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Rubblization of Airfield Concrete Pavements

By

Eileen M. Vélez-Vega

Research Civil Engineer

Airfields and Pavements Branch

Overview

- **Introduction**
  - FY 03-04 AFCESA Research
  - FY 05 AMC Research
- **FY 03-05 Research Approach**
  - Phase 1
    - Equipment & Procedure
  - Phase 2
    - Highway and Airfield Rubblization Evaluations
    - Cost Analysis
      - Grand Forks Air Force Base Study
  - GF AFB Guidelines and Specifications
    - Runway Reconstruction Project
- **Results and Conclusions**
- **Future Research Studies**
- **Questions**

Rubblization

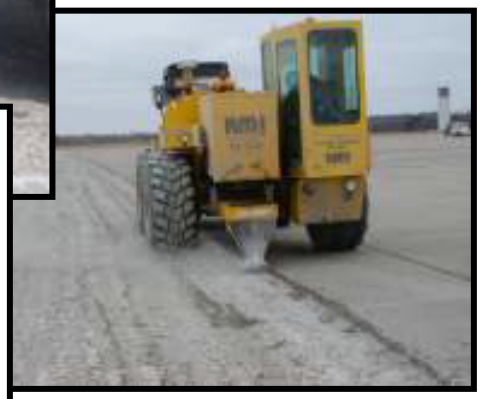
- ***Main Objective:***
  - Develop a design procedure and criteria for the design of asphalt overlays over rubblized, and crack and seat PCC pavements.
- Project History:
  - FY 03-04 AFCESA: Rubblization Design Procedure
  - FY 05 AMC: Grand Forks AFB Runway Reconstruction Project
- ***Rubblization…***
  - …is a relatively "new" rigid pavement rehabilitation technique.
  - …eliminates existing slab action by breaking the PCC pavement into small particles ranging from:
    - sand size to 75 mm (3 in) at the surface,
    - 150 to 230 mm (6-9 in) on the top half,
    - 305 to 380 mm (12-15 in) at the bottom half of the PCC layer.
- ***Crack and Seat*** has almost been replaced with Rubblization due to the significant advantages that it proves to have in the rehabilitation of PCC pavements.

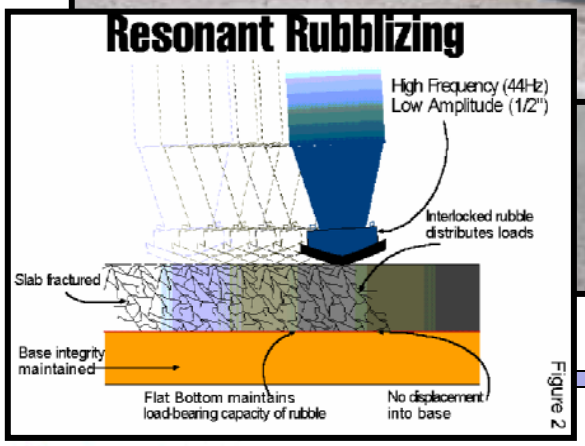
Why Rubblization?

- ***Pavement Distresses***
  - Reflective Cracking
  - Severe Joint Deterioration
  - Slab Settlement
  - Excessive Patching
  - “Pop-outs”, etc.

Rubblization Equipment *

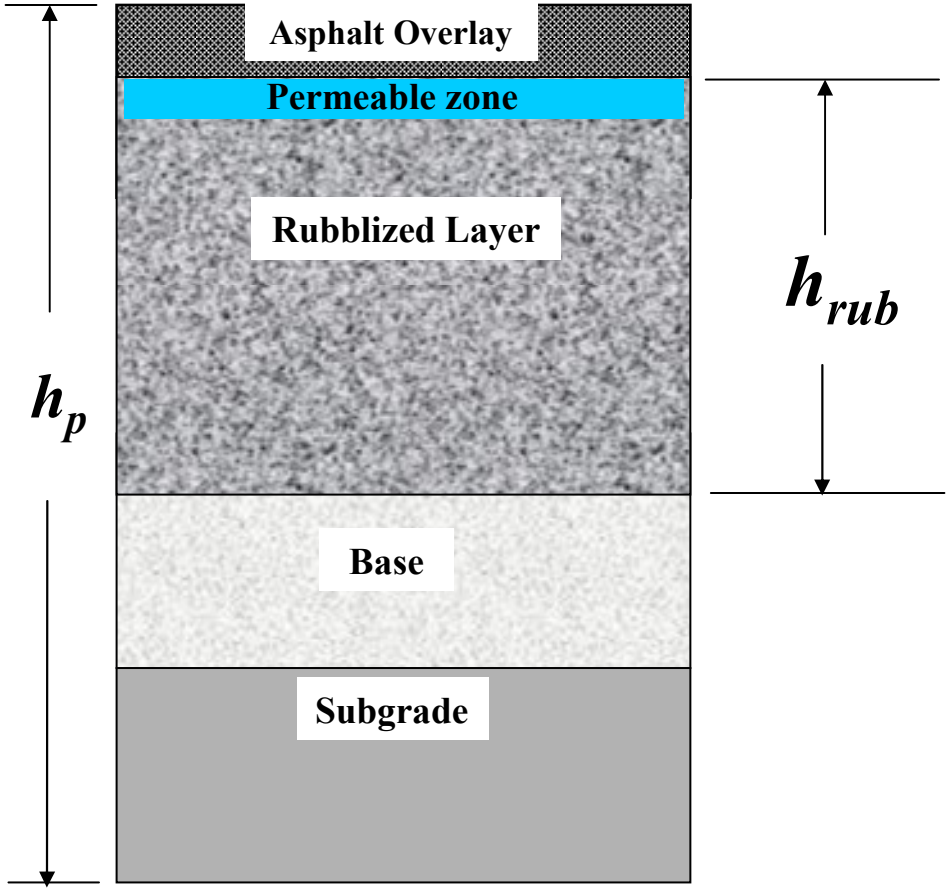
- ***Current U.S. major contractors:***
  - Resonant Machines Inc. (RMI)
    - Resonant Breaker, RB-500
      - Low Amplitude
        - » 12 to 20 mm (1/2-3/4 in)
      - High Frequency Hammer
        - » 44-47 Hz
  - Antigo Construction, Inc.
    - Guillotine Type Breaker
      - – 5,440 kg (12,000 lb), 2.4 m (8 ft) hammer
    - Multi-Head Badger Breaker®
      - – 16-450 kg (1,000 lb) hammers
      - – 4 m (13 ft) wide
      - – 1.5 m (5 ft) individual drops





*** Pictures from Antigo and RMI Website**

Particle Size Distribution



h_{rub} = *maximum depth of the slab*

h_p = *pavement thickness*

RMI Particle Size Specifications:

- Particle Size Range:

  Sand size to 6 inches not greater than 1.25 times h_{rub}

- Majority of the pieces:

  Sand size to 0.75 times h_{rub}

- For reinforced PCC:

  Larger pieces are accepted and reduced to the best possible size.

Antigo Construction Inc. Particle Size Specifications:

- Size Range:

  Sand size to 3 inches or less in the top half of the slab.

  9 inches or less in the bottom half of the slab.

- For reinforced PCC:

  Similar to the RMI Specifications

Highway Rubblization Projects

- I-10 Louisiana Rehabilitation Project
  - 11.0 km (7-mi) pavement rubblization
  - Contractor: Resonant Machines, Inc.
  - Pavement Structure:
    - 250 mm (10 in) AC O/L
    - 230 mm (9 in) Rubblized PCC
    - Subgrade: Sandy Soil

I-10 Louisiana

- I-65 Alabama Rehabilitation Project
  - Contractor: Antigo Construction, Inc.
  - Pavement Structure:
    - 280 mm (11 in) AC O/L
    - 250 mm (10 in) Rubblized PCC
    - Subgrade unknown
  - Test Pits required every 305 m (1000 ft)

I-65 Montgomery

Airfield Rubblization Projects

- **Hunter Army Airfield, Savannah, GA**
  - East Taxiway Rubblized in 2003
  - Equipment (Antigo Construction Inc.):
    - Guillotine type breaker
    - Multi-Head Badger Breaker
  - Pavement Structure
    - 250 mm (10 in) AC O/L
    - 11,000 m^2 (13,167 yd^2) of 200 mm (8 in) Rubblized PCC
    - Subgrade: Poorly Graded Sand

- **Selfridge Air National Guard Base, MI**
  - Runway Reconstruction, Summer 2002
  - Equipment (Antigo Construction Inc.):
    - Guillotine type breaker
    - Multi-Head Badger Breaker
  - Pavement Structure
    - 180 mm (7 in) AC O/L
    - 115 mm (4.5 in) Crushed Concrete Base Course (leveling course)
    - Rubblized PCC thicknesses varied from 330 to 530 mm (13-21 in)
    - Subgrade: Silty Sand soils

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Selfridge ANG Base Rubblization Project

ERDC

* Picture from the Antigo Construction, Inc. Website

Rubblization Evaluation Results

- **Pavement Structural Evaluation**
  - Collect and analyze HWD data
    - Maximum load: 114,400 kg (52,000 lb)
    - Data analyzed in the PCASE program
      - Back-calculate Modulus values using WESDEF
- **Airfield Evaluation Results**
  - Hunter Army Airfield
    - Average Rubblized PCC Modulus values:
      - 4,070 MPa (590 ksi)
  - Selfridge ANG Base
    - 530 mm (21 in) Rubblized PCC Modulus values:
      - 8,700 MPa (1,260 ksi)
- **Additional FWD data:**
  - Niagara Falls Joint Air Reserve Station
    - Data provided by AFCESA
    - Runway Pavement Structure:
      - 130 mm (5.0) AC O/L
      - 240 mm (9 in) Rubblized PCC
      - Subgrade: Silty Gravelly Sand

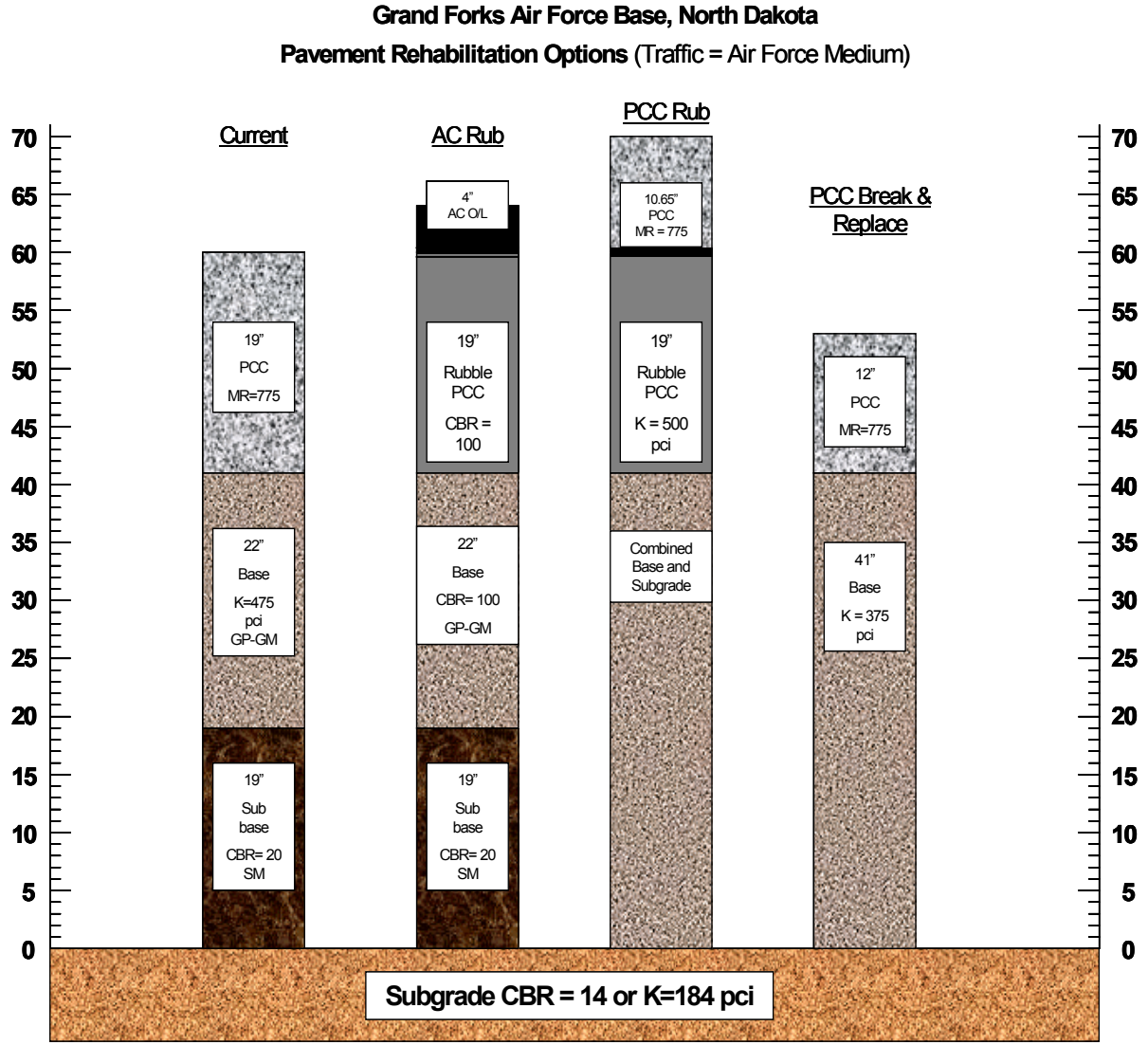
Heavy Weight Deflectometer

- Average Rubblized PCC Modulus values:
  - 700 to 1,080 MPa (100-157 ksi)
  - Variations:
    - High Water Table
    - Shallow Depth to Bedrock

Grand Forks AFB Cost Analysis

Based on the rehabilitation of a 480 mm (19 in) PCC pavement:

- **Grand Forks Air Force Base pavement design:**
  - Air Force Medium Traffic
    - 400 passes B-52
    - 400,000 passes C-17
    - 100,000 passes F-15E
- **Costs**:
  - Rubblization:
    - $1.15 - $5.50 per square meter ($0.95-$4.50 per square yard)
  - Break & Remove:
    - $3.95 - $7.50 per square meter ($3.30 - $6.50 per square yard)
  - Rubblization cost is approximately 40% of the cost of break and removal.



Grand Forks AFB Runway Reconstruction Project

- **Monitor Ongoing Rehabilitation Project in Grand Forks Air Force Base, North Dakota**
  - Interesting Facts:
    - 250,000 sq. yards of PCC Rubblization
    - Average PCC layer thickness = 16-19 inches
    - Rubblization contract
      - Replaced RMI for Antigo Construction Inc.
    - New pavement will consist of AC and PCC overlays
  - Measure pavement response (HWD/FWD):
      - Before rubblization
      - After rubblization, before seating
      - After seating/ before AC/PCC overlay
      - After AC/PCC Overlay
  - Material characterization
    - Particle size distribution
      - Test pit particle sampling
  - Verify existing Rubblization guidelines and specifications

GF AFB Rub. Phase 1

Grand Forks AFB Rubblization Process

Step 1

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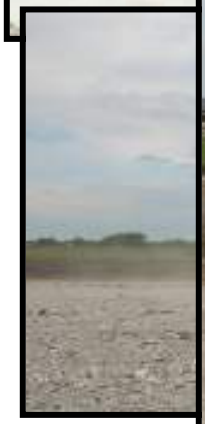

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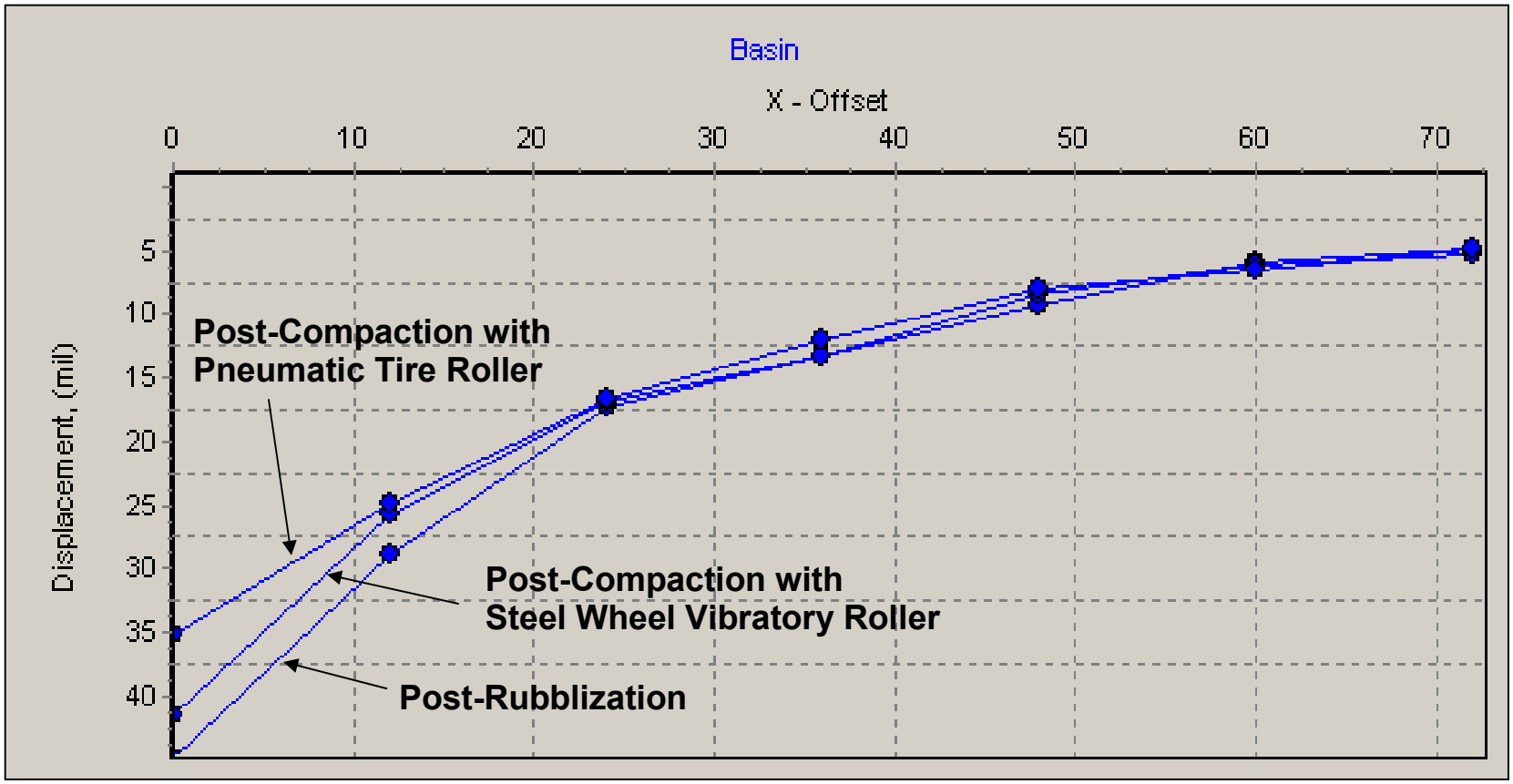
Overlay

Grand Forks AFB - FWD Test Results



- GF AFB Phase I Runway Rubblization: 14-inch PCC pavement

Results and Conclusions

- Without proper guidance rubblization may not be considered a practical solution and there is substantial risk of premature failures.
- Overall cost of rubblization represents a 10% cost savings.
- Important Considerations:
  - Concrete slab
    - Thickness
    - Reinforcement type (if any)
    - Underground utilities
  - Base and Subgrade Strength
    - Soil moisture
    - Type of material
    - Subgrade Modulus >15,000 psi.
  - Proper drainage system
- The engineer may require more roller passes to achieve proper compaction. Over-compaction will break particle interlock.

Proper drainage is required

Test Pits – Verify Cracked Pattern

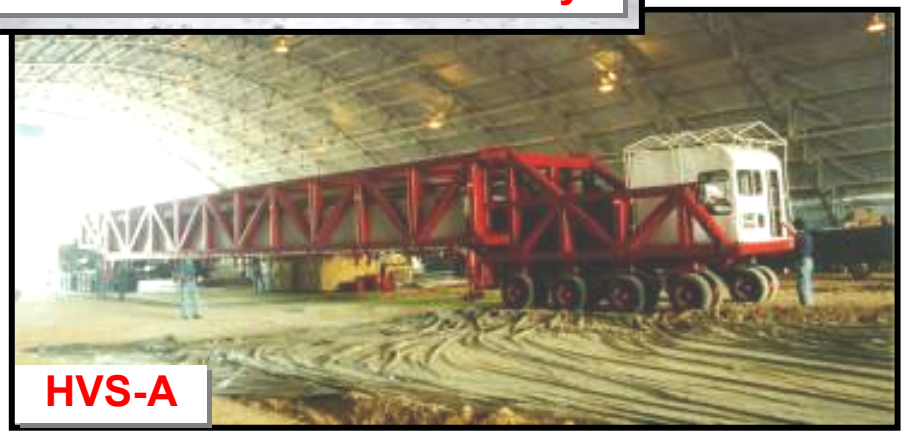
Traffic Control

Future Research Studies

- **FAA Pavement Test Facility, New Jersey**
  - Load/Rolling tests
    - HVS
    - Aircraft loading
- **Monitor Long-term Rubblization Projects**
  - Existing condition evaluations
  - Non destructive testing:
    - HWD/FWD
  - Evaluate “old” crack & seat projects
    - Aberdeen Proving Grounds
  - Traffic responses
    - 5 (+) year term
    - HVS-A
      - Full-Scale Accelerated Pavement Testing
  - Other projects:
    - USAF – Elimination of Alkali-silica Reaction (ASR)
    - Travis AFB, California


HWD


FAA Pavement Test Facility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Acknowledgements

- This past and ongoing research is sponsored by the Air Force Civil Engineering Support Agency (AFCESA) and conducted by the Geotechnical and Structures Laboratory in Vicksburg, Mississippi.

- For additional information on rubblization specifications:
  - Asphalt Institute Website, www.asphaltinstitute.org
  - Engineering Brief No.66 *Rubblized Portland Cement Concrete Base Course*, February 13, 2004 Federal Aviation Administration

- US Army Corps of Engineers Rubblization Specifications are currently under development. For more information please contact Eileen M. Vélez-Vega at **Eileen.M.Velez-Vega@erdc.usace.army.mil**

Thank you for your time!

QUESTIONS?

Contact Information

Eileen M. Vélez-Vega

US Army Research and Development Center
Geotechnical and Structures Laboratory
Airfields and Pavements Branch

Telephone number: 601-634-2717

Email: Eileen.m.velez-vega@erdc.usace.army.mil