Kentucky’s Experience with Pavement Warranties, Bidding Alternative Pavement Design and Long Life Pavements

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Bidding Warranties

Pros:
- Encourage A Consistent Level of Workmanship
- Encourage Consistent Level of Service
- Encourage Contractor Innovation
- Distribution of Risk

Cons:
- Administrative Issues
- Bonding
- Thresholds/Background data
- Distribution of risk
Types of Contracts

- Bidding Alternate Pavement Type With Warranties
- Pavement Warranties Without Bidding Alternate Pavement Types
- Incentives/Disincentives
- Fixed Completion Date
Bidding Alternate Pavement Types – Why?

• No Significant Engineering Factors Favoring One Pavement Type Over Another
• Life Cycle Cost Analysis “Too Close To Call”
• Stimulate Competition
Bidding Alternate Pavement Types With Warranties

- Functional Equivalence Among Alternatives
Difference Between Functional and Structural Equivalence

• Pavement Designs are said to be “Structurally Equivalent” if they can accommodate the same number of axle load applications.

• Pavement Designs are said to be “Functionally Equivalent” if they provide the same intended purpose at the same level of service.
Example of Functional Equivalence

- In terms of pavement ride quality (RI, IRI, etc.) two pavement designs would be considered functionally equivalent if it could be demonstrated that the change in ride quality over time would be the same for both pavements.
- Similar examples for other distress modes.
Warranty Parameters

- Contractor Responsible for Mix Design
- Contractor Will Develop a QC Plan
- Contractor Permitted to Enhance Structural Design
- Initial and Annual Distress Identification
- Joint Review Team
- Traffic Monitoring Program
Contract Bidding Innovations
Recent Kentucky Experience
Evaluation of Bids

- Low Bid – “A”
- Low Bid – “A+B”
- Low Bid – “A+B-C”
- Low Bid – “A-C”

A = Cost for Materials and Labor ($)
B = Value of Time to Completion (Days x $/day)
  - Contractor Defines Days (Or Hours)
  - Agency Defines Value of Time Increment ($/Day, $/hour, etc.)
C = Value of Warranty ($/Year of Warranty)
Bidding Alternate Pavement Types With Warranties

- A+B-C
- A-C
- Variable Warranty Period
  - 5 Years Required
  - 5, 6, 7, 8, 9, or 10 Year Optional
- “C” – Credit For Extended Optional Warranty
- 2 Projects Awarded
Pavement Warranties Without Bidding Alternate Pavement Type

• Fixed Warranty Period - - 10 years
• Project Not Awarded
Incentives/Disincentives

- A+B
- Fixed Completion Date
- A+B-C
Incentives/Disincentives

- A+B Bidding
- “A” – Cost of Materials and Labor
- “B” – Value of Time to Completion (Days x $/Day)
- Numerous Projects
Incentives/Disincentives
Fixed Completion Dates

- Specified Completion Date
- Incentive ($/Day) for Early Completion
- Disincentive ($/Day) for Late Completion
- Incentive/Disincentive for Intermediate Contract Phases
- Numerous Projects Without Warranties
Incentives/Disincentives

A+B Bidding with fixed completion date
- “A” – Cost of Materials and Labor
- Modified “B” – Value of Time to Completion
- One Project Awarded
Incentives/Disincentives with Warranty

A+B-C

- “A” – Cost for Materials and Labor
- “B” – Value of Time to Completion (Days x $/Day)
- “C” – Value of Warranty

One Project Awarded
Example Projects

WARRANTY PROJECTS
- I-275 Northern Kentucky
  - A+B-C Bidding
- I-65 South-Central Kentucky
  - A-C Bidding

OTHER INNOVATIVE CONTRACTING
- I-264 Louisville
  - A+B Bidding with fixed completion date
I-275 Northern Kentucky Pavement Rehabilitation

A+B-C Bidding

- Initial Construction
  MP 1.05 - 4.06 -- 1973
  MP 4.06 - 7.15 -- 1977

- Current Traffic Levels
  - 39,200 -- 76,000, AADT, year 1999
  - 11% Trucks;
    10,700,000 -- 21,000,000 ESALs @ 20 Years

- Existing Pavement Structure
  - 11” PCC
  - 6” DGA
I-275 Northern Kentucky Pavement Rehabilitation

• Alternate Pavement Designs Considered
  – Unbonded PCC Overlay
    10 Inches Section 1
    9 Inches Section 2
  – Break and Seat and Asphalt Overlay
    13 Inches Section 1
    12 Inches Section 2

• Life Cycle Cost Analyses Indicated No Definitive Alternative – “Too Close To Call”
Kentucky LCCA Procedure

- 40-year analysis period
- Historical Average Unit Bid Prices
- User Costs Determined Using FHWA DP-115 Procedures
I-275 Northern Kentucky

MP 1.05 - 4.06

Discount Rate (%)

Net Present Value

AC Overlay

PCC Overlay

Net Present Value

Discount Rate (%)
I-275 Northern Kentucky Pavement Rehabilitation

• Warranty
  – 5 Year Fixed Warranty (Required)
  – Optional Warranty (6 -10 Years)

• Incentive/Disincentive
  – $25,000/day

• “A + B – C” Bidding
I-275 Northern Kentucky Value of Optional Extended Warranty

- Based on the Anticipated Future User Costs for Years 6 - 10

- Warranty Value
  - Year 5: $0
  - Year 6: $500,000
  - Year 7: $1,000,000
  - Year 8: $1,500,000
  - Year 9: $2,100,000
  - Year 10: $2,900,000
I-275 Northern Kentucky Determination of Value of Warranty

User Cost Normalized for Years 5-10 and Zero Value of Warranty at Year 5

User Delay, 1-lane 24 hr Closure
Value of Warranty
I-275 Northern Kentucky Results

- Three Bidders
  - Two Bidders for Concrete Alternatives
  - One Bidder for Asphalt Alternative
- All Bid 10-year Warranty
- Successful Bidder 380 days
  - All Others 450 Days
- Project Complete – 194 Days
- Total Incentive -- $2,900,000
I-65 South Central Kentucky
A-C Bidding

- **Initial Construction**
  MP 35.2 – 40.5  1969

- **Current Traffic Levels**
  - 42,000 2002
  - 36% Trucks; 40,417,000 ESALs @ 20 years

- **Existing Pavement Structure**
  - 10” PCC
  - 6” DGA
I 65 South Central Kentucky

• Initial Bidding
  • Asphalt Alternate ONLY
  • 10 Year Warranty Required
  • Could Not Be Awarded

• Administrative Decision to Bid Alternatives

• Alternate Pavement Designs
  – Unbonded PCC Overlay – 10 Inches
  – Break and Seat and Asphalt – 11 Inches
I 65 South Central Kentucky

- Warranty
  - 5 Year Fixed Warranty (Required)
  - Optional (6-10 Years)
- Incentive/Disincentive
  - $10,000/Day
- A-C Bidding
Value of Optional Extended Warranty

- Based on Anticipated Future User Costs for Years 6-10
- Warranty Value
  - Year 5  $0
  - Year 6  $250,000
  - Year 7  $800,000
  - Year 8  $1,500,000
  - Year 9  $2,150,000
  - Year 10 $3,350,000
I-65 South Central Kentucky Determination of Value of Warranty

User Cost Normalized for Years 5-10 and Zero Value of Warranty at Year 5
I 65 South Central Kentucky Bid Results

- Two Bidders
  - One Concrete Alternative
  - One Asphalt Alternative
- Both Bid 10-year Warranty
- Construction Complete
  June 2, 2003, 120 days ahead of schedule
Kentucky’s Experience with other Innovative Contracting

• I-264 in Louisville
I-264 Louisville A+B Bidding

- **Initial Construction**
  - 1968-1971

- **Current Traffic Levels**
  - 39,000 to 85,000 (2000 AADT)
  - 12% Trucks; 55,000,000 ESALs @ 40 years

- **Existing Pavement Structure**
  - 10” PCC
  - 6” DGA
I-264 Louisville

PROJECT SPECIFICATIONS

- Pavement Rehabilitation
- Maintain 2 lanes each direction
- Minimize ramp closures
- Public Awareness Program
  - Coordination with Local Government
  - Media Partner
  - Public Awareness
- Separate Landscaping Contract
• 7.76 Miles of Existing Expressway
• 39 Mainline Bridges
• 5 Interchanges
• Existing 4-Lane MP 0.46 to MP 1.9 (To be widened to 6-Lanes with this project)
• Existing 6-Lane MP 1.9 to MP 8.26 (Pavement Overlay/Replacement)
I-264 Incentive/Disincentive

Incentive = (# Days Bid - # Days Used)*$25,000 (max. 500 days could be bid)

Disincentives

• $25,000/day after bid calendar days elapses
• $50,000/day additional after October 1, 2004
• $25,000/day during Kentucky Derby Events
• Variable disincentives for ramp closures
I-264 Louisville Results

- Five Bidders
- 500 Days Allowed
- Fixed Completion: Oct. 1, 2004
- Successful Bidder: $66M
  - Others: $69M-$76M
- Successful Bidder: 500 days
  - Others: 430, 486 & 500(2)
- Currently Under Construction
Where Do We Go From Here?
Alternate Bidding: Present and Future

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1993 AASHTO Pavement Guide

- Type Selection Guidelines in Appendix B.
- Lists Primary and Secondary factors
Primary Factors

- Traffic
- Soil Characteristics
- Weather
- Construction Considerations
- Recycling
- Cost Comparison
Secondary Factors

- Similar Pavements in the area
- Conservation of Materials
- Contractor Capabilities
- Traffic Safety
- Experimental Features
- Stimulation of Competition
- Municipal Preferences
It’s Not Always Black or White
Alternate Bidding Approaches

- Initial Cost Alternative Bidding
- “Optional Bid” (ODOT)
- Others?????
Initial Cost Bidding

- No Significant Engineering Factors Favoring One Pavement Type Over Another
- Initial Cost within 5-10%
- Life Cycle Cost Analysis “Too Close To Call”
LCCA (AC-10r, PCC-15-yr)

Initial Cost: AC= $3,670,357    PCC= $3,870,123

5% Difference in Pavement Items only

Asph: 13" Break & Seat
PCC: 11" PCC with 1" Bondbreaker

Net Present Value

Discount Rate (%)
“Optional Bid” (ODOT)

- $60M construction project in Ohio
- ODOT “Pavement Selection Score” could not select one pavement type over another
- Alternatives
  - Unbonded PCC Overlay
  - Rubblize and Asphalt Overlay
- Contractors permitted to choose pavement structure they feel is the most economical and appropriate
“Optional Bid” (ODOT)

- Predetermined Future Maintenance costs will be added to bids
- Lowest responsive and responsible bidder will be awarded contract
- Project scheduled to sell in May 2004
Is there a better method?
Long Life Pavements
Kentucky’s Perspective

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Kentucky’s Pavement Design History

- Mechanistic-Empirical Design Procedure
- Developed Since the 1940’s
- Based on Mechanistic Analysis and Field Experience
Timeline of Pavement Design Development in Kentucky


- '42
- '48
- '59
- '68  '73  '81

Early Pavement Studies  Expanded Pavement Studies  Mechanistic-Empirical Studies  Implementation and Refinement
Achieving Long Life Pavements

- Limiting Strain Criteria
- Minimize Fatigue Cracking
- Improvements in Material Properties
- Performance Related Specifications
- Extended Design Life 40 - 50 year ESAL's
- What is Long Life
  - Functional Life
  - Structural or Fatigue Life
Classical AC Limiting Strain

1. Compressive strain - rutting.
2. Tensile strain - fatigue or alligator cracking.
3. Compressive strain - rutting.

TYPICAL FLEXIBLE PAVEMENT WITH GRANULAR BASE
AC Critical Strain Kentucky Criteria

Repetitions of 18,000 lb Axle

Tensile Strain @ Base of AC Layer

Current Experience

- 1,800 KSI
- 600 KSI
- 270 KSI
- 150 KSI
- 70 microstrain
AC Strain Asphalt Institute, Shell, and Kentucky

Number of Repetitions

Tensile Strain @ Bottom of AC Layer

- SHELL
- ASPH. INST.
- 70 microstrain
- Ky 480 ksi

Current Experience
Design Life (msa) vs. Thickness of Asphalt Layers (mm)

- DBM, 3.1 Gpa – 450 ksi
- DBM50, 4.7 Gpa – 680 ksi
- HDM, 6.2 Gpa – 900 ksi
Kentucky’s Current Approach to Long Life Pavements

• Long Life Designs are typically defined as having the ability to carry extended traffic loads.

• Typical High Type Pavement Facility Rehabilitations have been due to Functional Distresses and Not Necessarily Fatigue Related
Where Do We Go From Here?

- NCHRP 1-37A Design Procedure
- Other Design Procedures
- Fatigue Life vs. Functional Life
- Limiting Strain for Infinite Fatigue Life
- Forecasts for Long Range Traffic
- Innovative Materials
- New Construction Techniques
Thank You