Full Depth Reclamation

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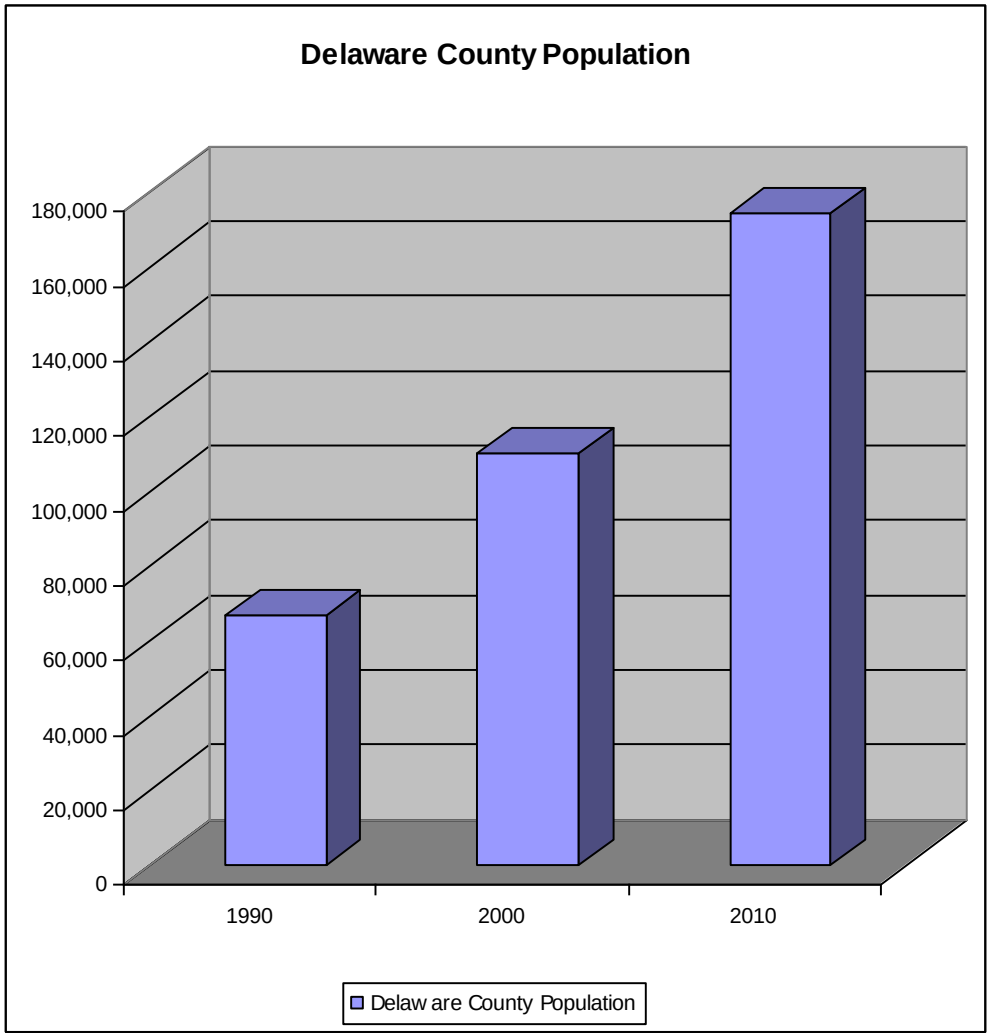
About Delaware County

- Highly diverse county
- Large scale rural development in southern half
- Northern half remains largely rural

About Delaware County

- Fastest growing county in Ohio
- 160% population growth between 1990 and 2010



About Delaware County

- Explosive growth since 1990 fueled by opening of I-71 & Polaris Pkwy. interchange in 1991

- Growth created major roadway infrastructure needs in fringe areas of development

Road History

- Many old farm-to-market roads now serving large scale residential and commercial developments
- Inadequate pavement structure to support construction traffic

Road History

- Most county roads were less than 20 feet wide with chip and seal surfaces
- HMA overlay projects through the early 1990's were ineffective at maintaining or improving pavement
  - Reflective cracking
  - Loss of cross slope early in maintenance cycle

Need for Road Improvement

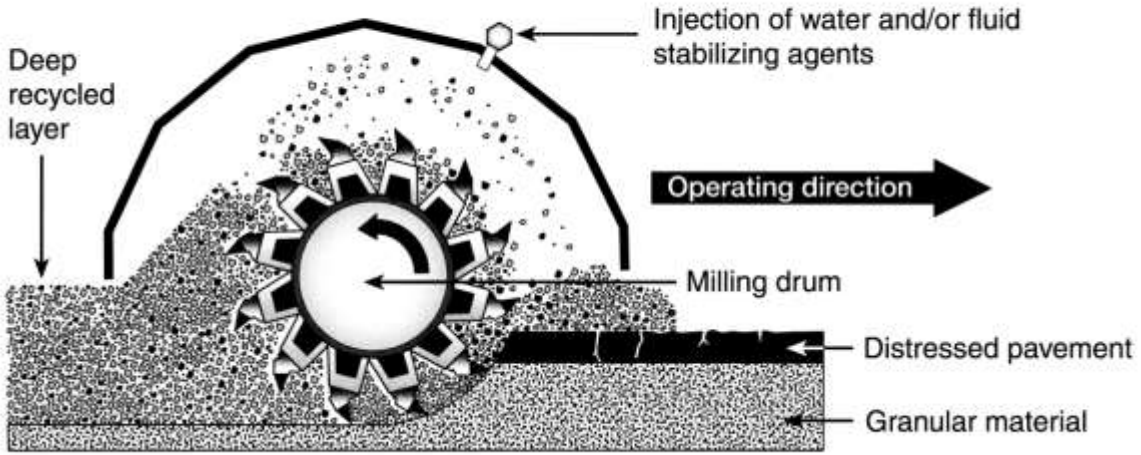
- 1990’s – explosive residential and commercial growth creating huge need for improvement to old farm to market roads
- 1997 – first Delaware County road improved by full depth reclamation

What Is Full Depth Reclamation (FDR)

- Full Depth Reclamation is a pavement rehabilitation technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly crushed, pulverized or blended

What Is Full Depth Reclamation (FDR)

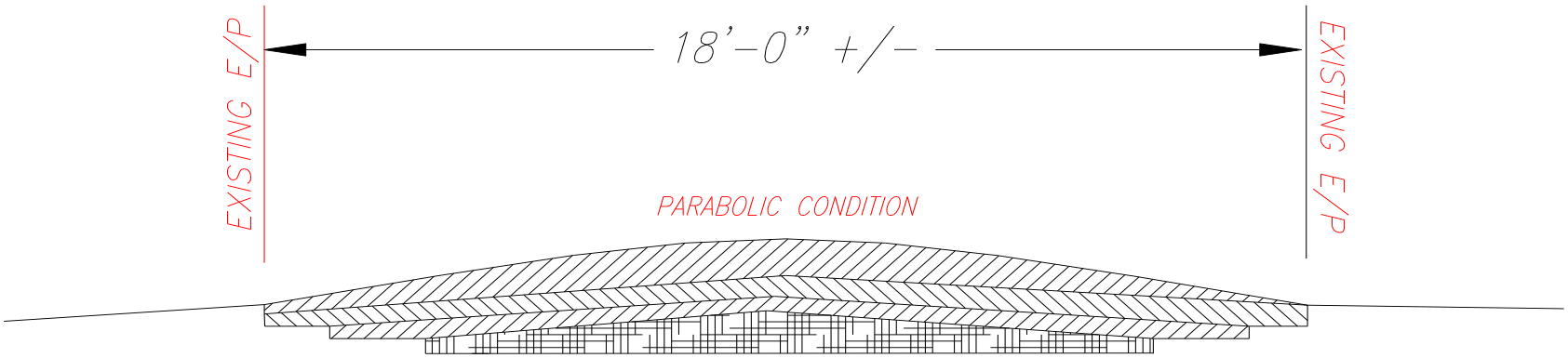
- Pulverization of pavement and underlying road base to create a uniform, stabilized base course



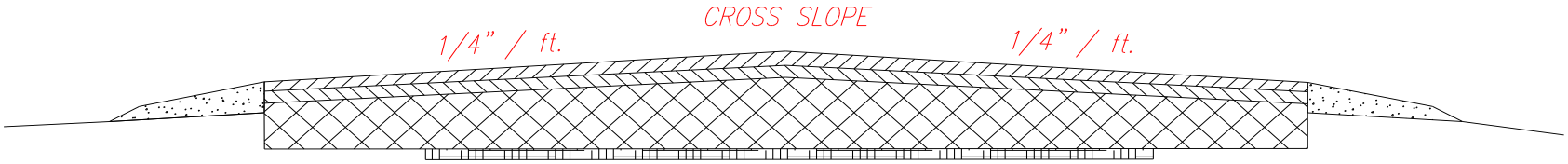
What Is Full Depth Reclamation (FDR)

- Chemical additives can increase performance of the stabilized base
  - Asphalt recycling emulsions
  - Pozzolans
    - Cement
    - Fly ash
    - Lime or lime kiln dust

Restore Cross Slope

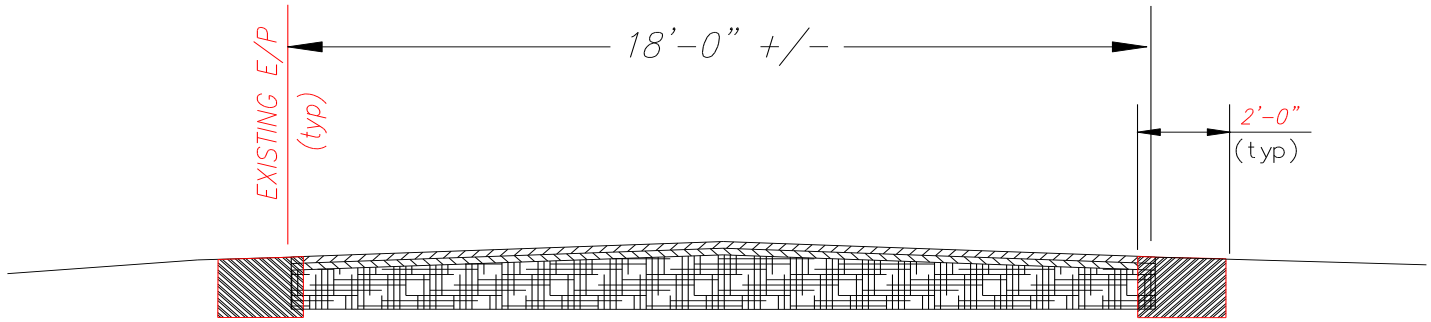


EXISTING SECTION (BEFORE FDR)



PROPOSED SECTION (AFTER FDR)

Widening with FDR



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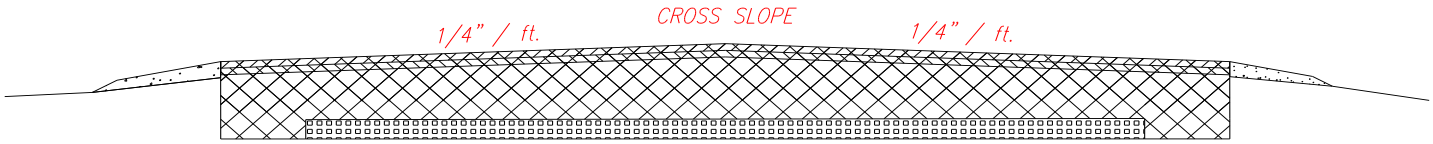
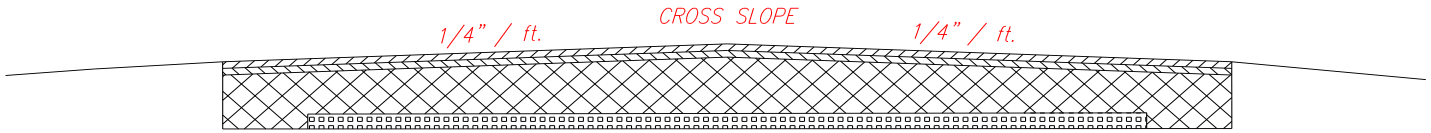


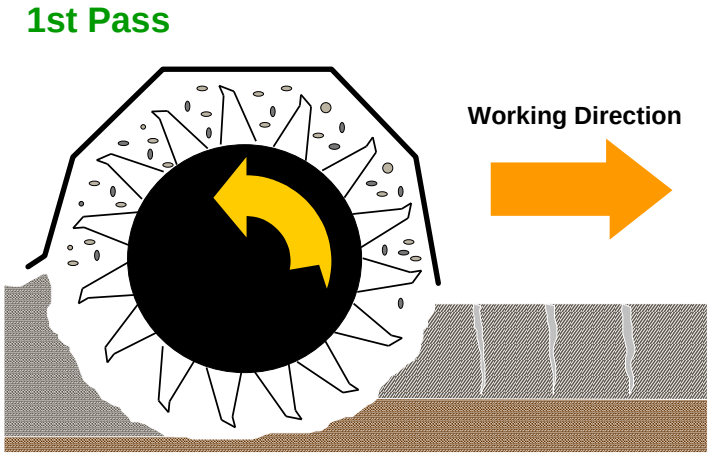
PROPOSED WIDENING SECTION (AFTER FDR WITH STONE)



PROPOSED WIDENING SECTION (AFTER FDR W/O STONE)

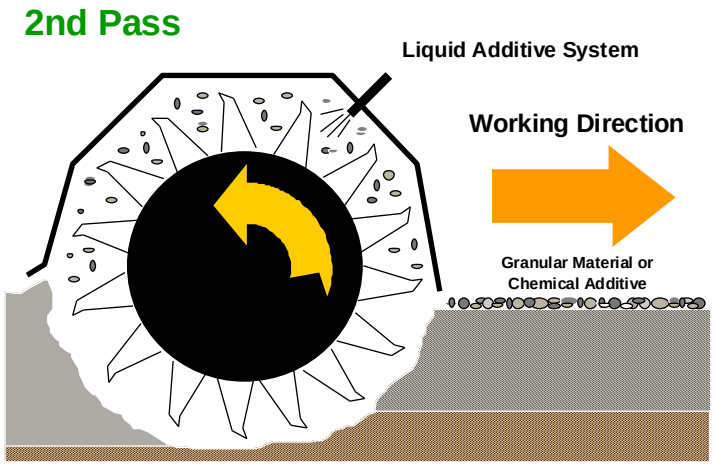
FDR Process

- Step 1: Pulverization



FDR Process

- Step 2: Mixing of additives



FDR Process

- Step 3: Grading and compaction

FDR Process

- Step 4: Chip seal or fog seal on stabilized base

FDR Process

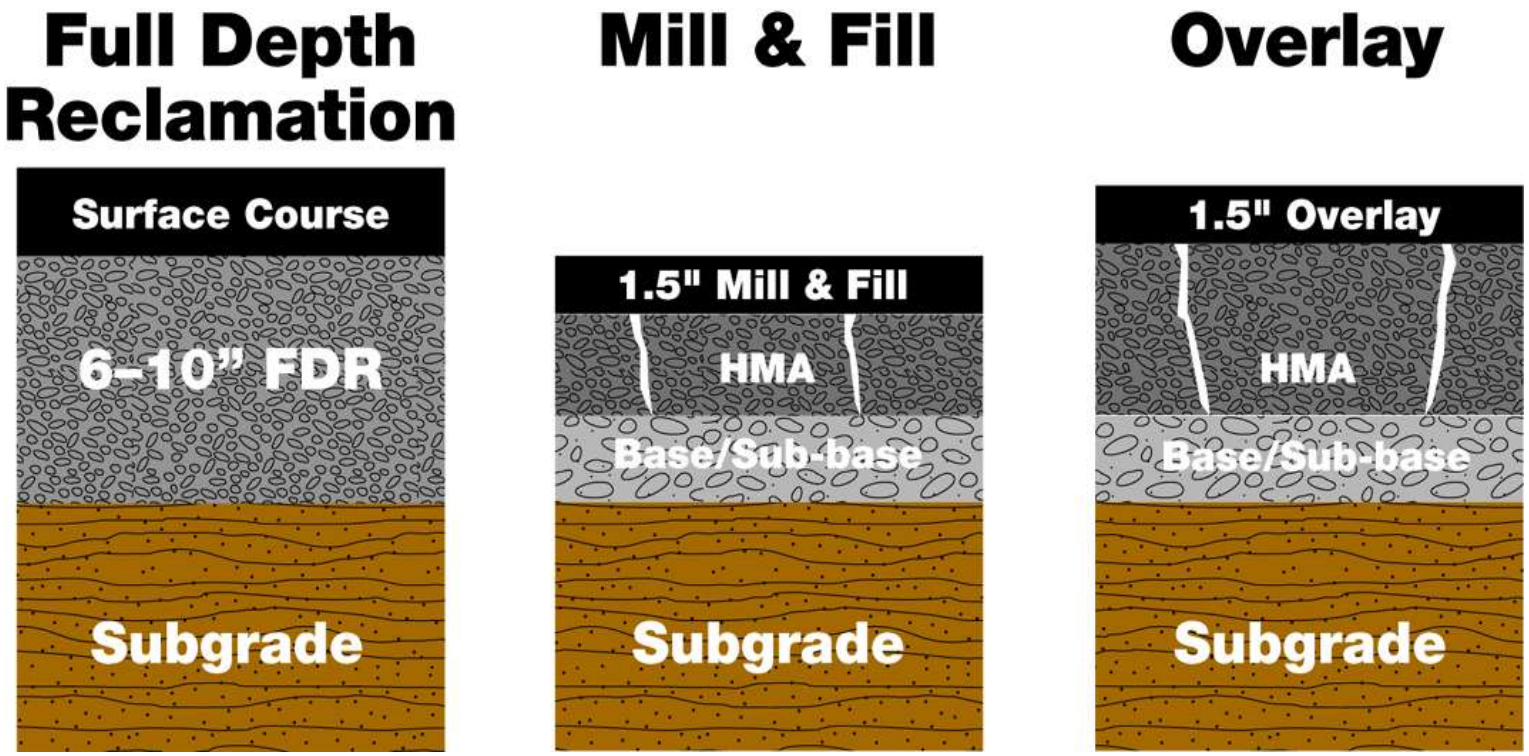
- Step 5: Placing asphalt surface

Maintenance of Traffic

- Desirable to close road during pulverization and mixing, but can maintain one lane, two-way local or low volume traffic
- Once compaction is complete and base is seal coated, local traffic can be restored
- Typical 5 to 10 day curing period for cement treated base course… **keep trucks off!**
- Normal one lane, two-way local traffic during asphalt placement

Why Use FDR

- FDR eliminates reflective cracks



FDR vs. Base Replacement

Low to moderate volume road example

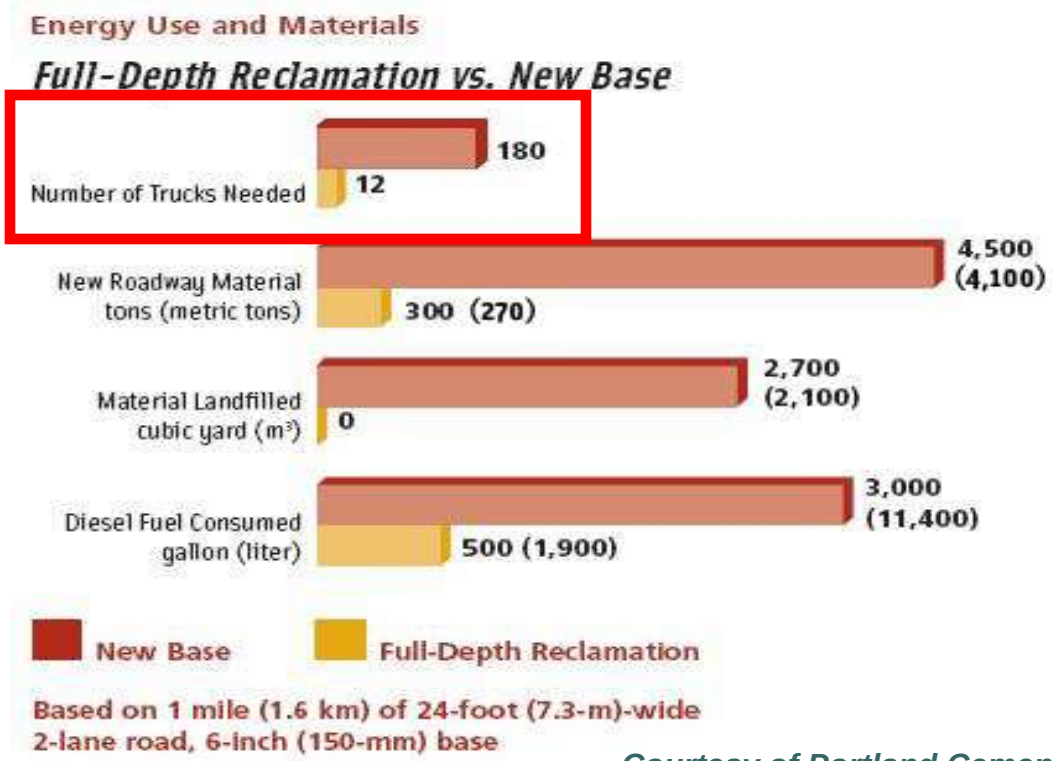
	FDR	Base Replacement
Total Cost per sqare yard Base HMA Overlay	**$16 to $22** $6 to $10 $10 to $12 (3”)	**$26 to $34** $8 to $12 $18 to $22 (6”)
Time	5-8 days per lane mile	2-3 weeks per lane mile
Result (Overall SN)	Increased structure 3.45+	Adequate structure 2.94
Energy Use	Low	High

FDR: 8” cement treated reclaimed base + 3” HMA surface

Base Replacement: 6” aggregate base + 6” HMA surface

FDR vs. Base Replacement

Less truck traffic = Less damage to haul routes



Courtesy of Portland Cement Association

FDR Design Process

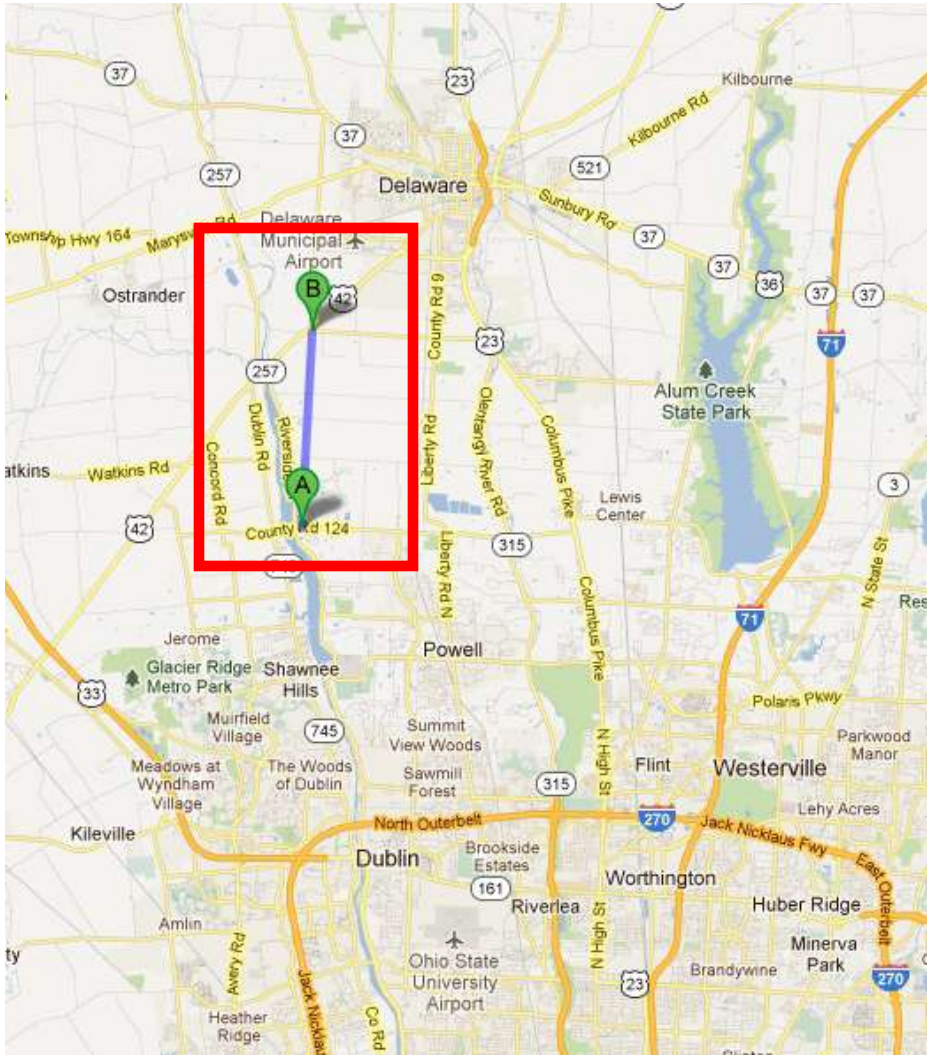
- FDR is an engineered process!
- For proper design, you need to know
  - Existing pavement composition
  - Required design structural number
  - Allowable pavement profile rise

FDR Design Process

- Pavement design structural layer coefficient for stabilized base course
  - Depends on existing pavement composition
  - Typical SN layer coefficient of 0.26 to 0.30 for FDR with emulsion
  - Addition of pozzolans (cement, fly ash, lime kiln dust) yields higher SN layer coefficients in the range of 0.30 to 0.45.

South Section Line Road Research Project

- South Section Line Road carries high truck traffic volumes
- Good candidate for reclamation due to thick existing asphalt, but with base failure



South Section Line Road Research Project

- In 2006, Delaware County worked the Ohio State University and the Ohio Coal Development Office to construct a research project to evaluate reclamation additives
- 4 miles of road reclaimed using test sections with various FDR additives
- Project sought a beneficial use of coal fly ash

South Section Line Road Research Project

- Test sections included the following FDR additives:
  - Portland cement
  - Cement and asphalt emulsion
  - Lime kiln dust and emulsion
  - Fly ash and lime kiln dust
  - Fly ash and lime
- Also a mill and fill only control section

South Section Line Road Research Project

After

Before

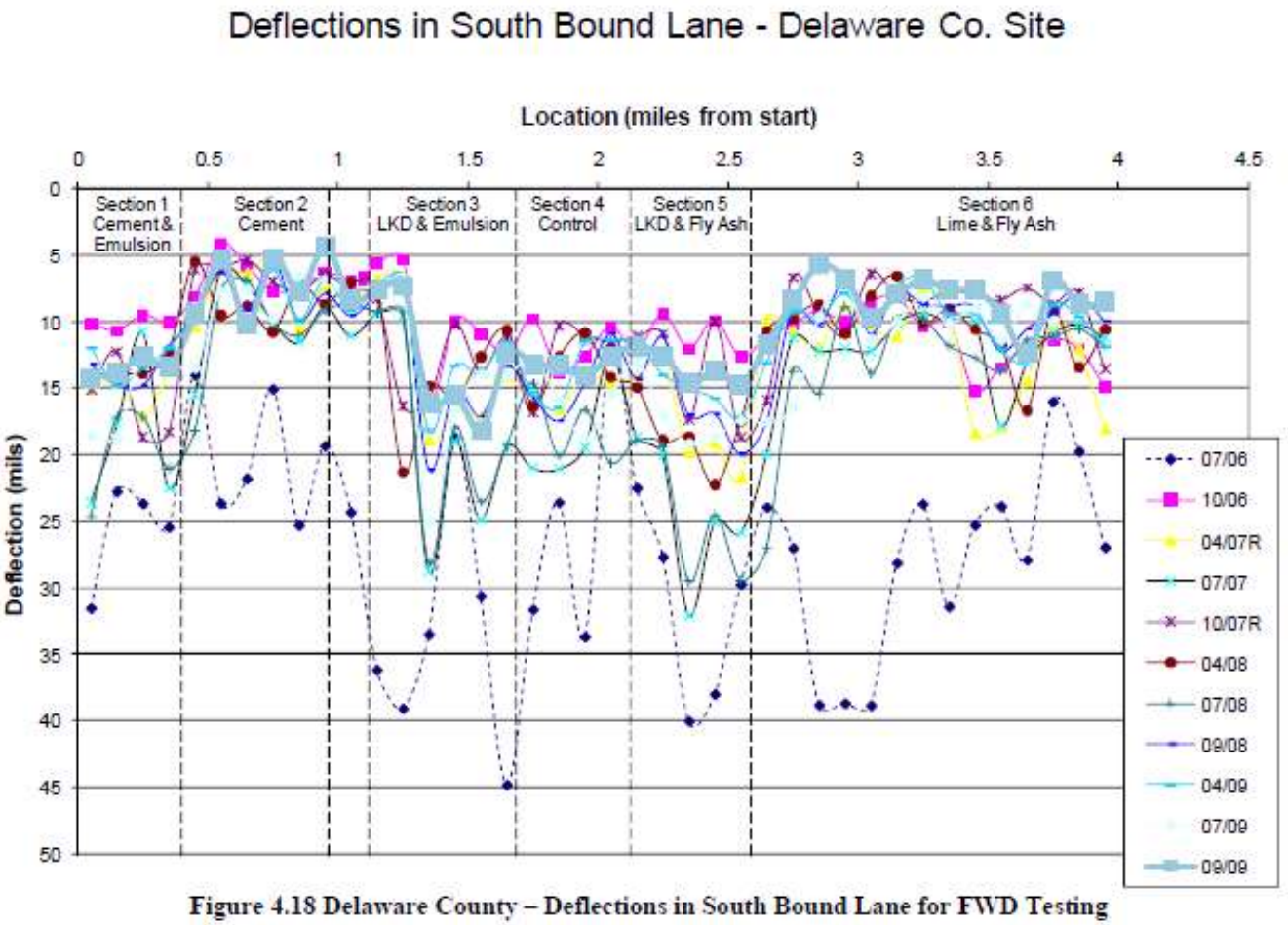


Figure 4.18 Delaware County – Deflections in South Bound Lane for FWD Testing

South Section Line Road Research Project

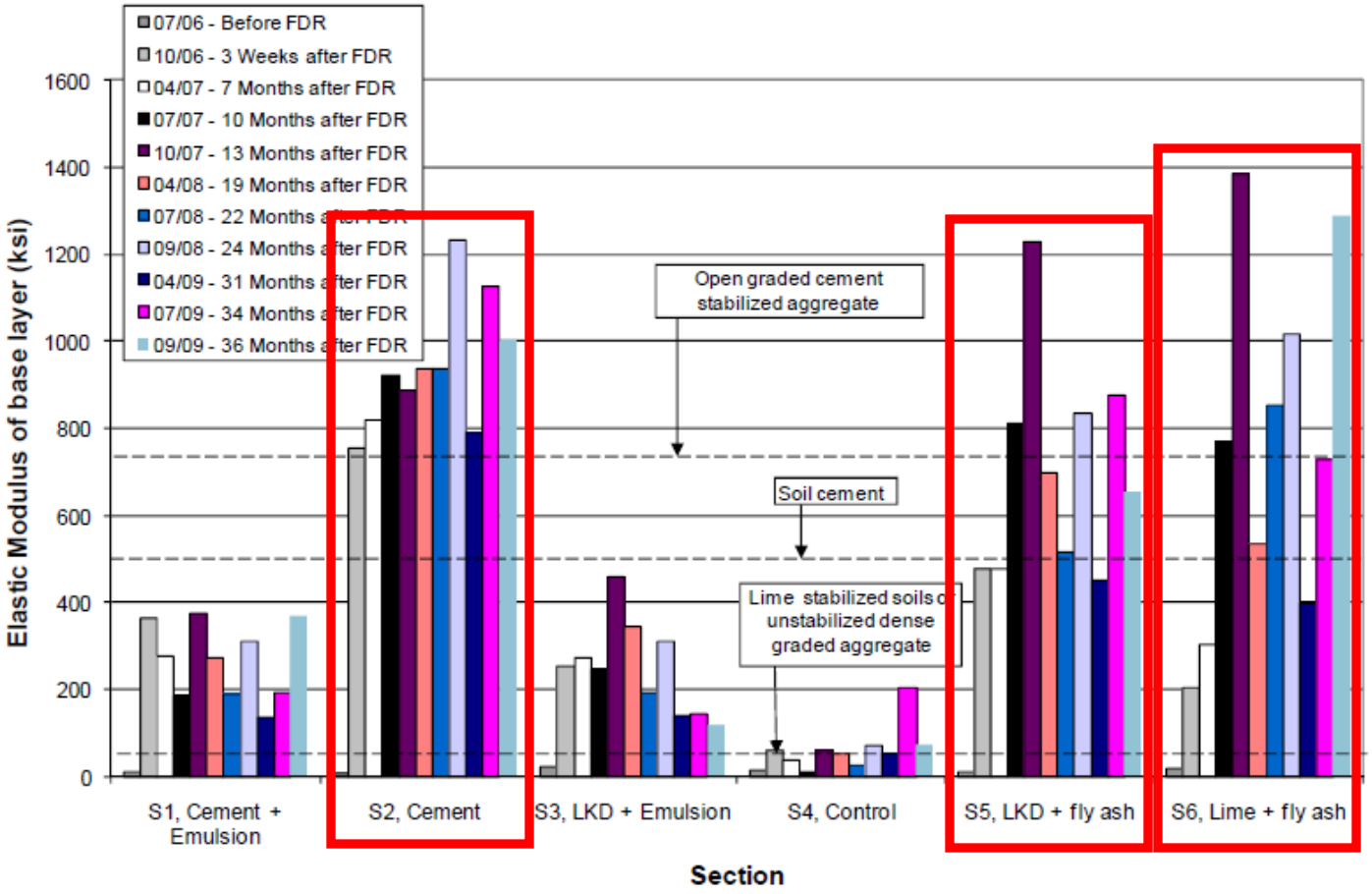


Figure 4.20 Delaware County – Resilient Modulus Results from FWD Testing

South Section Line Road Research Project

- Conclusions of project:
  - FDR sections performing well with minimal surface distress after 5 years
  - Adding cement provides fastest increase in base layer stiffness
  - Fly ash and lime kiln dust also develop high strength but over longer time period
  - FDR process is highly cost effective versus traditional base replacement/reconstruction

South Section Line Road Research Project

- Final report available on the OSU Coal *Combustion Products Program* website

USE OF LIME-ACTIVATED CLASS F FLY ASH IN FULL DEPTH RECLAMATION OF ASPHALT PAVEMENTS

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Final Report for Project CDO/D-05-8/9

This report does not contain Trade Secret / Propriety Information

This project was funded in part by the Ohio Coal Development Office of Ohio Air Quality Development Authority, State of Ohio

Period of Performance: 1/01/06 – 9/30/09

THE OHIO STATE UNIVERSITY

August 20, 2010

Delaware County Experience with FDR

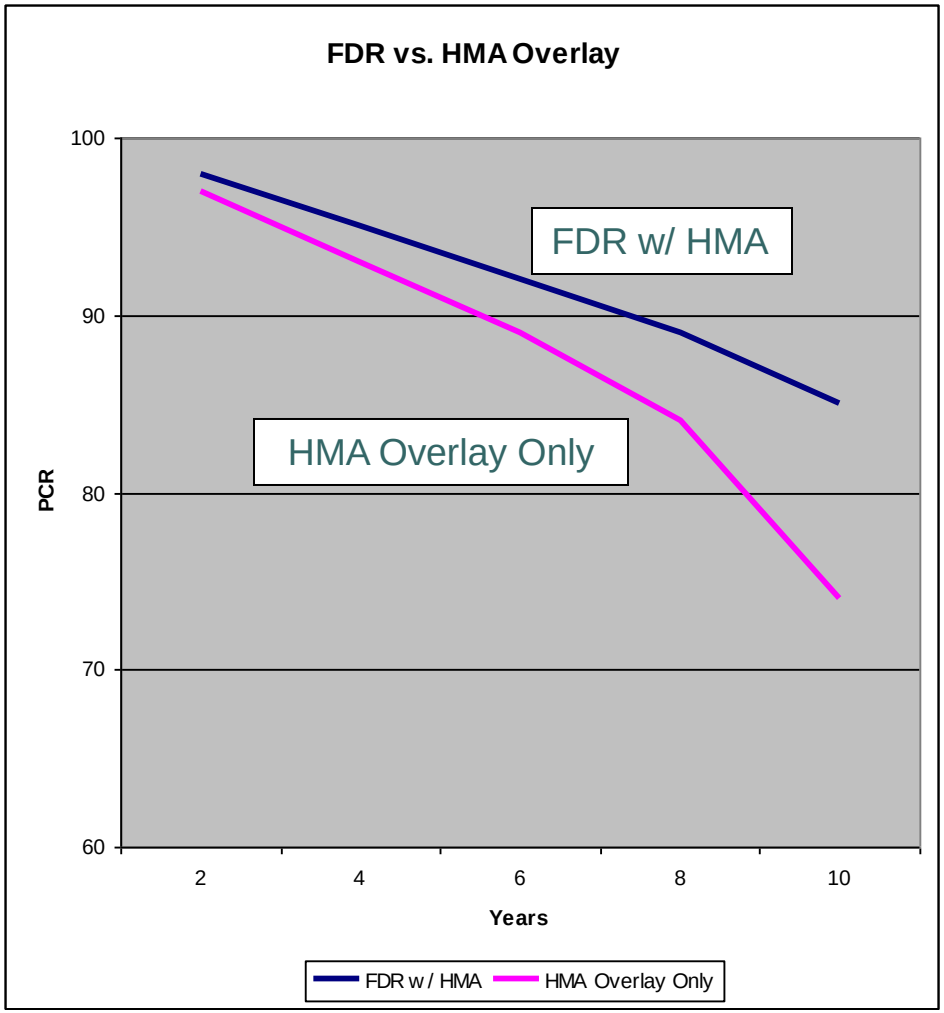
- Over 50% of county maintained roads were reclaimed by FDR between 1997 and 2006
- Now in a pavement preservation mode rather than pavement rehabilitation
- Delaware County has been able to use less expensive preservation treatments on these roads such as microsurfacing and chip sealing instead of additional asphalt to maintain the good condition

Delaware County Experience with FDR

- Excellent performance with addition of pozzolans (typically Portland cement)
- Less performance with addition of asphalt emulsions
- Minor widening to achieve acceptable pavement width through FDR process
  - 2 foot widening commonly done in conjunction with FDR process by edge trenching prior to pulverization

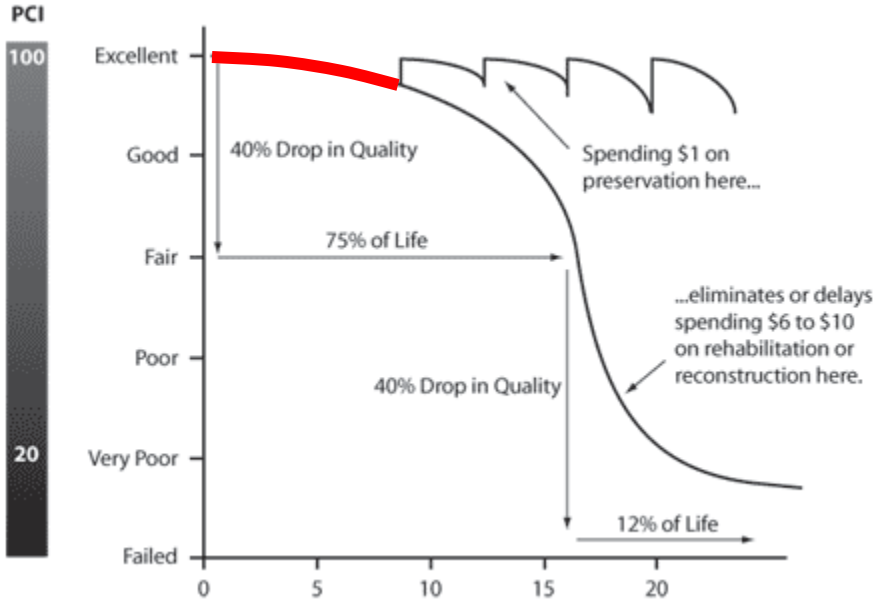
Delaware County Experience with FDR

- FDR provides longer service live for the asphalt wearing surface
- Pavement deterioration curve is flatter and sharp drop-off is delayed by several years



Delaware County Experience with FDR

- Pavement preservation must start with good pavement
- FDR can be a critical first step in getting into a pavement preservation mode



Where To Use FDR

- Uncurbed roads with base failure that can tolerate profile rise of 3 to 6 inches
  - Best bang for the buck – no need for removal of existing pavement materials
- Roads with adequate shoulders where minor pavement widening is needed
  - 1 to 4 foot widening is possible
- Roads needing cross slope correction

Where Not To Use FDR

- Thin existing pavements without at least 8 inches of existing asphalt and granular pavement
  - Process requires granular material to produce acceptable composition of the stabilized base course
  - If existing pavement is only a little bit too thin, course aggregate can be spread before the pulverization pass and be incorporated into the RSB

Conclusions

- Excellent system for improving road base at a fraction of the cost of reconstruction
- Though it is possible to field engineer the process, doing borings and pavement design in advance is key to optimizing the process
- A special thanks to OSU for their work on the South Section Line Road fly ash project

Questions

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