

**ENGLOBE**

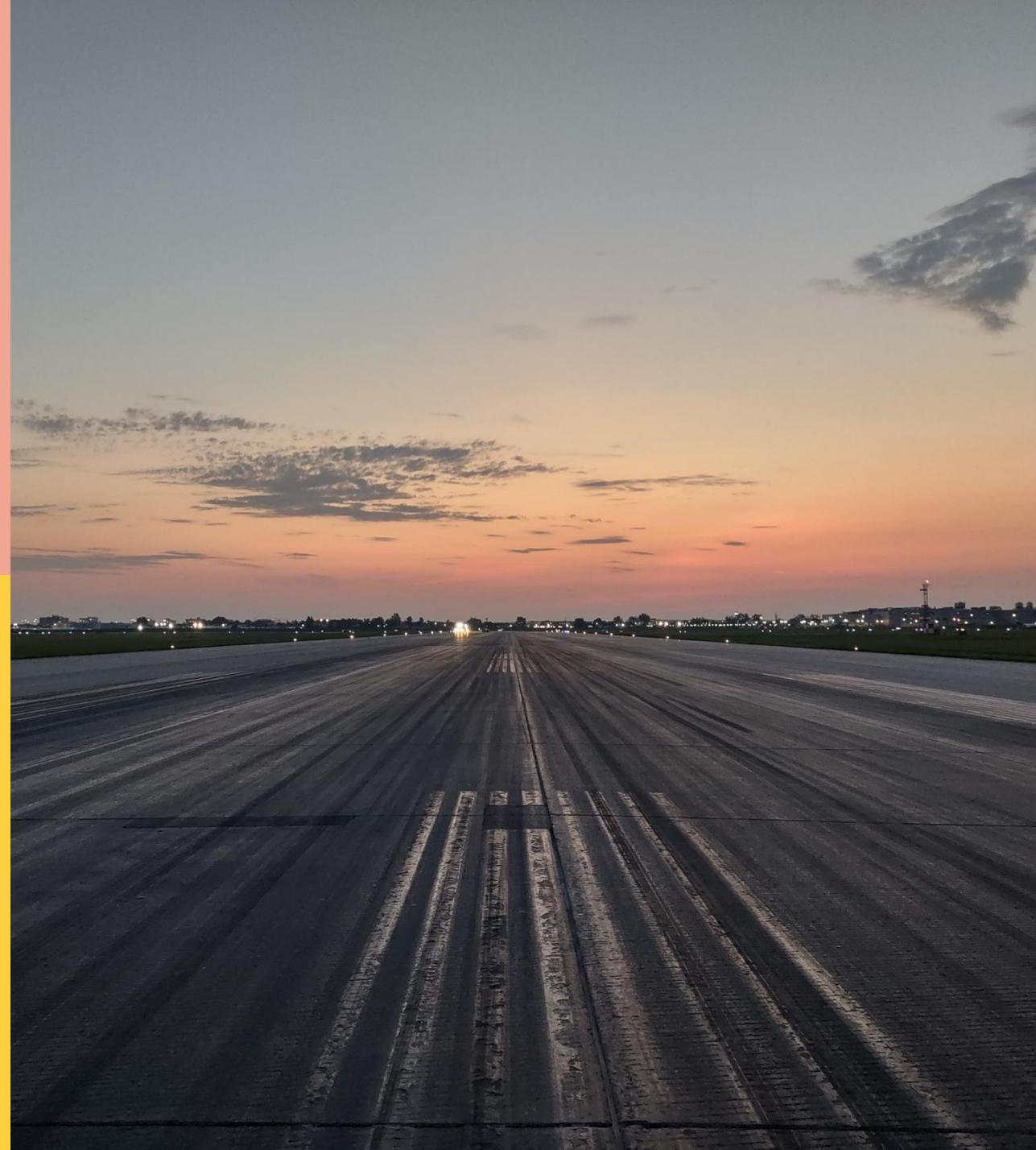


# Challenges of PCR Implementation at Canadian Airports

**SWIFT 2025**

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# Outline



Traffic Data - Lack of Accurate Data and its impact on the results



Existing Pavement structures - Incomplete Data and Composite Pavements



Field Investigations - Access to Airside and Working with Canadian Winters



Impact of Frost Protection on PCR values



# Traffic Data



# Key Components of PCR Calculation

Input:

- Pavement structure
- Traffic mix and annual departures
- Evaluation period

1

### Critical Aircraft

- Aircraft with highest contribution to total CDF
- All other aircrafts are removed from the traffic mix

2

### Annual Departures

- Adjust the annual departures of the critical aircraft to obtain the CDF previously calculated

3

### Maximum Allowable Gross Weight

- Adjust the weight of the critical aircraft to obtain a CDF of 1 considering the adjusted annual departures
- This is the MAGW

4

### PCR

- The PCR is equal to the critical aircraft's ACR at MAGW



# Impact of traffic data and evaluation period

## Rigid Pavement Structure:

- Concrete slab thickness: 395 mm
- Concrete Flexural Strength: 5 MPa
- Granular base thickness: 850 mm
- Subgrade modulus: 85 Mpa
- Construction year: 2012
- **PCN : 91 R/AW/T (PCN > ACN)**

## Flexible Pavement Structure:

- Asphalt thickness: 265 mm
- Granular base thickness: 1,010 mm
- Subgrade modulus: 33 Mpa
- Last rehabilitation: 2020
- **PCN : 101 F/DW/T (PCN < ACN)**

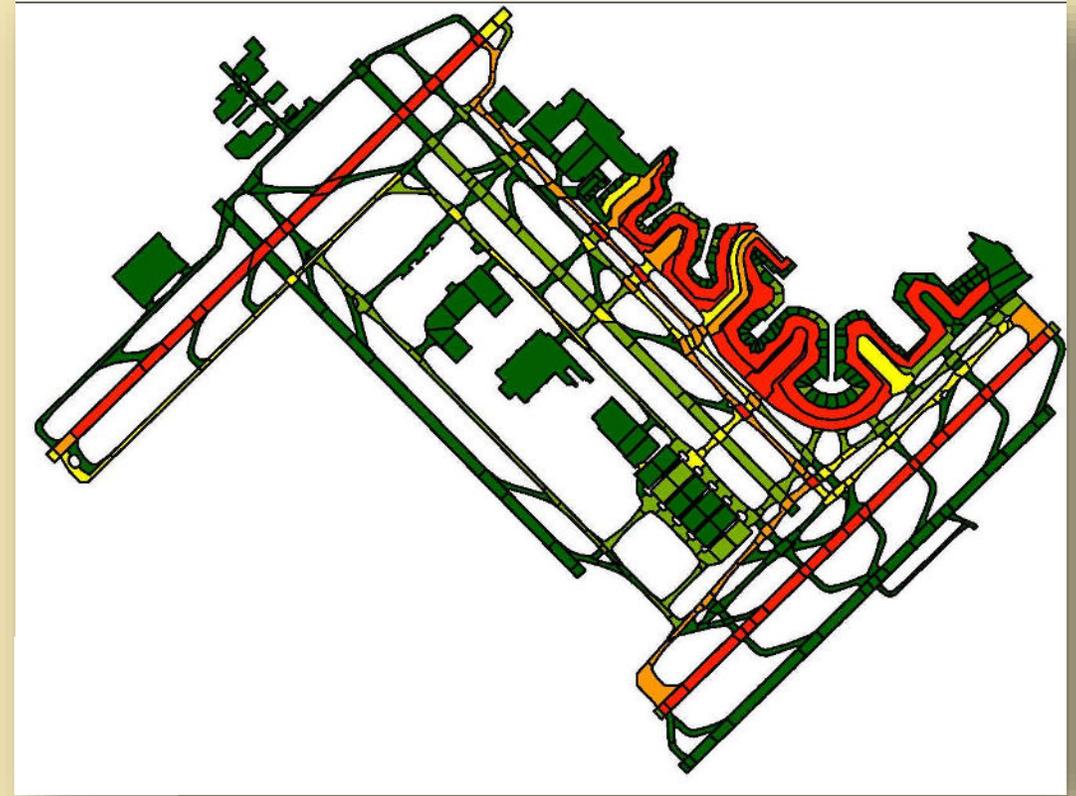
Rigid Pavement	Max ACR	PCR				
		100% of traffic	75% of traffic	50% of traffic	25% of traffic	10% of traffic
20 year evaluation period	1,177	1,050	1,080	1,110	1,170	1,260
7 year evaluation period	1,177	1,150	1,180	1,220	1,290	1,390

Flexible Pavement	Max ACR	PCR				
		100% of traffic	75% of traffic	50% of traffic	25% of traffic	10% of traffic
20 year evaluation period	1,232	940	970	1,010	1,090	1,230
15 year evaluation period	1,232	970	1,000	1,040	1,130	1,290



# Multilateration System (MLAT) Data

- With the data, the pavement structures can be sectioned according to the traffic data:
  - Types of aircrafts
  - Departures vs arrivals
  - Frequency
  - Entry and exit
- Depending on the development work going on at the airport, the available MLAT data might not be representative of the current traffic - it could however give an estimate of the traffic distribution



# Existing Pavement Structures



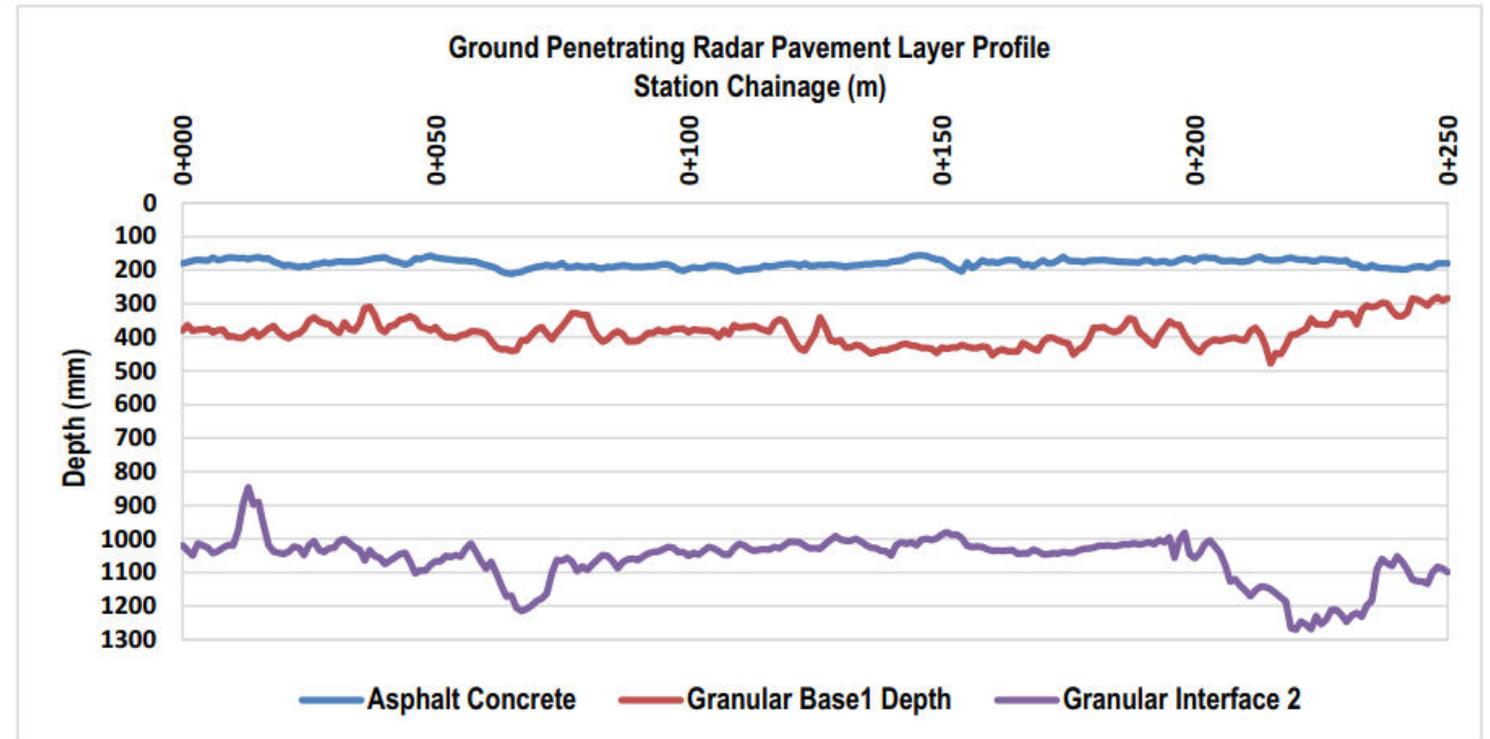
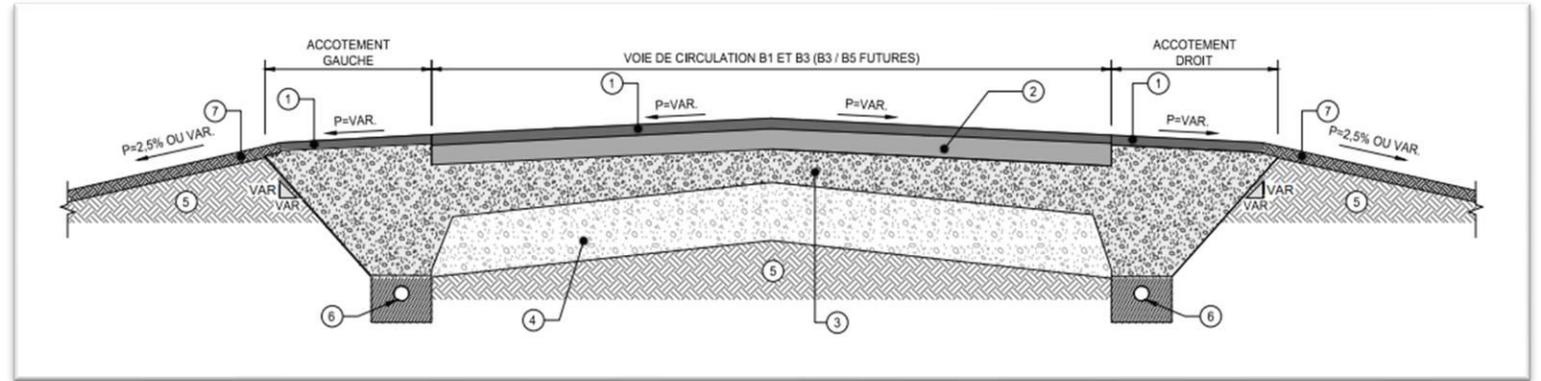
# Comparing As-built to GPR Data - Taxiway B5

## According to as-built:

- Asphalt thickness: 150 mm
- New granular base thickness: variable
- Existing granular base thickness: unknown

## From GPR Data:

- Asphalt thickness: 180 mm
- New granular base thickness:  $\pm 200$  mm
- Existing granular base thickness:  $\pm 675$  mm



# Comparing As-built to GPR Data - Taxiway B

## According to as-built:

- Concrete slab thickness: 410 mm
- Existing asphalt: 125 to 195 mm
- Existing concrete slab: 305 mm

## From GPR Data:

- Concrete slab thickness:  $\pm 410$  to 430 mm
- Existing asphalt: none or  $\pm 150$  to 165 mm
- Existing concrete slab:  $\pm 265$  to 290 mm

## From Google Earth:

- We could confirm that concrete slabs had been constructed in around 2004 at the B3 and B5 intersections before the whitetopping rehabilitation in 2010



# Modeling Sandwich Pavements in Faarfield

## FAARFIELD

- According to the FAARFIELD Design Manual:  
« Design of overlays on existing rigid pavements which already have an asphalt overlay cannot be done directly using FAARFIELD because a PCC surface layer cannot be placed further down than the second layer in a structure. »
- The method suggested is to create a user-defined or variable stabilized layer in the pavement structure.

## Transport Canada (PCN)

- For the PCN evaluation (AC 302-011), TC has a clear method to incorporate composite pavement for PCN evaluation (section 5.4 - 7):
  - If the separation course is less than or equal to 15 cm in thickness, the thickness of the two slabs is converted to an equivalent single slab
  - If the separation course is greater than 15 cm in thickness, the upper overlay is considered to act independently as a single slab



# Examples of Different Concrete Pavement Condition and their Associated SCI Values

SCI ≥ 80



80 ≥ SCI ≥ 67



SCI ≤ 67



Cement Stabilized Base



# Composite Pavements Impact on PCR

### Pavement Structure:

- Concrete Slab: 425 mm
- Asphalt: 150 mm
- Concrete Slab: 215 mm
- Granular Base: 575 mm

### Concrete modulus:

- PCC surface: 27,579 MPa
- User defined layer - SCI of 80: 20,000 MPa
- User defined layer - SCI of 67: 12,000 MPa
- Cement treated base: 3,447 MPa

Subgrade Modulus	PCR			
	FAARField - User Defined Layer		FAARField - Cement Treated Base	Transport Canada - Equivalent Slab
	SCI of 80	SCI of 67		
105 MPa	1,390	1,340	1,270	1,210
75 MPa	1,470	1,420	1,350	1,290
50 MPa	1,480	1,440	1,380	1,340



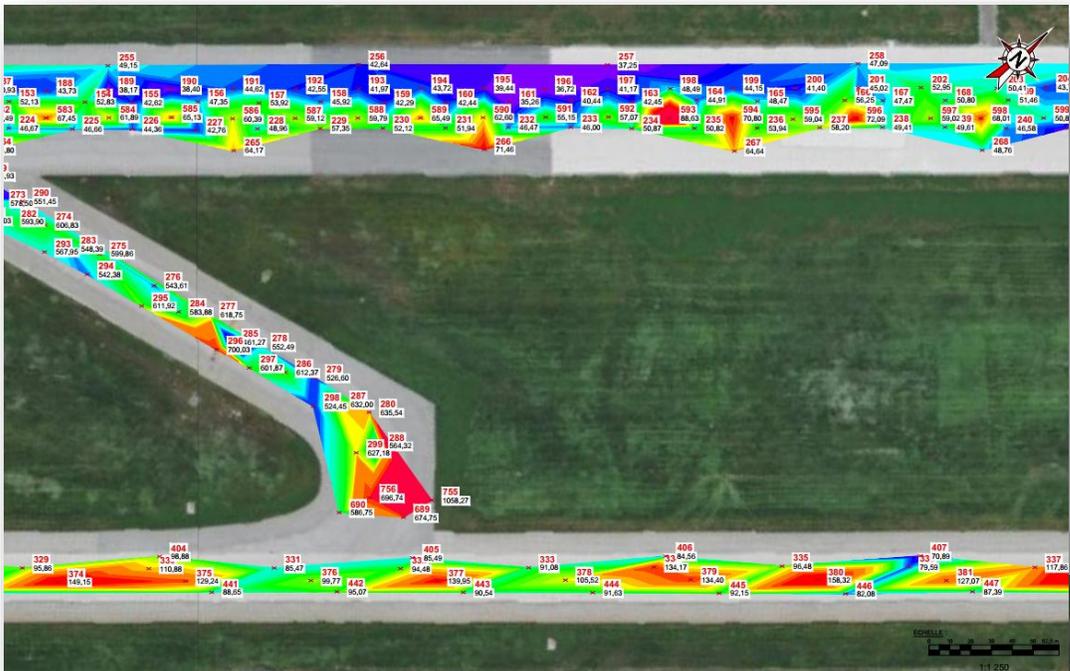
# Field Investigations



# Limiting the Impact on Airside Operations

Heat maps are created from the HWD data and boreholes can be strategically placed to investigate further.

By having GPR data, it is also possible to limit the amount of boreholes needed in existing pavement structures when no rehabilitation work is planned

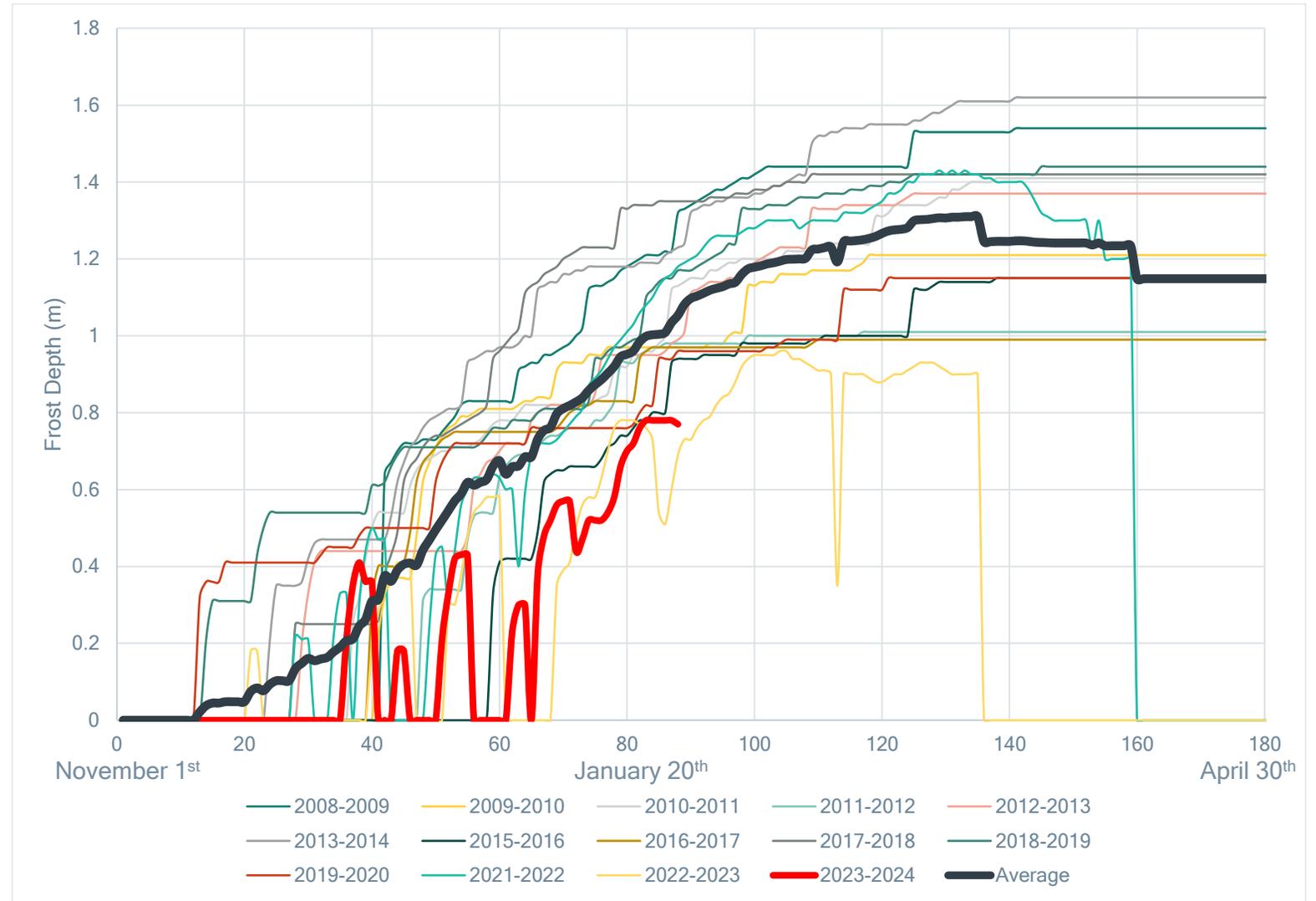


# Freeze-Thaw Monitoring

In order to maximize the available time for the field investigations, a freeze-thaw monitoring can be done to determine more precise start and stop dates.

In the case of the Montreal-Trudeau international airport, we were able to use publicly available road-weather data from the Ministère des Transports et de la Mobilité durable (MTMD).

However, if such data isn't available, a thermistor string can be put in place to monitor the frost depth in the pavement structures and subgrade.



# Impact of Frost Protection on PCR values



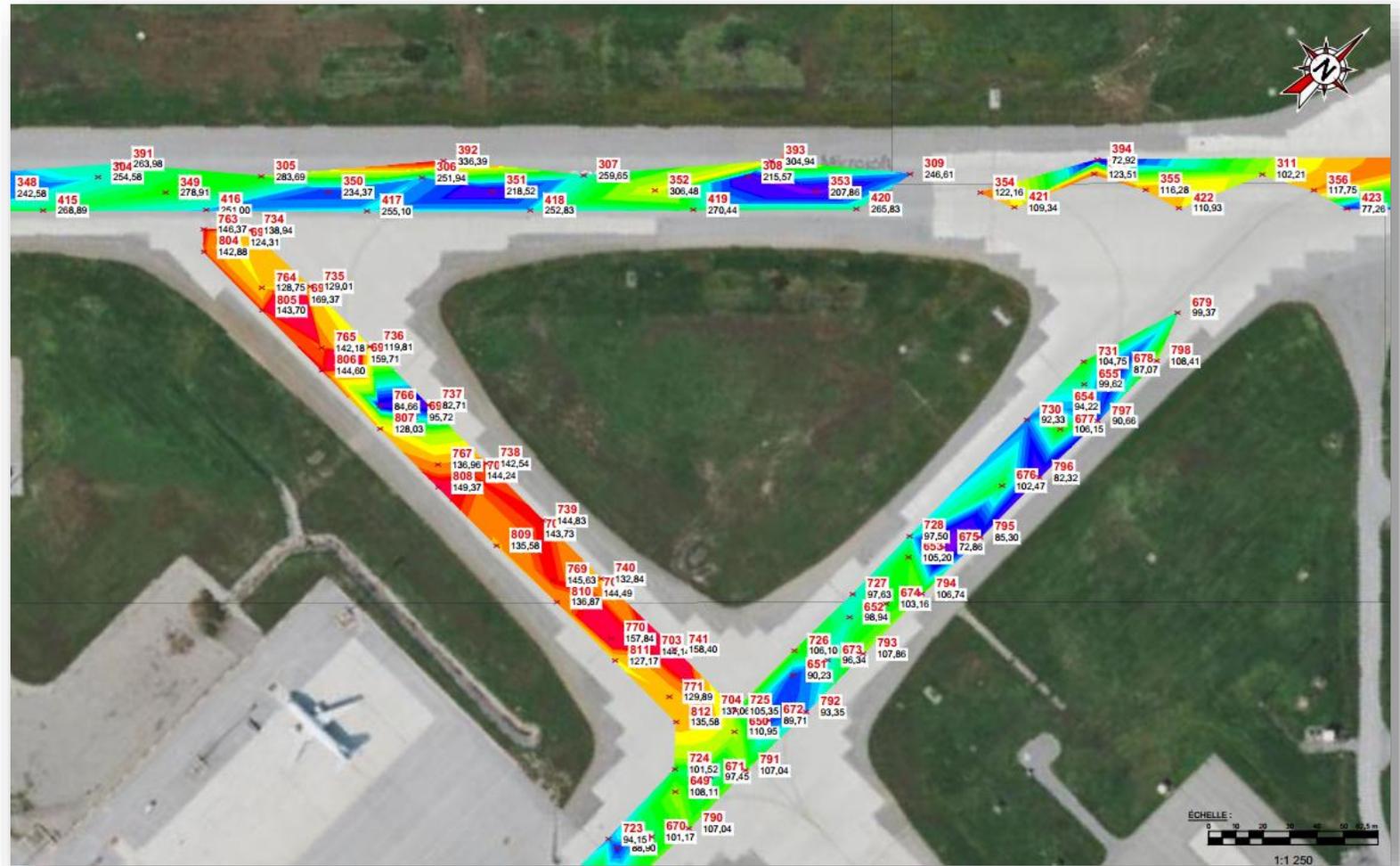
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# Impact of Frost Protection on HWD Data

## Comparison of taxiways E and I at YUL:

- From boreholes and DCP results, there is no change in the subgrade type or strength
- From HWD D9 results, a different subgrade response is obtained
- Stable backcalculated moduli for the PCC and the granular base for taxiway I and not for taxiway E



### Taxiway I:

- Concrete thickness: 395 mm
- Granular Base thickness: 820 mm

### Taxiway E:

- Concrete thickness: 410 mm
- Granular Base thickness: 1,700 mm

# Impact of Frost Protection on PCR

The main impact of frost protection on PCR is an exaggerated PCR value compared to the maximum ACR. When this is the case, its recommended to limit the PCR to 1.25x the maximum ACR.

However, it should not be assumed that a thick granular base guarantees a high PCR value, given that frost protection might have been considered in the original design.



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

## Advisory Circular

**Subject:** Standardized Method of Reporting  
Airport Pavement Strength - PCR

**Date:** 4/29/2022

**AC No:** 150/5335-5D

**Initiated By:** AAS-110

**Change:**

B.6.3.4

As there is no upper limit on the ACR-PCR scale, it would be acceptable to publish PCR 1568/F/D, which would have the effect of allowing unrestricted operations of all aircraft. However, such a number has no practical meaning, because no existing or planned aircraft yield ACR numbers in that range. A more conservative alternative would be to arbitrarily select a value 25% larger than the largest ACR of all using aircraft in the list and publish that value as the PCR. In this example, the largest ACR is for the B777-200ER (878/F/D), so publish PCR = 1098/F/D/X/T.

PCR limit of 1.25 x ACR



# Conclusion



# Challenges of PCR Implementation at Canadian Airports

## Traffic Data

- Necessity of accurate traffic data and evaluation period
- Interpretation of MLAT data to optimize the traffic considered

## Existing Pavement Structures

- GPR testing to obtain detailed information on the existing pavement structures
- Use of engineering judgement for concrete modulus in composite pavements

## Field Investigations

- Optimization of field investigation through different types of data collection
- Monitoring of road-weather data to extend the investigation period

## Frost Protection

- Determining the depth of base/subbase to obtain representative subgrade modulus
- Limiting the PCR to 1.25x ACR



# Thank you!

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