Long-Life Concrete Pavements

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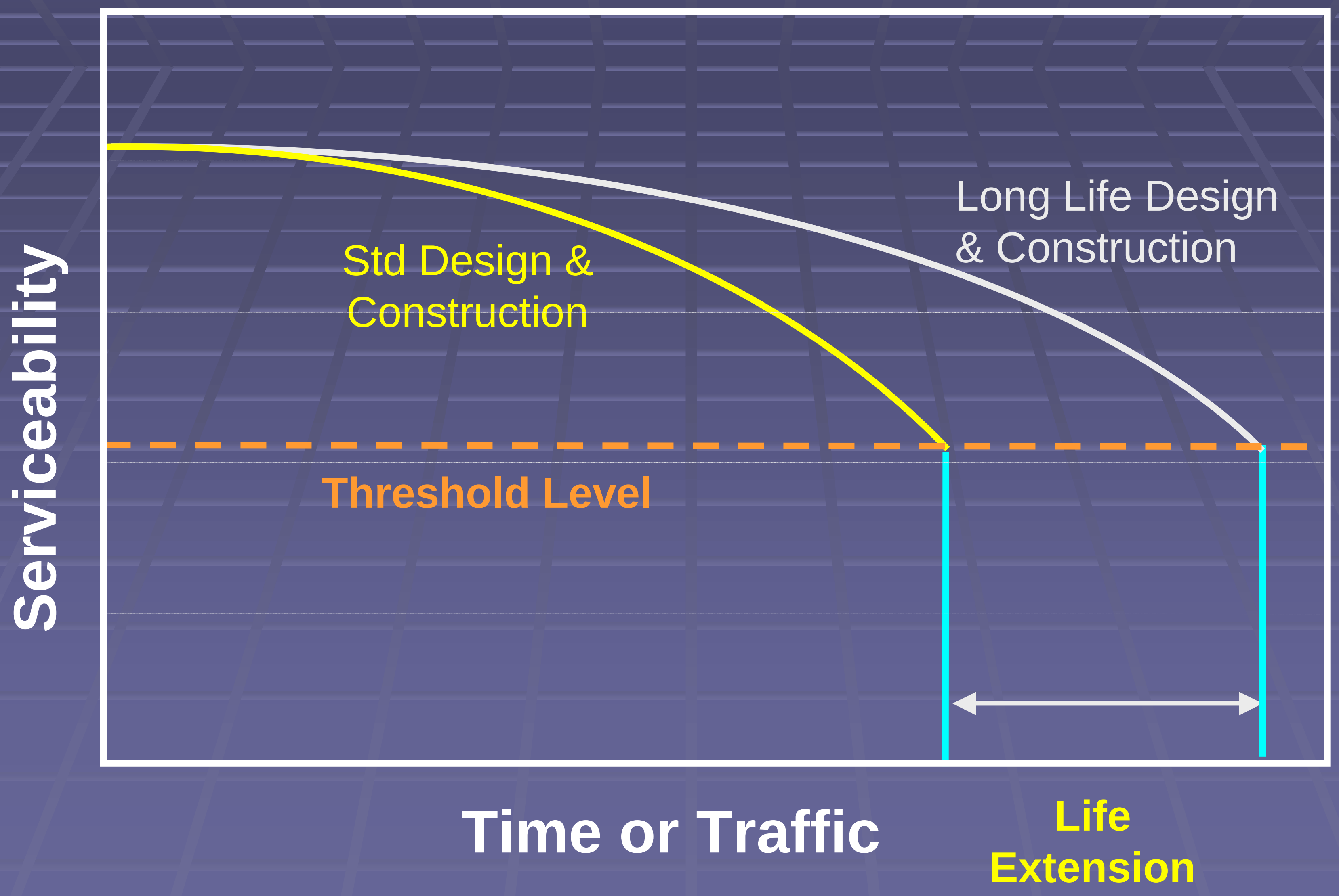
Presentation Outline

- Background
- Goals and Features
- Components
  - Materials
  - Structural Design
  - Construction
  - Maintenance
- Example State Initiatives
- Future Needs and Summary

Background

- Why long life?
  - Reduce future maintenance and rehabilitation requirements
  - Minimize traffic disruptions
  - Reduce user costs
  - Increase safety (fewer work zones)
  - Reduce life-cycle costs
- What is long life?
  - 30-60 year service lives
  - Includes minor maintenance and rehab

Long-Life Design Concept



Concrete Pavement Hall of Fame

- Bellefontaine, OH (Court Street)—1893
- Calumet, MI (7th Street)—1906
- Salt Lake City, UT (B Street)—1907
- Duluth, MN (6th and 7th Streets)—1910
- Urbana, IL (Central Ave)—1911
- Texas (IH 40 Frontage Road)—1920s
- Jacksonville, FL (SR 228)—late 1930s
- Hollywood, GA (SR 17)—1942
- Fairfield, CA (I-80)—1948 (CRCP)
- Dorchester County, SC (I-26)—1962

Goals of Long-Life Concrete Pavements

- Eliminate “early” failures related to design or construction inadequacies
- Prevent materials-related distresses
- Control structural distresses below threshold levels over design period
  - Cracking
  - Faulting
  - Punchouts (CRCP)
- Maintain effective functional performance (smoothness, noise, surface friction) over design period

Features of Long-Life Concrete Pavements

- Increased service life (30 to 60 years)
- Lower life-cycle cost
- Fewer maintenance closures
- Deferred rehabilitation activities
- Reduced construction times

Components of Long-Life Concrete Pavements

- Materials and mix design
- Structural design
- Construction
- Maintenance

Materials and Mix Design

What we want to avoid

Materials and Mix Design

- High-quality, durable aggregates
- Combined gradation
- Portland cement plus pozzolans or slag for durability
- Minimum cementitious content: 500 lb/yd^3
- Effective air void system for environment
- Max w/cm of 0.45

Structural Design

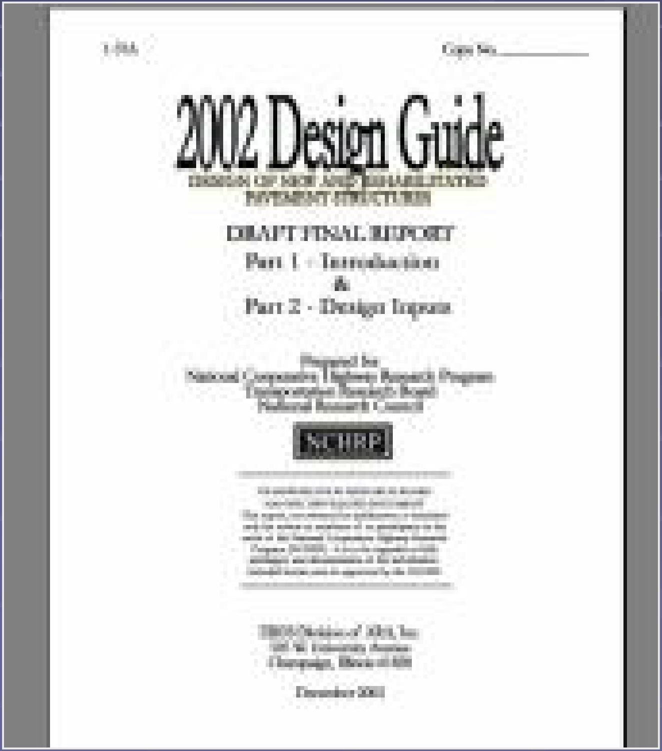
What we want to avoid

Structural Design

- Slab thickness
- Base type/drainage
- Joint design
  - Joint spacing
  - Joint sealant
  - Load transfer
- Edge treatments

Structural Design
—Slab Thickness—

- Thicknesses $\geq$ 12 in
  - Depends on truck traffic and design period
- Thickness is inter-related with many other design variables
- New M-E design software allows for evaluation of interactive effects



Structural Design
—Base Type/Drainage—

- Stabilized base (LCB/CTB or ATB) for medium to heavy truck traffic
  - High strength LCB/CTB not necessary
  - Interface treatment critical
- Drainable base
  - Stability more important than permeability
  - 500 to 800 ft/day

Structural Design

—Joint Design—

- Joint spacing
  - Shorter joint spacings (15 ft works well)
- Joint sealant
  - High quality sealants
  - Longer resealing cycles
- Load transfer
  - Dowel bars a necessity
  - Minimum 1.5 inch for slabs $\geq$ 12 in thick
  - Corrosion resistant

Structural Design

—Edge Treatment—

- Widened Lane
  - Slab paved 1-3 ft wider
  - Lane striped at 12-ft width
  - Reduces edge and corner stresses/deflections

- Tied concrete shoulder
  - Reduces edge stresses/deflections
  - Reduces moisture infiltration
  - Use as emergency or future traffic lane

Construction

What we want to avoid

Construction

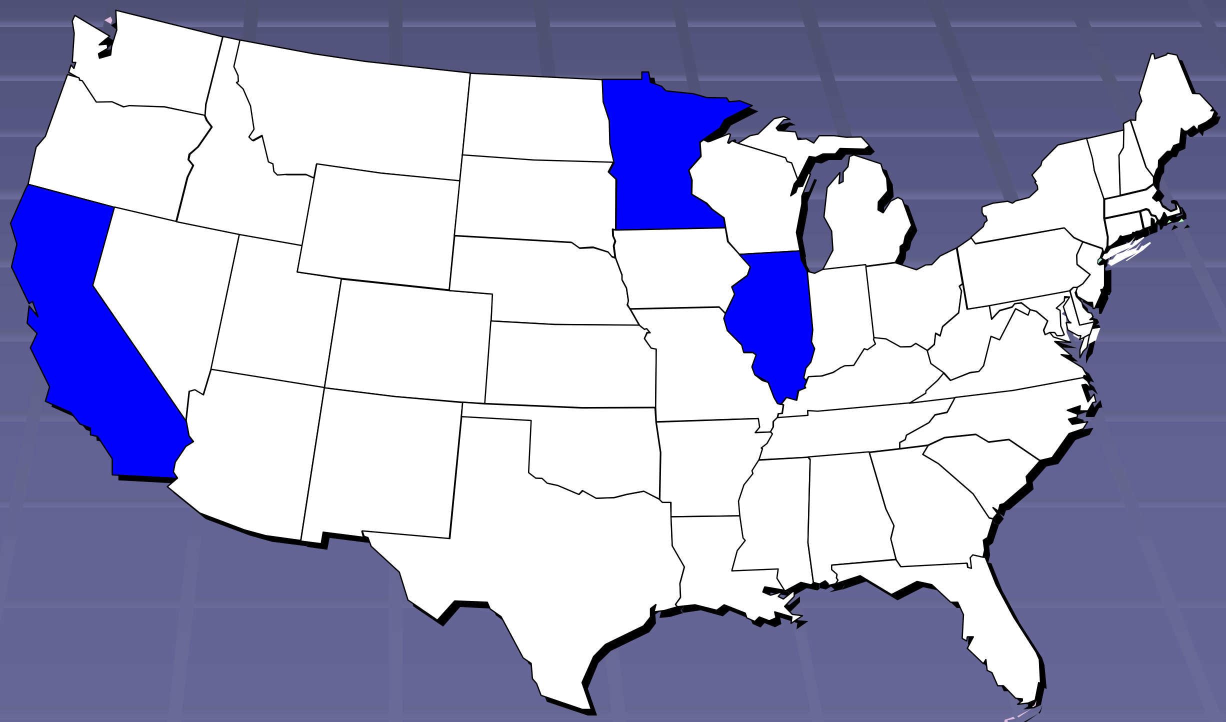
- Uniform production and delivery
- Effective placement
  - Embedded steel
  - Consolidation
- Effective finishing, texturing, and curing
  - Minimal manual finishing
  - Durable, low-noise texture
  - Timely and adequate curing
- Timely joint sawing
- High levels of initial smoothness

Maintenance

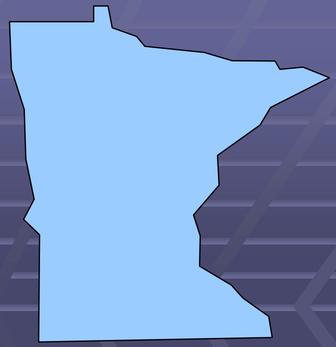
- Maintain serviceability of pavement
- Activities
  - Joint resealing (as appropriate) with long lasting materials
  - Periodic surface texturing as needed for rideability and safety
  - Localized repairs

Example State Initiatives

- Minnesota
- Illinois
- California



Minnesota



- 60-year design
- Urban freeways (Twin Cities)
- Features:
  - Thicker slab (14-in JPCP)
  - Durable mix design
    - High quality, well-graded aggregate
    - Dense, impermeable mix (35% GGBFS, w/cm<0.4)
  - 1.5-in stainless steel clad dowel bars
  - 4-in granular base / 12-in select granular / sand

Illinois

- 30^{+}-year design
- Urban freeways and heavy traffic downstate corridors
- Features:
  - 12 to 14 in CRCP
  - Durable aggregate (D-cracking concerns)
  - Higher steel content
  - Epoxy-coated steel and tie bars
  - 6 in ATB / 12 in aggregate subbase

California

- 40-year design
- For corridors with 20-year traffic > 150,000 vpd or >15,000 tpd
- Features:
  - Maximum 12-in JPCP (includes 3/8 in for sacrificial grinding)
  - Stabilized base (LCB or ATB)
  - Tied PCC shoulders or widened slab

Increase in initial cost only about 3 – 5 %
(about $25,000 – $50,000/lane mile)

Future Needs

- Continue to improve
  - Understanding of pavement behavior
  - Design feature optimization
  - Concrete mixture optimization
  - Construction practices
- Perform accelerated structural and durability testing to gain more rapid feedback and insight on performance of new designs and materials

Summary

- Movement toward long-life pavements
  - Selected (high-volume) highways
  - 30-60 year design lives
  - Minimize future rehabilitation activities
  - Minimize life-cycle costs
- Minimal increase in initial costs (~5%)
- Requires holistic approach
  - Materials and mix design
  - Structural design
  - Construction
  - Maintenance