SWIFT
WORLD'S PREMIER
AIRFIELD OPERATIONS CONFERENCE

captg
Canadian Airfield Pavement Technical Group

Vancouver
September 15 – 18, 2014

Do's and Don'ts with Airfield Concrete Pavement

GTAA

Toronto Pearson
International Airport | Aéroport International

Concrete Pavement Distresses and Repair Methods at Toronto Pearson

Presented by Chris Stewart, Manager Airside and Infrastructure Engineering

SWIFT
WORLD'S PREMIER
AIRFIELD OPERATIONS CONFERENCE

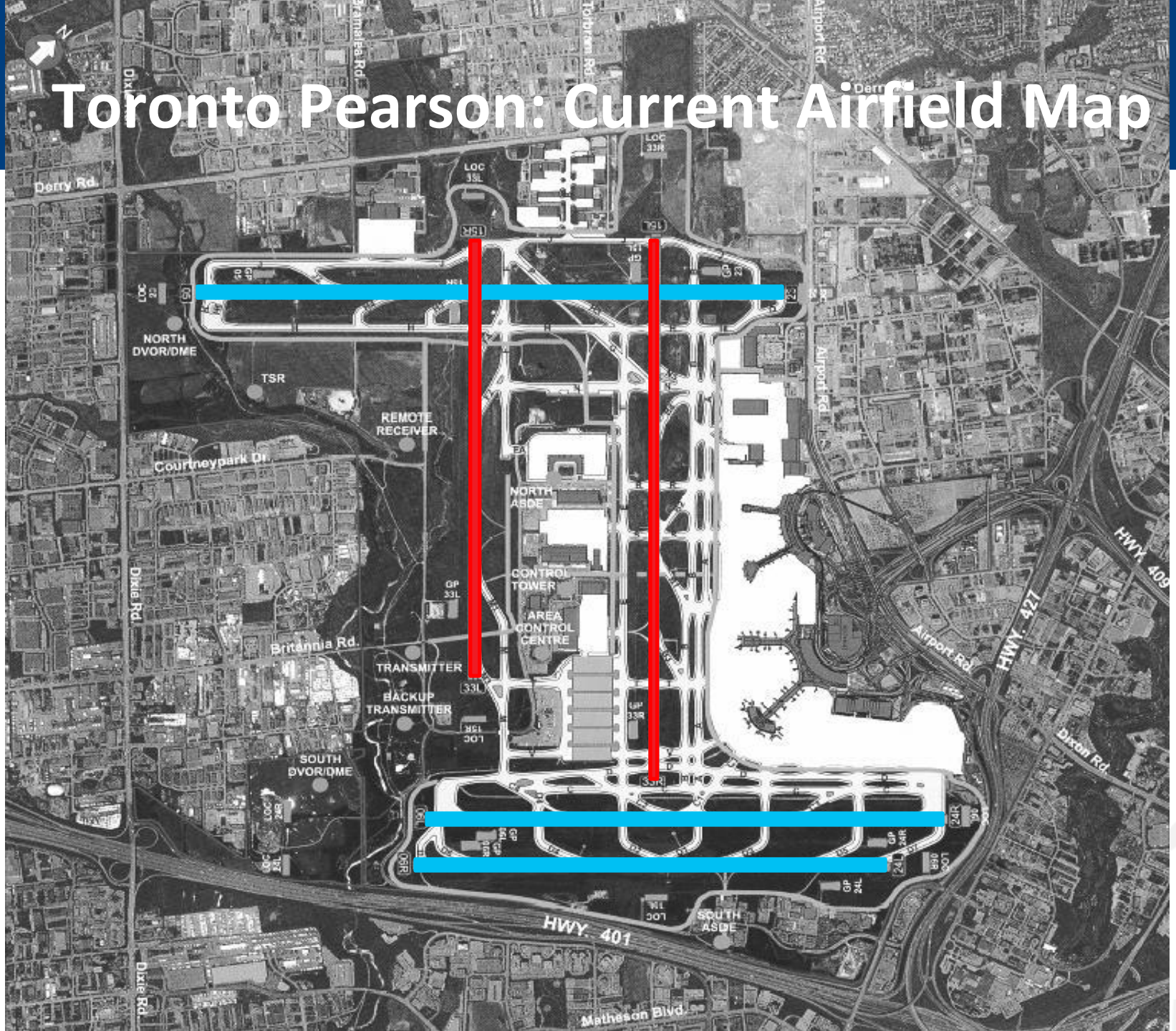
captg Canadian Airfield Pavement Technical Group

A little humour to start (completely unrelated)

- A man walks into the Police Station wishing to speak with the burglar who had broken into his house the night before
- “You’ll get your chance in court” said the Desk Sergent
- “No, No, No!” said the man. “I want to know how he got into the house without waking my wife. I’ve been trying to do that for years!”

One more that is airport related

Toronto Pearson: Current Airfield Map



Toronto Pearson Airport – Canada's Largest Airport

- 2011 Passenger Volume: 33.4 Million PAX.
- Ranking in North America: 12th busiest airport
  (in terms of passenger volume)
- Total airside paved areas: approx. 5,838,000 m2
- (concrete and asphalt)
- # aircraft movements: approx. 428,000 annually
- Cargo processed in 2011: over 500,000 kg

Toronto Pearson Airport – Canada's Largest Airport (cont'd)

- Toronto currently operates using 5 runways; three in the east-west direction and two in the north-south direction.

05-23	3,389 m (11,120 ft)
06L-24R	2,956 m (9,697 ft)
06R-24L	2,743 m (9,000 ft)
15L-33R	3,368 m (11,050 ft)
15R-33L	2,770 m (9,088 ft)

- A Central Deicing Facility (CDF) which consists 6 deicing pads and having the capability of deicing and staging up to twenty four (24) narrow bodied and twelve (12) wide body aircraft or any combination of the two simultaneously.

Concrete Pavement Distress & Repair: Outline

Concrete Pavement Distress & Repair: Outline

1. Concrete Pavement Distress: Issues
2. Concrete Pavement Distress: Common Types & Causes
3. Concrete Pavement Distress: Impact on Quality
4. Methodology for Concrete Repair
5. Concrete Pavement Repairs

1. Concrete Pavement Distresses: Issues

- What are the causes of the distress?
- What are the consequences of not addressing the existing distress?
- How long before conditions deteriorate to the point where they become hazardous?
- Does the proposed treatment of repair option address the cause of the distress? Or will the distress eventually re-occur?
- How will the application/construction of the proposed option affect traffic operation?

1. Concrete Pavement Distresses: Issues (cont'd)

- Should a temporary treatment be considered?
- What is the cost of the proposed treatment or repair option?
- What is the life expectancy of the proposed treatment or repair? What is the remaining service life of the pavement?
- Does the proposed option coincide with other rehabilitation plans?
- How can the above different issues be balanced?

2. Concrete Pavement Distress: Common Types

- CORNER CRACKS
- DIAGONAL CRACKS
- TRANSVERSE CRACKS
- SPALLING AT JOINTS
- STEPPING
- ERRATIC CRACKS

PCC Pavement Defects: Corner Cracks

PCC Pavement Defects: Diagonal & Corner Cracks

PCC Pavement Defects: Transverse Cracks

PCC Pavement Defects: Spalling at Joints & Compression Cracks

CAUSE: IMPROPER JOINT SEALING, DEBRIS IN JOINT PRESENT MOVEMENT

PCC Pavement Defects: Joint Faulting/Stepping

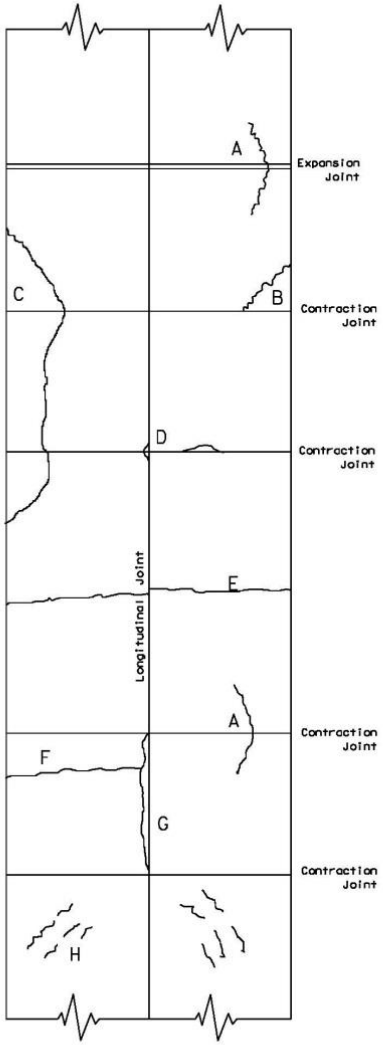
PCC Pavement Defects: Erratic Cracks

CAUSE: SUBGRADE SETTLEMENT, FROST HEAVE, FRICTION BONDING TO SUBBASE

2. Concrete Pavement Distress: Causes

TORONTO PEARSON
GTAA

Greater Toronto Airports Authority
Engineering
P.O. Box 6031, Toronto AMF, Ontario, Canada L5P 1B2
Fax (416) 776-4640



A – A Crowfoot Crack:
These may be parallel to the pavement edge or at an angle. They may be caused by failure to extend expansion-joint filler to the edge of the pavement, or by infiltration of foreign material into the end of either expansion or contraction joints.

B – A Corner Break:
These cracks, which generally form a rough isosceles triangle with sides at least 450mm long, are caused by overstressing the pavement.

C – A Diagonal Crack:
These are caused by a differential in subgrade support. This may be due to settlement or volume change of the subgrade (frost heave/settlement)

D – Spalls:
These may develop at any joint or at an intersection of two joints. They may be caused by improper joint construction or infiltration of foreign material at the top of the joint.

E – Transverse Cracks:
These may be caused by the omission of a contraction joint or by using a joint spacing too great to control cracking.

F – A Transverse Crack:
These cracks, which occur 1.2m to 2.4m, ahead of the joint, are ususally caused by loss of subgrade support due to pumping.

G – A Longitudinal Crack:
These are caused by the omission of intermediate longitudinal joints in wide construction lanes.

H – Plastic-Shrinkage Cracks:
These are caused by rapid loss of water from the fresh concrete, which may be due to lack of early curing, rapid evaporation from the surface, or loss of water because of a dry subgrade or a dry,absorptive aggregate.

NO.	INIT.	DATE:	REVISIONS
DRAWN: FH	DESIGNED:	APPROVED: MFM	
ENGINEERING		DATE: 04/22/04	

PAVEMENT CONSTRUCTION
PCC PAVEMENT DEFECTS AND CAUSES

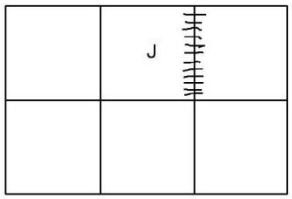
SHEET 1 OF 2 | FILE:
SD90C115-1

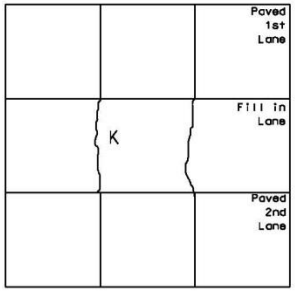
TORONTO PEARSON INTERNATIONAL AIRPORT

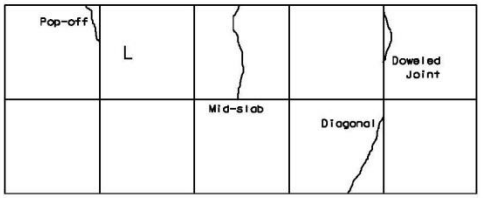
sd90c115-1.dgn 9/12/2014 2:51:17 PM

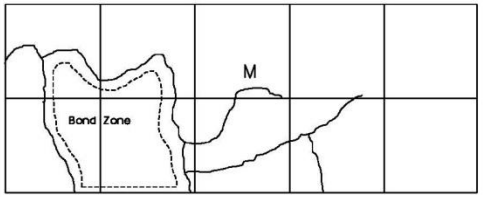
TORONTO PEARSON
GTAA

Greater Toronto Airports Authority
Engineering
P.O. Box 6031, Toronto AMF, Ontario, Canada L5P 1B2
Fax (416) 776-4640









J – Doweled Joint Subsidence:
Occurs directly over dowel bars, due to subgrade subsidence or sloughing or high slump concrete over embedded bars.

K – Edge Restraint:
Typical of not sawing concrete slab or sawing too late thereafter. A form of sympathy cracking.

L – Random Crack Formations:
Typical of sawing too late.

M – Erratic Cracks:
Typical of high friction or bonding to subbase or major subgrade settlement or frost heave or loss of subgrade support causing differential movement, or a combination of both.

NO.	INIT.	DATE:	REVISIONS
DRAWN: FH	DESIGNED:	APPROVED: MFM	
ENGINEERING		DATE: 04/22/04	

PAVEMENT CONSTRUCTION
PCC PAVEMENT DEFECTS AND CAUSES

SHEET 2 OF 2 | FILE:
SD90C115-2

TORONTO PEARSON INTERNATIONAL AIRPORT

sd90c115-2.dgn 9/12/2014 2:52:26 PM

3. Concrete Pavement Distress: Impact on Quality

Pavement Defects	Defect Influence on Pavement Quality Characteristics				
	Strength	Smoothness	Skid Resistance	Structural Integrity	Surface Drainage
Slab Cracking	X	X		X	
Corner Cracking	X			X	
Edge Cracking	X			X	
Scaling & Spalling		X		X	
Joint Faulting		X		X	
Surface Texture			X		X
Rubber Deposits			X		
Settlement/ Ponding		X	X		X
Frost Heave		X			
Patching		X		X	
“Pot-Holes”		X		X	
Shoulder Erosion				X	
Shoulder Slopes					X
Catch Basin Heave					X

4. Methodology for Concrete Repair

- Review Existing Conditions
  - Geotechnical Reports
  - Design Records
  - Year Constructed/Service Life
  - Maintenance Records
  - Existing Underground Utilities
  - Surface and Sub-surface Drainage
  - Design Aircraft and Mix
  - Future Use

4. Methodology for Concrete Repair (cont'd)

- **Evaluate Prior to Diagnose**
  - Evaluate Pavement Condition Surveys
  - Service Life remaining
  - FOD generation
  - Distress Analysis and Cause

- **Recommend Repair Method**
  - Options: Temporary or Permanent
  - Funds Available
  - Benefit Analysis/Life Cycle Costing
  - Recommended Option
  - Documents for repair

5. PCC Pavement Repairs: General Rules

< ¼ INCH (6.5 MM)	LEAVE ALONE
¼ – ½ INCH (6.6 – 13 MM)	ROUTE AND SEAL
3/8 – 1 INCH (9.5 – 25 MM)	TIE STITCHING & ROUTE SEAL
> 1 INCH (25 MM)	FULL DEPTH REPAIR

NOTES:

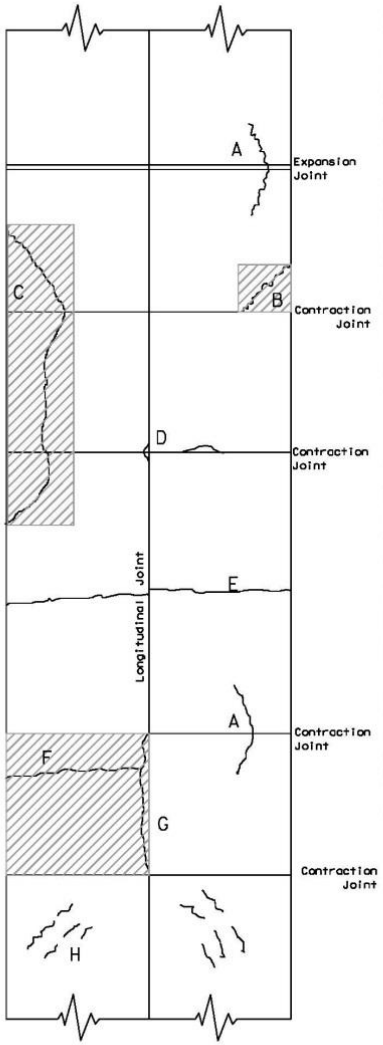
PCC SLABS WITH MORE THAN TWO CRACKS OVER 13 MM WIDE, FULL SLAB SHOULD BE REPLACED

CORNER CRACKS LARGER THAN 13 MM SHOULD BE PARTIALLY FULL DEPTH REPLACED

5. PCC Pavement Repairs: General Guide

TORONTO PEARSON
GTAA

Greater Toronto Airports Authority
Engineering
P.O. Box 6031, Toronto AMF, Ontario, Canada L5P 1B2
Fax (416) 776-4640



A – A Crowfoot Crack:

These may be parallel to the pavement edge or at an angle. They may be caused by failure to extend expansion-joint filler to the edge of the pavement, or by infiltration of foreign material into the end of either expansion or contraction joints.

Clean and reestablish joints

B – A Corner Break:

These cracks, which generally form a rough isosceles triangle with sides at least 450mm long, are caused by overstressing pavement corner and loss of support.

Partial slab replacement when crack exceeds 20mm

C – A Diagonal Crack:

These are caused by a differential in subgrade support. This may be due to settlement or volume change of the subgrade (frost heave/settlement)

Partial slab replacement and recompact subgrade

D – Spalls:

These may develop at any joint or at an intersection of two joints. They may be caused by improper joint construction or infiltration of foreign material at the top of the joint. It is less observed with chamfered joints.

Clean and seal joints

E – Transverse Cracks:

These may be caused by the omission of a contraction joint or by using a joint spacing too great to control cracking.

Rout and seal joints

F – A Transverse Crack:

These cracks, which occur 1.2m to 2.4m, ahead of the joint, are usually caused by loss of subgrade support due to pumping.

Replace slab and compact subgrade

G – A Longitudinal Crack:

These are caused by the omission of intermediate longitudinal joints in wide construction lanes.

Rout and seal cracks

H – Plastic-Shrinkage Cracks:

These are caused by rapid loss of water from the fresh concrete, which may be due to lack of early curing, rapid evaporation from the surface, or loss of water because of a dry subgrade or dry absorptive aggregate.

Do nothing but monitor with time

NO.	INIT.	DATE:	REVISIONS
DRAWN: FH	DESIGNED:	APPROVED: WFM	
ENGINEERING		DATE: 04/22/04	

PAVEMENT CONSTRUCTION
PCC PAVEMENT DEFECTS CAUSES AND REPAIRS GENERAL GUIDE

SHEET 1 OF 2 | FILE:

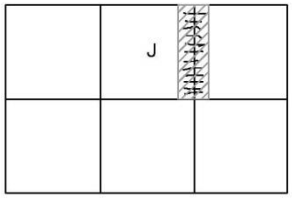
S D 9 0 C 1 1 6 – 1

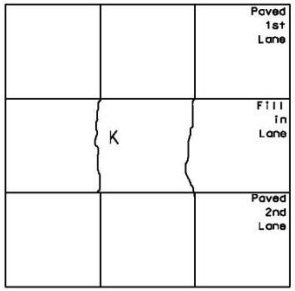
TORONTO PEARSON INTERNATIONAL AIRPORT

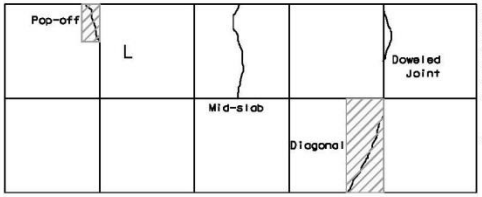
sd90c116-1.dgn 9/12/2014 2:53:17 PM

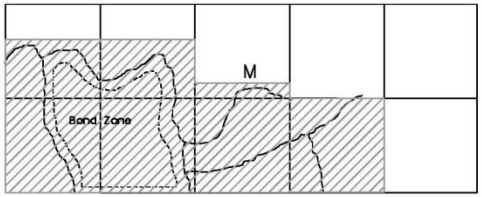
TORONTO PEARSON
GTAA

Greater Toronto Airports Authority
Engineering
P.O. Box 6031, Toronto AMF, Ontario, Canada L5P 1B2
Fax (416) 776-4640









J – Doweled Joint Subsidence:

Occurs directly over dowel bars, due to subgrade subsidence or sloughing or high slump concrete over embedded bars.

Reconstruct approx. 1.0m from each side

K – Edge Restraint:

Typical of not sawing concrete slab or sawing too late thereafter. A form of sympathy cracking.

Crack routing and sealing

L – Random Crack Formations:

Typical of sawing too late.

Routing and sealing and/or partial slab replacement or cross stitching

M – Erratic Cracks:

Typical of high friction or bonding to subbase or major subgrade settlement or frost heave or loss of subgrade support causing differential movement, or a combination of both.

Reconstruct/Replace slabs and recompact subgrade

GUIDE: TYPES OF DISTRESS THAT OCCUR IN RIGID PAVEMENTS WHICH MAY JUSTIFY FULL-DEPTH REPAIR WHEN CLASSIFIED AS MEDIUM OR HIGH-SEVERITY (ASTM 1778) INCLUDE:

- CORNER BREAK
- DURABILITY ("D") CRACKING (FOD GENERATION)
- PATCH DETERIORATION
- SHATTERED SLAB (A SLAB BROKEN INTO FOUR OR MORE PIECES WITH SOME OR ALL CRACKS OF MEDIUM OR HIGH-SEVERITY)
- JOINT OR CRACK SPALLING (IF SPALLING IS ONE-HALF THE SLAB THICKNESS OR DEEPER)

NO.	INIT.	DATE:	REVISIONS
DRAWN: FH	DESIGNED:	APPROVED: WFM	
ENGINEERING		DATE: 04/22/04	

PAVEMENT CONSTRUCTION
PCC PAVEMENT DEFECTS CAUSES AND REPAIRS GENERAL GUIDE

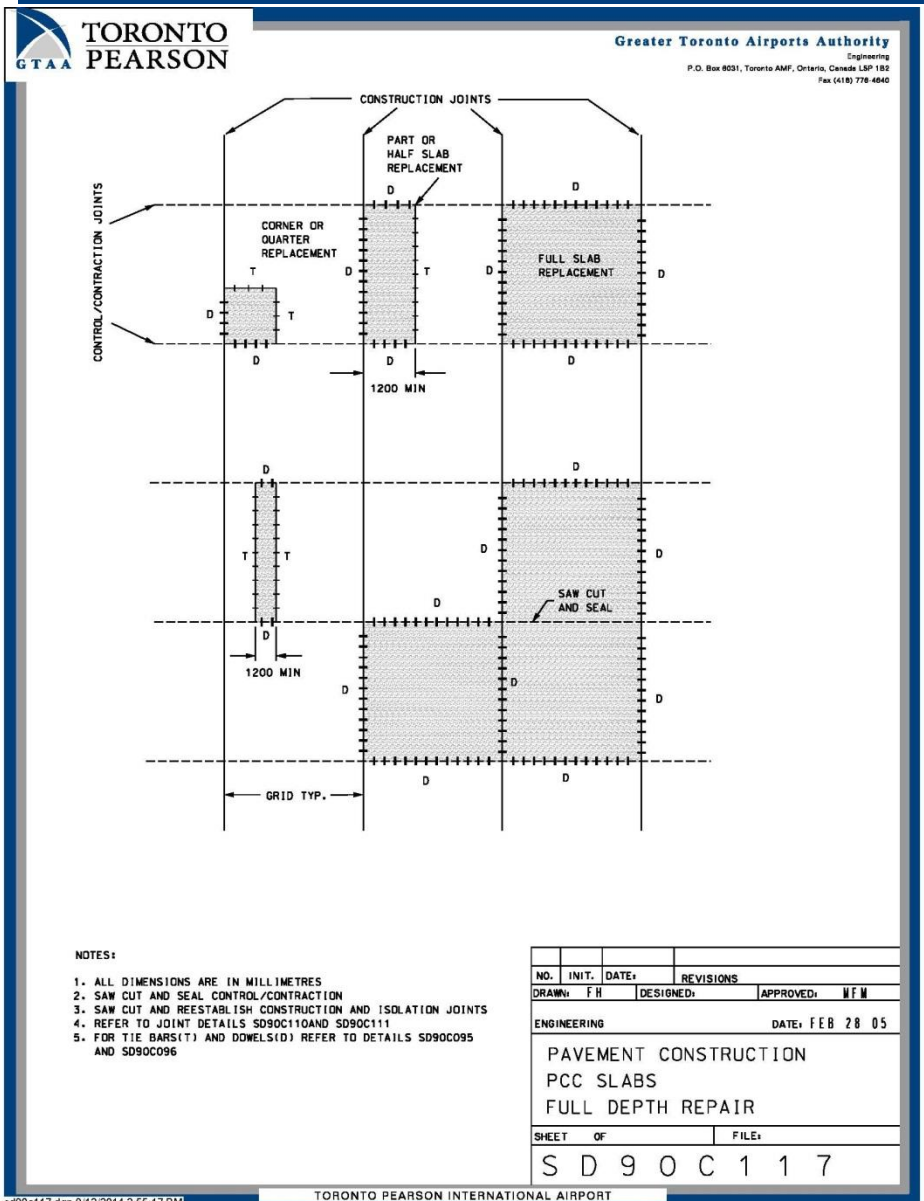
SHEET 2 OF 2 | FILE:

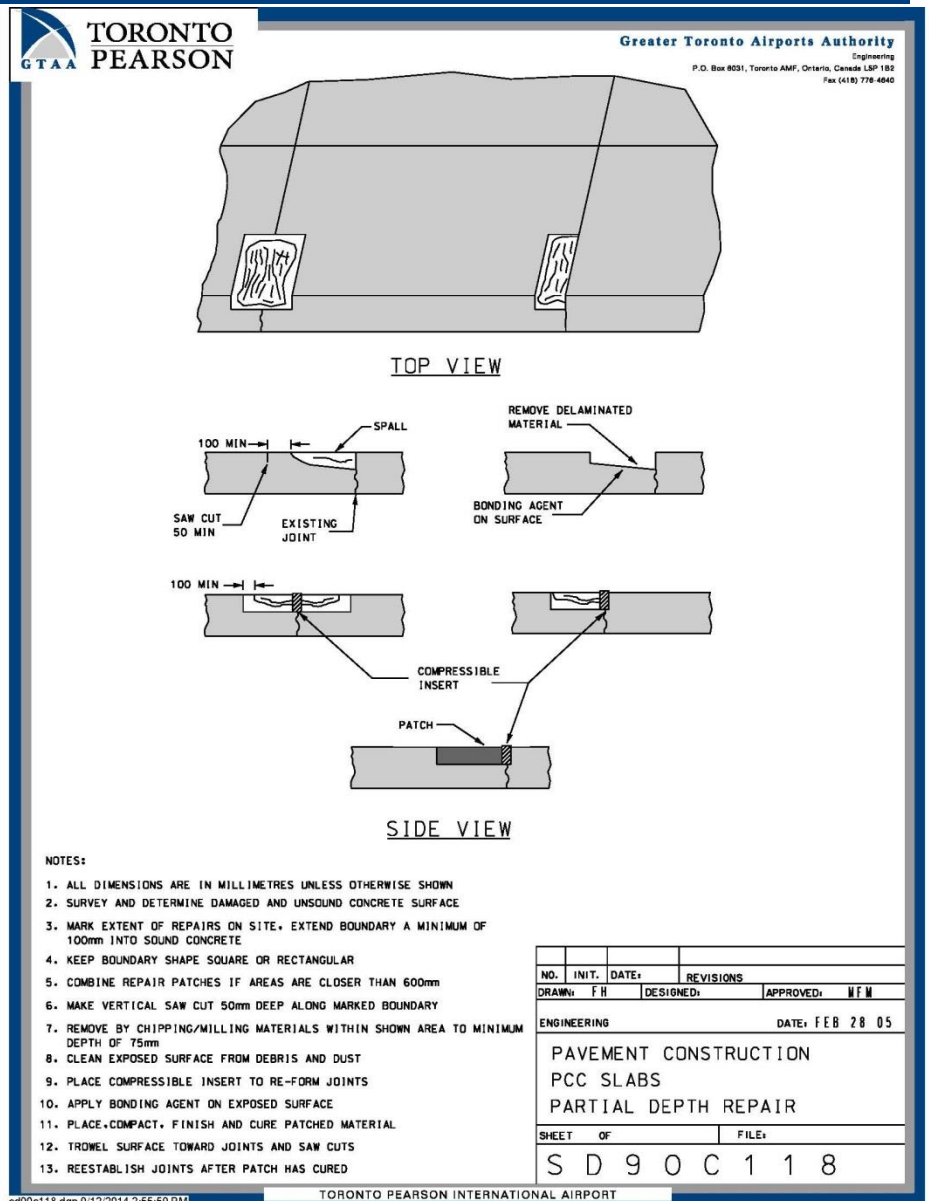
S D 9 0 C 1 1 6 – 2

TORONTO PEARSON INTERNATIONAL AIRPORT

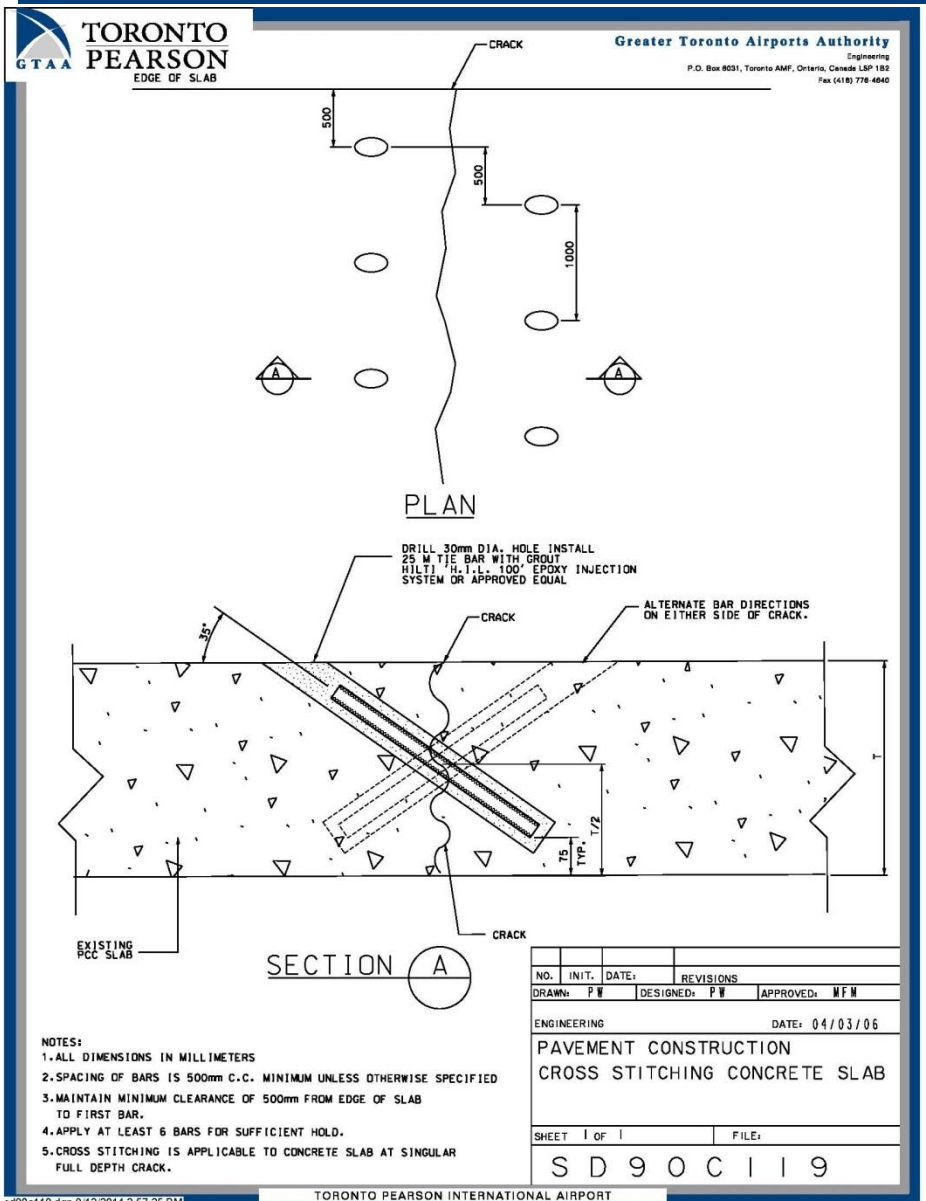
sd90c116-2.dgn 9/12/2014 2:54:15 PM

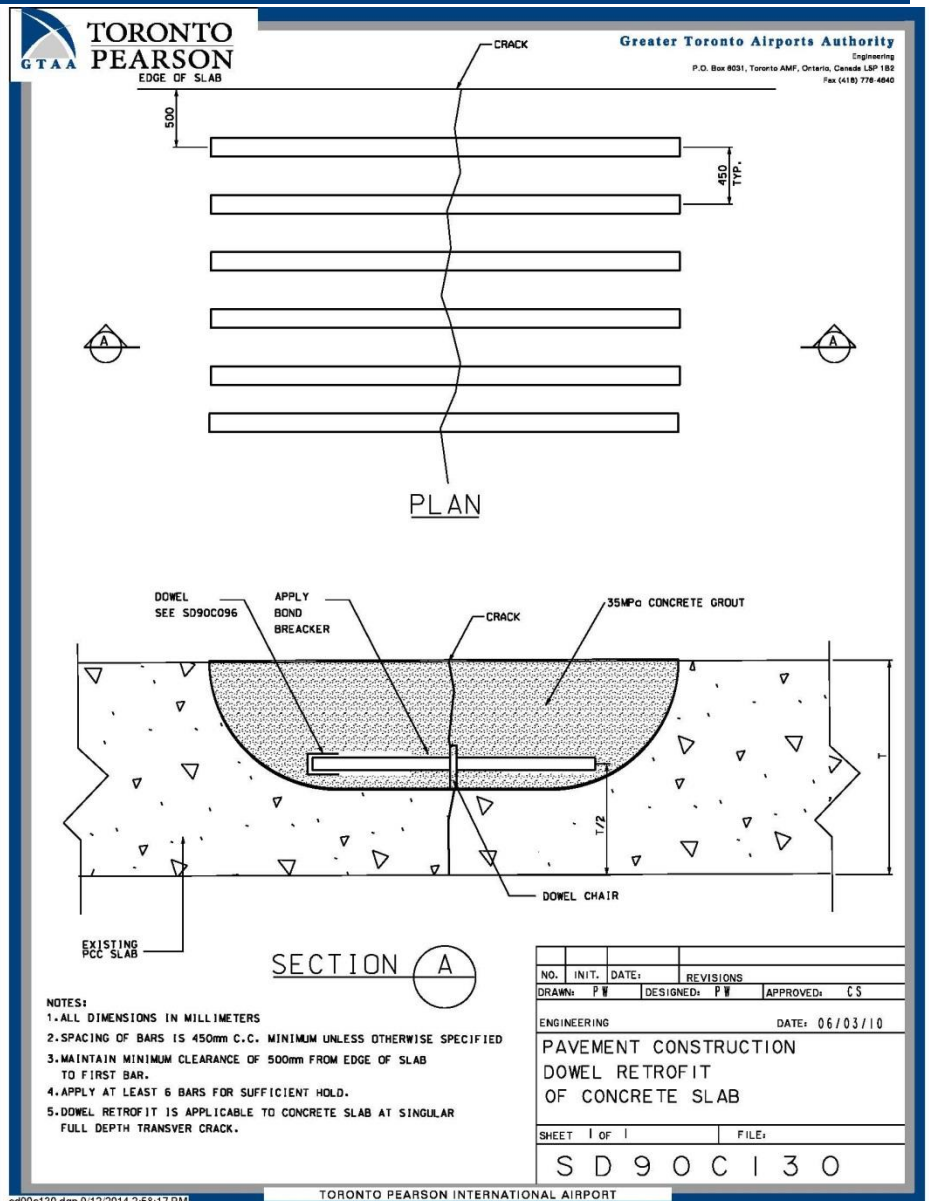
5. PCC Pavement Repairs: Methods



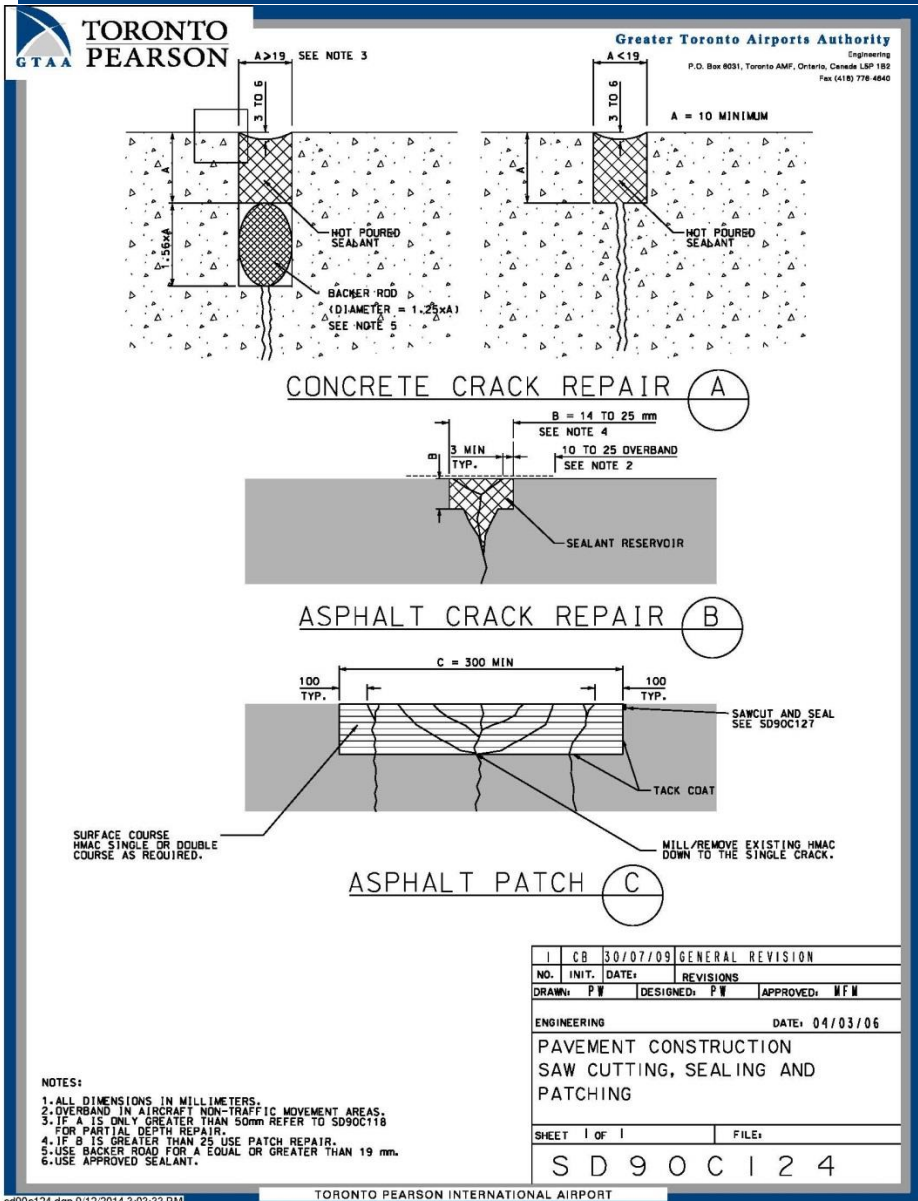


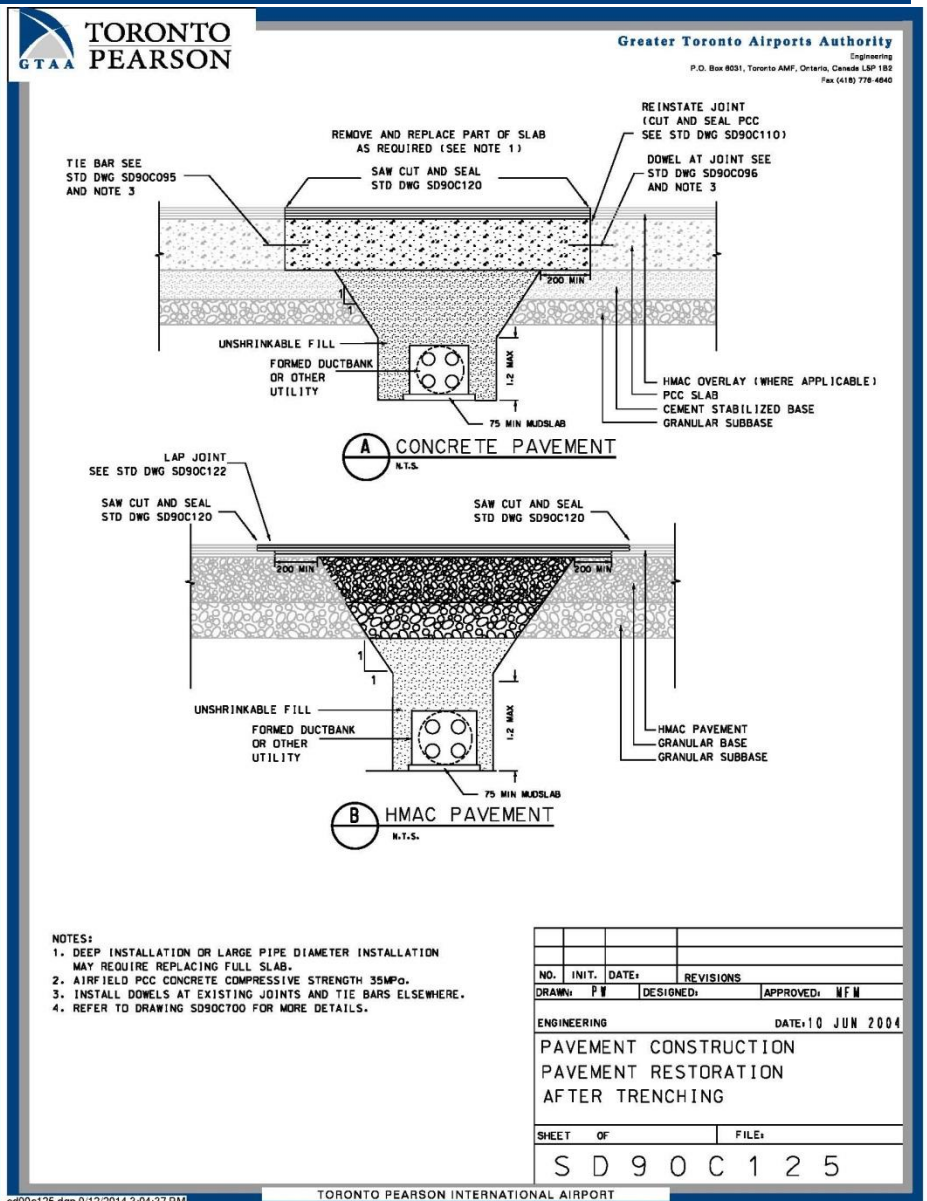
5. PCC Pavement Repairs: Methods (cont'd)





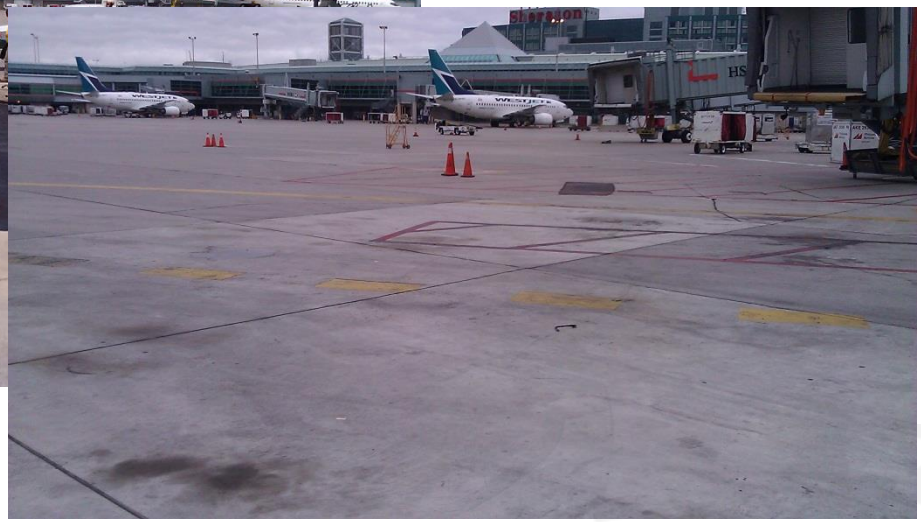
5. PCC Pavement Repairs: Methods (cont'd)





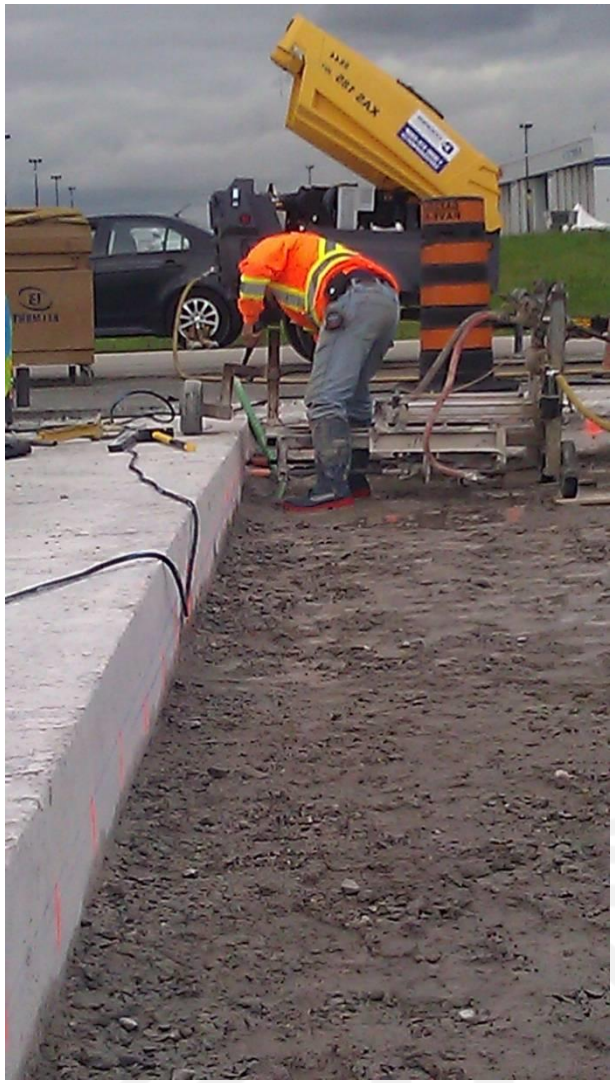
Photos

Permanent Repair – Full Slab full depth replacement



Photos (cont'd)

Permanent Repair – Partial Slab full depth replacement



Photos (cont'd)

Temporary Repair – Partial depth repair w/proprietary material

Photos (cont'd)

Temporary Repair – Diamond grinding for joint faulting

Photos (cont'd)

Temporary Repair – Spalling repair w/proprietary material

Photos (cont'd)

Temporary Repair – Crossing stitching

GTAA

Toronto Pearson
International Airport | Aéroport International