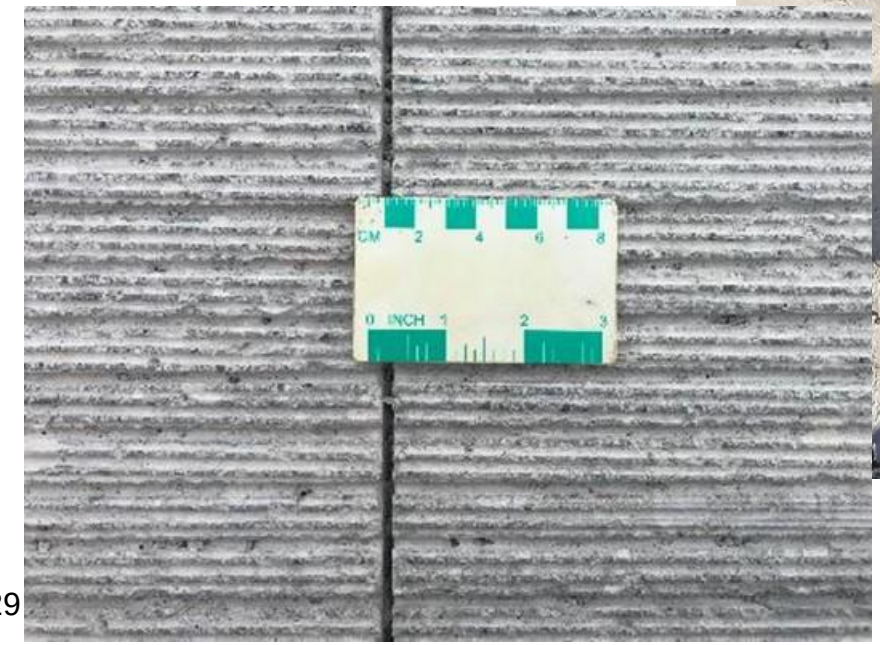
1. The payment factor shall not exceed 1.000 for subsequent MRI measurements which are taken after repairs regardless of the reason for the repairs.
2. The payment factor for concrete base shall not exceed 1.000.

Better Friction

- Fine aggregate shall have a minimum insoluble residue content of 60% when tested according to LS-613.
- Acid insoluble residue testing that restricts the carbonate content of fine aggregate is used by many transportation agencies as an indicator of aggregate suitability for pavement frictional performance.

Quieter Pavement → Grooving

- Longitudinal grooving of hardened concrete replaces transverse tining of plastic concrete.



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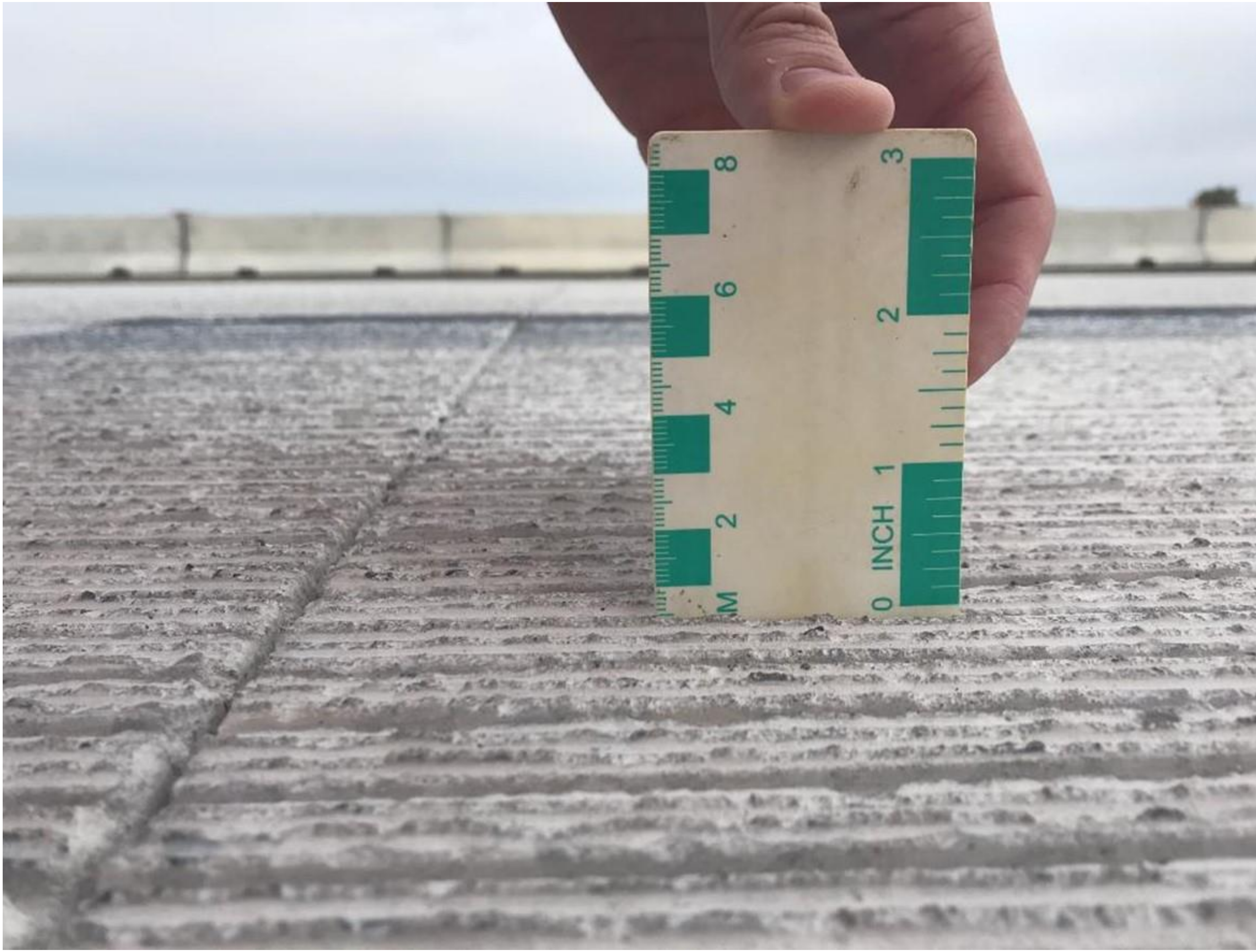
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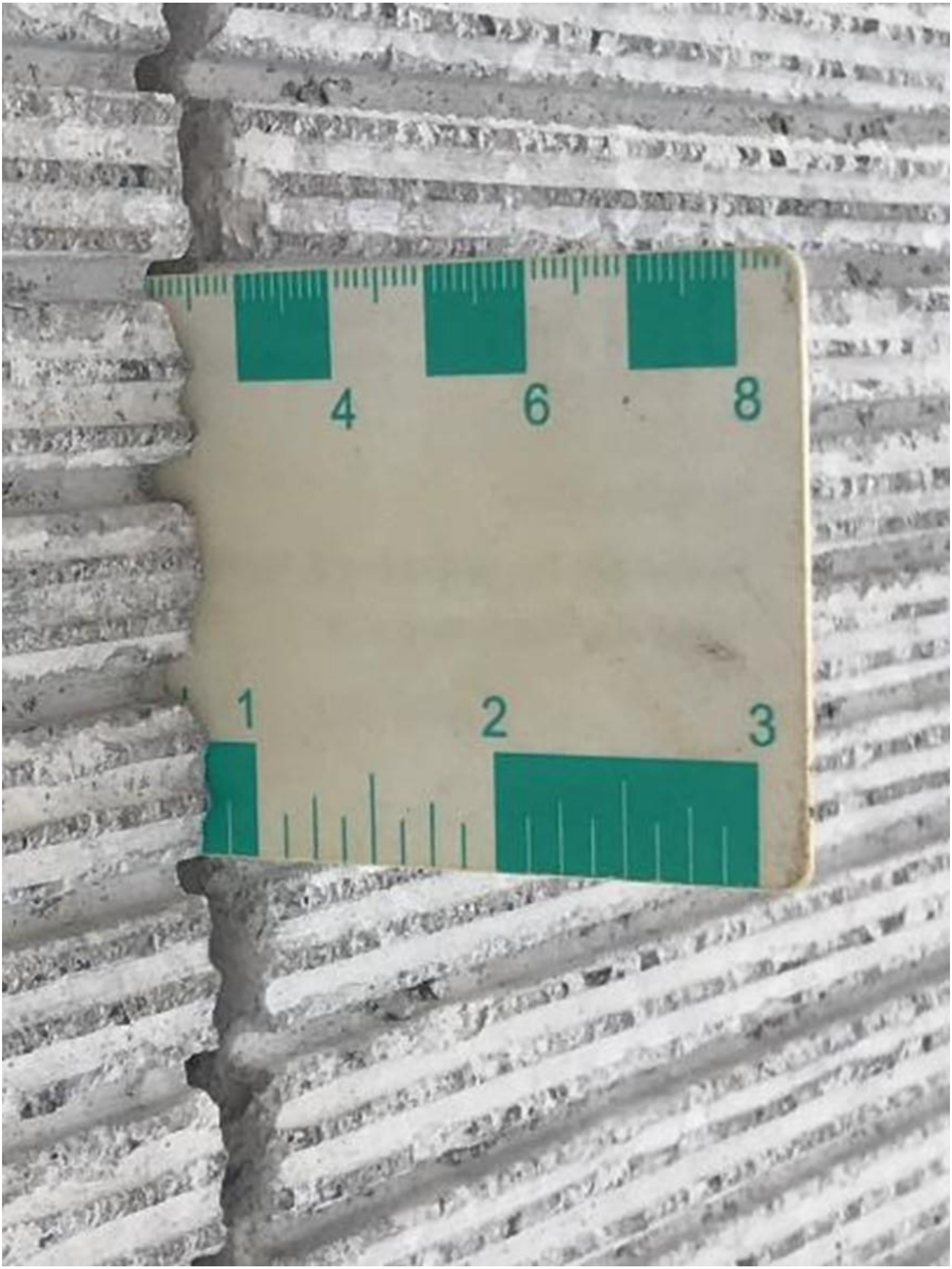
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Summary of New Concrete Pavement Specification

- Improved concrete properties
- New joint design for durability
- Smoother pavement – better ride
- Longitudinal grooving – less noise
- Better friction properties

Contract Results With 2018 Specification

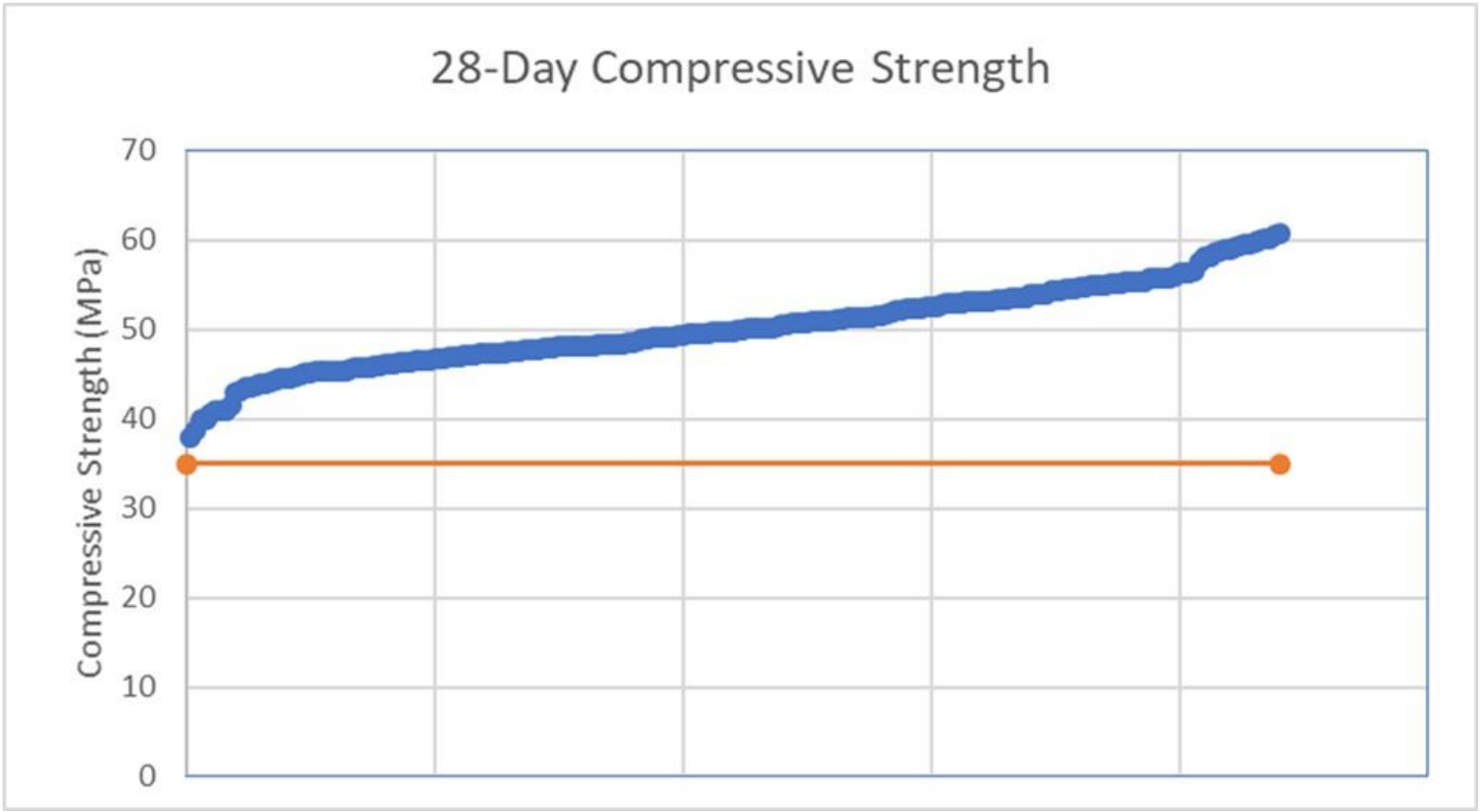

CHESTER

Summary of Contract Results

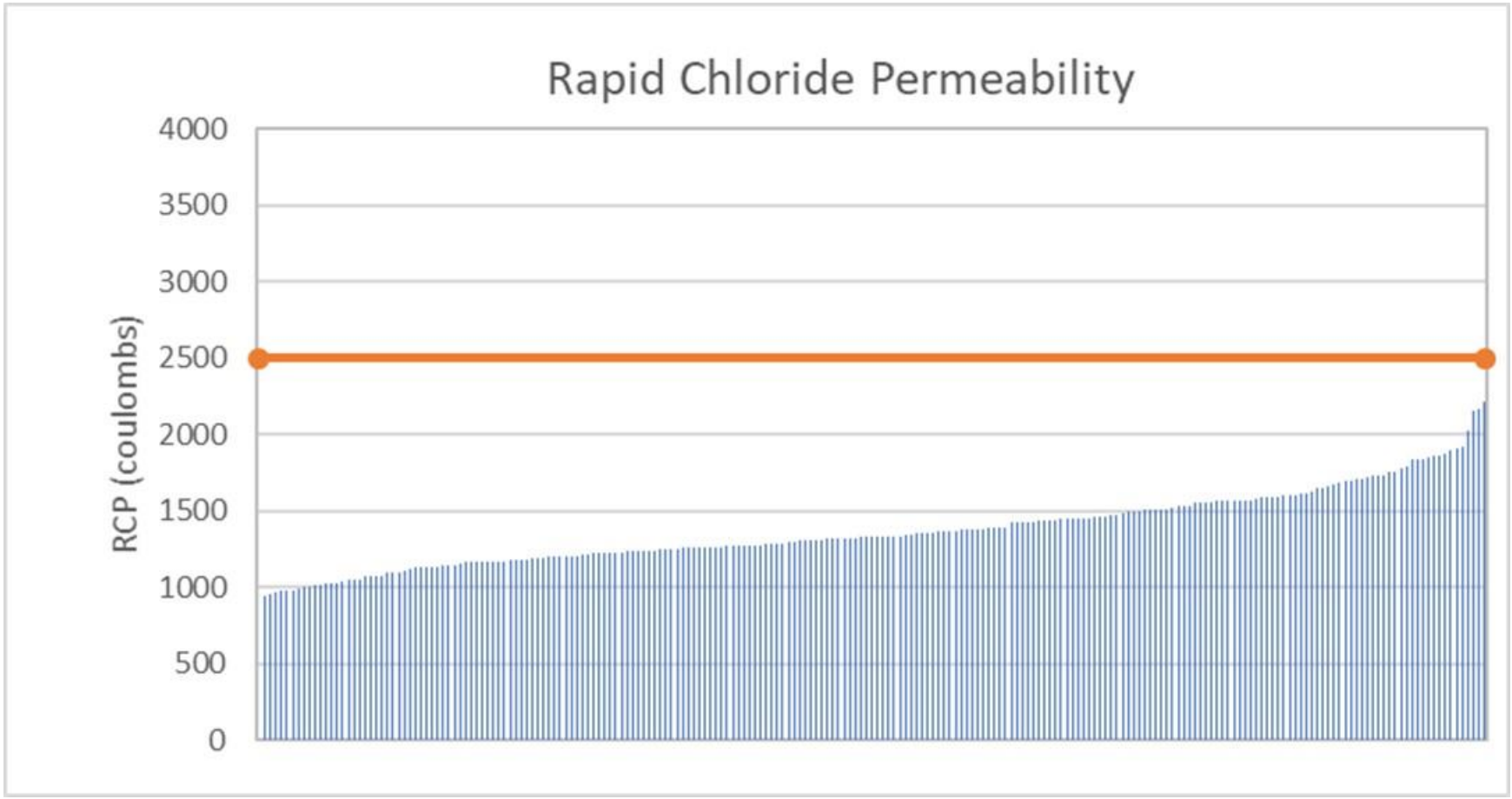
Criteria	Average Results	Requirement
28-day Compressive Strength (MPa)	50.2	35 (minimum)
Hardened air content (%)	4.6	3.0 (minimum)
Spacing Factor (mm)	0.156	0.230 (maximum)
RCP (coulombs)	1377	2500 (maximum)
MRI Smoothness (m/km)	0.698*	1.000 (maximum)

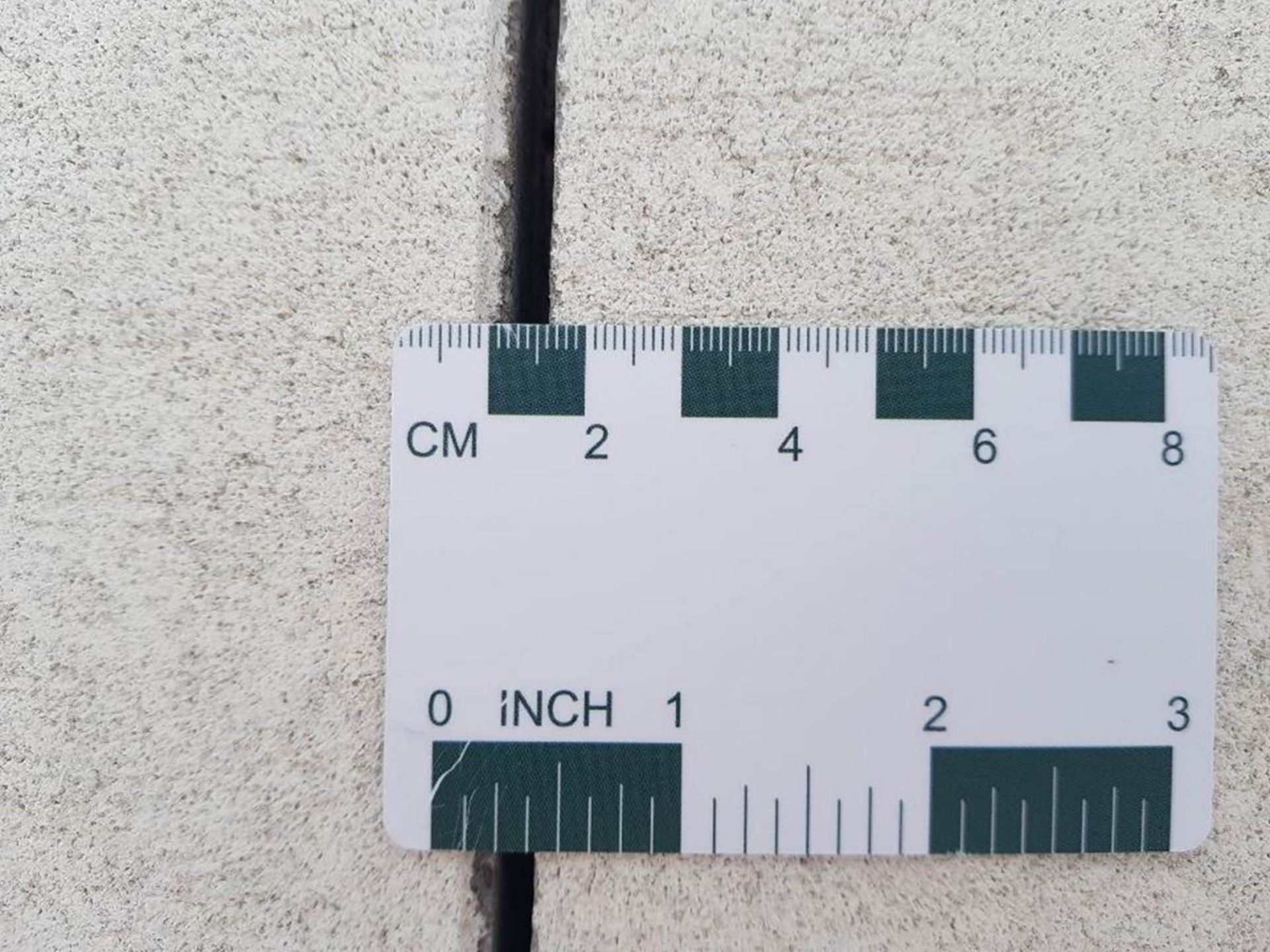
*Note: Some sections were diamond ground.

28-day Compressive Strength – multiple contracts



28-day RCP Results – multiple contracts

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Specification Updates

Specification Updates - February 2019

Some minor changes were made to the specification in 2019:

- Reduced maximum bonus for smoothness from 5% to 2%. Total maximum bonus for concrete pavement is 5% (2% smoothness, 2% AVS, 0.5% strength, 0.5% thickness), maximum for concrete base is 3%.
- Clarified that MIT scan data should be converted to absolute values prior to analysis.
- Application of curing within 15 minutes of being formed by paver.
- Sealing of joints may be done prior to or after grooving.
- Joints must be “topped up” within 8 hours.

Planned Updates to Specification - 2021

- Thickness: additional core for thickness measurement taken after any repairs, QA and referee done on same core.
- Relaxed smoothness requirements for concrete base by 20%.
- Dowels: concrete strength must be 20 MPa prior to drilling dowels into hardened concrete.
- Joint Sealing:
  - Added provision for samples to be taken at joints to determine if the joints have been sealed according to the specification requirements.
  - Require a double boiler, oil jacketed kettle.
- Sublot Size: For lots greater than 50,000 m^2, the Contractor may elect to submit a proposal to divide the lot into sublots of approximately 2000 m^2.

Aggregate Stockpile Contamination

CONCRETE ONTARIO

Technical Bulletin

November 13, 2019 T-097

Concrete Aggregate Inspection Procedures to Prevent Contamination

At a recent MTO Liaison Committee meeting the issue of concrete aggregate contamination was raised. While the requirements of the RMCAO Plant Certification program are clear, all members are encouraged to review their aggregate stockpiling and handling operations to ensure that contamination of the material does not take place. Issues that should be reviewed on a routine basis at both portable and fixed concrete plant locations include:

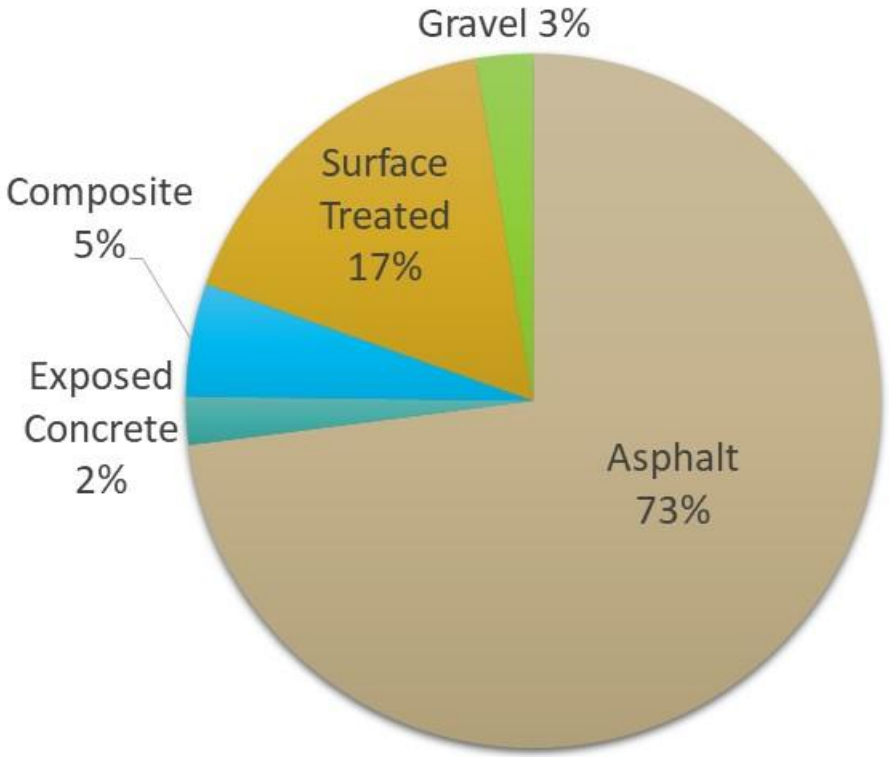
Aggregate Loading & Transportation Procedures – Care must be taken by the aggregate producer when loading aggregates into haulers that only the aggregate material that is specified is loaded into the trucks. Stockpiles should be clearly separated and when aggregates are not stored on hard paved surfaces, care must be taken not to load materials from the granular base below the pile. Secondly, while dedicated aggregate hauling trucks are not always available, the beds of all trucks must be inspected for potential contamination and fully cleaned prior to hauling concrete aggregates.

Concrete Plant Aggregate Loading Procedures – Once the aggregate materials have been stockpiled at the concrete plant, similar care must be taken by the concrete producer when storing and loading concrete aggregates into the concrete plant. The stockpiles must be clearly separated from one another to prevent material contamination, and the loader operator must ensure that the pattern of material extraction from the pile prevents segregation of the fine material. Additionally, when aggregates are not stockpiled on paved surfaces, care must be taken to ensure that contaminants are not dragged into the aggregate piles by the loader tires and that the loader does not excavate into the granular base of the pile.

Additional resources regarding aggregate stockpile procedures can be found on the Ontario Stone, Sand & Gravel Association (OSSGA) website (www.ossga.com)

MTO's Use of Life Cycle Costing and Alternative Bid Contracts

MTO Pavement Types 2019



	Lane-km
Asphalt	29,544
Exposed Concrete	905
Composite	2,129
Surface Treated	6,839
Gravel	1,075
Total	**40,492**

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Alternative Bid Contracts

- Alternative Bid (AB) contracts were first implemented by MTO in 2001.
- AB contracts incorporate Life Cycle Cost (LCC) into the bidding process to allow both asphalt and concrete contractors to bid on the same contract.
- AB contracts were initially required for all new and full depth reconstruction freeway projects, five 2-lane km or longer in length.
- The AB policy was updated in March 2012 to allow non-freeway projects, including arterials.
- The intent is to allow selection of the most cost-effective long-term pavement design.

AB Contracts

- AB contracts require the preparation of two pavement designs, one asphalt and one concrete, and two sets of contract documents.
- Under the AB process, bidders determine their Construction Bid for a concrete or asphalt option, then add a Bid Adjustment Factor, included in the tender documents, to their Construction Bid.
- Bid Adjustment Factors are calculated by MTO in advance, based on LCC models.
- The lowest Total Adjusted Bid wins.
- 20 Alternative Bid contracts have been awarded to date, fostering competition for both industries and allowing them equal opportunity to bid the work

Moving Forward:

- New and improved MTO standards for smoother, quieter and more durable Ontario pavements.
- Demonstrated contractor success in meeting the new requirements.
- Alternative Bid process provides for selection of most cost-effective pavement.

Thank You!

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