Updating City Pavement Sections with ME-PDG

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Gary Pence, City of Westfield
Phil Sundling, City of Westfield
Why are we here?

• City of Westfield Growing
  – Ensure dollars being spent on pavement were allocated properly

• New pavement design methodology
  – More accurate prediction of service life
Outline

- ME Pavement Analysis
- Life Cycle Cost Analysis
- Savings Realized

- Local Perspective
- Case Study

Mike

Gary
Outline

- Audience Participation
- Candy Distribution
First Question...
ME Pavement Analysis

• What is ME-PDG?
ME Pavement Analysis

• What is ME-PDG?
  • Mechanistic Empirical Pavement Design Guide
ME Design Procedure

Climate

Structure

Traffic

Materials

Predicted IRI
Initial IRI: 63.0 in/mi

Pavement Ages (date)


IRI (in/mi)

Threshold Value
Specified Reliability
50% Reliability
Does Not Predict This Distress...

CHUCK NORRIS AS A CHILD
ME Pavement Analysis

• Methodology
  – Determine Program Inputs
    • Local
    • Collector
    • Arterial
  – Evaluation
    • Existing Section
    • Alternative Sections
  – Determine Life Cycle Costs
  – Select Optimum Thickness
ME Pavement Analysis

• Methodology
  – Determine Program Inputs
    • Local
    • Collector
    • Arterial
    Conservative values based on local experience
  – Evaluation
    • Existing Section
    • Alternative Sections
  – Determine Life Cycle Costs
  – Select Optimum Thickness
ME Pavement Analysis

• Methodology
  – Determine Program Inputs
    • Local
    • Collector
    • Arterial
    • Traffic based on Westfield traffic counts

– Evaluation
  • Existing Section
  • Alternative Sections

– Determine Life Cycle Costs
– Select Optimum Thickness
ME Pavement Analysis

• Methodology
  – Determine Program Inputs
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  – Evaluation
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  – Determine Life Cycle Costs
  – Select Optimum Thickness

Varied Pavement Thicknesses
ME Pavement Analysis

• Methodology
  – Determine Program Inputs
    • Local
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  – Evaluation
    • Existing Section
    • Alternative Sections

– Determine Life Cycle Costs
– Select Optimum Thickness
• “E.A.A.”
  • Construction Costs
Equivalent Annual Annuity (EAA)

- Calculates *constant annual cash flow* generated by a project over its lifespan as if it was an annuity
- Way of comparing different design lives
Equivalent Annual Annuity (EAA)

• Calculates **constant annual cash flow** generated by a project over its lifespan as if it was an annuity

• Way of comparing different design lives

\[ C = \frac{r(NPV)}{1 - (1 + r)^{-n}} \]

- **C** = Equivalent Annuity Cash Flow
- **NPV** = Net Present Value
- **r** = rate per period
- **n** = number of periods
Life Cycle Cost Analysis

Cost of Arterial/Industrial Sections

- Construction Cost
- EAA

AMERICAN STRUCTUREPOINT INC.
Life Cycle Cost Analysis

Cost of Collector Sections

- Construction Cost
- EAA

C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12
Life Cycle Cost Analysis

Cost of Local Sections

- Construction Cost
- EAA

L1, L2, L3, L4, L5, L6, L7
# Cost Savings per Lane Mile

<table>
<thead>
<tr>
<th>Construction Cost</th>
<th>Equivalent Annual Cost</th>
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<td>• Local</td>
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| • Collector | |
| — $32,000 | Section 1 | — $6,600 |
| — $50,800 | Section 2 | — $1,900 |

| • Arterial | |
| — ($-2,700) | Section 1 | — $7,500 |
| — $16,000 | Section 2 | — $440 |
Building community. Connecting families.

Westfield’s Roadway System

Mayor Andy Cook
Quality of Life
Local Streets

2006 Design

- Option 1
  - 1” surface
  - 5” binder
  - 4” base
  - 8” comp agg.
- Option 2
  - 1” surface,
  - 4” binder
  - 6” comp agg.
  - 12” lime

Recommended Section

- Option 1
  - 1.5” surface,
  - 3” binder,
  - 6” comp agg on
  - Lime or 12” comp agg. subbase
### Cost Savings per Lane Mile

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**Vs.**

- Section 1
- Section 2
Arterial and Industrial

2006 Design

• Option 1
  – 1” surface,
  – 2” binder,
  – 6” base (25mm),
  – 9” comp agg.

• Option 2
  – 1” surface
  – 2” binder
  – 4” base (25mm)
  – 6” comp agg.
  – 12” lime

Recommended Section

• Option 1
  – 1.5” surface
  – 2.5” binder
  – 2.5” base (19.0mm)
  – 3.5” base (19.0mm)
  – Subgrade treatment type 1

• Option 2
  – 1.5” surface
  – 2.5” binder
  – 5.0” base (25.0mm)
  – 6.0” comp agg.
  – Subgrade treatment type 1
## Cost Savings per Lane Mile

### Construction Cost

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Question

• Why use 1.5” surface instead of 1” as previously proposed?
Answer

• Recommended minimum thickness for 9.5mm pavement is 1.0”
  – 2 x (max aggregate size)
• Variability in construction is +/- 0.5”
• 1.0” + 0.5” = 1.5”
Bonus Question

• What is the maximum aggregate size for 19.0mm pavement?
Answer

• 25.0mm
Collectors

2006 Design

• Option 1
  – 1” surface
  – 2” binder
  – 4” (25mm) base
  – 9” compacted agg.

• Option 2
  – 1” surface
  – 2” binder
  – 4” (25mm) base
  – 6” compacted agg.
  – 14” lime

Recommended Section

• Option 1
  – 1.5” surface
  – 2.5” binder
  – 2.5” base
  – Subgrade Treatment Type 1

– 14” lime
Cost Savings per Lane Mile

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Recommended Section

• Option 1
  – 1.5” surface
  – 2.5” binder
  – 2.5” base
  – Subgrade Treatment Type 1

This section was revised...
Why the revision??
Revised Section

Recommended Section

• Option 1
  – 1.5” surface
  – 2.5” binder
  – 2.5” base
  – Subgrade Treatment Type 1

Local Experience

• Early cracking of base by construction vehicles
Collectors

• Revised Section
  – Option 1
    • 1.5” surface
    • 2.5” binder
    • 3.5” (19mm) base
    • subgrade treatment type 1

  – Option 2
    • 1.5” surface
    • 2.5” binder
    • 2.5” (19mm) base
    • 6” comp agg.
    • subgrade treatment type 1

  • Increase Base to 3.5”

  OR

  • Add 6” Stone
Grand Park Boulevard Extension

- Actual project
- 2.95 lane miles
- Let Fall 2014
- Typical section

Full Depth HMA Pavement
165 #:SYS HMA Surface, Type B on
275 #:SYS HMA Intermediate, Type B on
275 #:SYS HMA Base, Type B
Subgrade Treatment, Type IB
Wheeler Road (INDOT Design)

• Pavement Section
  – 1.5” surface
  – 2.5” binder
  – 7.0” Compacted Agg.
  – 14” Subgrade Treatment
Cost per lane Mile Calculation

Unit Costs

• Surface
  – $75 /ton
• Binder
  – $59 /ton
• Base
  – $56 /ton
• #53 Stone
  – $25 /ton
• Lime
  – $5.50 /sys

Pavement Costs

• 2006 Design Section
  – $249,507
  – $258,879
• Proposed Pavement Section
  – $275,176
  – $196,504
• Wheeler Road Section
  – $207,870
• Westfield Revised Section
  – $215,283
  – $255,200
Grand Park Boulevard Pavement Costs

• 2006 Design Section
  – $736,046
    • $100,962 more

• New Proposed Section
  – $579,697
    • $55,397 less

• Wheeler Road Section (INDOT Design)
  – $613,217
    • $21,867 less

• Westfield Revised Section
  – $635,084 per lane mile
• What is the City of Westfield buying for the extra construction costs?
Asphalt Life Cycle Effects of Routine Maintenance

As you can see, you do not have to apply a preservative seal every year.
THINKING...

NEED TO USE ENGINEERING JUDGEMENT
THINKING...

• What factors should go into Pavement Design decisions?
Factors

- Initial construction costs
- Life cycle costs
- Amount of traffic anticipated in future
- Type of traffic
- Soils
- Cut or Fill section
- Is it a curb and gutter section
- Construction inspection/quality control
- Timeline/weather
THINKING...

• Make the right decision for the right roadway and right reasons
Goals

• Optimize pavement sections for best long term savings
  – Initial Construction Cost
  – Maintenance Cost

• Better align City pavement standards with latest technology and processes currently used by FHWA and INDOT
Questions?