Rubblization Performance History

Charles Wienrank, P.E.
Pavement Design Engineer
Bureau of Materials and Physical Research

2014 IAPA Annual Meeting

Illinois Department of Transportation

Presentation Outline

- Background
- Construction Sequence
- Project History
- Project Performance
- Design Procedure

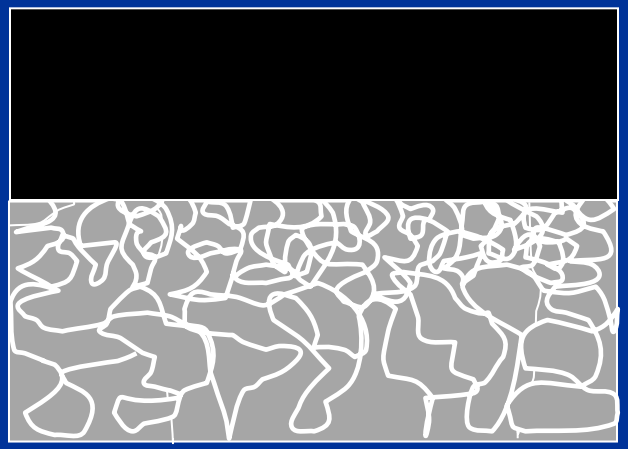
What is Rubblization?

- ***Reconstruction*** alternative for deteriorated concrete pavements
  - Substitute for extensive patching or complete removal and replacement
- Pavement in effect becomes a high-quality, moderately drainable aggregate base
- Eliminates virtually all reflective cracking in the overlay

Rubblization

PCC Slab

HMA Overlay



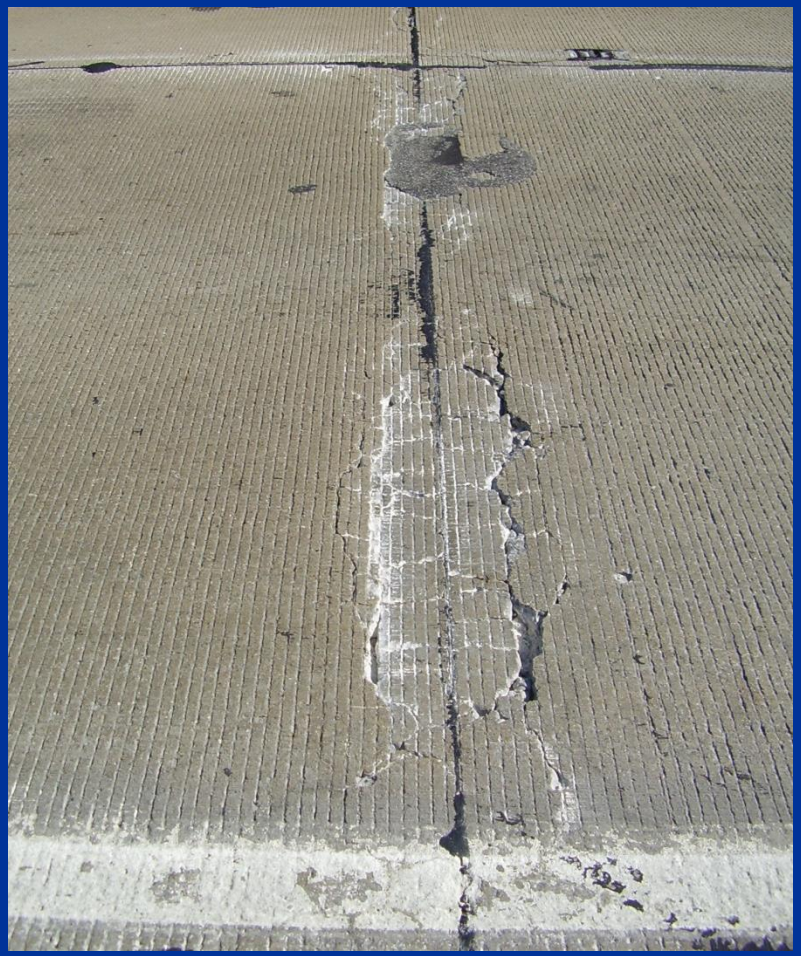
Rubblized PCC Slab -
75% of pieces < 9”
in lower half

Why Rubblization?

- Aging infrastructure
- Materials problems such as D-cracking and alkali silica reactivity (ASR)
- Multiple overlays on many routes
  - Large quantities of patching required
  - Reflective cracking at joints/patches

D-Cracking

Alkali Silica Reactivity (ASR)



Prime Rubblization Candidate

Construction Sequence

- Install underdrains
- Mill existing overlays
- Replace unsound patches
- Rubblize pavement
- Consolidate broken pavement
- Pave binder lifts (allow traffic if nec.)
- Pave surface lift

Pavement Breaking Equipment

- Resonant frequency breaker
  - Multiple passes (14 to 20 per lane)
  - Machine can encroach on adjacent lane
- Multi-head breaker
  - Breaks full width in single pass
  - No encroachment on adjacent lanes
  - Z-Grid roller required
  - Most commonly used

Resonant Frequency Breaker

Encroachment of Resonant Frequency Breaker

Multi-Head Breaker

Broken Pavement Behind Multi-Head Breaker

Z-Grid Roller

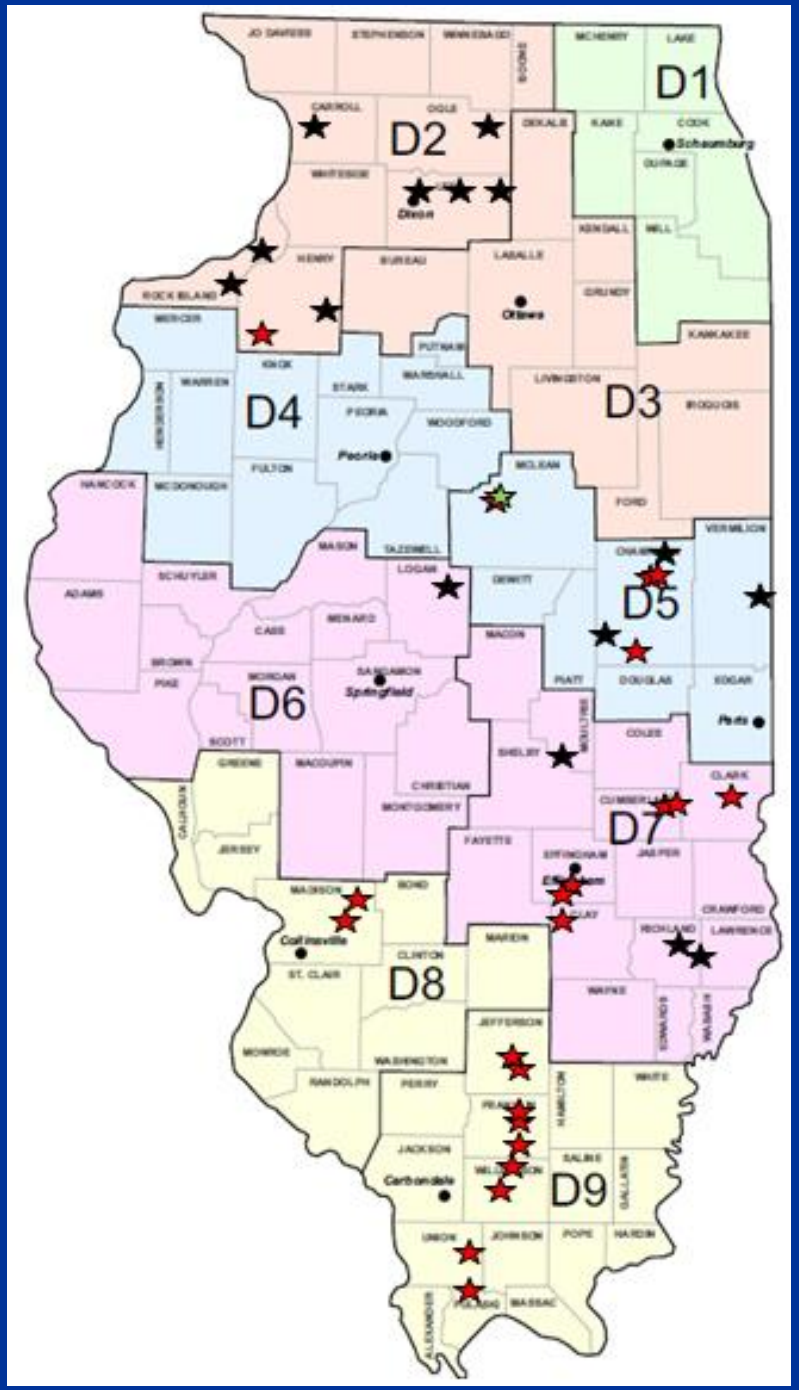
Rubblized Pavement Ready for HMA Overlay

Project History

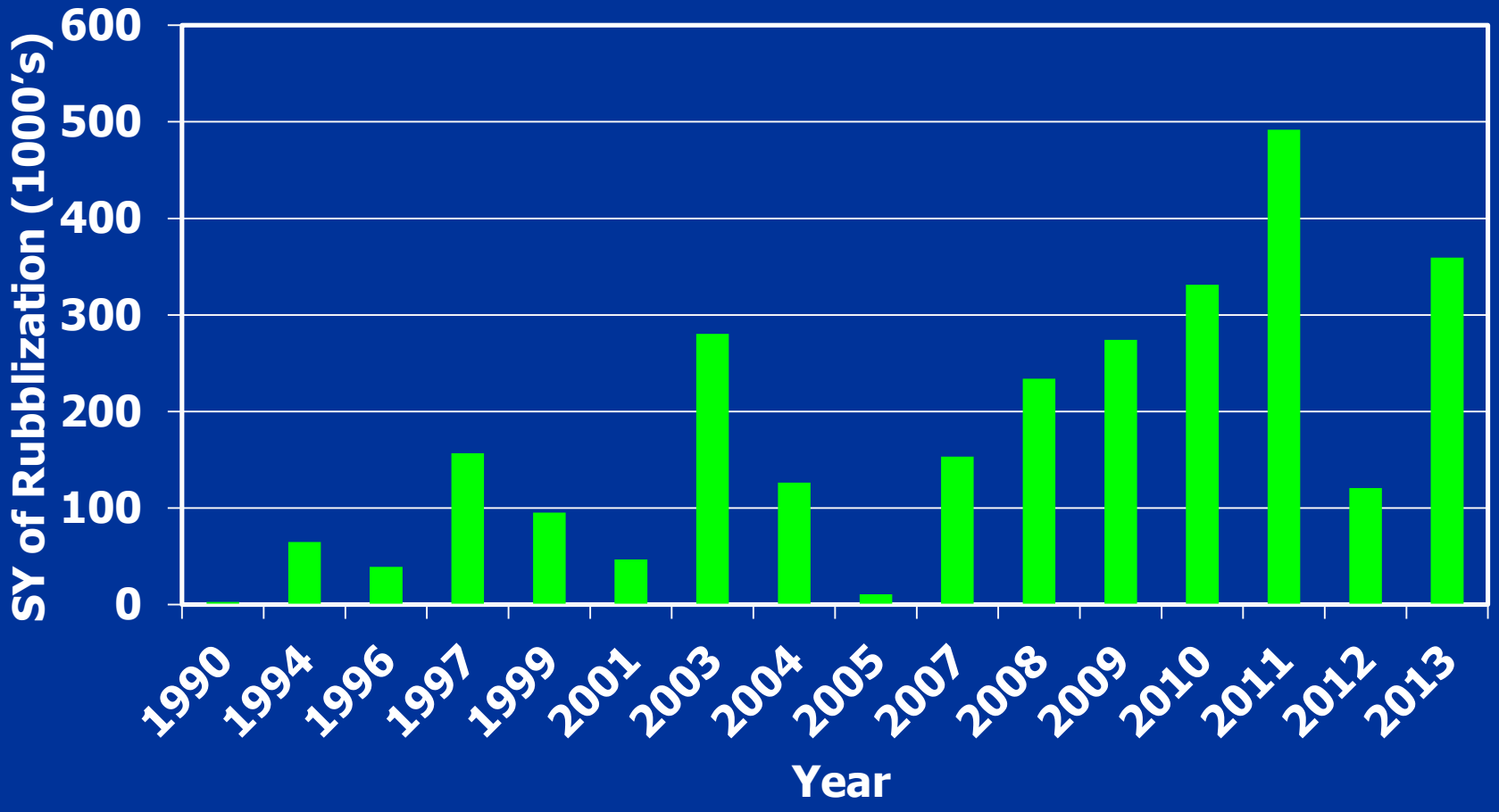
- First project in 1990
  - SHRP LTPP SPS-6 experiment
- Approximately 400 lane-miles of rubblization on IDOT projects to date
  - Used on local roads to high-volume interstate routes
  - Also used on Tollway

Rubblization Projects

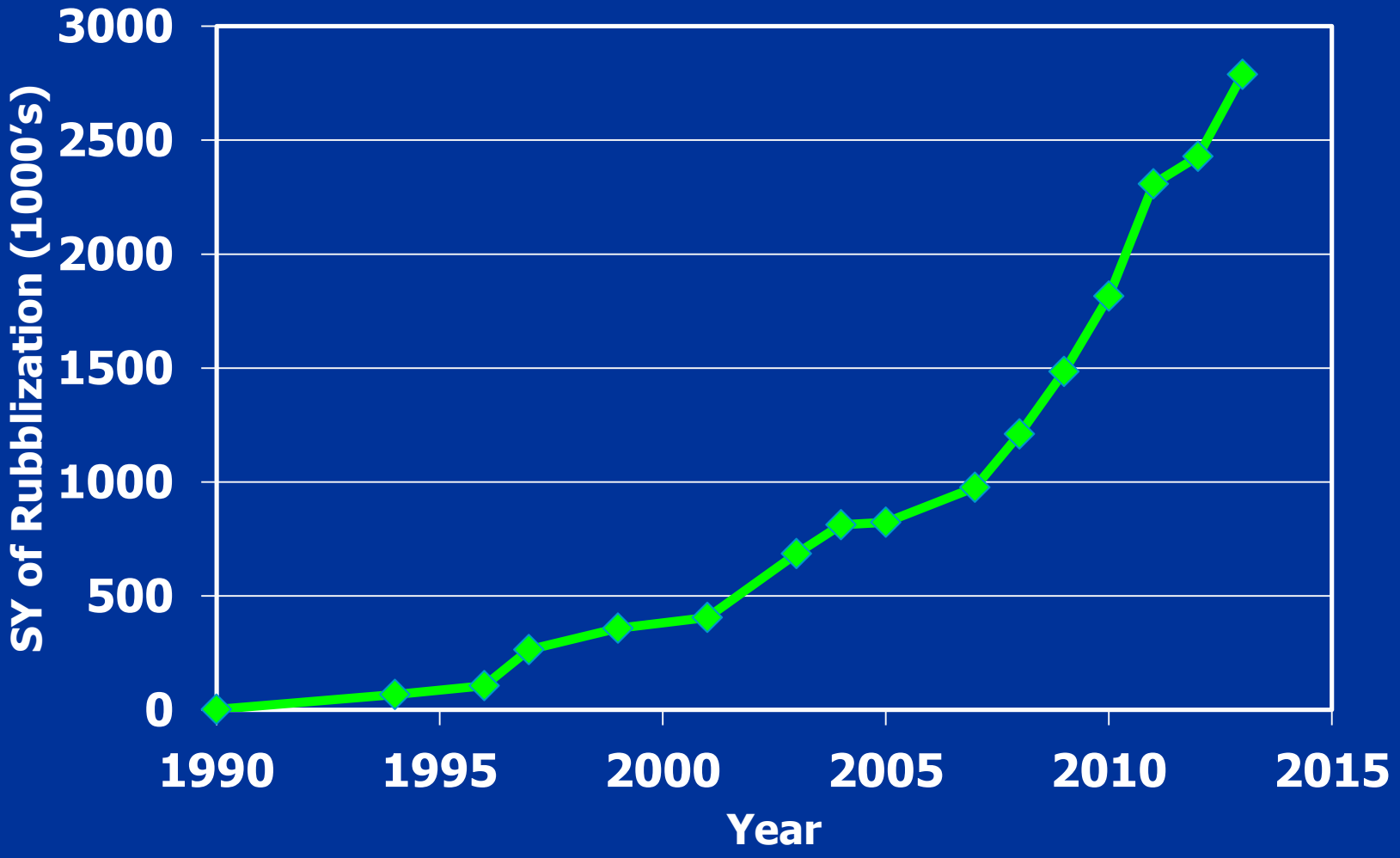
- Non-Interstate
- Interstate
- 2014



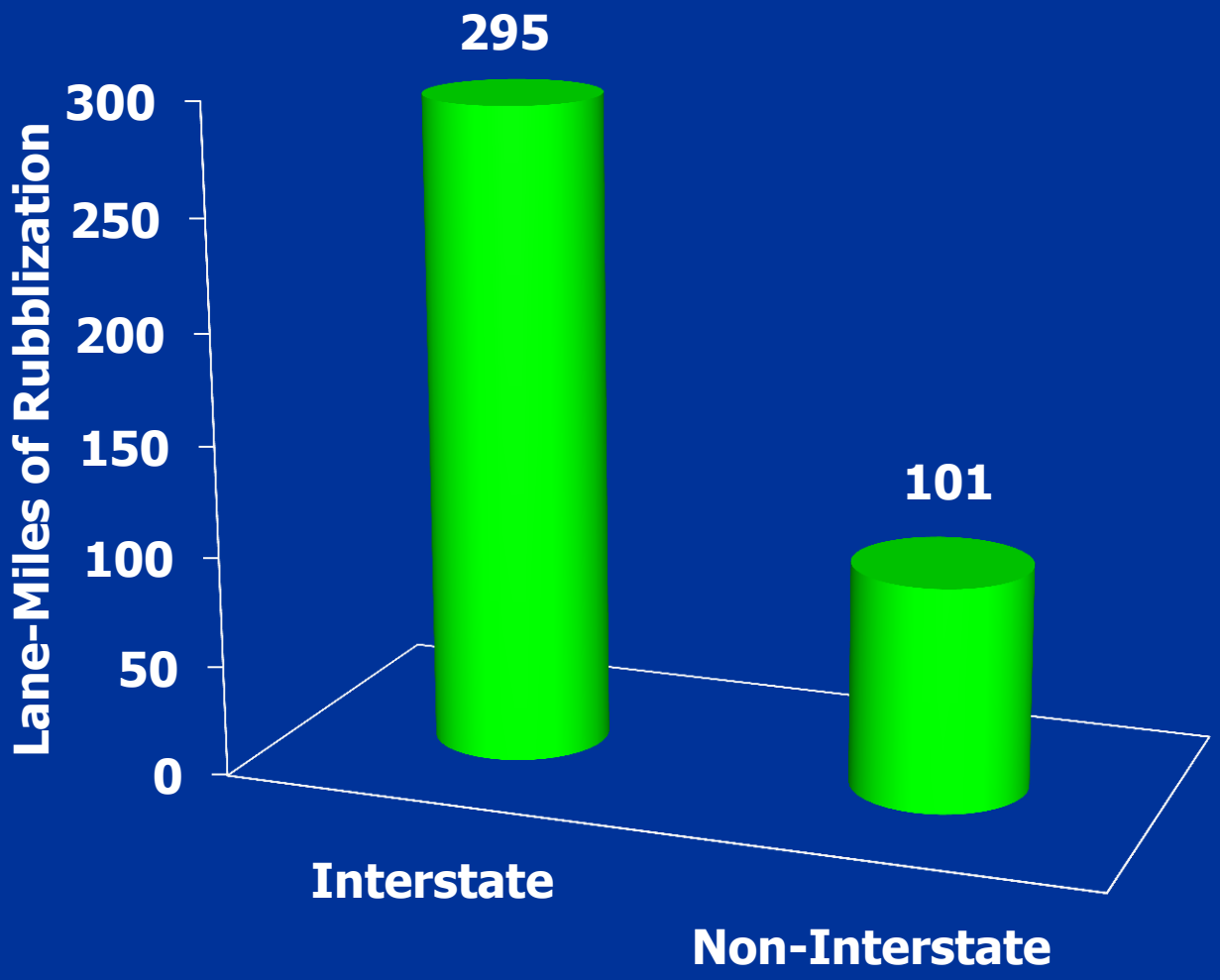
Rubblization by Year



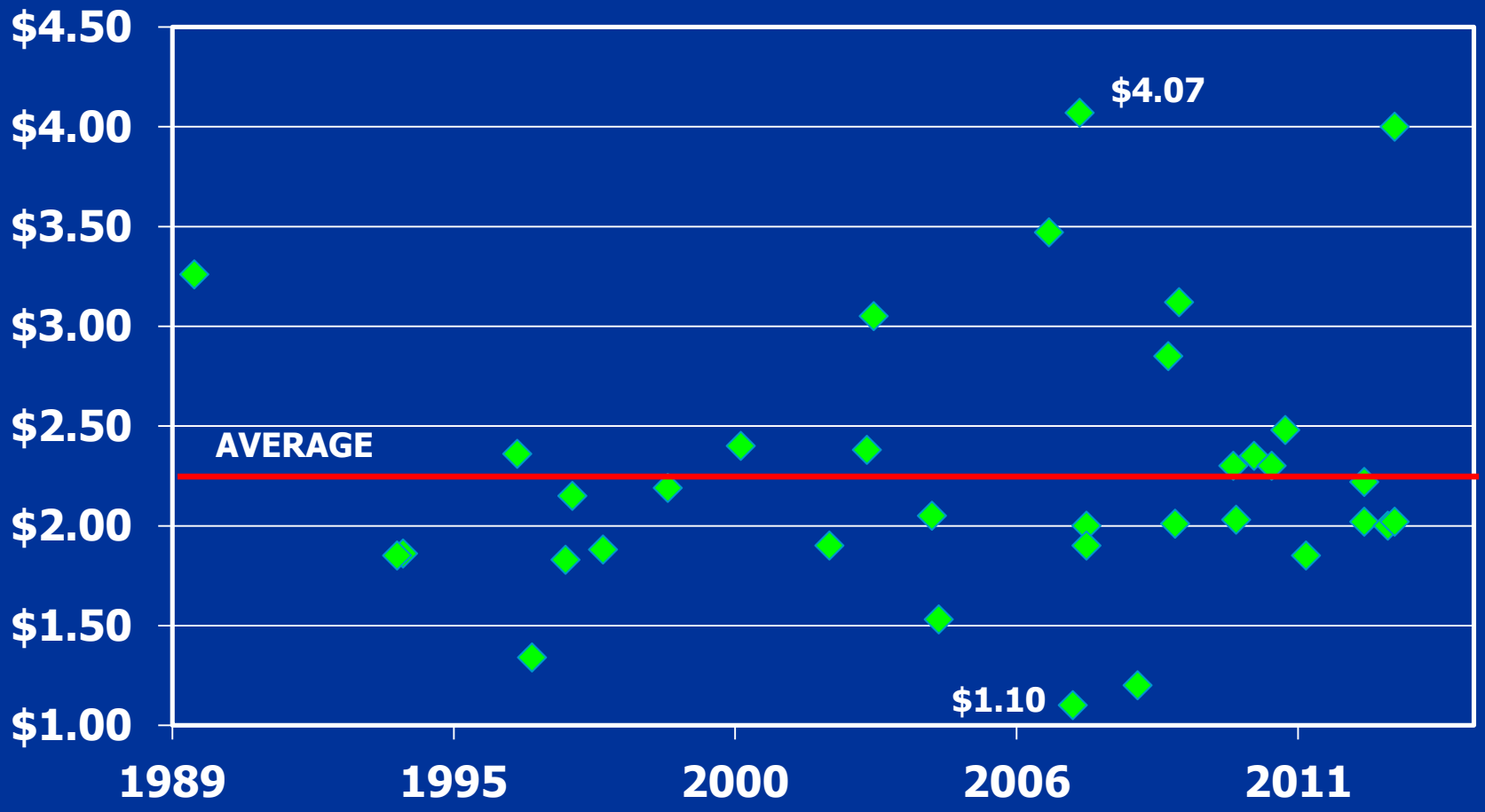
Cumulative Rubblization Quantities



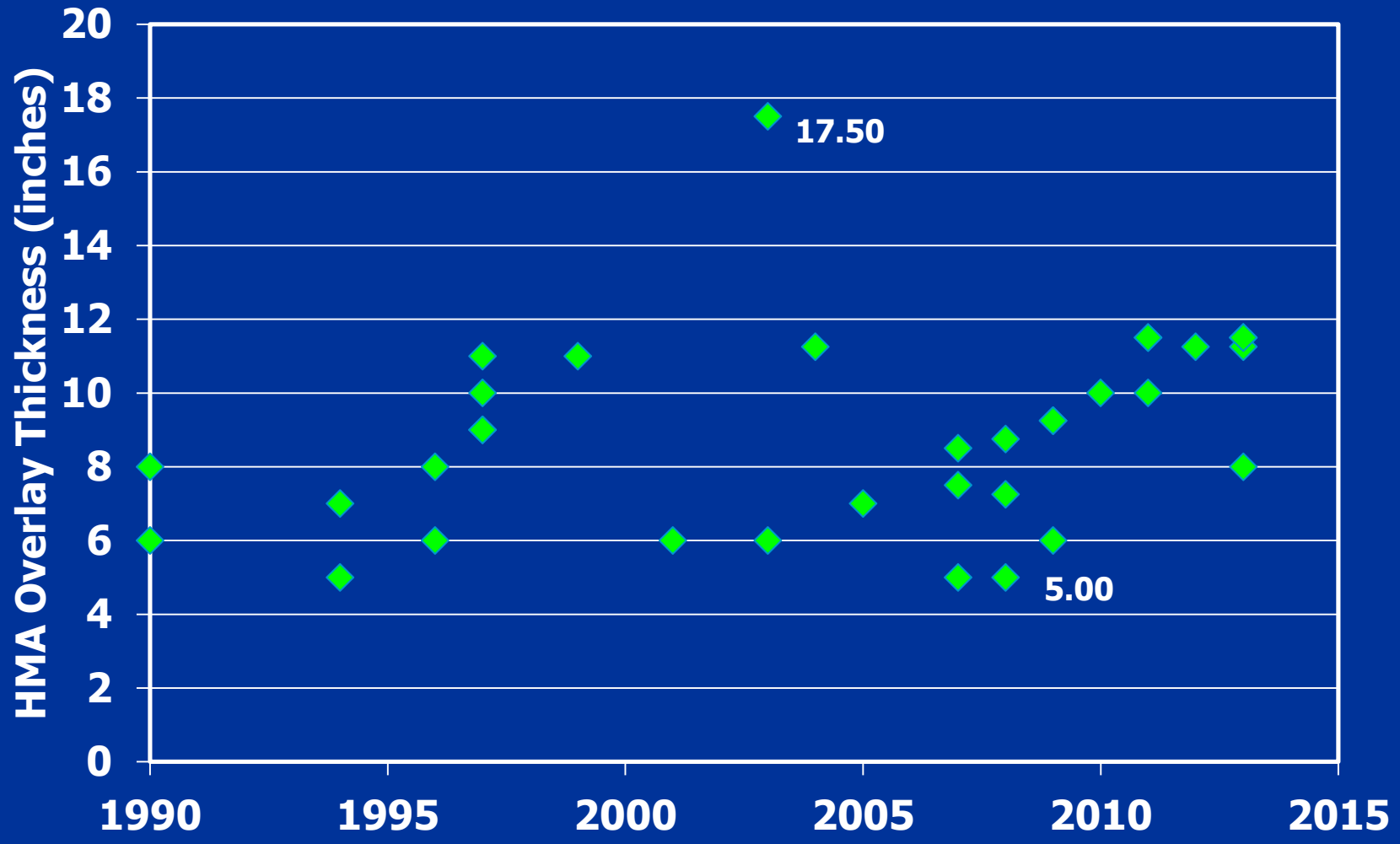
Lane-Miles of Rubblization



Rubblization Cost / SY



HMA Overlay Thickness



Project Performance Measures

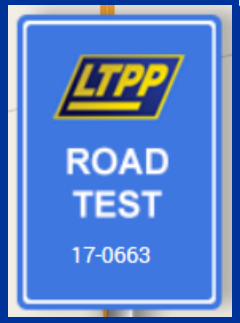
- Automated data collection vehicles
  - IRI (ride quality)
  - Rutting
  - Digital imagery (CRS)
- Manual distress surveys
- Falling weight deflectometer testing

Condition Rating Survey (CRS)

- CRS 1.0 – 4.5 = Poor
- CRS 4.6 – 6.0 = Fair
- CRS 6.1 – 7.5 = Good
- CRS 7.6 – 9.0 = Excellent

I-57 Champaign County – Design Details

- Existing 10-in. JRCP on granular (1965)
  - 100-ft. joint spacing
- Rehabilitated in 1990 (SHRP SPS-6 exp.)
- 2 500-ft. test sections
  - 6-in. overlay of rubblized JRCP
  - 8-in. overlay of rubblized JRCP
- Control – 3.25-in. overlay of patched JRCP
- Resonant frequency breaker



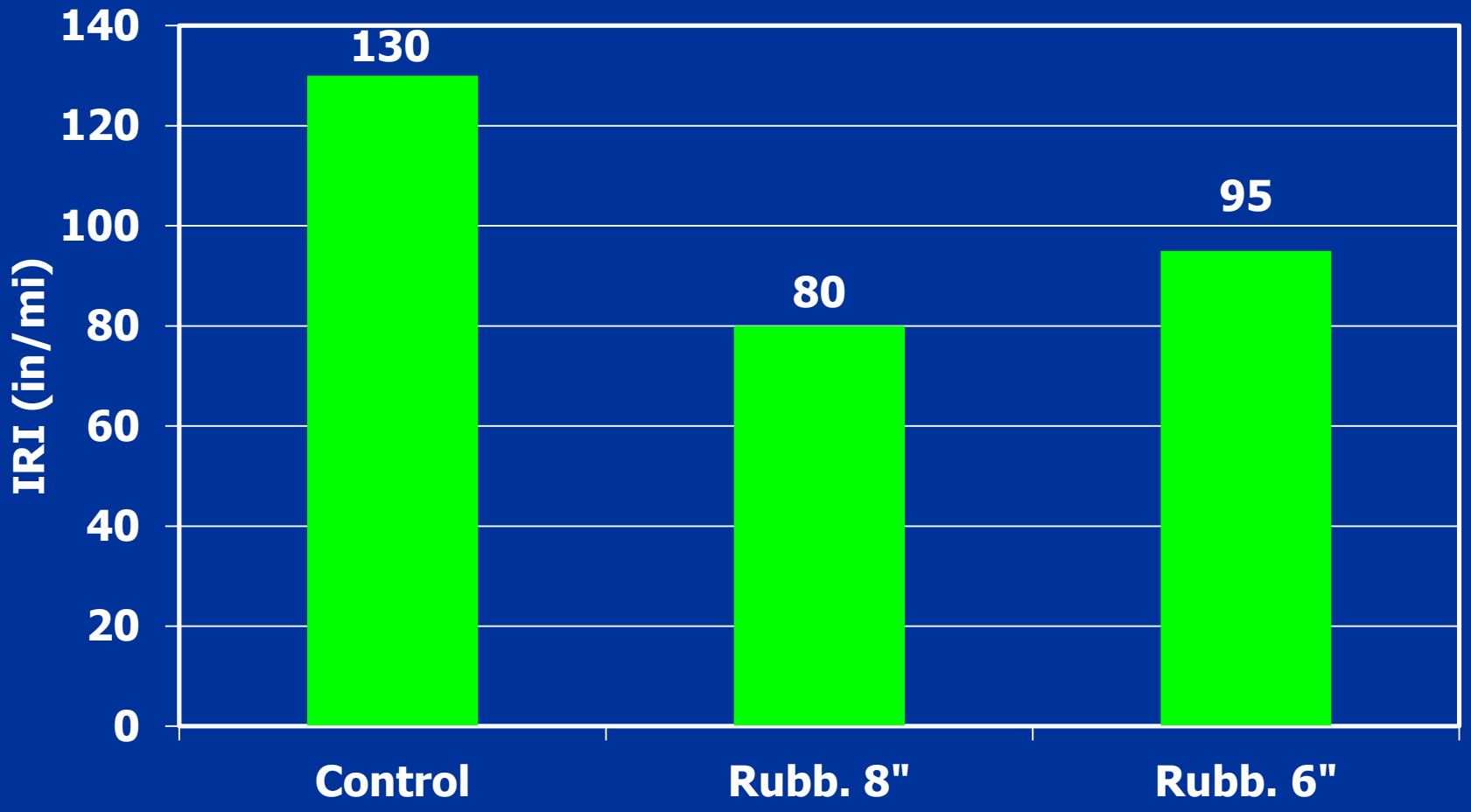
I-57 Champaign County – Performance

- 2008 CRS of 4.8 (all 14 sections combined)
- Reflective cracking and patching in control section
- Block cracking developing in rubblized sections
- IRI highest in control section
- Rutting low (1/8 in) on all sections
- Overlaid in 2010 after 20 yrs. and 20M ESALs

I-57 Control Section

I-57 Rubblized Section

I-57 IRI (Ride) Data



I-57 Effingham County – Design Details

- Existing 8-in. CRCP on BAM (1971) with overlay (1985)
- D-cracking susceptible aggregates
- Rubblized and overlaid with HMA in 1996
- 6 and **8**-in. overlay thicknesses
- 5-in. overlay of existing CRCP (control)
- Multi-head breaker

I-57 Effingham County – Performance

- 2010 CRS of 4.7 (all sections combined)
- Mid-lane longitudinal cracking in all sections (more in control section)
- Extensive patching in control section
- IRI values higher in 6-in. rubblized section and control section than 8-in. rubblized
- Overlaid in 2011 after 15 yrs. and 18.5M ESALs

I-70 Cumberland County – Design Details

- Existing 8-in. CRCP on BAM (1971) with overlays (1983, 1990)
- D-cracking susceptible aggregates
- Rubblized and overlaid with HMA in 1997
- 9, **10**, and 11-in. overlay thicknesses
- 5.5-in. overlay of existing CRCP (control)
- Multi-head breaker

I-70 Cumberland County – Performance

- All sections performed very well
- Mid-lane longitudinal cracking primary distress, eventually developing into light block cracking
- IRI and rutting values low for all sections
- Milled and overlaid in 2013 after 16 yrs. and 32M ESALs

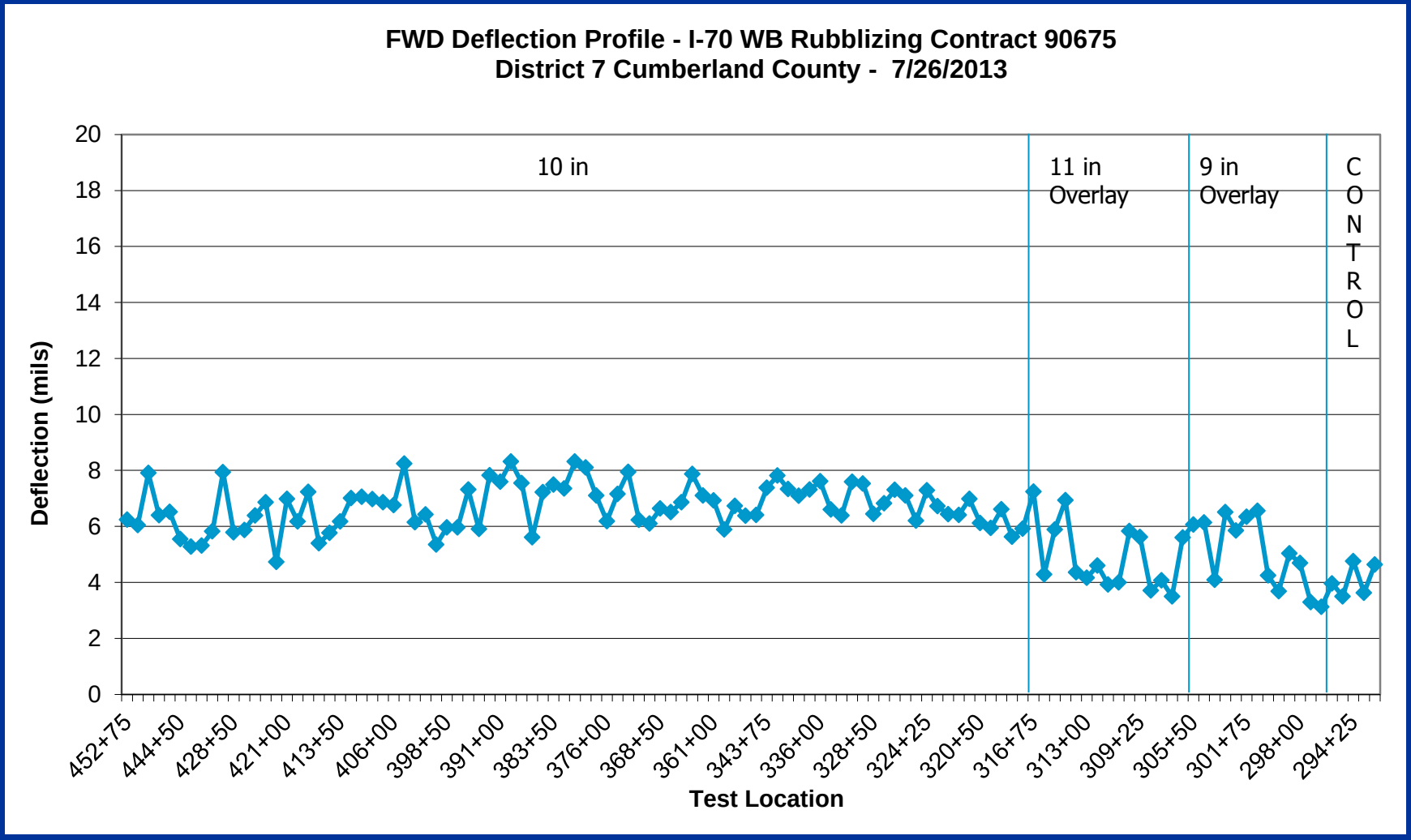
Longitudinal Cracking

Light Block Cracking

Milled Surface

FWD Testing

FWD Deflection Profile

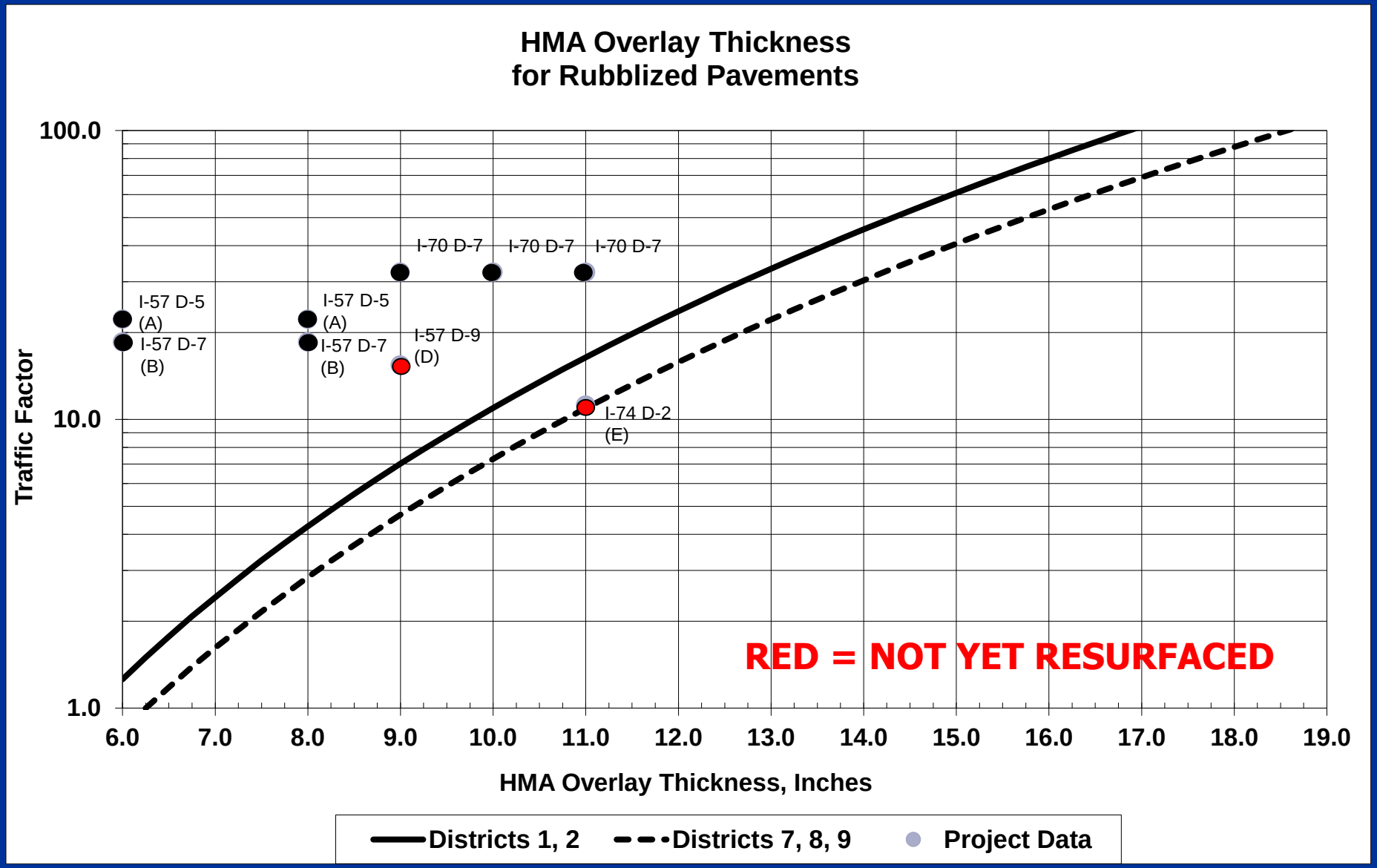


I-70 Clark County – Design and Performance

- Existing 8-in. CRCP with 2 prior overlays
- 30-year (extended life) design period
- 17.5-in. overlay of rubblized CRCP
- Multi-head breaker
- No significant distress after 10 yrs. and 22M ESALs
- CRS=8.2, IRI=41, 0.10 in. rutting

I-70 DCV Image

Performance of Early Projects



Performance Summary

- Overall performance has been very good
- Surface cracking is primary distress
- Rutting has been minimal on most projects
- Maintaining proper drainage is important

Drainage Issues

Clogged Drainage Outlets

(Un)clogged Drainage Outlet

Tufa – Calcium Carbonate Precipitate

Rubblization Design Policy

- Early designs were experimental features
- Guidelines and special provision developed in early 2000's
  - Designs still performed by BMPR
- Full design procedure published in 2011
  - Chapter 54 of BDE Manual, Section 54-5.03
- Updates issued in 2013
  - Similar to full-depth HMA design procedure
  - Includes limited strain criterion (max) thickness

HMA Overlay Thickness

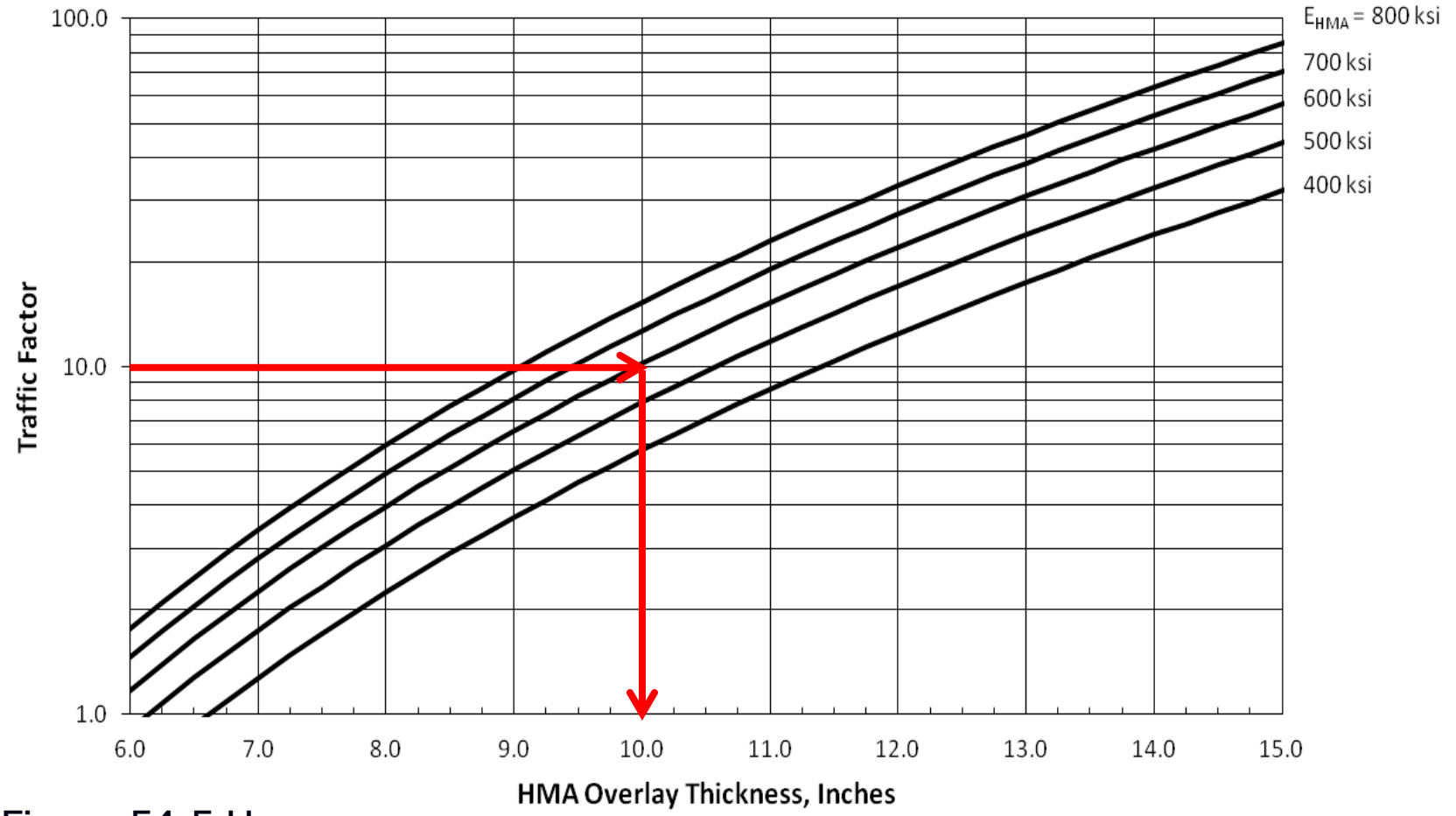
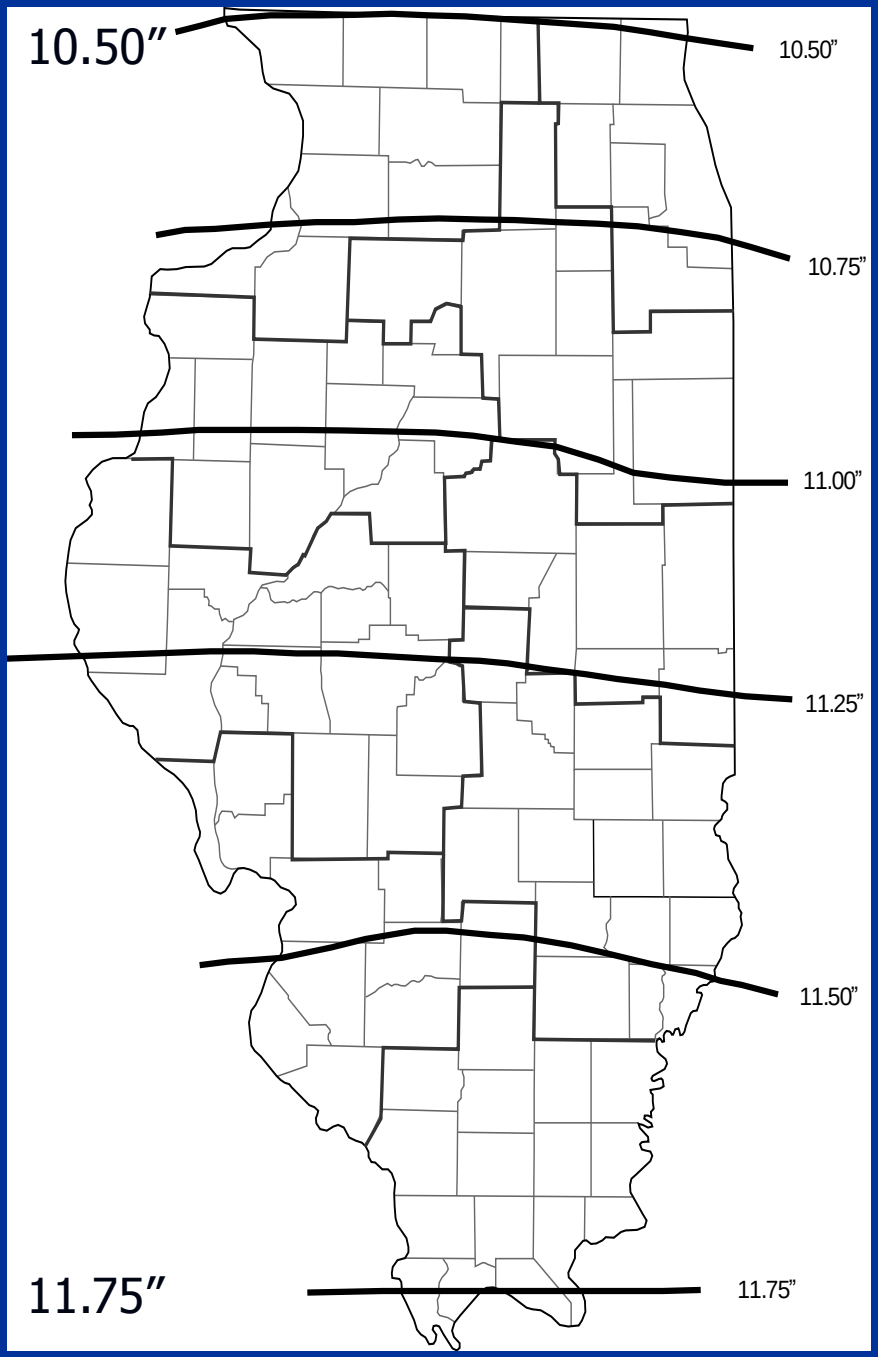
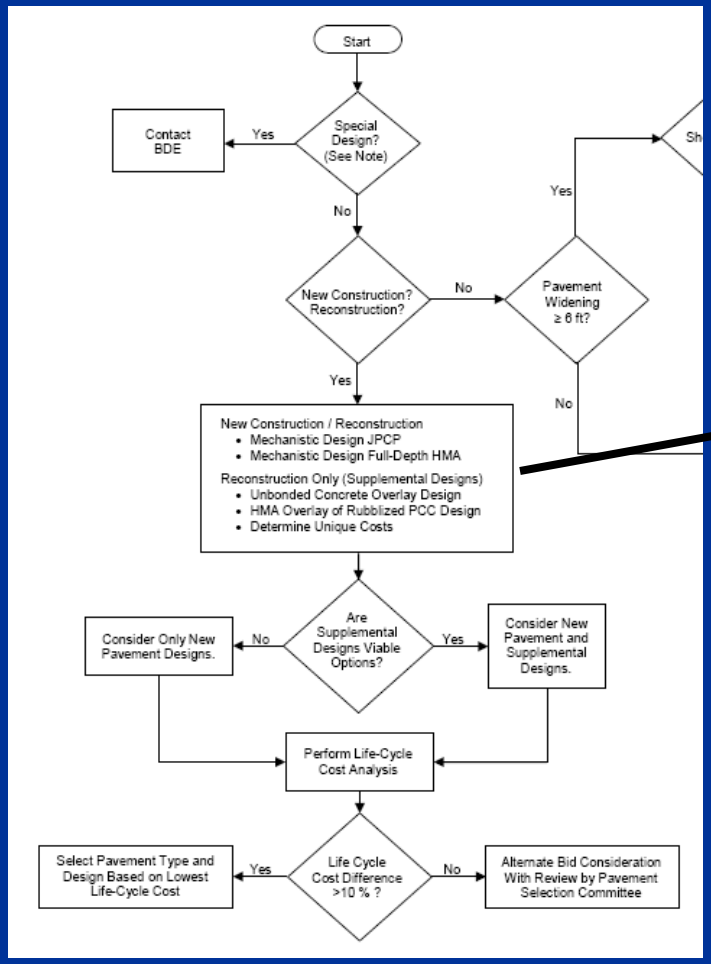


Figure 54-5.U

Limiting Strain Criterion (Maximum) Thickness – Figure 54-5.V



Design Methodology Flowchart



BDE Manual Figure 54-1.A

New Construction / Reconstruction
- Mechanistic Design JPCP
- Mechanistic Design Full-Depth HMA

Reconstruction Only (Supplemental Designs)
- ~~Unbonded Concrete Overlay Design~~
- HMA Overlay of Rubblized PCC Design
- ~~Determine Unique Costs~~

- 20-yr. Design Life
- Life-Cycle Cost Analysis

Conclusions

- Illinois' experience with rubblization has been a positive one
- Rubblization is both reliable and cost-effective
- Rubblized sections have performed as well, or better than, control sections
- Experience from early projects used to further refine design procedures

Questions?

Charles Wienrank
(217) 782-0570
Charles.Wienrank@illinois.gov