CEMENT COUNCIL OF TEXAS

Key Design Considerations for Durable Concrete Pavements

Houston, TX
May 22, 2025

Nancy Beltran, PhD
Director of Concrete Pavements
Cement Council of Texas

Types of Concrete Pavements and Applications

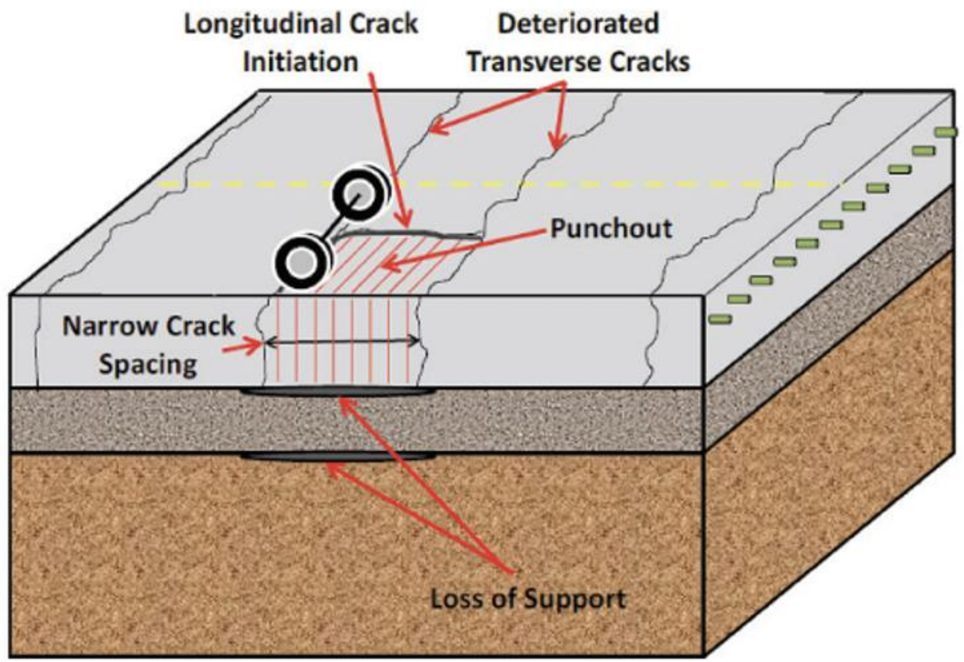
- Pavement Types:
  - Continuously Reinforced Concrete Pavements (CRCP)
  - Jointed Plain Concrete Pavements (JPCP)
- Applications: Highways, city streets, local roads, parking lots and industrial zones.

CEMENT COUNCIL OF TEXAS

CRCP

CEMENT COUNCIL OF TEXAS

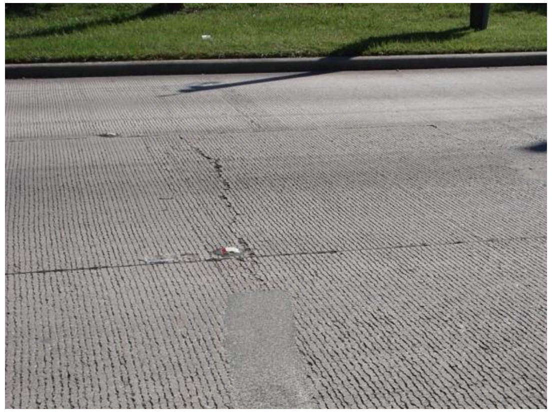
Performance Indicators



Punchouts

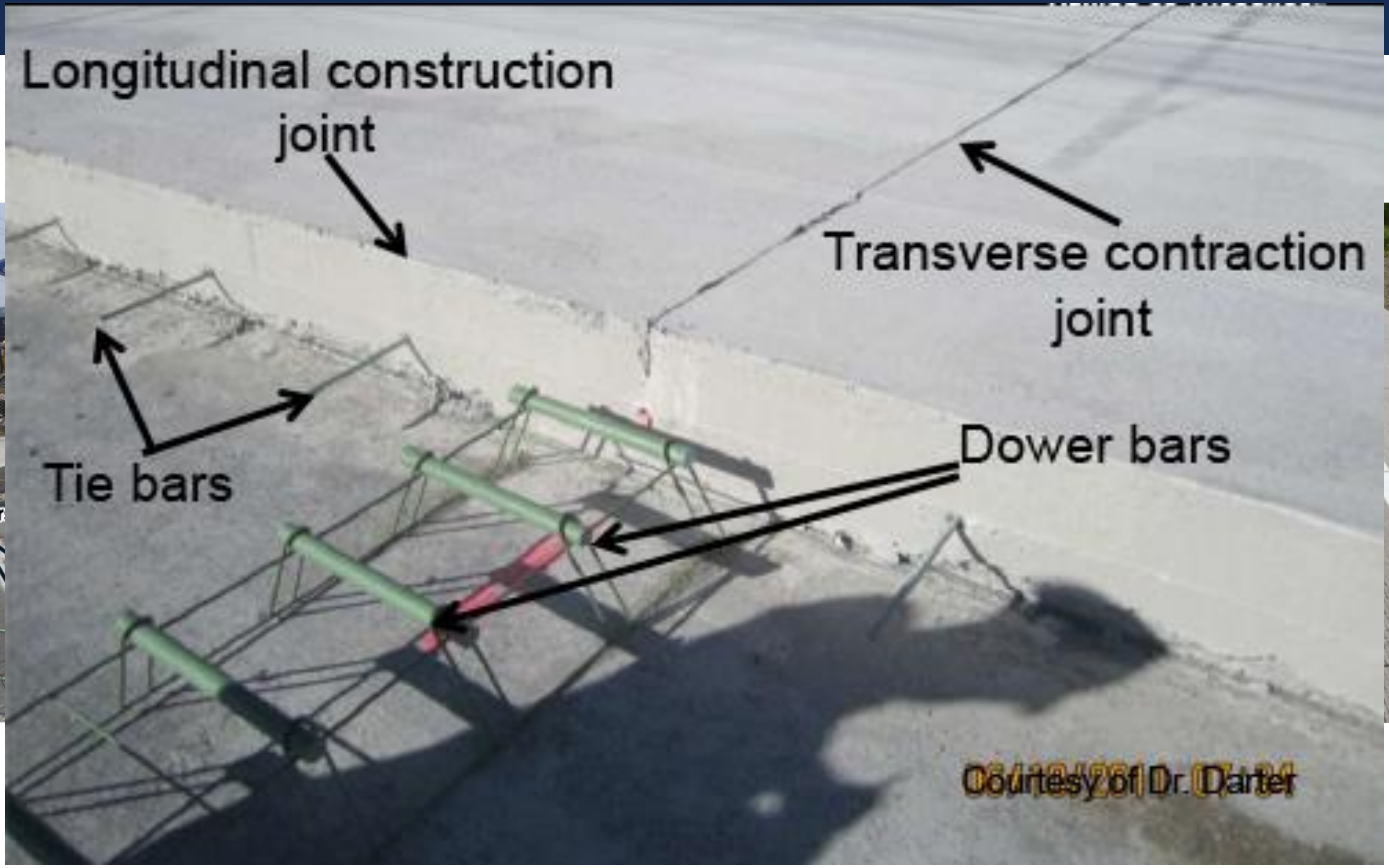
Spalling

Ride Quality



CEMENT COUNCIL OF TEXAS

JPCP



CEMENT
COUNCIL
OF TEXAS

Performance Indicators

- Joint Spalling
- Surface distress
- Crack Propagation

Joint Spalling

Surface distress

Crack Propagation

CCT CEMENT COUNCIL OF TEXAS

Key Characteristics

- High durability
- High Structural Strength
- Long service life
- Low Maintenance Requirements

Key Design Considerations

Loads

Subgrade Treatment

Base Selection

Concrete Thickness

Reinforcement

Mix Design

LCC/LCCA

CEMENT COUNCIL OF TEXAS

Load and Environmental Considerations

- Account for both traffic loading (magnitude and frequency) and environmental stresses (temperature gradients, moisture changes).
- For CRCP:
  - Consider **temperature gradients and curling stresses** in crack spacing and reinforcement selection.
- For JPCP:
  - Consider **joint movement and thermal expansion** in joint spacing and sealant durability.

CEMENT COUNCIL OF TEXAS

Subgrade Treatment and Base Selection

- Subgrade
  - Consider stabilization (cement, lime, or fly ash) for weak or moisture-sensitive soils.
- Base
  - Consider CTB vs HMA base where feasible.

Pavement Thickness and Joint Design

- Design adequate slab thickness based on expected traffic loads and subgrade support.
- For JPCP
  - Carefully design slab thickness and **joint spacing** based on loading and support conditions.
  - Install dowel bars at transverse joints for effective load transfer and longevity.

CEMENT COUNCIL OF TEXAS

Pavement Thickness and Joint Design – cont.

- For CRCP
  - Determine slab thickness based on load and support conditions.
  - Use **continuous longitudinal reinforcement** to control crack widths and spacing.
  - Ensure proper reinforcement placement and concrete cover to prevent corrosion and maintain structural integrity.

CEMENT COUNCIL OF TEXAS

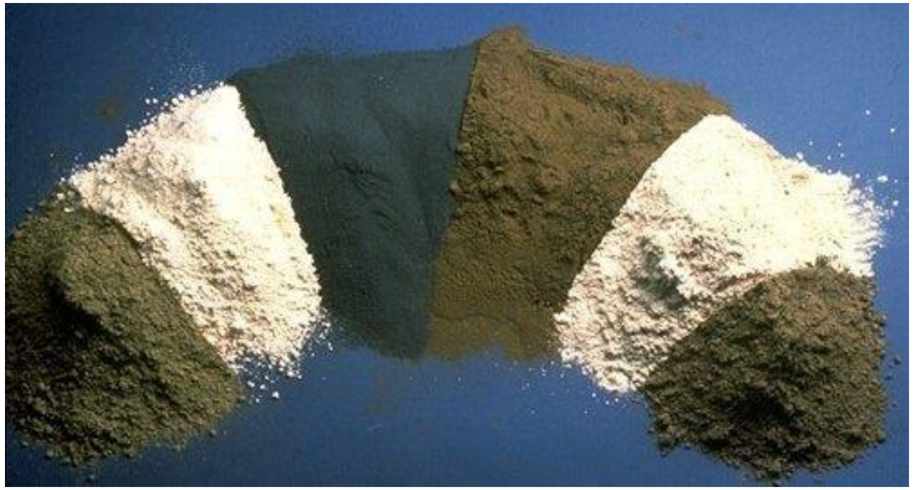
Concrete Mix Design

- Use durable, well-graded aggregates and a low water-to-cementitious materials ratio (typically ≤0.45).
- Include supplementary cementitious materials (SCMs) like fly ash, slag, or silica fume to enhance durability.
- Specify air entrainment for freeze-thaw resistance in applicable climates.

CEMENT COUNCIL OF TEXAS

Material Selection Based on Conditions

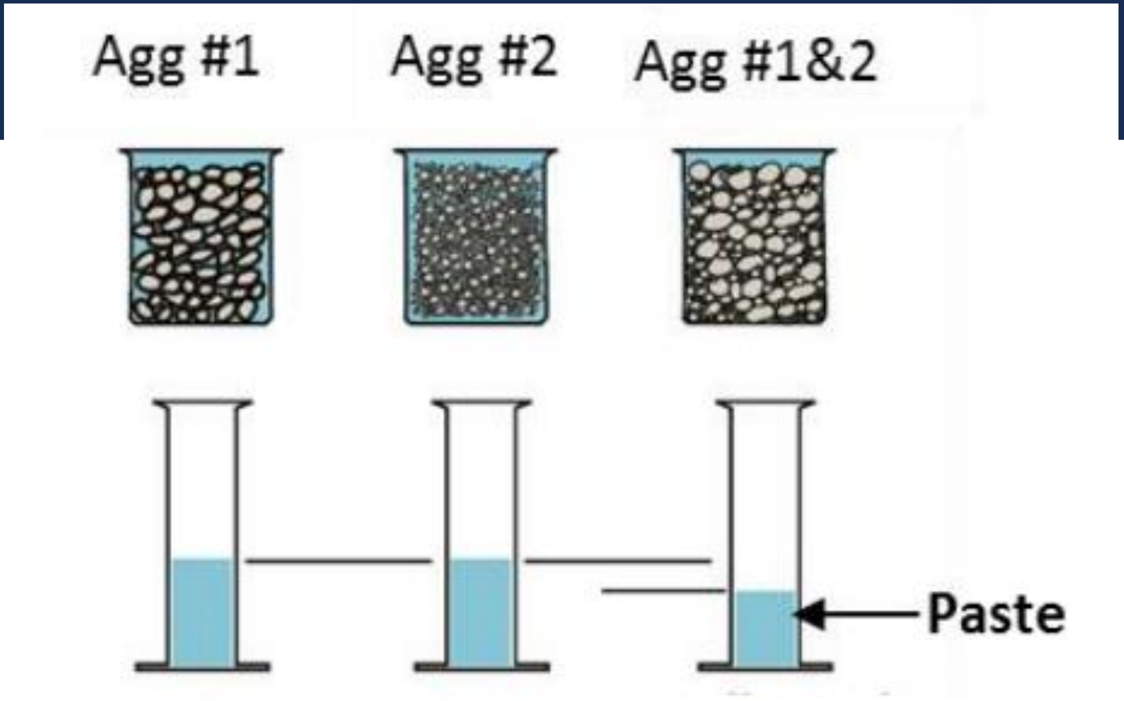
- Sustainable Material Options
  - PLC or other blended cements
  - Supplementary Cementitious Materials (SCMs)
  - Recycled Concrete Aggregates (RCA)
  - Admixtures
- Traffic
  - High vs low
- Environmental Factors
  - Freeze-thaw cycles
  - Hot vs cold



CEMENT COUNCIL OF TEXAS

Optimized Mix Design

- Durability
- Workability
- Sustainability
  - Reduce paste content (cement)
- Economical
  - Lowest material costs



Long-Term Maintenance Strategy

- JPCP
  - Plan for routine joint resealing and potential slab replacement in areas of severe cracking or faulting.
- CRCP
  - Design for minimal maintenance – monitor for punchouts and spalling.
    - Optimize reinforcement design
    - Ensure strong foundation support
    - Use durable concrete mix designs

CEMENT COUNCIL OF TEXAS

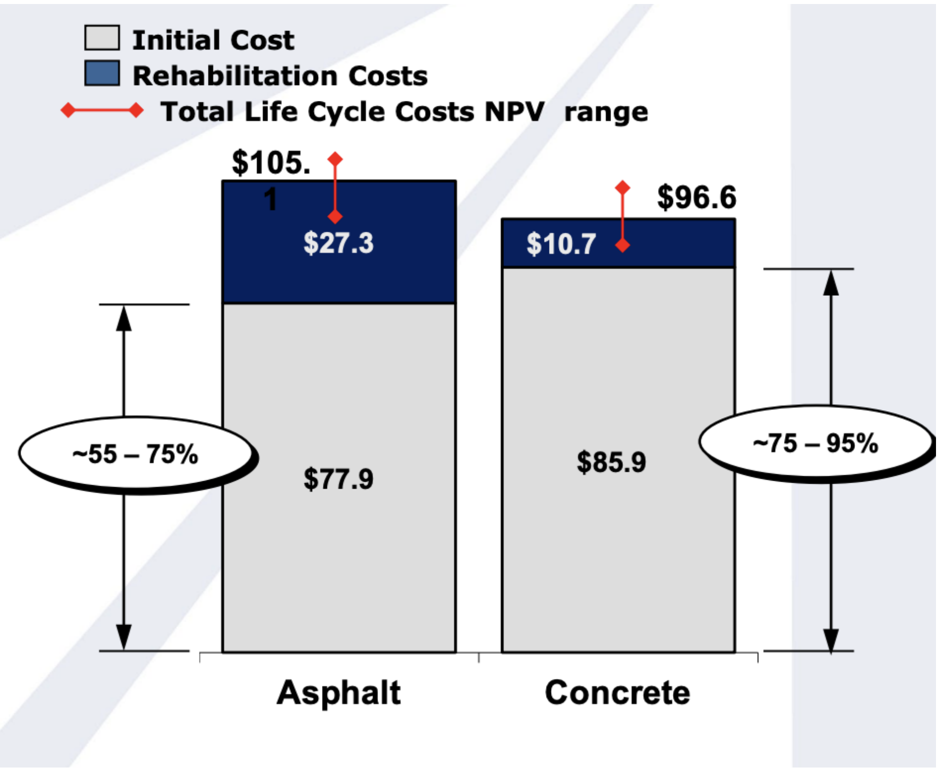
Long-Term Maintenance Strategy – cont.

- Design with **life-cycle cost** in mind, including long intervals between required maintenance.
- Use **surface texturing** to maintain skid resistance and manage noise performance over time.

CEMENT COUNCIL OF TEXAS

Why Bother with LCCA?

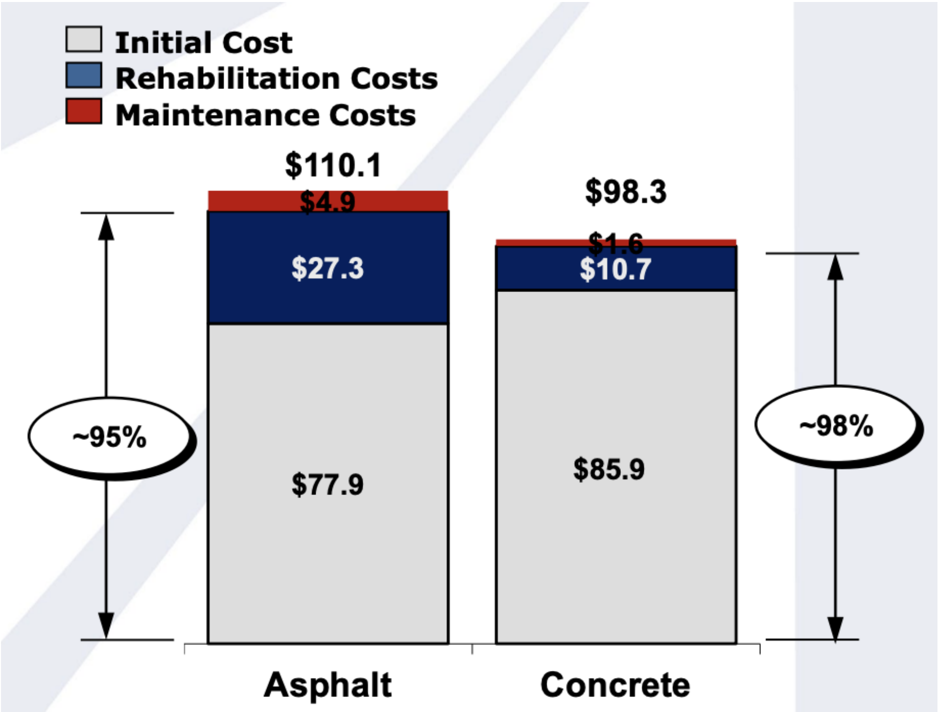
- LCCA compares different options for a given project and determines which pavement design is most cost effective over the analysis period.
- Initial costs account for 55-75% for Asphalt 75-95% for Concrete
  - Depends on initial designs, rehabilitation activities, rehabilitation timing, discount rates, etc.



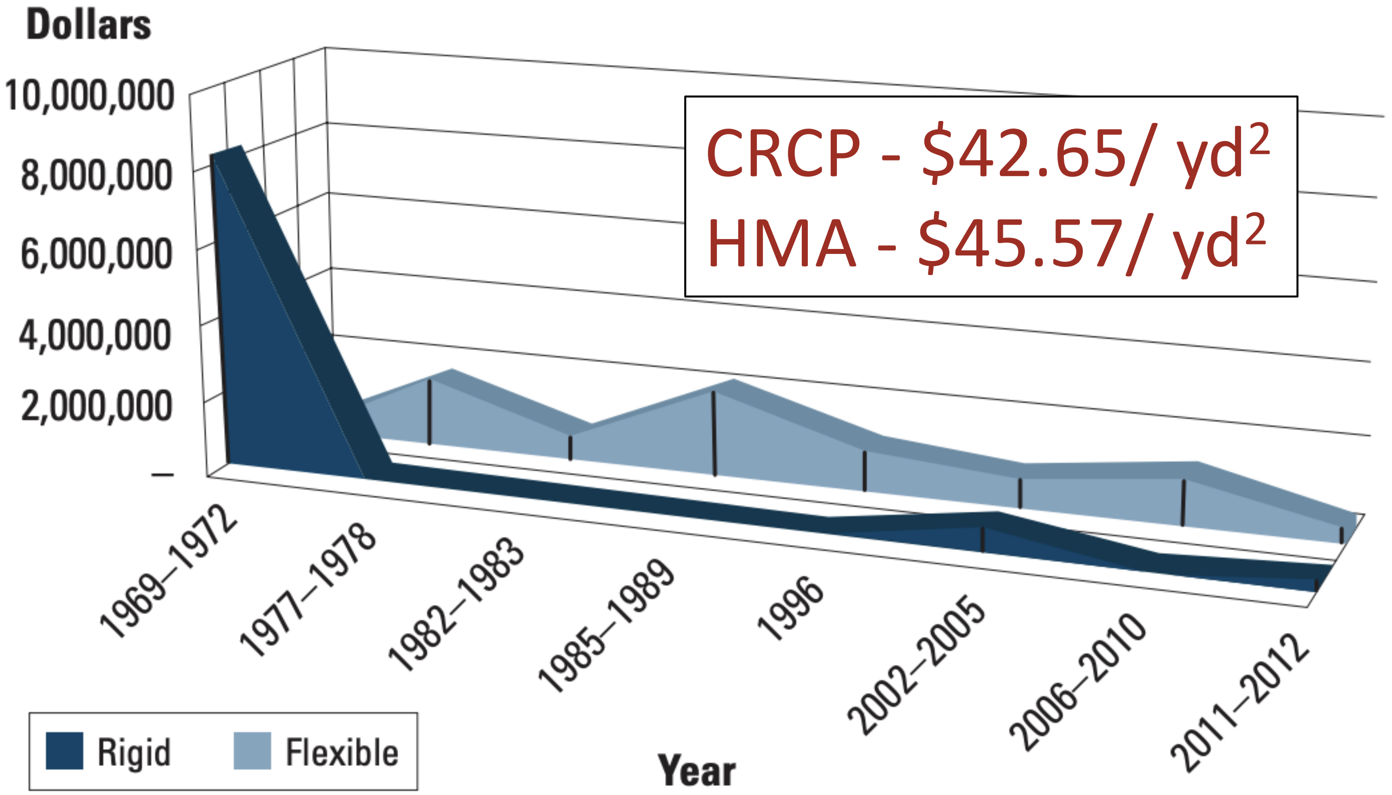
CEMENT COUNCIL OF TEXAS

Why Bother with LCCA? – cont.

Cost Phase	Asphalt	Concrete
Initial Cost	55-75%	75-95%
Rehabilitation Costs	25-45%	5-25%
Maintenance Cost	~5%	~2%



Wichita Falls District, TxDOT - CRCP vs HMA LCCA



CRCP - $42.65/ yd^2
HMA - $45.57/ yd^2

Key Summary Points

- **Design Factors**:
  - Concrete pavements must balance long-term durability, traffic, and environmental factors.
  - Pay more attention to the foundation layers. Consider soil stabilization and CTB where feasible
- **LCC/LCCA**: Though concrete pavements can have a higher upfront cost compared to asphalt, their longevity and reduced maintenance needs make them more cost-effective over time.

CCT CEMENT COUNCIL OF TEXAS

These are NOT equal!