Spall and Intermediate-Sized Repairs for PCC Pavements

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US Army Engineer Research and Development Center

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.

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JRAC
Joint Rapid Airfield Construction

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

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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

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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

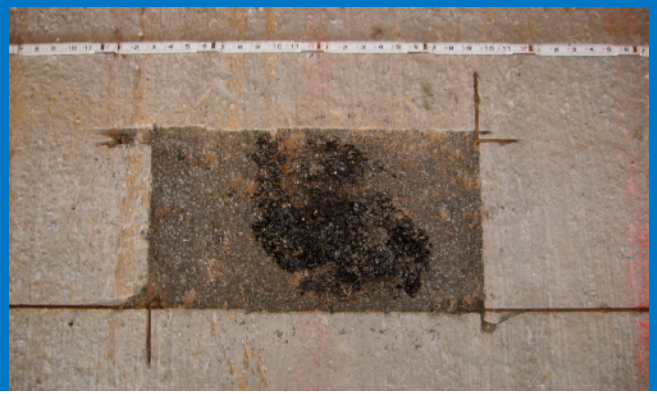
‘Field’ Placements

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

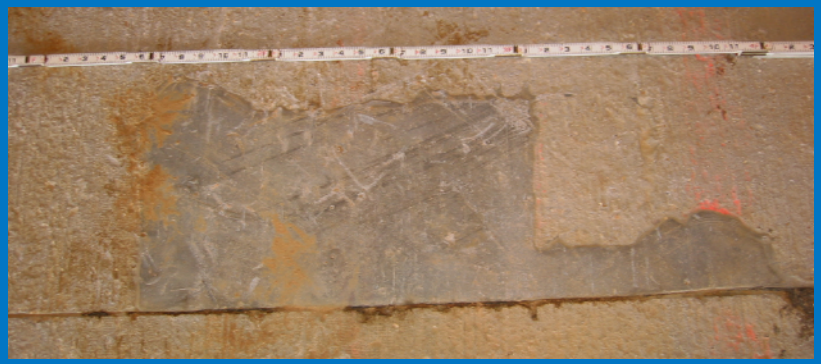


Field Placements – Findings

- 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

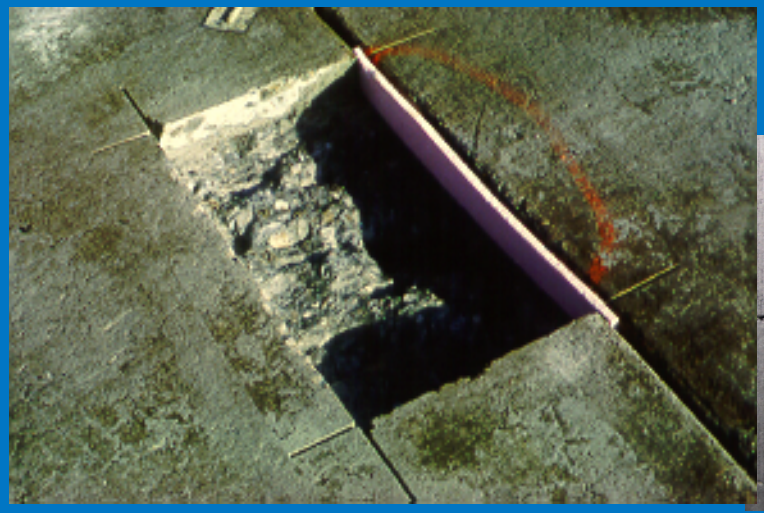
- PaveMend
  - Used successfully as a leveling material

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
  - 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
  - Delcrete NG > 95 °F
  - 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 x 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 x 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

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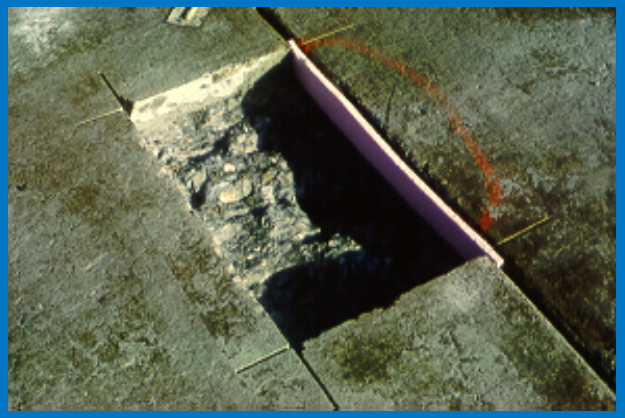
Categories of Repair

- 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

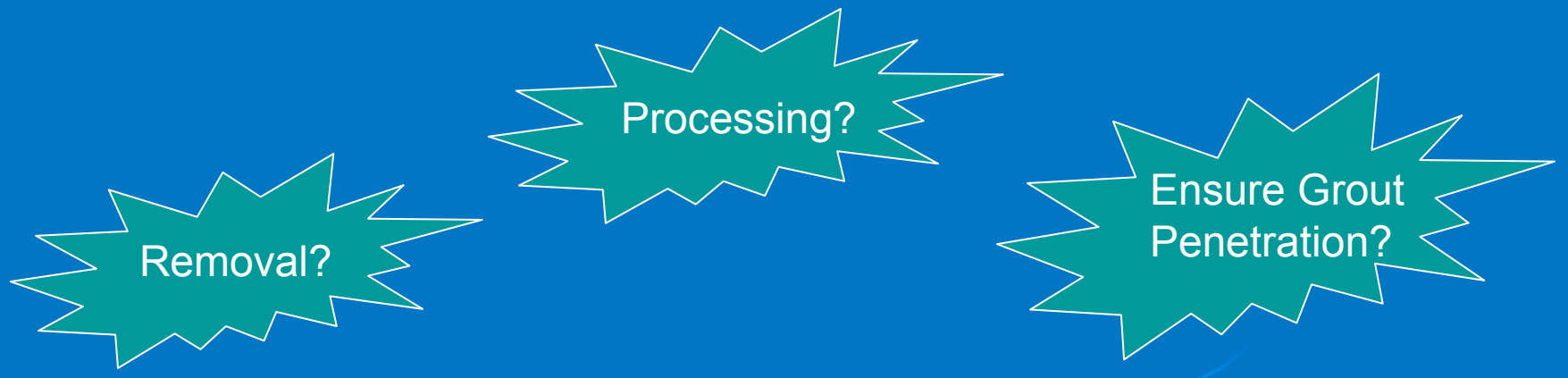
- Intermediate-Sized Repairs
  - up to partial slab replacement, < 1 cu.yd. (typ.)
  - full-depth concrete
  - minimal work on base course

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

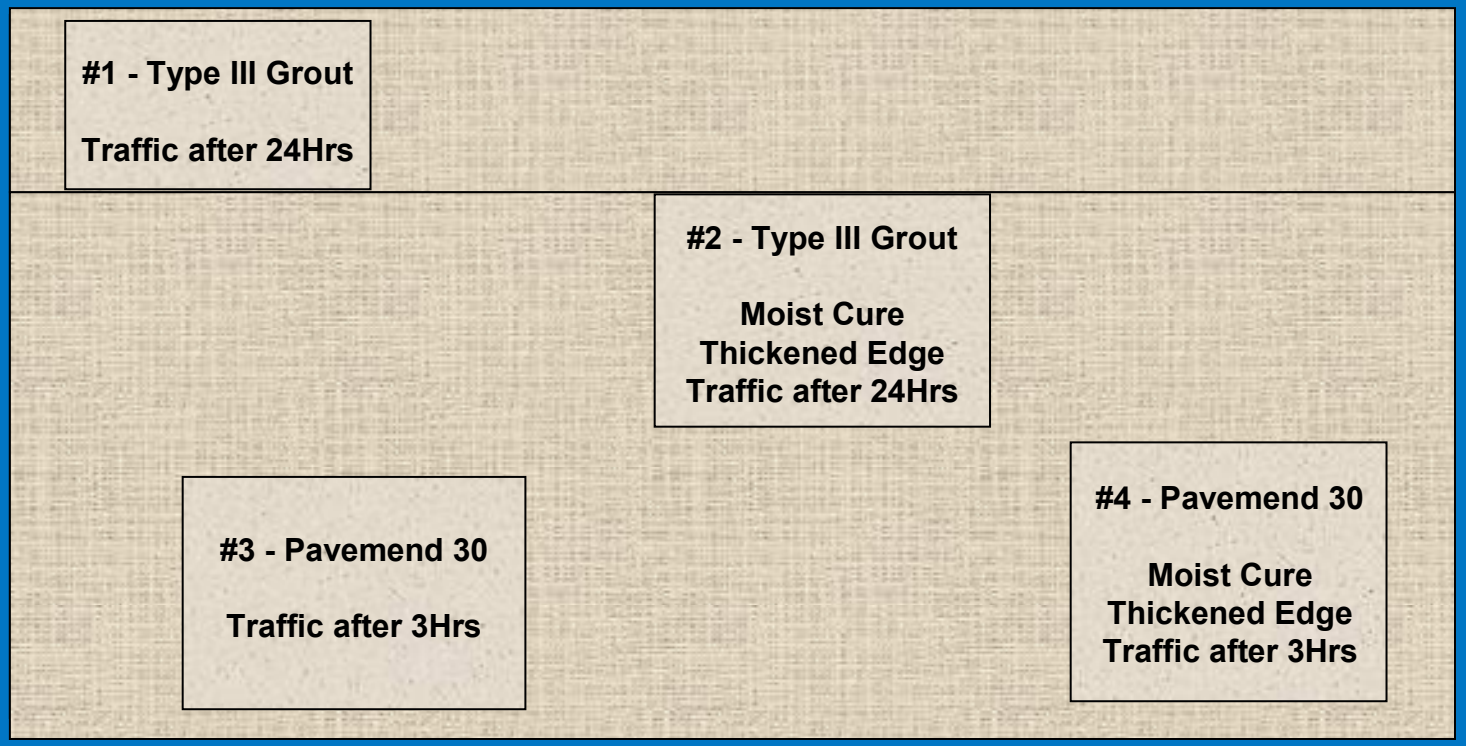
Intermediate Repairs

- 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



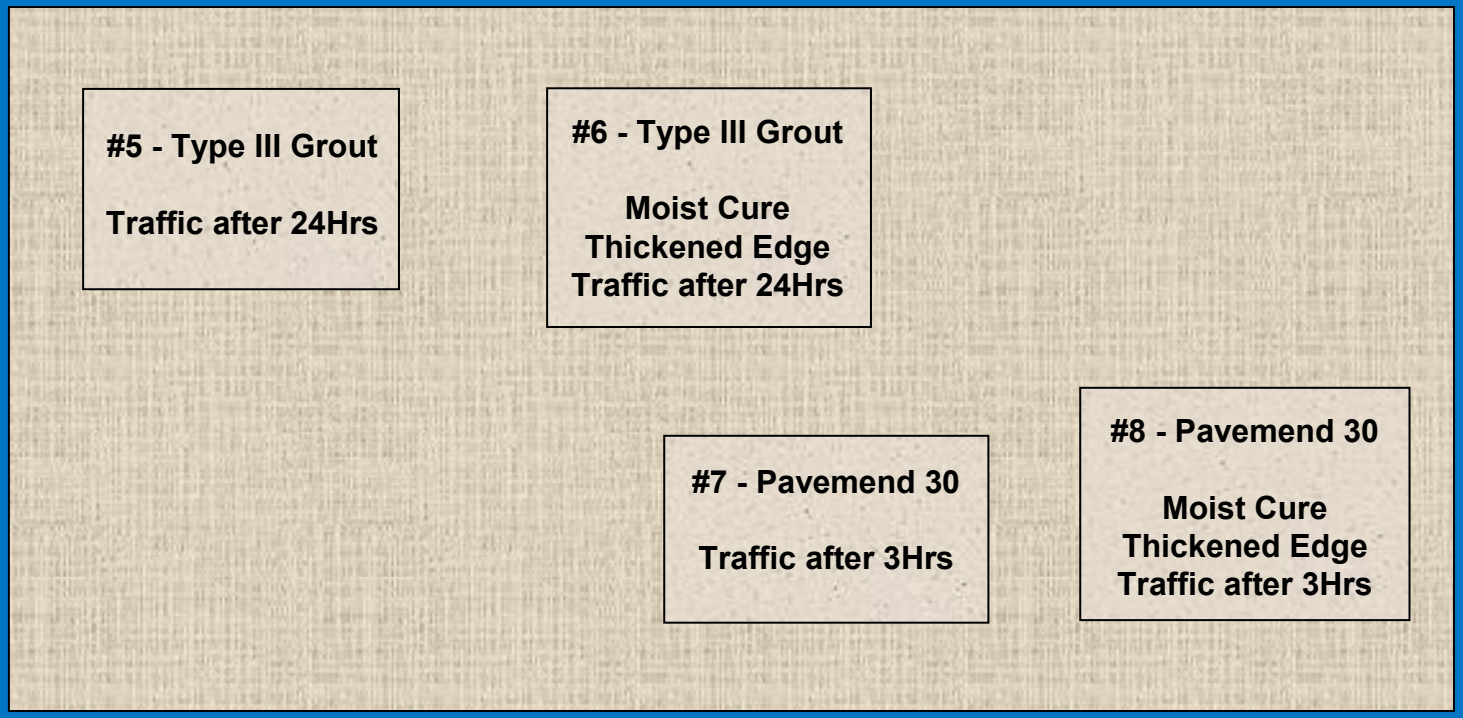
Field Placements

- 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



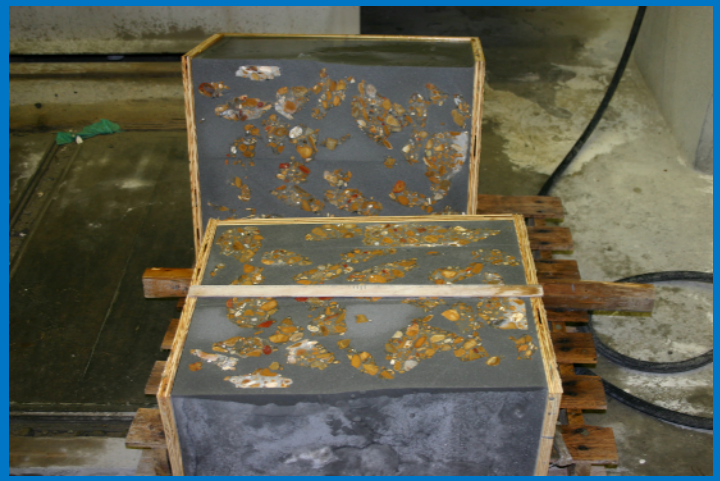
Develop Method of Removal

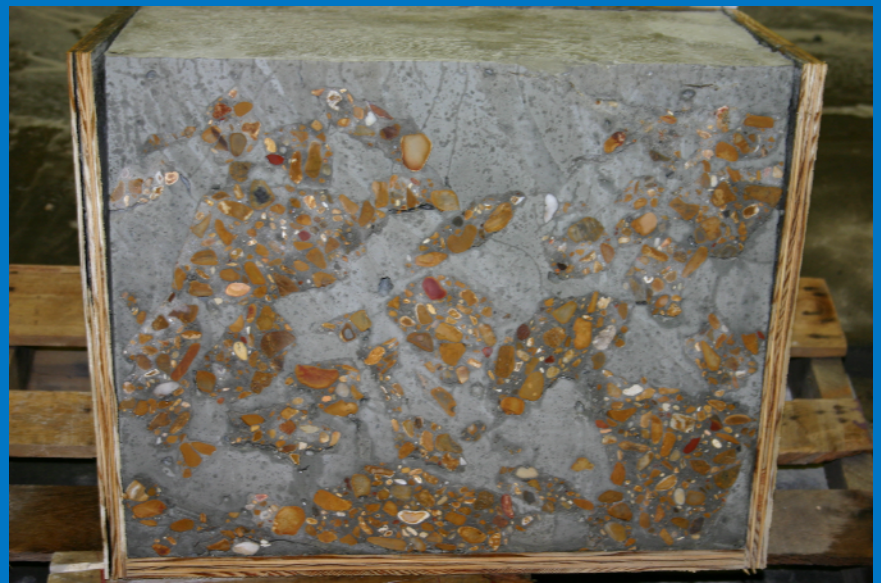
Characterize Debris

Ensure Grouts Could Penetrate

Ensure Grouts Could Penetrate

Ensure Grouts Could Penetrate





Field Placements

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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


UFC 3-270-07
12 August 2002

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O&M:
AIRFIELD DAMAGE REPAIR

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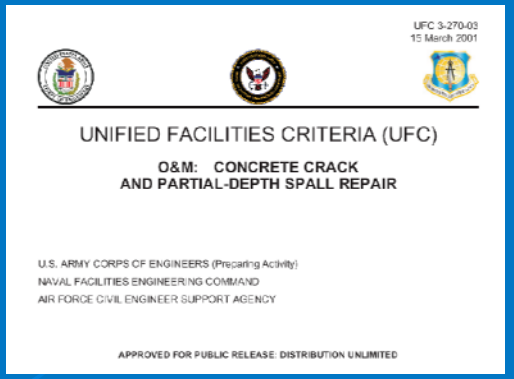
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O&M: CONCRETE CRACK
AND PARTIAL-DEPTH SPALL REPAIR

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NAVAL FACILITIES ENGINEERING COMMAND
AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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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”


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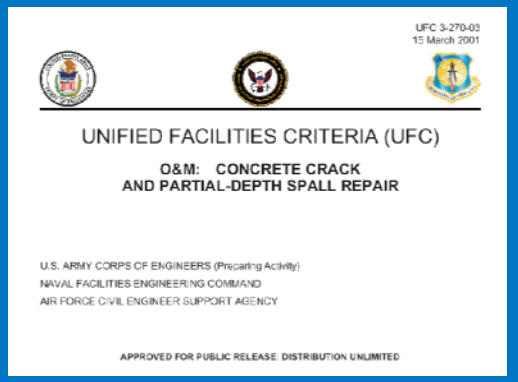
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