Guidelines for Rubblization

AAPTP Project 04-01

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Airport
Asphalt
Pavement
Technology
Program

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Cracking on Airfield Pavement Surfaces Leads to Foreign Object Debris (FOD)


F-16D
- 285 psi tire pressure on main gear
- Single engine low to the ground

Aircraft loads can exceed 1M pounds

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AAPTP Project 04 – 01: *Developing Rubblization Guidelines for Airfields*

- **Research Team:**
  - Mark Buncher (PI), Gary Fitts, Roy McQueen and Tom Scullion
- **Overall Objectives**
  - Document state-of-the-art rubblization technology
  - Develop guidance for the design, construction and quality control aspects of airfield rubblization
  - Prepare guide spec, design and construction manual
- **Started Sept 2005**
  - Duration: 24 months

What is Rubblization?

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

Earliest Use of Rubblization on Airfields: 1997, 10in PCC, Jacksonville NAS TW “A”

State DOT's Adopt Rubblization

- Technology developed for highways
  - Approx. 2% of all rubblization SYs has been airfields
    - Same with crack/break and seat
- Became predominate PCC rehab technique in 1990's
  - From 1994 - 2004, > 50 million sq yds rubblized
- Most highway thicknesses between 8-14 inches

But What About Thicker PCC on Heavy Load Airfields?

- **Resonant Pavement Breaker at Wright-Patterson AFB, OH, 2002**
  - **Up to 26 inches**
- **Multi-Head Breaker at Selfridge ANGB, MI, 2002**
  - **Up to 21 inches**

RB-500 at WPAFB

- 2000 lbf blows @ 44 cycles/second
- < 1 in amplitude
- 9-12 in wide, multiple passes

Test pits at WPAFB confirmed:

- **Complete slab destruction full depth (26 inches)**
- **Max particle size: 12in**

Rubblization Process at Selfridge

- Edgedrains and Cross Underdrains
- Pre-fracture
- Rubblize
- Test Pits
  - agency approval before full scale
- Rolling
  - Z-grid roller
  - 25-ton proof roller
- Leveling Course
  - crushed PCC
- Paving

Completed Selfridge RW

In May 2002, 85,000 sq yds of PCC RW was rubblized in 16 days (5300 sq yds/ day)

Some Preliminary Findings and Recommendations from AAPTP 04-01

(not necessarily the views of AAPTP, the FAA, etc)

Conclusions on Material Characterization

- Data Shows Range of In-service E_{rub}: 100 to 430 ksi
  - Avg of 205 ksi
  - Closer to HMA Base than CAB
  - Larger Particles and Steel Result in Higher E_{rub}
  - Poor Underlying Support Can Result in Larger Particles
  - Poor Correlation of E_{rub} to Slab Thickness
  - E_{rub} May be Related to Pre-fractured Modulus
    - Better correlation, but less data
- For CBR Designs: Consider Equivalency Factors
  - 10” Rub = 10+” CAB

Other Findings Regarding Material Characterization

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- Several (4) Projects Show E_{rub} Tends to Increase With Time
- E_{rub} Dependent On Rubblization Effort
  - Repeated Runs Of Either Equipment Type Reduces E_{rub}.
- No Rubblization Project Found In Literature That Reported Reflective Cracking From Underlying PCC
  - But Full Depth Fracture Can Be A Challenge On PCC That Is Reinforced, Very Thick (>20”) Or Very Thin (<9”) With Poor Support
- No Change In Subgrade Moduli After Rubblization
- No Consistent Difference In E_{rub} With Two Equipment Types

Minimum HMA Overlay Thickness Recommendations

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- If HMA Placed Directly Over Rubblized Material
  - 5 inches Minimum HMA Total
    - At least 2 lifts, but 3 preferred (for smoothness)
    - 1st lift at least 3 inches (to achieve density)
- If Unbound Material Directly Over Rubblized
  - Use Existing Minimum HMA Thickness Criteria For That Unbound Material (RAP, CAB, Etc)
    - Typically 3 or 4 inches
  - Leveling Courses Often Used On Runway and Taxiway Projects To Correct Grade
- Design May Require Greater Thicknesses

Assessing Suitability of Project for Rubblization

- Marginal candidates are thin slabs (< 9” approx.) with poor underlying support
  - Either no subbase or thin select fill
  - Weak or saturated subgrade
  - Typical of WWII era airfields
  - Three recent runway projects
    - Pratt, Kegelman, Tullahoma

Pratt RW, KS

-6” PCC, virtually no subbase, subgrade CBR of 2-4

-Spec required RPB

-Edge drains installed but no water ever drained

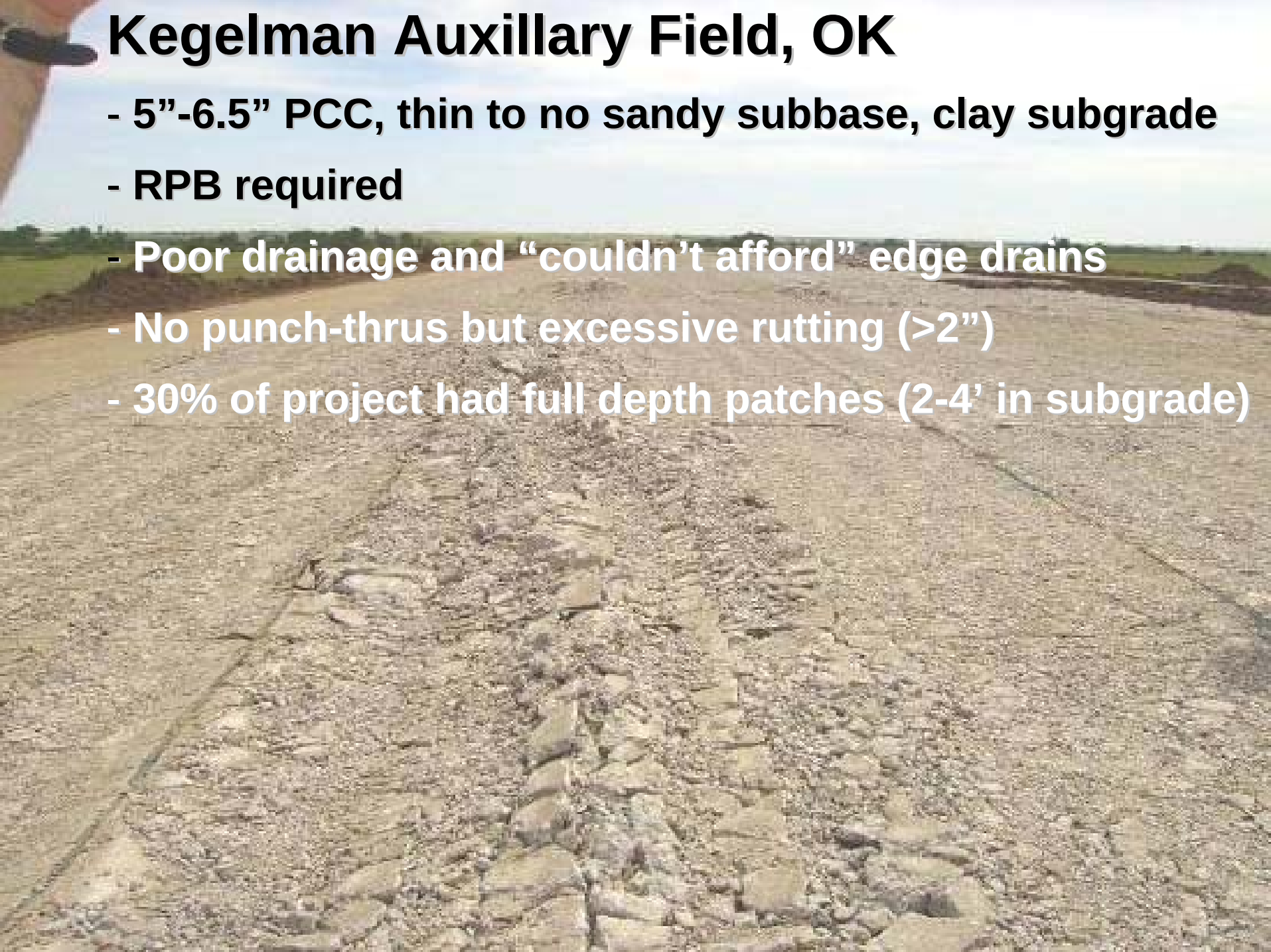
- Rubblization started OK on edge, but problems as moved toward center

Pratt RW

- 45% of first phase required full depth patching

Kegelman Auxillary Field, OK

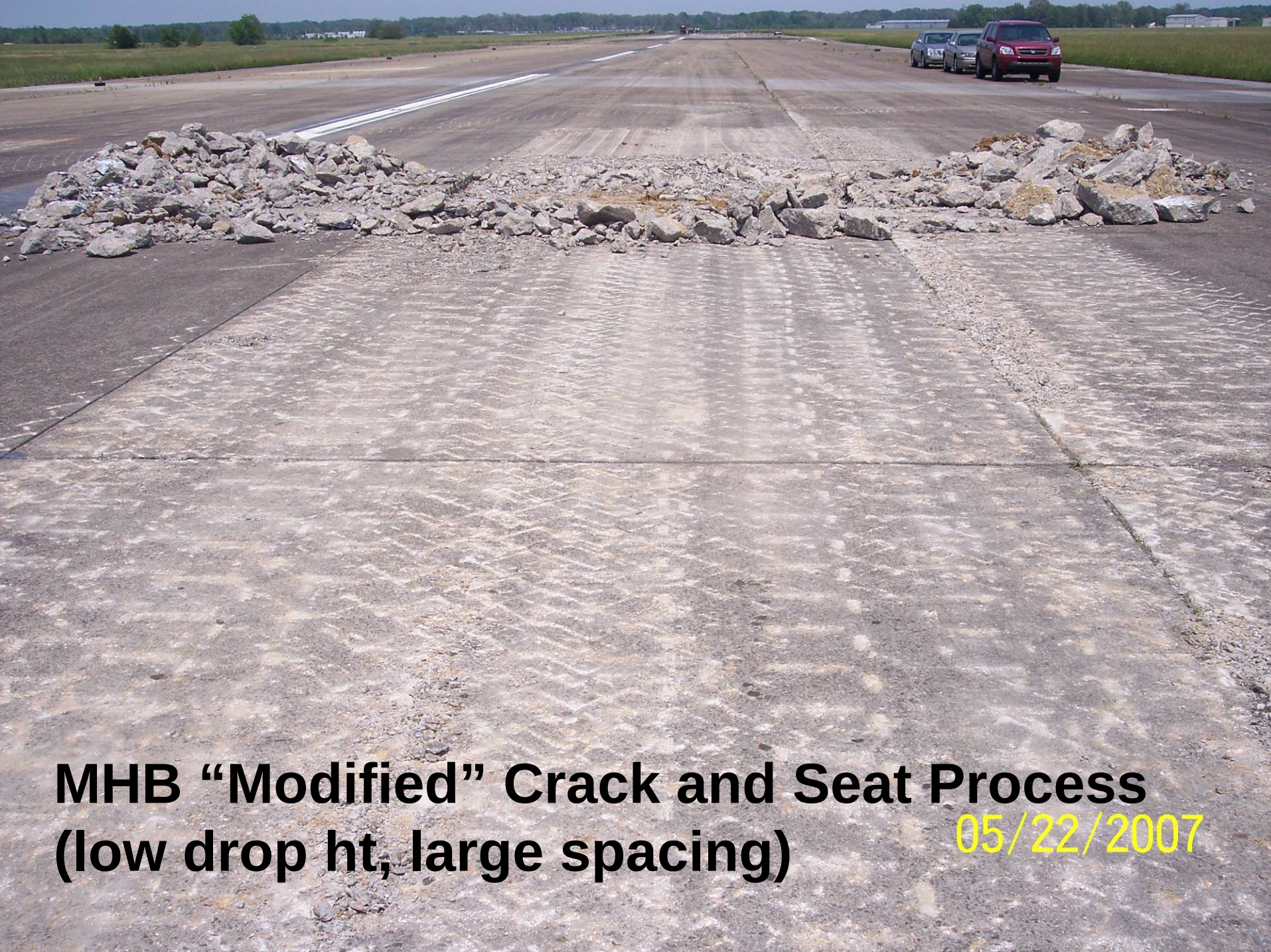
- 5”-6.5” PCC, thin to no sandy subbase, clay subgrade
- RPB required
- Poor drainage and “couldn’t afford” edge drains
- No punch-thrus but excessive rutting (>2”)
- 30% of project had full depth patches (2-4’ in subgrade)



Tullahoma TN Airport RW

- Built During WWII
- 7.25” PCC Over Clay Subgrade
- CBRs Reported of 4 to 12
  - Variable levels of moisture and strength
- Closed For Some Time
- Design Called For Rubblization With 6” CAB and 5” HMA Overlay
- Suggested Trial Demo With Both Types Of Rubblization Equipment Before Project Let

Start-up of MHB, normal ht (24”) and spacing



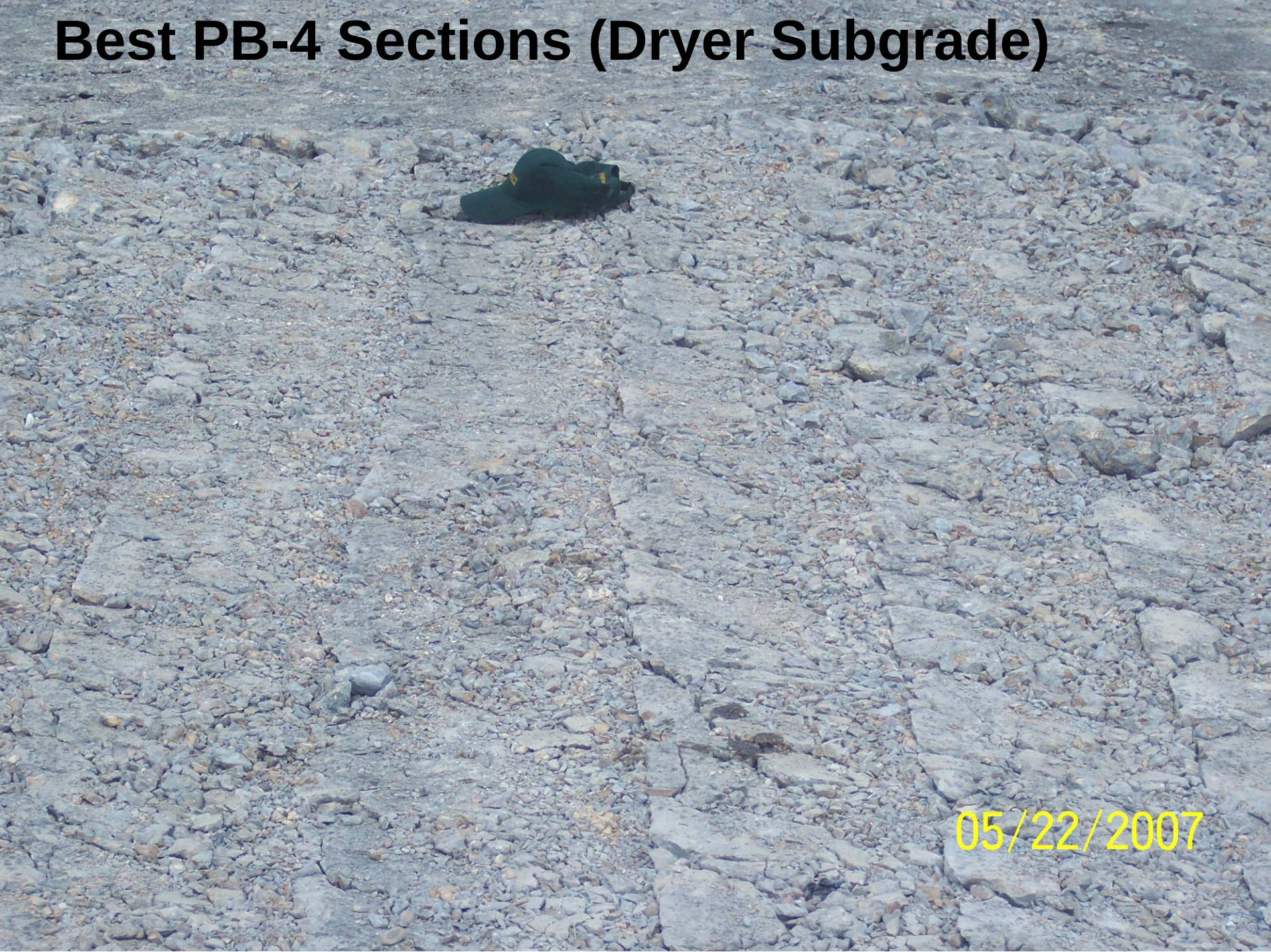
MHB "Modified" Crack and Seat Process (low drop ht, large spacing)

Test Pit from MHB "Modified" or Crack and Seat Process, low (16") drop ht, large (10") spacing

PB-4 Proof Rolled and Failed a MHB Section

Typical PB-4 Sections (rutting, poor breakage)

Best PB-4 Sections (Dryer Subgrade)



Best PB-4 Sections (Dryer Subgrade)

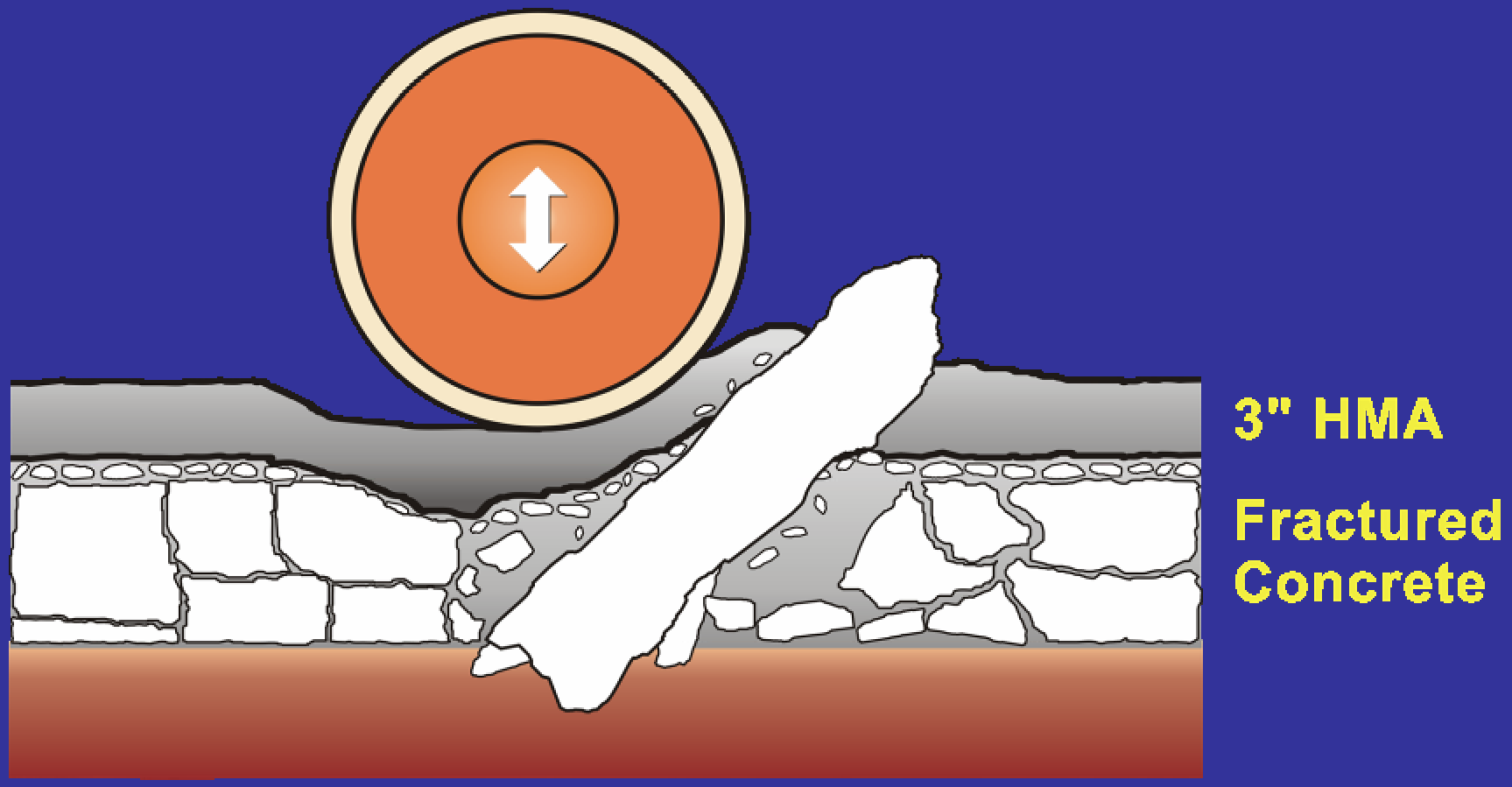
SH 70 in TX, MHB, No Base, 9-6-9 slabs on clay subgrade

More difficult to get good break on outer thickened and reinforced edge

Belly Dump operation

Problem Areas found during HMA placement

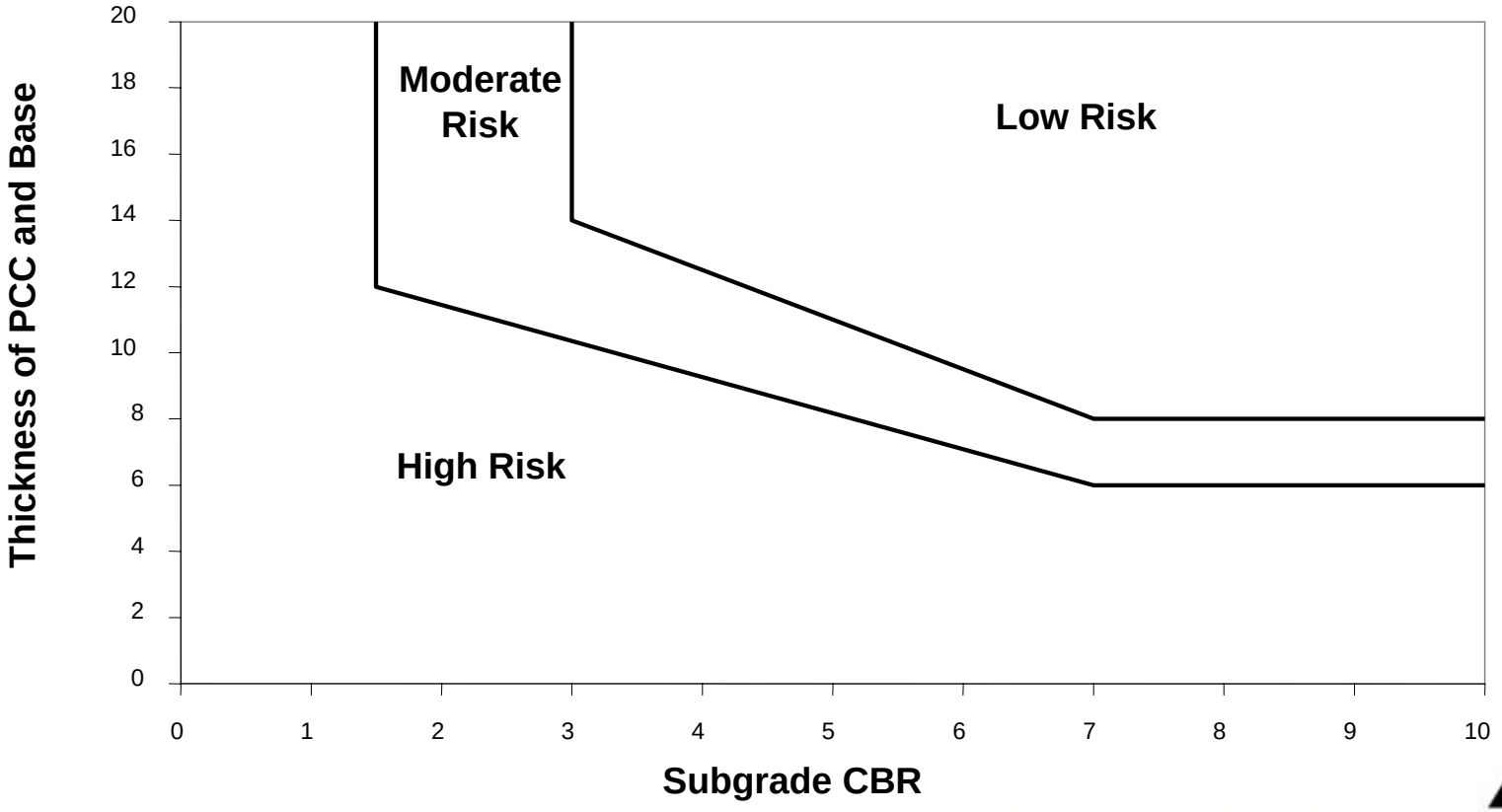
Large Particle Rotation



Very Poor Support

Project Feasibility

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).



Avoiding Problems on Marginal Candidates

- Assess risk before starting project
  - Estimate % of high, medium and low risk areas
- Proof rolling very important, especially if using the MHB
  - Don’t want to find weak spots when paving starts
- Consider trial demo
- Start rubblization away from wet season
- Consider other design options
  - crack and seat
  - Placing CAB layer before HMA

Other Recommendations for Marginal Candidates

- Always install edge drains before rubblization
  - Unless one is existing or self draining subgrade
  - Eases rubblization, better long-term performance
- Include full depth patching of unstable areas as separate bid item with estimated quantity
  - Provides competitive price
- If saturated subgrade, turn off vibrators on rollers
- Consider construction sequencing options <u>with first lift</u>
  - Keep trucks on adjacent unbroken PCC or new HMA
  - Cautious of using heavy MTV on first lift
  - Use tracked pavers on first lift

Remove all HMA

Did not completely remove old HMA at all locations

Scraping off HMA after rubblization revealed no breaking accomplished beneath HMA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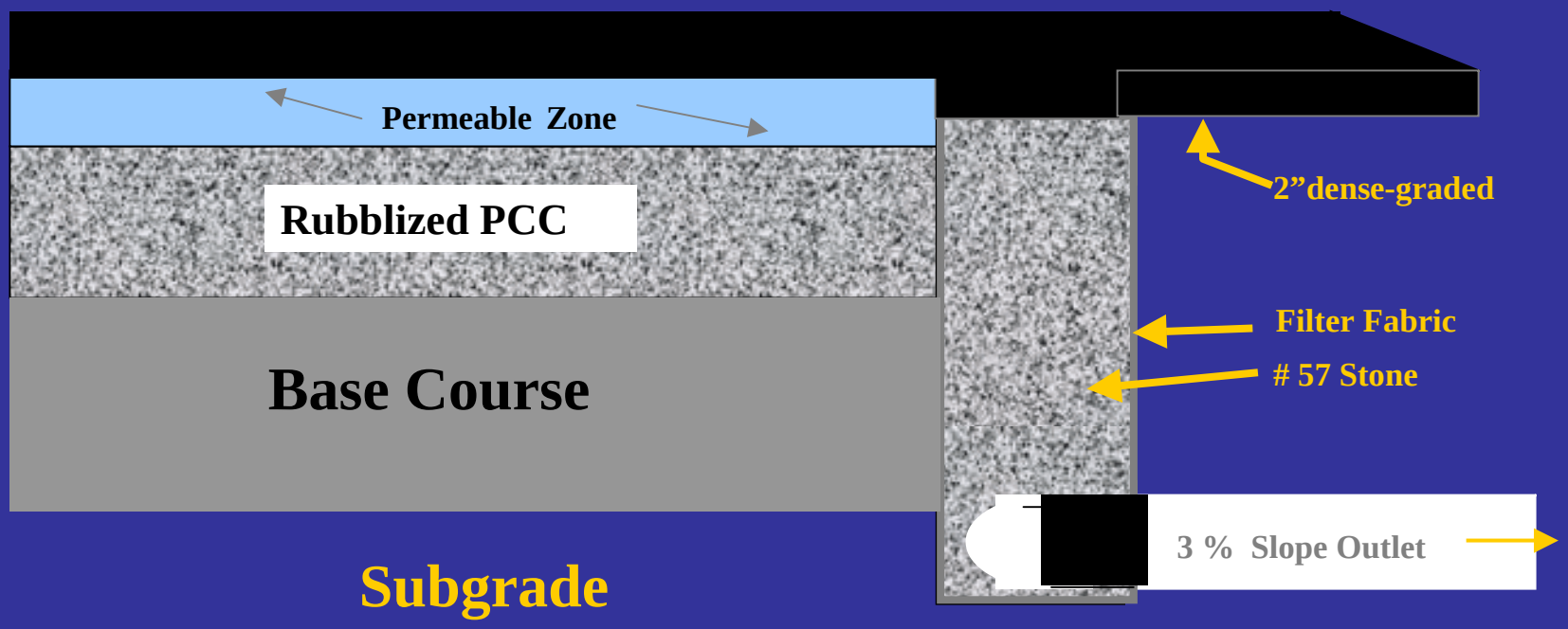
Rubblization Side Drainage

- Prior to rubblization
- Directly against edge of concrete
- Rigid PVC with smooth interior
- Drain for several days



Isolate Adjacent Pavements Not To Be Rubblized

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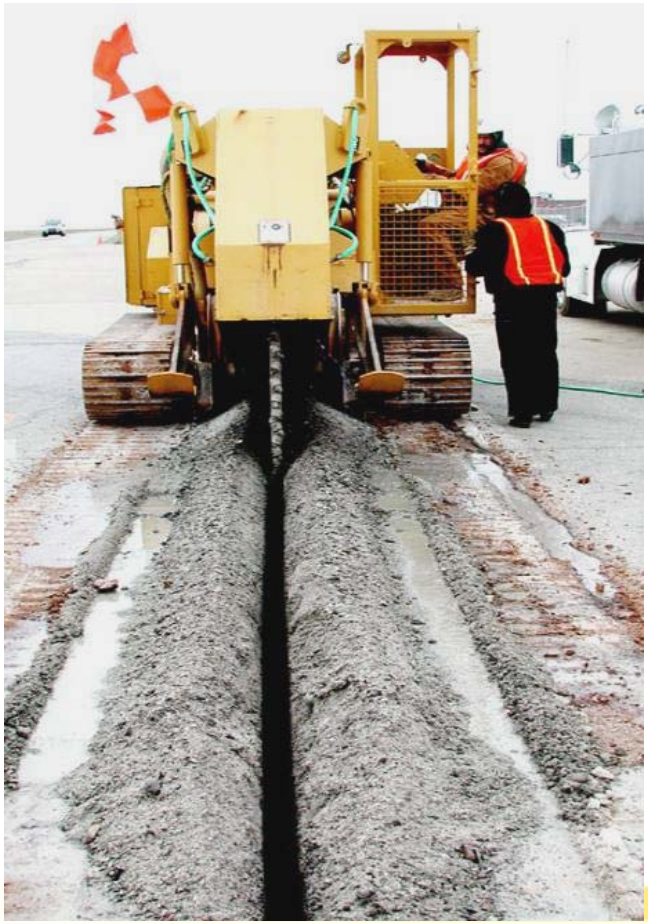

Protect structural integrity of adjacent pavement with:

- **wheel saw relief trench, or**
- **two parallel diamond blade saw cuts**

The End

Questions?