2020 ATL Pavement Design
A Case Study

Kumar Dave, P.E. INDOT
Pankaj Patel, P.E. INDOT
2016 Purdue Road School
March 2016
Outline

- INDOT Project Situation & Business Case
- Original General Plan
- Project History
- Pavement Evaluation
- Pavement Design Approach/Philosophy
- Pavement Treatment Options/MEPDG
- LCCA, Lane/mile/year cost
- Conclusions/ Lessons learned
2020 ATL.....

- INDOT Project Situation & Business Case........
INDOT Goals

Agency Results

- Take care of what we have
- On-time and On-budget
- Customer Satisfaction

SEE IT ↓
OWN IT ↓
SOLVE IT ↓
DO IT!
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.
MAJOR MOVES 2020

- First $200 Million 2020 Funds
  - I-65 Southport Rd to County Line Rd
  - I-65 County Line Rd Main St Greenwood
  - I-65 Main St to Whiteland Rd
  - I-65 Whiteland Rd to SR 44
  - I-65 SR 38 to SR 26
MAJOR MOVES 2020

- Second $200 Million 2020 Funds
  - I-65 SR 26 to SR 25
  - I-69 SR 37 (N. Jct) to SR 13
  - I-65 Old SR 311 to Memphis Rd
  - Lafayette Center Rd/ CR 900 (Ft Wayne Dist)
Original General Plan

- Resurfacing the existing lanes & ATL
- Concrete overlay & ATL
- ATL Inside or Outside
Project History

- Most of these Interstates are 4-lane divided Highways
- Built in 60’s-70’s and resurfaced in 80’s-90’s-2000+
- Old concrete (CRC & JRCP) 40-50 Yrs
- Shoulders were built with thin HMA (3-4”)
- Maintenance history..”D”cracking, Patching (Inverted “T”)
- Geocomposite Underdrains
Pavement Evaluation

- Field evaluation-Existing pavement pictures
- Core Report
- FWD Report
- Pavement Management data
- Old contracts review
I-65, Greenwood to Whiteland

2006 Pictures
I-65, Whiteland to Franklin

2006 Pictures
I-65, SR 44 to I-465 (2011)
I-65, Southport Rd to Main St.
Major Distresses

Reflective Cracking
D cracking of Concrete
Pavement edge cracking
Underdrain failure
Pumping
Pavement Condition data

2014
I-65 Pavement Management data
SR 44 to Southport Rd

<table>
<thead>
<tr>
<th>Direction</th>
<th>IRI (inches/mi)</th>
<th>Rutting (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northbound</td>
<td>86</td>
<td>0.14</td>
</tr>
<tr>
<td>Southbound</td>
<td>111</td>
<td>0.14</td>
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</table>
Pavement Design Analysis

- Pavement Design Approach/Philosophy
- Pavement Treatment Alternatives (MEPDG)
- Pavement design challenges
- LCCA
- Cost/lane mile/year
- ALT-BID option & Assumptions
- Recommendation: Reconstruction
Thank You!

Pankaj Patel....
## Project Scope for I-65 Added Travel Lane

<table>
<thead>
<tr>
<th>Des. No.</th>
<th>Location</th>
<th>Project Scope/Intent</th>
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</thead>
<tbody>
<tr>
<td>1383343 &amp; 1383354</td>
<td>SouthPort Rd to Main St (Greenwood)</td>
<td>Unbounded concrete overlay. New pavement for ATL and under overpasses.</td>
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<tr>
<td>1383341 &amp; 1383342</td>
<td>Main St to SR 44</td>
<td>Unbounded concrete overlay. New pavement for ATL and under overpasses.</td>
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<tr>
<td>1400597</td>
<td>SR 311 to 2.8 mi S of SR 160</td>
<td>2 lifts HMA Overlay. New pavement for ATL and under overpasses.</td>
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</table>
## Existing Geometry I-65

<table>
<thead>
<tr>
<th>Project</th>
<th>Existing Travel Lanes</th>
<th>Existing Shoulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>SouthPort Rd to Main St</td>
<td>6 lanes – 12 feet</td>
<td>4 feet Inside + 10 feet Outside</td>
</tr>
<tr>
<td>Main St to SR 44</td>
<td>4 lanes – 12 feet</td>
<td>4 feet Inside + 10 feet Outside</td>
</tr>
<tr>
<td>SR 38 to SR 25</td>
<td>4 lanes – 12 feet</td>
<td>4 feet Inside + 10 feet Outside</td>
</tr>
<tr>
<td>SR 311 to 2.8 mi S of SR 160</td>
<td>4 lanes – 12 feet</td>
<td>4 feet Inside + 10 feet Outside</td>
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</tbody>
</table>
## Proposed Geometry I-65

<table>
<thead>
<tr>
<th>Project</th>
<th>Proposed Travel Lanes</th>
<th>Proposed Shoulders</th>
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</thead>
<tbody>
<tr>
<td>SouthPort Rd to Main St</td>
<td>8 lanes – 12 feet</td>
<td>8 feet Inside + 10 feet Outside</td>
</tr>
<tr>
<td>Main St to SR 44</td>
<td>6 lanes – 12 feet</td>
<td>8 feet Inside + 10 feet Outside</td>
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<td>SR 38 to SR 25</td>
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<td>6 lanes – 12 feet</td>
<td>8 feet Inside + 10 feet Outside</td>
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</tbody>
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## Added Travel Lane I-65

<table>
<thead>
<tr>
<th>Project</th>
<th>Added New Lane</th>
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<tr>
<td>SouthPort Rd to Main St</td>
<td>Outside</td>
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<tr>
<td>Main St to SR 44</td>
<td>Inside</td>
</tr>
<tr>
<td>SR 38 to SR 25</td>
<td>Inside</td>
</tr>
<tr>
<td>SR 311 to 2.8 mi S of SR 160</td>
<td>Inside</td>
</tr>
</tbody>
</table>
Detail Case Study For
I-65 (Main St to SR 44)
Project length – 11.5 miles
I-65 is a 4-lane divided highway

2015 Traffic: 55,290 (AADT)
- 33% trucks (17,900)

Mainline Composite Pavement (A/C) with Asphalt Shoulders

Average Thickness
- Mainline 5.5” Asphalt over 9” Concrete
- Shoulders 8.5” Asphalt
Project History Cont.

- 1969 – Original Construction
  - 9” JRCP with 3” Asphalt Shoulder over CA
- 1984 – Inverted “T” Concrete Patch
- 1986 – 4.5” HMA Overlay and Geocomposite Edge drain
- 1996 – HMA Overlay
- 2002 – HMA Overlay
- 2007 – HMA Overlay
Pavement Evaluation

- Field evaluation-Existing pavement pictures
- Core Report
- FWD Report
- Pavement Management data
- Geotechnical Report
Pavement Evaluation
Major Distresses

Composite Section
- High Severity Reflective Transverse Cracks
- Edge Cracks
- Fatigue Cracks
- Pumping

Concrete Section (under Overpasses)
- Mid Panel Cracks
- Spalling
Pavement Cores - Mainline

PC_S2-RB-1 – Station -2+00, Line “165”, NB Slow Lane

PC_S2-RB-11 – Station 18+00, Line “165”, SB Slow Lane
PC_S2-RB-45 – Station 86+00, Line “I65”, NB Fast Lane

PC_S2-RB-59 – Station 114+00, Line “I65”, SB Slow Lane
PC_S2-RB-77 – Station 150+00, Line “I65”, NB Fast Lane

PC_S2-RB-87 – Station 170+00, Line “I65”, SB Fast Lane
PC_S2-RB-141 – Station 278+00, Line “I65”, SB Slow Lane

PC_S2-RB-144 – Station 290+00, Line “I65”, NB Slow Lane
Pavement Cores - Shoulders

PC_S2-SB-13 – Station 178+00, Lane “I65”, NB Shoulder

PC_S2-SB-20 – Station 286+00, Lane “I65”, NB Shoulder
PC_S2-SB-40 – Station 298+00, Line “I65”, SB Shoulder
Pavement Evaluation - FWD

- FWD Report (2014)
- High deflection > 8 mils, 10% Areas
- Pavement strength $Sn = 5.0$
- Remaining ESAL = 9.6 million
- Elastic modulus of concrete = 3.8 m psi
- Elastic Modulus of HMA = 400,000 psi
- CBR = 5.3, K-value = 291 pci
North Bound Driving Lane

Surface and Subgrade Deflection

- Surface Deflection
- Surface Deflection Criteria
- Subgrade Deflection
- Subgrade Deflection Criteria

Deflection (mils)

FWD Stations, DMI (meters)
South Bound Driving Lane

Surface and Subgrade Deflection

- Surface Deflection
- Surface Deflection Criteria
- Subgrade Deflection
- Subgrade Deflection Criteria

FWD Stations, DMI (meters)

Deflection (mils)
<table>
<thead>
<tr>
<th>Direction</th>
<th>IRI</th>
<th>Rutting</th>
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</thead>
<tbody>
<tr>
<td>Northbound</td>
<td>142</td>
<td>0.21</td>
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<tr>
<td>Southbound</td>
<td>172</td>
<td>0.22</td>
</tr>
</tbody>
</table>

2014 Data
Pavement Treatment Alternatives

- HMA (SMA Surface) Overlay
- Unbounded Concrete Overlay
- Rubblized Existing JRCP and HMA (SMA Surface) Overlay
- JPCP Reconstruction
- HMA (SMA Surface) Reconstruction
- CRC Reconstruction
Design Data

Traffic - 2015

- Construction Year AADT – 55,290
- Design Year AADT – 73,280
- Truck - 33%
  - AADTT (Trucks) – 17,900
- Growth – 1.74%
- Speed Limit – 70 mph
Geotechnical Report

- Existing Subgrade soil – Silty Loam (A-7-6)
- Resilient Modulus for improved subgrade soil – 7,500 psi
- Resilient Modulus for natural subgrade soil – 3,000 psi
- Subgrade Treatment – 14” Chemical soil modification
- Water Table – 3 feet
- Foundation soil improvement – 15%
## Pavement ME Input

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Performance Limit</th>
<th>Reliability</th>
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</thead>
<tbody>
<tr>
<td>Terminal IRI (in/mi)</td>
<td>160</td>
<td>90%</td>
</tr>
<tr>
<td>AC Bottom-up Cracking (% lane area)</td>
<td>10</td>
<td>90%</td>
</tr>
<tr>
<td>AC Thermal Cracking (ft/mi/lane)</td>
<td>500</td>
<td>90%</td>
</tr>
<tr>
<td>Permanent Deformation – AC only (in.)</td>
<td>0.40</td>
<td>90%</td>
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</tbody>
</table>

HMA Pavement
## Pavement ME Input

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Performance Limit</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal IRI (in/mi)</td>
<td>160</td>
<td>90%</td>
</tr>
<tr>
<td>Transverse Slab Cracking (%)</td>
<td>10</td>
<td>90%</td>
</tr>
<tr>
<td>Mean Joint Faulting (in.)</td>
<td>0.15</td>
<td>90%</td>
</tr>
</tbody>
</table>

Concrete Pavement
Pavement ME Cont.

- Traffic Group – C , (6,000 < AADTT ≤ 20,000)
- Weather Station (Climate Data) – Indianapolis
- LTPP Bind PG 76-22
Pavement Areas

- Total Areas: 729,000 sq yd.
- Overlay (Existing Mainline + OS): 283,500 sq yd.
- Pavement Recon: 161,300 sq yd.

  - Before & after bridge + Under Overpasses

- New + Reconstruction Areas: 445,500 sq yd.
  - 61%

- Mill/Overlay Areas: 283,500 sq yd.
  - 39%
Alternative 1 – 7.5” HMA Overlay

Existing Mainline Pavement
- 7.5” HMA (SMA Surface) Overlay after mill off the existing asphalt
- Design Life – 15 years

New Pavement for ATL & Under Overpasses
- 16.5” HMA (SMA Surface)
- Design Life – 25 years
Alternative 1 – 7.5” HMA Overlay

Existing Mainline Pavement

- Removal of the existing Geocomposite Pavement Edge Drain and install new Retrofit Underdrain
- Full depth concrete patch approximate 5-7% of areas
Alternative 1 – 7.5” HMA Overlay

**Pros**
- Lowest Initial Construction Cost

**Cons**
- Different Rehabilitation and Maintenance Cycle
- Higher Life Cycle Cost (cost/lane/mile/year)
- Two Underdrain system (new lane and retrofit)
Alternative 2 – 12.5” HMA Overlay

Existing Mainline Pavement

- 12.5” HMA (SMA Surface) Overlay after mill off the existing asphalt
- Design Life – 18 years

New Pavement for ATL & Under Overpasses

- 16.5” HMA (SMA Surface)
- Design Life – 25 years
Alternative 2 – 12.5” HMA Overlay

Existing Mainline Pavement

- Removal of existing Geocomposite Pavement Edge Drain and install new Retrofit Underdrain
- Full depth concrete patch approximate 5-7% of areas
Alternative 2 – 12.5” HMA Overlay

**Pros**
- Lower Initial Construction Cost

**Cons**
- Different Rehabilitation and Maintenance Cycle
- Higher Life Cycle Cost (cost/lane/mile/year)
- Two Underdrain system (new lane and retrofit)
Alternative 3 – 12” JPCP Overlay

Existing Mainline Pavement
- 12” Unbounded Concrete Overlay after mill off the existing asphalt
  - 1” new HMA layer top of existing concrete before concrete overlay
- Design Life – 18 years

New Pavement for ATL & Under Overpasses
- 13” JPCP at 15’ D-1 Joint Spacing
- Design Life – 27 years
Alternative 3 – 12” JPCP Overlay

Existing Mainline Pavement

- Removal of the existing Geocomposite Pavement Edge Drain and install new Retrofit Underdrain
- Full depth concrete patch approximate 5-7% of areas
Alternative 3 – 12” JPCP Overlay

**Pros**
- Lower Initial Construction Cost

**Cons**
- Different Rehabilitation and Maintenance Cycle
- Higher Life Cycle Cost (cost/lane/mile/year)
- Two Underdrain system (new lane and retrofit)
Alternative 4 – Rubblized & HMA Overlay

Existing Mainline Pavement
- Mill off asphalt then Rubblize Concrete
- Overlay 14” HMA (SMA Surface)
- Design Life – 17 years

New Pavement for ATL & Under Overpasses
- 16.5” HMA (SMA Surface)
- Design Life – 25 years
Existing Mainline

- Removal of the existing Geocomposite Pavement Edge Drain and install new Underdrain before Rubblized the concrete
Alternative 4 – Rubblized & HMA Overlay

Pros

- Lower Initial Construction Cost than reconstruction of the entire section.

Cons

- Different Rehabilitation Cycle
- Highest Life Cycle Cost (cost/lane/mile/year) among all Alternatives
- Two Underdrain system (new lane and retrofit)
- Potential problem with the rubblized existing concrete during construction
Alternative 5 – HMA Reconstruction

Reconstruction of existing Mainline Pavement and New Pavement for ATL & Under Overpasses

- 16.5” HMA (SMA Surface)
- Design Life – 25 years
Alternative 5 – HMA Reconstruction

INSIDE SHOULDER

NOTES:
Mainline & Shoulders
1. 165 lb/yd² HMA Surface 9.5 mm
2. ___ lb/yd² HMA Intermediate
3. ___ lb/yd² HMA Base
4. ___ lb/yd² QC/QA-HMA Intermediate OG
5. ___ lb/yd² HMA Base
6. Subgrade Treatment, Type _____
7. Underdrain. See Figure 304-211 for detail.

OUTSIDE SHOULDER

8. Variable-Depth Compacted Aggregate, No. 53
9. Safety edge as required for Surface and Intermediate layers. See Figure 304-21X for detail.
11. Liquid Asphalt Sealant required on Surface layer over longitudinal joint, 24" width.
12. Base seal is required under all open-graded HMA layers.

* See Figure 304-21D for lay rate.
Alternative 5 – HMA Reconstruction

**Pros**
- Same Maintenance and Rehabilitation Cycle
- Only one underdrain system for entire section and away from the travel lane
- Reset the pavement life for 50+ years
- Lower cost/lane/mile/year
- Can be let as Alternate Pavement Type Option with new JPCP reconstruction alternative

**Cons**
- Higher Initial Construction Cost
Alternative 6 – JPCP Reconstruction

Reconstruction of existing Mainline Pavement and New Pavement for ATL & Under Overpasses

- 13” JPCP at 15’ D-1 Joint Spacing
- Design Life – 27 years
Mainline and Shoulders
1. PCCP
2. Subbase for PCCP (3 in. Coarse Aggregate No.8 on 6 in. Coarse Aggregate, No. 53)
3. Variable-Depth Compacted Aggregate, No. 53
4. Underdrain. See Figure 304-21T for detail.
5. Subgrade Treatment, Type _____
6. Longitudinal Joint or Longitudinal Construction Joint.
   See Figure 304-21W for detail.
7. Concrete Median Barrier
8. Safety edge as required. See Figure 304-21X for detail.

* Where underdrains are not required, Dense Graded Subbase should be used.

PCCP SECTION WITH PCC SHOULDER
Alternative 6 – JPCP Reconstruction

**Pros**
- Same Maintenance and Rehabilitation Cycle
- Only one underdrain system for entire section and away from the travel lane
- Reset the pavement life for 50+ years
- Lower cost/lane/mile/year
- Can be let as Alternate Pavement Type Option with new HMA reconstruction alternative

**Cons**
- Higher Initial Construction Cost
Alternative 7 – CRC Reconstruction

Reconstruction of existing Mainline Pavement and New Pavement for Added Lane & Under Overpasses

- 11.5” CRC
- Design Life – 50 years
Alternative 7 – CRC Reconstruction

Pros

- Same Maintenance Cycle
- Only one underdrain system for entire section and away from the travel lane
- Pavement Design life 50 years
- Lowest cost/lane/mile/year

Cons

- Very High Initial Construction Cost
## Economic Analysis Summary

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Initial Pavement Cost</th>
<th>Cost/Lane/Mile/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5” HMA (SMA Surface) Overlay</td>
<td>$40,600,000</td>
<td>$40,500</td>
</tr>
<tr>
<td>12.5” HMA (SMA Surface) Overlay</td>
<td>$45,200,000</td>
<td>$33,800</td>
</tr>
<tr>
<td>12” JPCP Overlay</td>
<td>$44,000,000</td>
<td>$32,900</td>
</tr>
<tr>
<td>Rubblized Existing JRCP and 14” HMA (SMA Surface) Overlay</td>
<td>$46,000,000</td>
<td>$43,000</td>
</tr>
<tr>
<td>16.5” HMA (SMA Surface) Reconstruction</td>
<td>$49,500,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>13” JPCP Reconstruction</td>
<td>$50,300,000</td>
<td>$27,500</td>
</tr>
<tr>
<td>11.5” CRC Reconstruction</td>
<td>$68,500,000</td>
<td>$20,500</td>
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</tbody>
</table>
Life Cycle Cost Analysis

Compare LCCA for 50 years Pavement life

- 16.5” HMA Reconstruction
- 13” JPCP Reconstruction

LCCA between these two reconstruction Alternatives was within 10%
Recommendation

Pavement Reconstruction Bid as Alternate Pavement Type Options

- 16.5” HMA Reconstruction
- 13” JPCP Reconstruction
## Bid Review for I-65 Added Travel Lane Projects

<table>
<thead>
<tr>
<th>Contract</th>
<th>Location</th>
<th>Low Bid Amount</th>
<th>Engineer’s Estimate</th>
<th>% below Engineer’s Estimate</th>
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</thead>
<tbody>
<tr>
<td>R-37075</td>
<td>SouthPort Rd to Main St (Greenwood)</td>
<td>$35,816,694.00</td>
<td>$41,100,00.00</td>
<td>13%</td>
</tr>
<tr>
<td>R-37096</td>
<td>Main St to SR 44</td>
<td>$84,030,501.00</td>
<td>$97,000,000.00</td>
<td>14%</td>
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<tr>
<td>R-37115</td>
<td>SR 38 to SR 25</td>
<td>$82,813,411.00</td>
<td>$83,950,000.00</td>
<td>1.5%</td>
</tr>
<tr>
<td>R-37383</td>
<td>SR 311 to 2.8 mi S of SR 160</td>
<td>$67,055,136.00</td>
<td>$70,200,000.00</td>
<td>5%</td>
</tr>
</tbody>
</table>
Pavement Evaluation is important
Need to explore all possible options
Cost/lane-mile is good exercise
Plan for future
Pavement Reconstruction with Alt-Bid saved $22.5 Millions.
Questions?