Rehabilitation of PCC Airfield Pavement with Asphalt

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Asphalt Institute
• Over 100 million SY of heavy load concrete airfield pavements
  ≥ 13 inches thick
• Much of this needs major rehabilitation soon
< 5 years
• 405. OVERLAYS OF EXISTING RIGID PAVEMENTS
  • C. Hot Mix Asphalt Overlays of Existing Rigid Pavements
    • (5) Reflection Cracking in Hot Mix Asphalt Overlays
      • (ii) Rubblization of Existing PCC Pavement
        • AAPTP Report 04-01
1. Total Reconstruction
   – Into completely new flexible or rigid system
   – Very costly

2. Concrete Pavement Restoration (CPR)
   – Slab/joint replacement, spall repair, subsurface drainage, diamond grinding, joint sealing
   – Effectiveness depends on type and extent of distresses, timing of application, etc.

3. HMA Overlays
   – Over intact PCC pavement
   – Over fractured PCC
HMA Overlays on Intact PCC Pavements

• Improve functional characteristics
  • Ride quality, surface friction, surface drainage
• Often as short-term relief from crack maintenance
  • Before major rehab or reconstruction
• Reflection cracking is biggest challenge
• Rule of Thumb (if no treatment): 1 yr per inch HMA
This study provides necessary detailed guidance for selecting adequate mitigation strategies for both PCC and HMA pavements.

Introduction:

“Although the problems of reflective cracks has been known for decades, established procedures to select, design, and construct effective mitigation strategies have not been adopted. FAA AC-150/5320-6 provides general design recommendations for HMA overlays of existing PCC pavements, but detailed guidance is not provided on what constitutes an appropriate treatment method for a given situation.”

www.aaptp.us
Procedure Illustrated

Reference

Establish Template

Sawcut/Clean

Pour/tool sealant
Interlayers

• Stress absorbing membrane interlayers (SAMIs)

• Fabrics/geotextiles

• HMA interlayer
  • Specialized fatigue resistant mix
Binder Application for Chip Seal

(Note: Chip seals typically not used on airfields due to FOD)

“SAMI layers have been successfully employed to reduce the rate of reflective cracking…but eventually crack will work through.” AAPTP 05-04
Geotextile Application

- Best applied on leveling course
- Requires 2 inches min cover
- Ensure fabric can be milled and is recyclable

“Fabrics do not perform well when placed directly on old PCC pavement joints/cracks.” AAPTP 05-04
HMA Interlayer (Crack Relief Layer)

Dampens movement from PCC & Seals water out of PCC

- Low voids (0.5-2.5%)
- High AC% (7-10% typical)
- Heavily-modified
  - 7-10% polymer
- Fine-graded placed 1” thick
- Fatigue resistant mix
- Produced & placed w/ conventional equipment

HMA Interlayer
• PCC should be structurally sound
  • No working cracks, corner breaks, faulting, pumping,
  • Good joint load transfer (>80%)
• Only controls (saw and seal) or delays (interlayers) reflective cracking
HMA Overlay on Fractured PCC Slabs

- Fractured Slab Technology
  - Crack/ Break and Seat
  - Rubblization

- Ideal for PCC that is not structurally sound
- Cost effective alternative to total reconstruction
  - Utilizes all in-place material layers
• No hauling or disposal costs, none of PCC is discarded
• Existing PCC stays in place to serve as new base overlay
• Saves natural resources, landfill space, environmentally friendly
• Expedites construction time
• Weather delays minimized since subgrade is never opened up
• Cost effective as rehab technique
References
  • AI MS-17 Manual (Ch 13) and AAPTP Report 05-04
  • Reduces effective slab length (2 - 5 ft) by inducing fine vertical transverse cracks in concrete
  • Seat layer by rolling to reestablish subbase support

  • Crack and Seat applies to jointed plain concrete
    • Very good performance history

  • Break and Seat applies to jointed reinforced concrete
    • Must rupture the bond between the reinforcing steel & PCC to be effective, so more fracture energy needed
    • Break/seat (bond not always broken)
Cracking and Seating Process

- Remove existing overlay
- Correct drainage problems
- Crack PCC slabs
  - “guillotine” hammer
- Seat cracked PCC
  - 35-50 ton pneumatic roller
- Remove/patch any soft areas identified
- HMA Overlay
Rubblization

References: AI MS-17 (Ch 12), FAA EB-66 & AAPTP 04-01

- Fracturing techniques that:
  - Rubblizes PCC slabs into high quality agg. base
  - Eliminates all slab action and other inherent distresses
    - Reflective cracking
    - D-cracking and ASR
    - Slab rocking, pumping, curling, etc.
  - Destroys bond between concrete and any steel
  - Converts failed rigid system into new flexible one

- Two distinct methods and equipment types:
  - Multiple Head Breaker (MHB)
  - Resonant Pavement Breaker (RPB)
Before Rubblization
After Rubblization
Resonant Pavement Breaker (RPB)

Result

Roll shattered PCC

Place HMA
Multi Head Breaker (MHB)

Z-Grid Roller Processing
Rubblized Surface

Roll MHB broken PCC

Place HMA
Two “Heavy Load” Pavement Projects

- Multi-Head Breaker (MHB) at Selfridge ANGB, 2002
  - Up to 21 in thick

- Resonant Pavement Breaker (RPB) at Wright-Patterson AFB, OH, 2002
  - Up to 26 in thick
Rubblization Process with MHB at Selfridge ANGB w/ 21” thick PCC

- Edgedrains and Cross Underdrains
- Pre-fracture
- Rubblize
- Test Pits
- Rolling
- Aggregate Leveling Course and HMA Paving
Selfridge Test Pit

agency approval before full scale rubblization
Particle Size Acceptance Criteria
(recommended in 04-01)

• Upper half of slab
  • All particles < 6”
  • 75% of material (by weight) < 3”

• Bottom half of slab or below steel
  • All particles < 2x slab thickness
Completed Selfridge RW

85,000 SYs rubblized in 16 days (5300 SY / day)
Rubblized Concrete at WPAFB

- 55,000 sq yds of 26” PCC rubblized in 10 days
  - 5,500 sq yds per day
- Rubblization proved viable for PCC up to 26 inches thick
Approximately 30 Airfield Rubblization Projects as of 2006

- Jacksonville NAS, Portions of Main RW, FL (1997)
- NAVFAC, C-17 Assault Strip, SC
- Willow Grove NAS, RW 15-33 Thresholds, PA
- Rantoul Municipal Airport, RW, IL (1999) – Demo (3 Rubblized Sizes)
- Hunter Army Airfield, Ramp, GA
- Watertown Airport, RW and Hanger Area, SD (2001, 2003)
- Columbus Airport, Three TWs, IN (2000, 2003, 2004)
- Kalamazoo/ Battle Creek AP, TW, MI (2002)
- Capital Airport, RW Overrun, Springfield, IL (2005)
- Grand Forks AFB, Rehab Main RW, ND (2005)
- Kegelman (Vance AFB Auxiliary) Runway, OK (2006)
- Pratt Airport, RW, KA (2005)
- Moses Lake Airport, Runway, WA (2003)
- Toledo Metcalf Field, RW 4-22, OH (2006)
FAA Engineering Brief No. 66, *Rubblized PCC Base Course*

- Guidance and spec for rubblizing PCC airfields
  - Industry consulted
  - Released 2004
  - OK to use, but also strongly encourage referencing and use of AAPTP 04-01 report

- Both performance based and method based
  - Allows either type equipment. Unique method requirements depending on which rubblization type

- For Reinforced PCC...
  - Steel debonded and left in place
Overall Objectives

• Document state-of-the-art in rubblization
• Develop guidance regarding project feasibility, structural design, construction, quality control
• Improve quality of airfield rubblization projects

Deliverables

• Final Report posted on www.aaptp.us
• Summary of Findings (5 pgs) in course workbook
• Recently became official

FAA guidance 150/5320-6E, Airport Pavement Design and Evaluation
Background

- Airfield engineers always assumed rubblized equivalent to crushed agg base (CAB), P-209
  - Stiffness Modulus ($E_{rub}$) = 50 - 60 ksi
  - $CBR_{rub}$ = 100
- Literature suggests this is conservative
Conclusions on Material Characterization

• Range of in-service $E_{rub}$: 100 to 430 ksi
  • Avg was 205 ksi (stronger than CAB)
• Thicker PCC layers provided higher $E_{rub}$
• Larger PCC pieces and presence of reinforcing steel produced higher $E_{rub}$ values
• Recommended $E_{rub}$ values (now in FAARFIELD):
  • 6-8” thick: 100-135ksi
  • 8-14” thick: 135-235ksi
  • >14” thick: 235-400ksi
Minimum HMA Overlay Thickness Recommendations

- If HMA placed on rubblized material
  - 5 inches minimum HMA
    - Minimum 2 lifts, but 3 preferred (for smoothness)
    - 1st lift: minimum thickness of 3 inches (for density)
- If unbound material placed over rubblized
  - Use existing criteria (3 - 4 inches min. HMA)
- Note: Structural design may require greater HMA thickness
Pratt KS
- 6” PCC, virtually no subbase, subgrade CBR of 2-4
- Spec required RPB
- Edge drains installed but no water ever drained
- Rubblization started OK on edge, but problems as moved toward centerline
Assessing risk of having inadequate structural support for effective rubblization (resulting in inconsistent breakage, large and shifting PCC particles, punch-thus or rutting from construction equipment).

04-01 Protocol for Assessing Risk to Aid in Determining Project Feasibility
Information to Assist with Risk Assessment Protocol

• Plans
  • Pavement structure and features
• Visual Inspection
  • Pumping and poor drainage
• GPR
  • Global look for trapped water and feature changes
• FWD
  • Range of subgrade modulus (high and low spots)
• Coring and DCP
  • PCC and base thicknesses, layer CBRs
No documented instance found in literature of any reflective cracking on any rubblization project

- Hundreds of Highway Projects
- Over 30 Airfield Projects
- Over 50 Million SYs of rubblization
  - Dating back into the early 1990s