Full-Depth Recycling (FDR)

INDOT Perspectives, Lessons Learned and Future

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Outline

- Very Brief INDOT FDR History
- INDOT Pavement Situation & FDR Business Case
- ‘Restart’ of FDR Pavement Approach
- Lessons Learned
- Future of INDOT FDR
Very Brief INDOT FDR History

- SR 38, E of Dayton
- 1980s or 1990s?
- Appears to be lost to history at this time
  - Research continuing
**Very Brief INDOT FDR History**

- SR 1, NW of Portland, IN
- CY2009
  - 2-lift HMA overlay on FDR layer
  - Included 3R-4R upgrade (Super 2?)
  - Performed as well as 2-lift HMA overlay
  - Expensive for what we needed vs. got
  - Cost more than I expected
    - Maybe should have?
INDOT Mission

INDOT will plan, build, maintain and operate a superior transportation system enhancing safety, mobility, and economic growth.
INDOT Profile

- Six district offices
- 3,400 employees
- $1 billion/annual capital expenditures
- 28,400 total roadway lane miles
- 5,300 INDOT-owned bridges
- Assists 42 railroads in planning & development of more than 3,880 miles of active rail lines
- Supports 69 Indiana State Aviation System Plan airports
INDOT VALUES

1. **Respect** — Treat others fairly. Value the individual skills, experience, diversity and contributions of fellow employees.

2. **Teamwork** — Share information and seek input from co-workers and agency partners to achieve goals.

3. **Accountability** — Take personal responsibility for actions and decisions.

4. **Excellence** — Provide exceptional customer service through individual initiative, innovation and delivery of quality results.

Values are the core behaviors that all employees, as an organization, will support, promote and exhibit to achieve agency goals.
21st Century, One INDOT Results

On-time and On-budget
- Deliver projects in accordance with key performance indicators and INDOT performance measures.
- Deliver quality services according to identified work plans and within financial targets.

Take Care of What We Have
- Implement a plan that maintains steady improvement in pavement and bridge quality.
- Ensure a commitment to safety.
- Implement a talent management system that links strategy and operations to results.
- Establish a culture of continuous improvement.

Customer Satisfaction
- Improve internal and external customer satisfaction.
- Take an outside in view to ensure the highest level of customer service.
Pavement Surface Conditions Over 10-Years for Current Funding Trends

Pavement condition should remain relatively static at the current investment levels.

IN policy for CAFR reporting, minimum requirement (12.2%)
INDOT Pavement Situation

**Current Service Level**

11.4% Poor in 2024

$394M Annual Investment
10-Years
1,305 Miles of Poor Pavement

**INDOT’s Target Service Level**

≤7.5 % Poor in 2024

$498M Annual Investment
10-Years
826 Miles of Poor Pavement

**INDOT’s Recommended Service Level**

≤4.75 % Poor in 2034

$561M Annual Investment
20-Years
533 Miles of Poor Pavement

What is the acceptable result for the taxpayer?

Joint Transportation Committee
Business Case

- **Home furnace repair/ replacement**
  - **Contractor #1:**
    - Good service life and reliability
    - $5,000
  - **Contractor #2:**
    - Good service life and reliability
    - $3,400
  - **Contractor #3:**
    - Good service life and reliability
    - $1,600
Business Case

- Home furnace repair/ replacement

- Vote for which one would you use?
  - Contractor #1:
  - Contractor #2:
  - Contractor #3:
Why would a project’s pavement scale of work be any different than home furnace repair/ replacement?

- Taxpayer funded?
- $170K, $250K, $450K, $675K, $950, or $1.25 Million / Lane-mile of construction cost?
- Assumed roughly similar service life and future maintenance cycles?
So which engineer’s recommendation would you use?

- $170K  Oops!  Can’t do it for this?
- $250K  Okay
- $375K  Even better!
- $675K  Same result, just more expensive
- $950K  Ditto, but even more expensive
- $1,250K  If only I won the Lottery
Project Situations

- SR 1 W of Portland, IN & SR 227 NW of Richmond, IN
- CY2014
  - $170K option
    - Not including significant cost increases
  - 150 psi FDR stress capacity
  - 2-lift HMA overlay
Project Situations

- Tricky subgrade conditions?
- May have not withstood construction loads?
- Significant risk w/low bid vs. necessary FDR ‘mix’ design supplemental materials
- Neither contractor, nor INDOT may have fully understood issues and consequences
- Significantly redone (mostly?) at my cost
- Proof of Concept/relearning & refining technological approach
Project Situations

- I-74
- FY2014-15
  - $11 Million (total project)
    - FDR for MOT shoulder only
  - Revised Specification
  - 1-lift HMA overlay
Project Situations

- Supplemental aggregate types & quantities vs. low bid generated challenges
  - Lots of contractor risk
  - Increased cost to me
- FDR shoulder performed well w/MOT traffic loads
- Improve & refine technological approach and bidding approach
- Much less expensive than shoulder reconstruction - A Success!
Informed Owner’s Considerations

What we want:

- Not necessarily cheapest construction cost
- Best operating-owning cost/service life ratio ($s/Yr)
  - Acceptable service level(s) & service life
  - Least cost to own/operate highway facility
- True partnership with our partners
Project Situations

- SR 59 vic. Waveland, IN  CY2015
  - $325K option
  - 500 psi FDR stress capacity
  - 2-lift HMA overlay
Project Situations

- 1-year AAR: looks good (so far)
- Still learning corrective aggregate and stabilizing agent bidding balance
- A little bit expensive, but less than alternatives
  - Within acceptable costs (if performs as expected)
- Success, at least at 1-yr
Project Situations

- SR 14 W of US 41
- CY2015
  - $210K option
  - 400 (variable) psi FDR stress capacity
  - 1-lift HMA overlay
Project Situations

- Appears to not be performing well
- Risk w/low bid vs. necessary FDR ‘mix’
  design supplemental materials
- Construction loads?
- Relatively thin overlay
  - Maybe 2&1/2” surface?
  - Overloaded truck route?
- Forensic assessment to be accomplished
- Refining technological approach
FDR Concept Issues

- FDR processed materials mix ultimate strength?
  - FDR layer mix design
    - Allow for designed-planned vs. actual (post-bid field calibration)

- Cement vs. Asphalt Emulsion
  - Unique Soils May Determine Stabilization Material
  - Maybe contractor preference in some cases
    - Two different specification subsections
FDR Concept Issues

- FDR layers, planned vs. actual
  - 14” mixing layer effectiveness?
  - 14” vs. 2 x 7” layer compaction

- More extensive project design testing

- Corrective aggregate estimate in design

- Variable stabilizing agent quantities

- IDM Pavement Design Chapter update

- MOT Loads
FDR Concept Issues

- Construction traffic loads
  - Shear and bending of bonded layers
    - Extreme fiber stress equals MC/I
    - Moment of Inertia equals bh^2/12
- Not sure this was fully understood by all parties in earlier projects
  - Still not sure fully understood
FDR Concept Issues

- Competent Contractor concept
  - Contractor is expert at what he/she does
    - Perhaps more than me/my staff
    - Knows how to do what is being done perhaps better than me/my staff
  - Should know potential consequences of actions relative to finished product and its life-cycle costs
    - Pre-damaging FDR layer?
  - Capping layer(s) make-up and thickness?
FDR Concept Issues

- Stress of extreme fiber under various loading?
  - During FDR operations?
  - During capping/paving operations?
    - Triaxles?  
    - My observations!
  - Ramifications for conventional paving operations?
INDOT will continue to better develop and utilize Full-Depth Recycling

- Lots of lessons learned already in very short period of time
- Lots of challenges still ahead
- Still appears to be best option available in many highway project situations
- Other options will be used when better able to effectively and efficiently achieve project objective