

Best Practices in the Design and Construction of Airfield Asphalt Pavements



2010 CAPTG Workshop - September 12, 2010

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GTAA: 2010 IATA Eagle Award winner

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Overview

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The goal of this presentation is to show:

- TPIA Asphalt Pavement Design requirements
- Issues/problems that have been encountered
- Best rehabilitation methods to meet budget constraints



Pavement Design

TPIA Asphalt Pavement Design

- Prior to 2000 all airfield pavements were designed according to Transport Canada standards with an asphalt mix using asphalt penetration 85-100 (for Southern Ontario) and having a Marshall Stability value of 10kN.
- Since 2000 performance grade (PG) asphalt cements have replaced penetration grade asphalt cements for most highway and airport applications in the Canadian market.

TPIA Asphalt Pavement Design

- In April 1998, Ontario Hot Mix Producers Association on behalf of MTO/ORBA established grade equivalencies of PG asphalt cement with respect to penetration asphalt. PG 58-28 grade was set to be equivalent to 85-100 penetration asphalt.
- Because of TPIA's heavy traffic, the asphalt grade for the surface course was bumped up one grade to PG 64-28. At that time all other criteria of the asphalt mix design remained the same with only minor changes to the quality of course aggregate requirements.

TPIA Asphalt Pavement Design

- It was observed that the crushed limestone aggregates are not able to meet the surface aggregate criteria of maximum loss by mass of 25% when tested for Los Angeles Degradation in accordance with ASTM C131.
- Therefore, in 2000 a blend of crushed limestone and trap rock was recommended to meet the loss by mass criterion as soft aggregates were subject to polishing over time causing the potential of lower friction values. Inclusion of trap rock crushed aggregates also necessitated the use of an anti-stripping additive to increase the adhesion between the aggregate and the bitumen.

TPIA Asphalt Pavement Design

- In 2002, the asphalt grade for the surface course was bumped up to a PG 70-28 to accommodate a combination of the global warming effect of high ambient temperature and heavier aircraft such as the Antonov An124 and the Boeing B777-300ER.
- In 2006, polymer modified asphalt was introduced to increase the stiffness of the asphalt at higher temperatures which should further reduce the likelihood of rutting and shoving.

History of Mix Design Development

Items	Prior to 2000	2000/2001	2002	2006
Asphalt Cement - Penetration Grade - Performance Grade	80-100	PG 64-28	PG 70-28	PG 70-28 E
Asphalt Content	5.5-5.8%	5.5-5.8%	4.8-5.2%	4.8-5.2%
Aggregate	Limestone	Blend of Limestone & Trap rock	Trap rock	Trap rock
Marshall Stability	10kN	10kN	14kN	14kN
Tack Coat (L/m²) - On existing asphalt surface - On rough concrete surface - Between new lifts	RS-1, max 0.5 RS-1, max 0.5 RS-1, max 0.2	RS-1 max 0.5 RS-1 max 0.5 RS-1 max 0.2	RS-1, 0.3-0.4 CRS-2P, 0.2-0.3 RS-1, 0.15-0.25	RS-1, 0.3-0.4 CQS-1HP, 0.3-0.4 RS-1, 0.15-0.25

TPIA Asphalt Pavement Thickness

The pavement structure thickness has not been updated since 1993 which was designed for the critical aircraft at the time; the B747-400.

Newer aircraft such as the B777- 200LR/300ER, A340-500/600, and A380 are all more critical for the determination of a suitable pavement structure

Failure to improve the pavement structure will result in reduced service life.

According to TC aircraft design chart and FAA design software, a pavement of equivalent granular thickness of 1600mm is required to accommodate these new large aircraft as compared to the 1450 mm currently used

Critical Aircraft

Old Pavement Structure

125 mm HMA
300 mm Granular Base
900 mm Granular Subbase

A380 aircraft landing at TPIA



Antonov 124 aircraft



New Pavement Structure Required

200 mm HMA
300 mm Granular Base
900 mm Granular Subbase

Critical Aircraft (cont'd)

Old Pavement Structure

125 mm HMA
300 mm Granular Base
900 mm Granular Subbase

B777-300ER aircraft



A340-600 aircraft

New Pavement Structure Required

200 mm HMA
300 mm Granular Base
900 mm Granular Subbase





Other Issues and Concerns



Shoving Problem

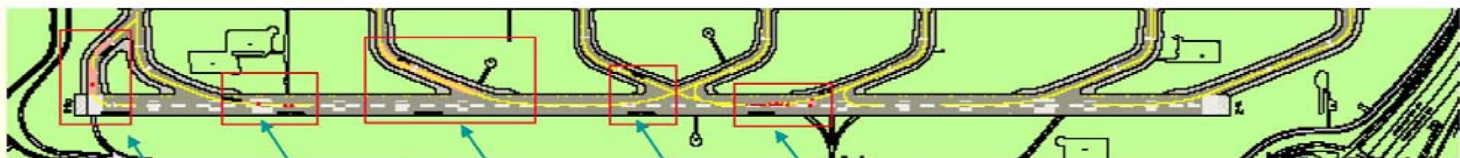
Shoving Problem

History

1. Runway 06R-24L was constructed in 2001. A blend of crushed limestone and trap rock was used in the surface course.
2. During the Summer of 2007, an irregular piece of surface course asphalt peeled off from the lower course of asphalt pavement on the runway between D1 and D3.
3. Asphalt slipping and shoving at different locations on the runway and taxiway exits was also observed. This was very noticeable at the interface with inset lights and at the runway holdlines. The slippage was produced by the original asphalt surface course sliding over the base asphalt course of the pavement.

Locations of Shoving

LOCATIONS OF SHOVING RUNWAY 06R-24L AND RAPID EXITS



8/31/2007

Distress Photos

Pavement shoved at the holdline position



Slippage of asphalt away from the inset light

Distress Photos (cont'd)

Shoving in asphalt



Shoving at locations of heavy braking of aircraft.

Shoving Problem

Findings

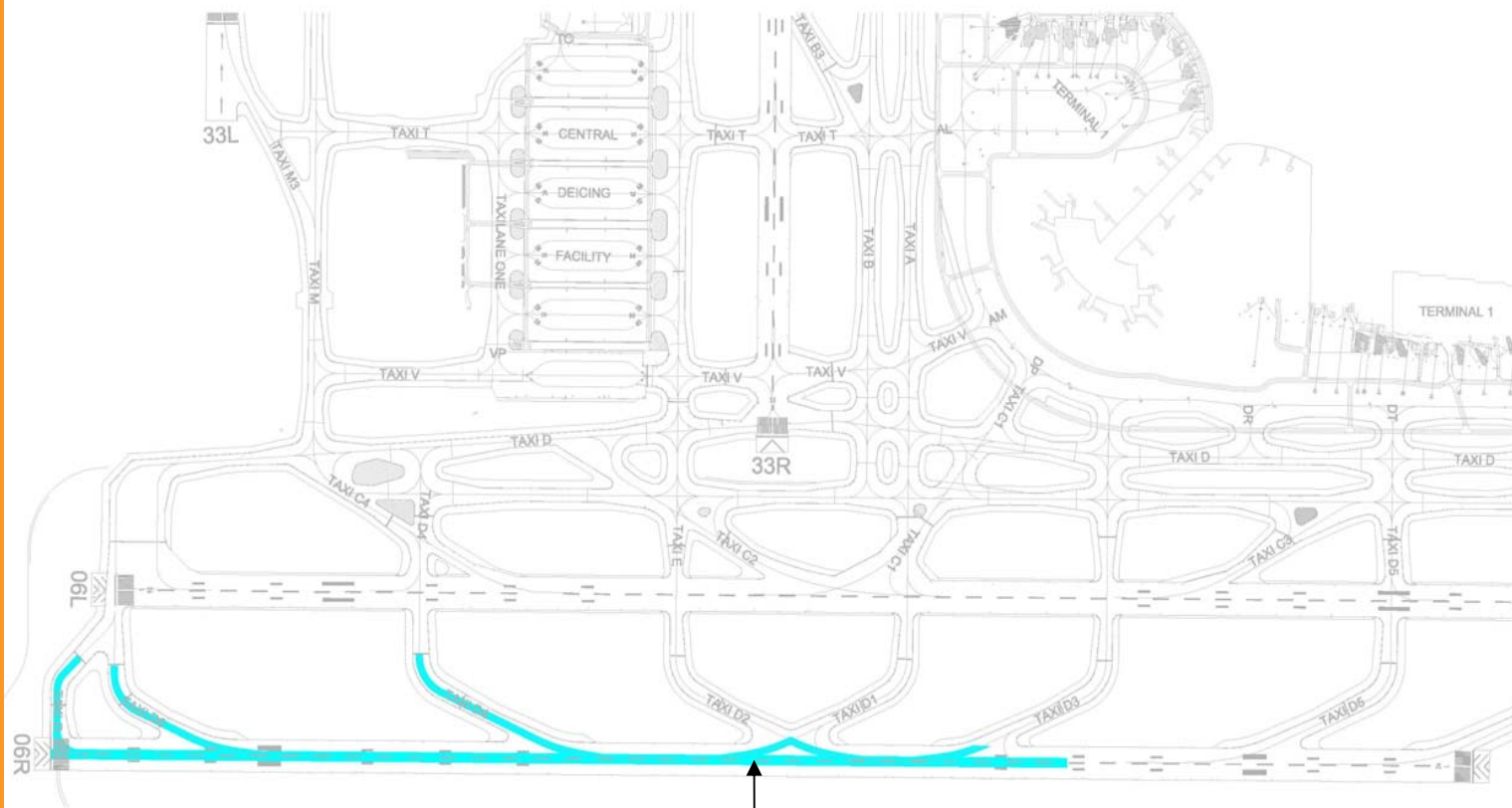
1. High ambient temperatures during the week of August 6, 2007, in the range of 30°C to 32°C.
2. Pavement surface temperature of 50°C to 52°C as recorded by the surface weather detection system.
3. Heavy traffic on runway 24L due to closure of runway 24R which was under construction and only a few exits were operational.
4. Heavy aircraft braking to make the nearest open exit (since some of the exits were closed due to the construction on adjacent 24R).

Shoving Problem

Findings (cont'd)

5. The asphalt cement PG68-28 used (2000/2001) for surface asphalt was of a lower viscosity at higher temperatures than is currently used.
6. The asphalt content specified at that time (2000/2001) for surface course was 5.8%.
7. The specified minimum Marshall Stability was 10kN.
8. The aggregate used in 2001 was a blend of crushed limestone and trap rock to meet the abrasion loss by mass of max 25%.
9. Tack coat RS-1 was used between two fresh asphalt courses.

Runway 06R-24L



Area was resurfaced in 2007 using 100% crushed trap rock

Shoving Problem

Recommendations

The following recommendations have been incorporated into GTAA current specifications since 2006:

1. Polymer modified asphalt cement PG70-28 has been used to increase the mixture's resistance to rutting, thermal cracking and durability.
2. Asphalt content has been reduced to a range between 4.8 to 5.2% to allow more voids in the mix and to produce a stiffer surface course at higher temperatures.

Shoving Problem

Recommendations (cont'd)

3. 100% crushed trap rock aggregate has been used in the surface course mix with less asphalt cement content, resulting in a 'stiffer' asphalt surface, less prone to shoving failure.
4. Minimum Marshall Stability has been increased to 14kN.
5. Polymer modified cationic emulsified asphalt tack coat CQS-1HP has been used on rough concrete surface
6. Anionic emulsified asphalt tack coat RS-1 has been used on existing asphalt surface and has been used between two fresh asphalt courses.

Shoving Problem

Ongoing Research

1. Further investigation to the current mix design and installation procedures is underway due to recent shoving on two heavily used taxiways.
2. Shoving location was located by the holdline position and was first observed after extreme high ambient temperatures this summer.
3. Slippage was produced by the asphalt surface course sliding over the base asphalt course of the pavement.

Distress Photos

Shoving at the holdline position



Asphalt Sliding



Joint Sealant Issue

Joint Sealant Issue

History

1. Runway 06R-24L centre section and associated exits, due to shoving problem, were resurfaced in 2007 using 100% crushed trap rock in the surface course. The perimeter of the resurfaced area was routed and sealed (slightly 'under-filled' method) using Beram 195.
2. In 2008, joints/cracks were routed and sealed using the slightly 'under-filled' method in the centre section of the runway and 'over-banding' method for the outer section. Both sections used Beram 3060 LM hot-poured rubberized sealant material.

Joint Sealant Issue

History (cont'd)

3. Joint sealant was installed using rotary-impact router.
4. Rout configuration was observed to vary significantly from a width of 6 to 18 mm and a depth of 11 to 23 mm.

Joint Sealant Issue

Findings

1. Sealant failure problem was first noticed in June 2009. Approximately 10 to 15 percent of the joint sealing had failed in the runway area.
2. Failures ranged from sections of intact sealant with only weak bonding, to complete removal of the joint sealant for short distances.
3. Small fragments/chips of fractured aggregate were observed to bond to the joint sealant surface, with little or no asphalt cement present on the joint aggregate.

Joint Sealant Issue

Findings (cont'd)

4. Particles of shattered aggregate were observed in the bottom of the joint reservoir which was likely caused by the use of rotary-impact router. This material was not cleaned out properly prior to the sealant installation.
5. Free standing water was observed at the bottom of the joint reservoir after blisters were opened up.

Photos



-Joint sealant was in poor conditions. It was only bonded to the top 2 to 3 mm of the joint reservoir and was easy to pull out.

-Rout configuration 11mm wide by 18mm deep.

-Surface and lower courses were separated during coring.



Photos



-Transverse joint sealant was completely lost with rough joint reservoir wall

-Rout configuration 13mm wide by 14mm deep

-Good asphalt bonding between surface and lower courses



Photos



-After sealant was pulled out, free standing water was observed at the bottom of the joint reservoir.



-Particles of shattered aggregate were observed in the bottom of the joint reservoir.

Joint Sealant Issue

Recommendations

1. Random crack saw with diamond blades should be used to minimize fracture damage of trap rock aggregate.
2. Additional random crack saw should be considered to accommodate the lower production rate when comparing to the standard rotary-impact router.
3. Rout configuration with width/depth ratio ≥ 1 (20mm width by 20mm depth) is recommended.
4. Use of hot lance to clean and dry the joint reservoir should be continued.
5. Use of sealant such as Beram 195 should be continued.

Installation Photos

Use of random crack saw with diamond blades to minimize aggregates damage and to provide a more rectangular rout reservoir with smooth walls.



Rout reservoir is sawcut to 20mm wide by 20mm deep.

Installation Photos

Use of heat lance to clean and dry the joint reservoir



Installation of hot pour joint sealant using slightly under-filled method



Cold Joint Issue

Cold Joint Issue

- Premature deterioration of longitudinal joint in asphalt pavement is mainly due to construction method, low compaction at joints combined with shrinkage during low temperature and heavy traffic load.
- In turn, these distresses combined with water penetration to the base, sub-base and sub-grade, causing various problems such as cracking, rutting, raveling, moisture damage; and ultimately leads to reduced fatigue life and durability.
- Three primary types of paving construction that can be utilized to give best performance to minimize cold joints are echelon paving, preheated joints and proper mat overlap.

Cold Joint Issue

Echelon Paving

- Paving multiple lanes side-by-side using adjacent pavers slightly ahead of another to have both lanes hot for compaction. Rollers behind the echelon pavers can pass directly over the longitudinal joint while both sides are hot which results in better compaction.

Preheating Joint

- Reheat the cold joint (initially paved surface) and bring it to plastic state prior to laying the next lane or new hot mix mat. The preheating permits better compaction at the joint, better cohesion and consolidation of the mat. Thus it makes the joint denser and less permeable.

Cold Joint Issue

Proper Mat Overlap

- Overlap the hot lane on the cold lane by about 25mm. The overlap should have adequate material for compression. A lack of material or inadequate overlap will lead to low density joints.

Cold Joint Issue

Current GTAA customized specifications Section 32 12 16 - Hot Mix Asphalt Concrete Airfield Paving and Section 32 12 15 - Asphalt Tack Coat require the following:

- Paving in echelon
- Self-powered shuttle buggy to minimize segregation
- Tack coat at joint interface
- Complete compaction prior to temperature drop below 100°C
- If cold joint, temperature drop below 80°C, is unavoidable then:
 - cut back by saw cutting 200mm to full depth and apply on the surface polymer modified tack coat, or
 - provide mat heaters to heat the cold joint to 135°C prior to paving adjacent lane

Photos

Paving in echelon to eliminate cold joint



Shuttle buggy to allow paver to run continuously to enhance smoothness and minimize segregation across the mat

Photos



Tack coat at joint interface will assist in bonding between paving lanes



Best Rehabilitation methods

How do we determine the best rehabilitation methods

In order to determine the best rehabilitation methods for GTAA to meet budget constraint, the following procedures are used:

Likelihood of Failure will be determined based on the following criteria

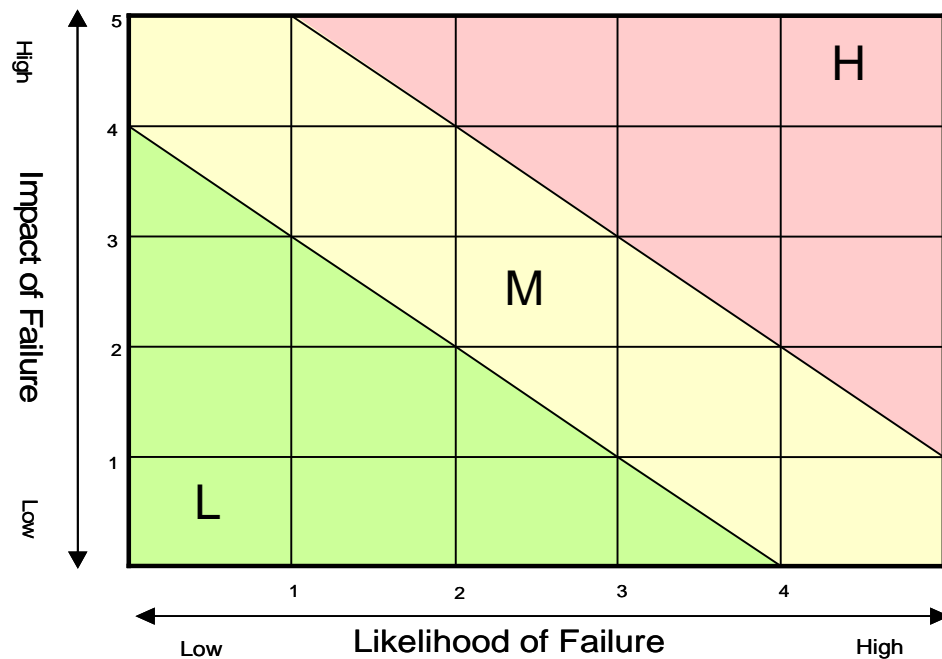
- Pavement Condition Index (PCI)
- In-situ Pavement Condition Inspection
- Foreign Object Damage (FOD) potential

Impact of Failure will be determined based on the priority ranking, listed from the highest to the lowest

- Runways
- Deicing Pads
- Taxiways
- Aprons
- Roadways

Prioritization Chart

- Therefore, projects are ranked as L (green), M (yellow) or H (red).



- “H” ranking projects are carried for design and construction.

Type of Restoration

Then the engineer will determine the type and limit of restoration

- Full depth restoration
- Partial depth restoration
- Restoration along the wheel path only. Usually pavement condition at the centre portion of the runway/taxiway is deteriorated faster than the outside portion
- Joint/crack restoration only, etc.

Based on the above methods, GTAA will be able to effectively manage airside pavements in the most cost effective way over the life of the pavement

GTAA's Repair Strategies for Various Distress Types

DISTRESS TYPES	REPAIR METHODS
Alligator Cracks, Shoving and Rutting, Multiple Secondary Cracks For PCI less than 50	Full depth mill and pave along the wheel path area
Multiple Primary Cracks For PCI 50-60	Partial depth repair
Minor Cracks--Longitudinal, Transverse, etc. For PCI over 55	Rout and Seal
PCI between 60 and 100	Preventive Maintenance

GTAA's Estimated Service Life for Airfield Pavement

Type of Pavement	Average Service Life Low Traffic	Average Service Life High Traffic
Original Concrete Pavement	35	30
Original Asphalt Pavement	18	14
Resurfacing 50-65mm AC Overlay	12	8
Resurfacing 75-95mm AC Overlay	14	10
Resurfacing > 100mm AC Overlay	16	12



Thank you



Any questions?