Spall and Intermediate-Sized Repairs for PCC Pavements

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Joint Rapid Airfield Construction (JRAC) Program

- Site Selection
- Enhanced Construction Technology
- Rapid Stabilization

... develop materials and techniques for rapidly upgrading existing or constructing new contingency airfields in-theater with a low logistical footprint.
Problem Statement

- **Existing airfields are typically in poor shape. However, they are essential to operations**
  - strategic locations
  - better than starting from scratch
- **Military demands extremely fast “return to service” time**
  - Rapid Repair – 24 hours
  - Very Rapid Repair – 3 hours
Project Plan

- **FY04:** partial-depth spall repair
  - PCC-surfaced and AC-surfaced

- **FY05:** partial replacement of PCC slabs
  - 1 cu.ft. < size of repair < 1 cu.yd.

- **FY06:** secure cracked surfaces
  - reduce FOD potential

- **FY07:** repair structurally deteriorated AC surfaces
  - also, program-wide demonstration for C-17
FY04 – Spall Repair

• **Specific Problem:**
  - many materials on the market
  - wide range of performances
  - need to define when to use what
FY04 – Scope

- **Spalls**
  - Surficial, not structural
  - Size that can be handled by a portable mixer

- **Asphalt and concrete surfaces**

- **Products**
  - Recommendations for materials and procedures
  - Establish material approval process
    - physical and mechanical requirements
Repair Requirements

- Ready for C-17 in less than 1 day ("rapid repairs") or 3 hours ("very rapid repairs")
  - Consistent with ASTM C 928
- Simple procedures and little equipment
- Should last a couple of years and sustain several thousand aircraft operations
**Materials**

- **Polymeric**
  - Delcrete

- **Asphaltic**
  - Quality Pavement Repair
  - Instant Road Repair

- **Cementitious**
  - Set-45
  - PaveMend

- **Aggregate**
  - Pea gravel
‘Field’ Placements
‘Field’ Placements

HVS

Load Cart
‘Field’ Placements
Field Placements – Findings

- **Delcrete**
  - Resists cracking
  - No rutting
  - Abraded by dozer blade
  - Not for use on asphalt concrete
  - Cumbersome
  - Expensive
Field Placements – Findings

- **Asphaltic materials**
  - Difficult to compact adequately
  - Couldn’t conform to irregularities
  - Both QPR and IRR rutted
  - QPR remained soft
  - Cheap
Field Placements – Findings

- **Set 45**
  - Mortar mixer required
  - Vibration and floating required
    - Particularly for “extended” mix
  - Good bond
  - Good color match for PCC
  - No cracking
Field Placements – Findings

- **PaveMend**
  - Drill and paddle mixer
  - Self-leveling
  - Excellent bond
  - Conformed to irregularities
  - No cracking
  - Technicians’ favorite
Field Placements – Findings

- PaveMend
  - Used successfully as a leveling material
Field Placements – Findings

- **Feathering**
  - Works for:
    - neat Set 45
    - and PaveMend
    - PCC pavement
  - No good for:
    - Delcrete
    - mixes extended with aggregate
    - AC pavement
Field Placements – Findings

- **Repairs at Joints**
  - Delcrete – can place through joint
  - Cementitious – place against joint filler
Field Placements – Findings

• **Accounting for climate**
  
  o PaveMend and Set45
    
    > 85 °F
    
    PM30 and Set45-HW
    cool materials, water, and repair surface
    extend with rounded gravel (max. particle size = ½ in.)

    < 45 °F
    PM5 or PM15 and Set45
    warm materials, water, and repair surface

  o Delcrete NG > 95 °F

  o Asphaltic materials NG < °32
Material Approval Process

- Cementitious Materials Only
- Include physical and mechanical considerations
- Use standard test procedures
- Learn from REMR study by ERDC (mid-1990’s)
Physical Property Requirements (1 of 2)

- **Flow (for grouts)**
  - Maximum = 80 sec
  - ‘self-leveling’

- **Coefficient of thermal expansion**
  - Maximum = $7 \times 10^{-6}$ / °F

- **Freeze-thaw resistance**
  - Maximum loss in dynamic modulus = 50% after 50 cycles
Physical Property Requirements (2 of 2)

- **Restraining Ring Shrinkage Test**
  - 14 days
  - 50 microstrain max.
  - No cracks
Mechanical Property Requirements

- **Chord modulus**
  - Max. = $3.5 \times 10^6$ psi

- **Compressive strength**
  - 3000 psi (3 hours) or
  - 3000 psi (1 day)

- **Bond strength (1 day)**
  - 500 psi (to opc mortar) and
  - 1000 psi (to self)
Material Approval Process

• **Test Summary**
  - Flow (for grouts) …………………………….(ASTM C 939)
  - Coefficient of thermal expansion …….(ASTM C 531)
  - Freeze-thaw resistance …………………….(ASTM C 666, Method A)
  - Restraining Ring Shrinkage ……………..(AASHTO PP34)
  - Chord modulus …………………………….(ASTM C 469)
  - Compressive strength ……………………..(ASTM C 109, ASTM C 39)
  - Bond strength ……………………………..(ASTM C 882)

• **Additional Important Considerations**
  - Shelf life
  - Simplicity
  - Safety / non-hazardous
  - Effects of using non-potable water
Project Plan

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Categories of Repair

- **Spalls**
  - < 1 cu.ft.
  - partial depth

- **Airfield Damage Repair (ADR)**
  - ‘crater repair’
  - surface area > 50 sq.ft. (typ.)
  - damage well into subgrade
Categories of Repair

- Intermediate-Sized Repairs
  - up to partial slab replacement, < 1 cu.yd. (typ.)
  - full-depth concrete
  - minimal work on base course
Intermediate Repairs

• **Requirements for Proposed Repair Method**
  - minimize requirement for transported materials
  - meet ‘rapid’ and/or ‘very rapid’ repair requirements
  - use only equipment accessed easily by military construction units
Intermediate Repairs

• **Description of Proposed Repair Method**
  - remove unsound concrete
  - place debris back in the hole
  - pour in grout that can penetrate to the bottom of the hole
  - ensure level, smooth pavement surface
Field Placements

• **Slab No. 1**
  - Repairs 1 through 4
  - Slab = 18 in. thick
Field Placements

• **Slab No. 2**
  - Repairs 5 through 8
  - Slab = 9.5 in. thick

Develop Method of Removal
Ensure Grouts Could Penetrate
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Field Placements
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Field Placements

44,000 lb, 50 passes
Field Placements - Findings

- Wheel saw + hammer attachments make the technique viable
- Type of concrete affects debris gradation
- No load-related distresses
- No evidence of thermal distress
- Type III grout had shrinkage cracks if not moist-cured
- Type III repair - $200 / cu.yd.
- PaveMend repair - $2000 / cu.yd.
Conclusions

- Recommend military units purchase wheel saw and hammer attachments.
- Sieve debris over 2 in. screen.
- Thickened edge not needed for short-term, but is good practice.
- Place larger debris near bottom, smaller near top of repair.
- Curing advisable for Type III grout if possible.
- Type III grout = rapid repair (24 hr).
- PaveMend = very rapid repair (3 hr).
- Type III grout – cheaper and consistent over time.
- PaveMend requires special care:
  - Reduced set time when placing layer on top of hot (setting) material.
  - Should use PM-TR as a cap.
Where to Publish?

- **Airfield Damage Repair (craters)**
  - UFC 3-270-07, “Airfield Damage Repair”

- **Spall Repair**
  - UFC 3-270-07 only provides expert contacts
  - Could incorporate modern (non-PCC) materials into
    - UFC 3-270-03, “Concrete Crack and Partial-Depth Spall Repair”
    - UFGS 02980, “Patching of Rigid Pavements”
  - Recommend posting material assessments on the Triservice Transportation website
    - http://www.triservicetransportation.com
Where to Publish?

- **Intermediate-Sized Repairs**
  - Could incorporate into:
    - UFC 3-270-07, “Airfield Damage Repair”
  - Could produce a flip-book manual similar to:
    - UFC 3-270-03, “Concrete Crack and Partial-Depth Spall Repair”
  - Could produce a new guide specification such as:
    - UFGS 02980, “Patching of Rigid Pavements” and
    - UFGS 03372, “Preplaced Aggregate Concrete”
Thanks