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FAA WORKING GROUP MEETING

EXTENDED SERVICEABILITY LIFE FOR AIRPORT PAVEMENTS

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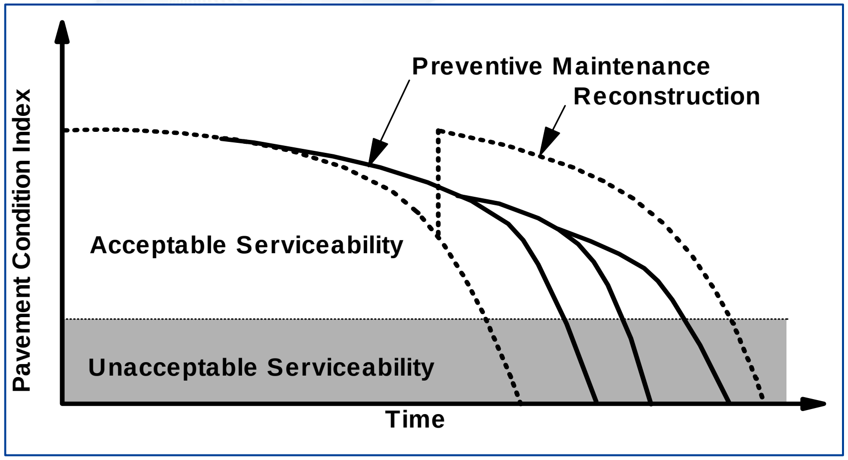
An Employee Owned Company

Objective of Presentation

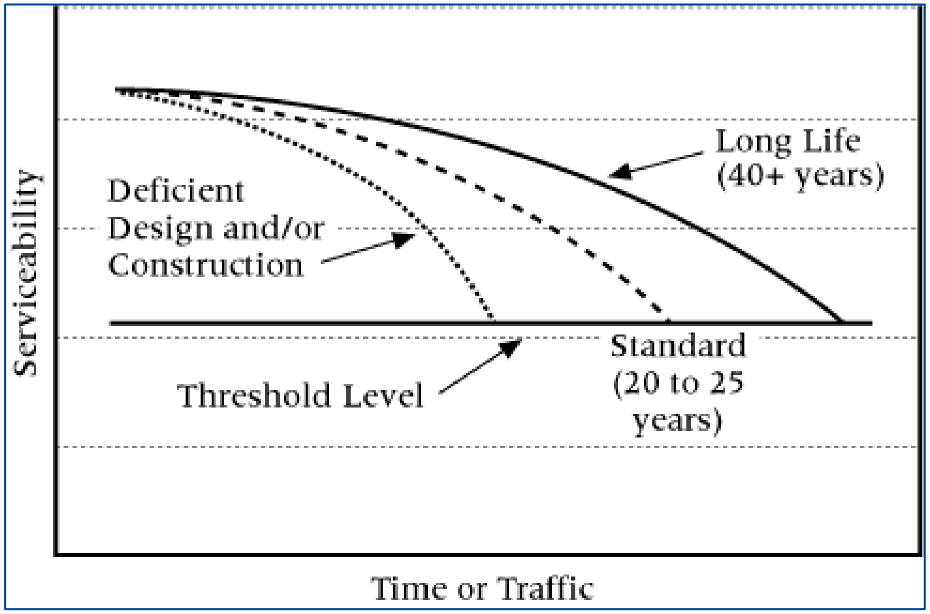
- **Discuss issues relating to extended pavement life**
  - How can pavement service life be extended beyond the current 20-year design life?
- **Items Related to Longer Pavement Life**
  - Design Thicknesses
  - Subsurface Drainage
  - Traffic Operations
  - Climate
  - Durability (Quality of Materials)
  - Plans and Specifications
  - Construction Processes
  - Quality Control/Quality Assurance
  - Maintenance Practices

Concept of Longer Service Life



- Pavements deteriorate with time through development of a range of distresses
- Pavement life can be extended with proper maintenance
- Deterioration ultimately reaches a level of unacceptable serviceability

- Current FAA design is typically for a 20-year pavement life
- Some pavements last longer than 20 years while others fail prematurely
- What factors impact extended pavement service life?



Design Thicknesses

- **Structural Thickness is Key to Providing Load Support**
- **What is Adequate Thickness for 40-Year Life?**
  - Theoretical analysis with FARFIELD
  - Performance Data from NAPTF and In-Service Pavements
- **Design Models Must Represent Performance**
- **Design Inputs Must be Clearly and Accurately Defined**
- **Non-Uniform Conditions May Produce Failures**
- **Changing Conditions Due to Climate and Traffic Must be Considered**

Design Thicknesses

Rigid Pavement Design Issues

- PCC Surface Layer Spreads Load Stresses
- Tensile Strength of PCC Must Be Greater Than Applied Tensile Stress
  - Subgrade Support (over life expectancy)
  - Tensile Strength of PCC
  - Traffic Load Distribution (over design life)
  - Load Transfer at Joints
  - Climatic Factors

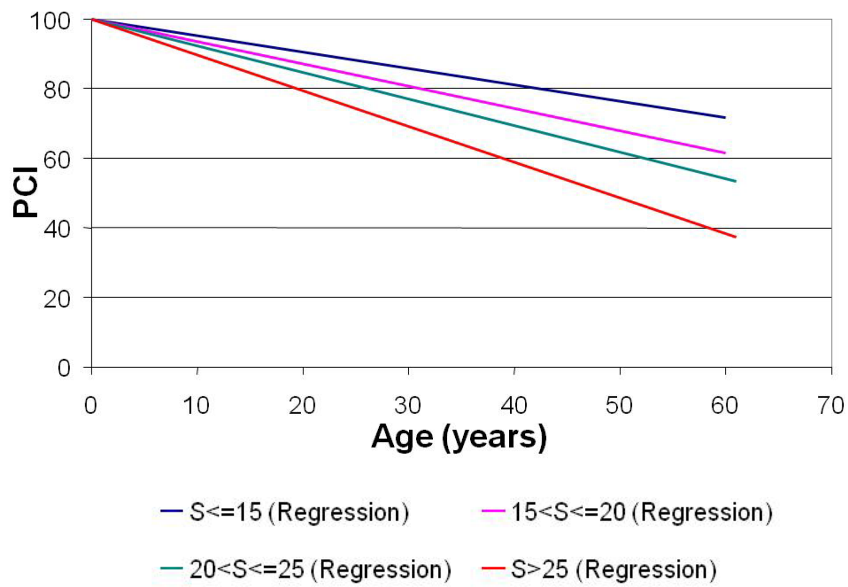
Flexible Pavement Design Issues

- Structural Layers Distribute Load and Protect Subgrade (from shear failure)
- Layers Consecutively Stronger from Subgrade to Pavement Surface
- Design for Lowest Expected Subgrade Strength (soaked CBR?)
  - Subgrade Strength
  - Traffic Load Distribution (over design life)
  - Quality of Pavement Layers
  - Climatic Factors

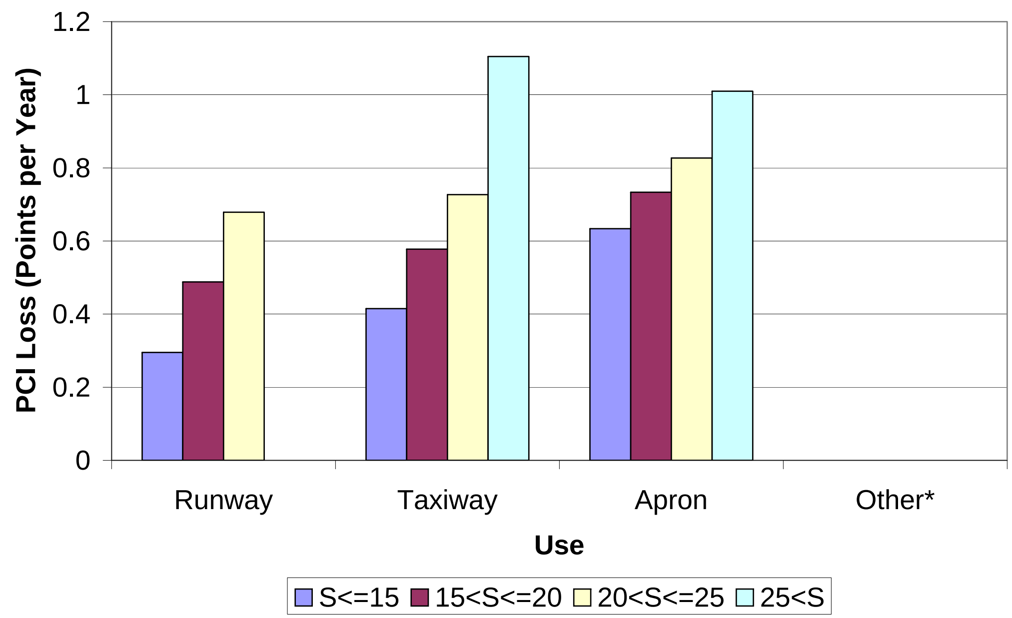
Geometrics of PCC Slabs

- **Joint Spacing Related to Cracking**
  - FAA Currently Recommends Maximum of 20 ft Joint Spacing
  - Performance function of climate, concrete aggregate type, slab thickness
- **Warping and Curling Stress**
  - Higher on Stiffer Subgrades
  - Higher Stresses on Larger Slabs
- **Early Age Cracking**
  - Some Effect From Slab Dimensions
  - Impacted by High Flexural Strength and Rapid Rate of Strength Gain
  - Affected By Weather Condition During Construction
  - Influenced By Type of Cementitious Materials

Joint Spacing Impacts Performance



- **Large Slabs May Result in Cracks That Impact Performance**

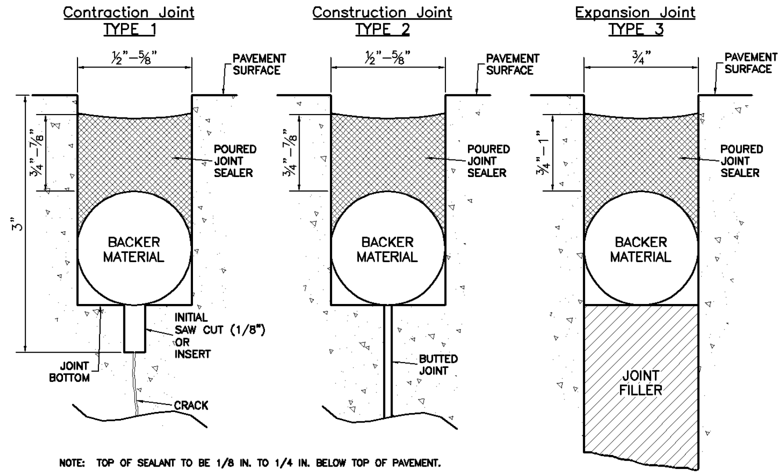


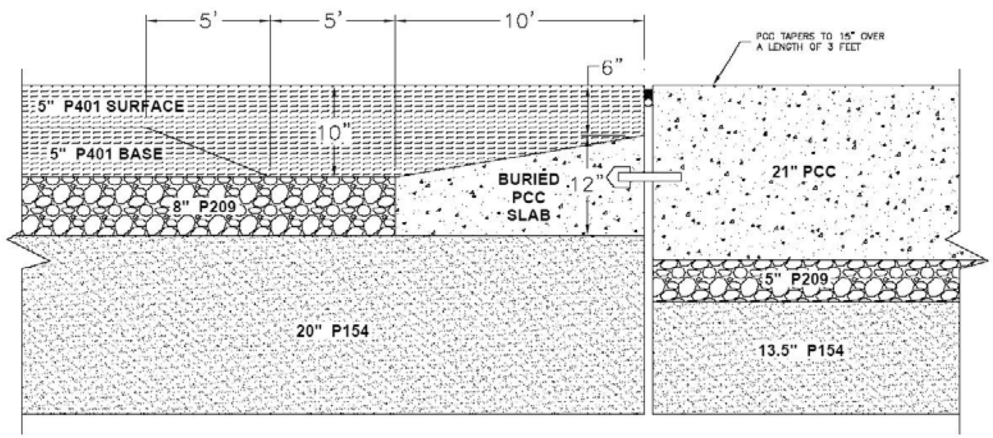
Joint Design and Load Transfer

- **Joint Design Determines Load Transfer**
  - Design typically assumes 75% load transfer
  - Aggregate Interlock Reduced When Slabs Shrink (curing and cold weather)
  - Shorter Joint Spacing Ensures Higher Load Transfer
- **Joint Types**
  - Construction Joints – Typically Doweled
  - Contraction Joints – Doweled or Undoweled
  - Expansion (Isolation) Joints
- **Doweled Joints – both directions?**
  - Military Airfields Dowel Only Longitudinal Joints on Runways and Taxiways
  - Aggregate Interlock Adequate for Transverse Joints on Taxiways and Runways?

Joint Design and Load Transfer

- **Beveled Edges**
  - Prevents Minor Edge Spalling (Sliver Spalls)
  - Improves Joint Performance
- **Joint Sealant Selection**
  - Hot Poured
  - Cold Poured
  - Preformed
  - Correct W/D Ratio for Sealant
- **Junctures Between AC and PCC**



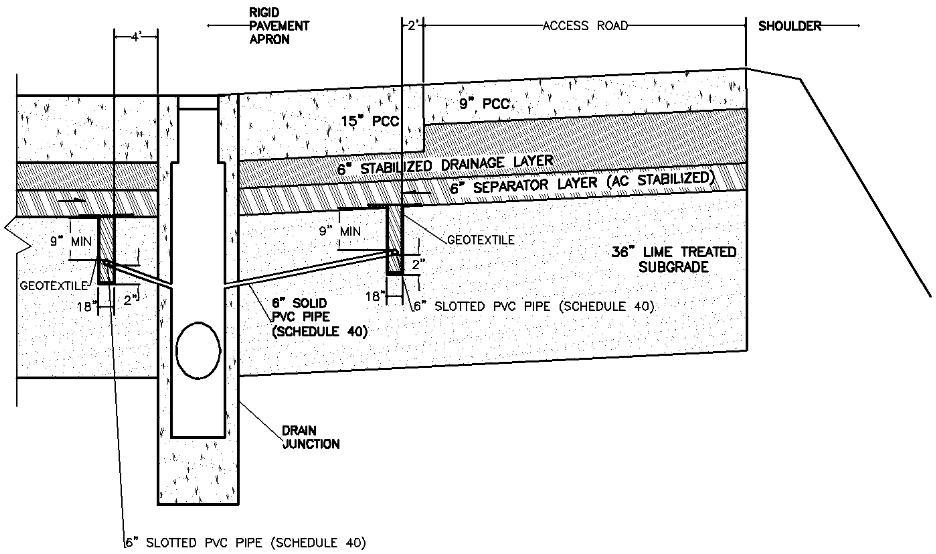


Subsurface Drainage

- **The old adage "water, water, and water" (Harry Cedergren)**
- **Subgrades naturally increase in moisture**
  - Reach approximately 85 to 90 percent saturation after 3 years
  - Equilibrium moisture tends to be near Plastic Limit
  - Free water can reduce subgrade support (to 100% saturation)
  - Loss of subgrade support leads to structural distresses

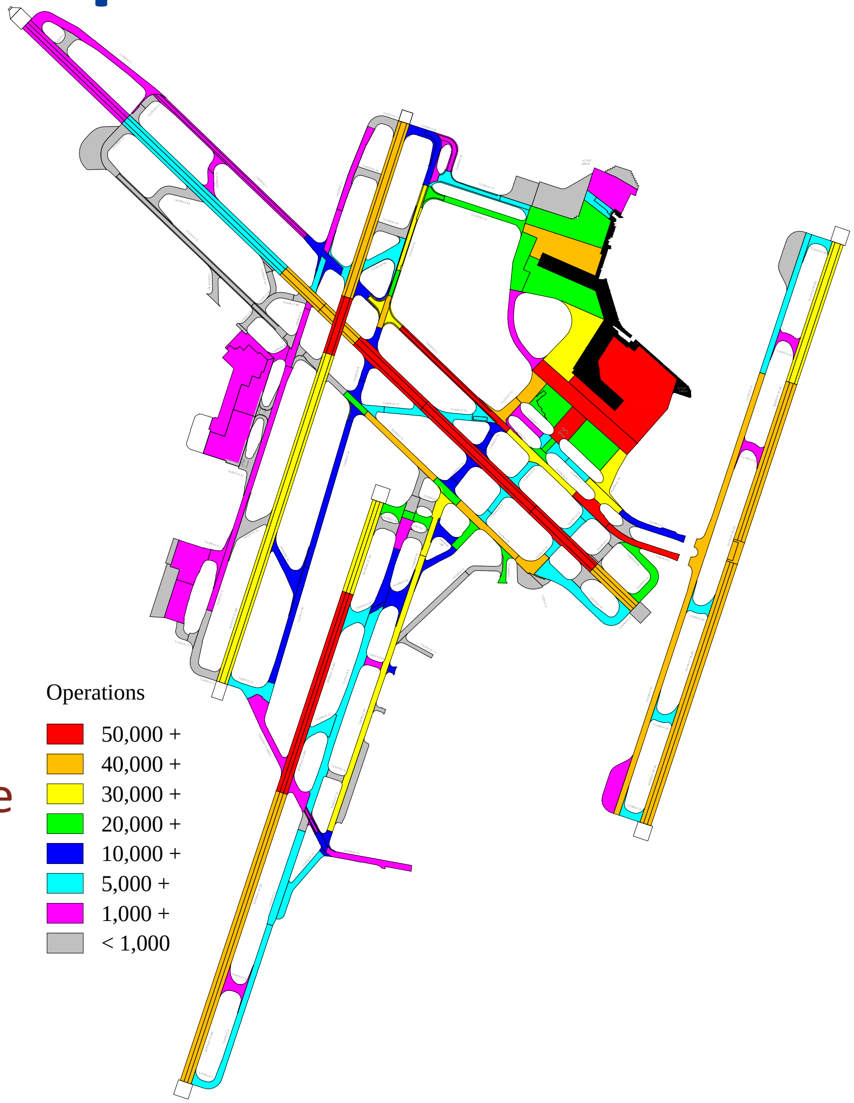
Subsurface Drainage

- **Subsurface drainage systems remove free water**
  - Water infiltrates into pavement structure
  - Design for permeability of 1,000 fpd
  - Typical Design to Remove 85% Free Water in 24 Hours
  - Separation Layer Prevents Migration of Subgrade Fines Into Drainage Layer
- **No official FAA guidance on subsurface drainage**



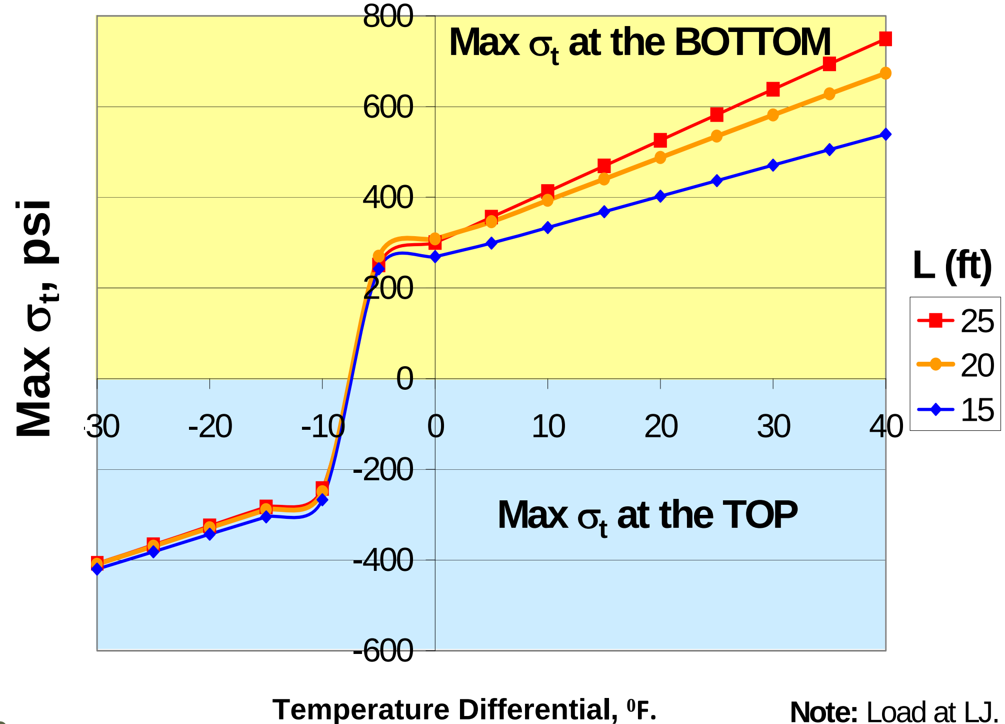
Traffic Impacts

- **Aircraft Variables**
  - Aircraft Types
  - Gross or Operating Loads
  - Annual Operations
- **Traffic Distribution**
  - Operations on Each Airfield Feature
  - Take-off and Landing Directions
- **Lateral Wander**
  - Based on studies in 1970's
- **Design for Actual Traffic**
  - Expected Traffic Over Life of Feature
  - What Traffic after 20 Years?



Climate Impacts

- **Climatic Zones**
  - Wet Freeze
  - Wet No-Freeze
  - Dry Freeze
  - Dry No-Freeze
- **Design for Freeze-Thaw (not well understood)**
- **Design Methodology Should Consider Impacts of Climate**
  - Daily Temperature Differentials
    - Large Differentials Produce High Warping Stresses
  - Seasonal Variations in Structural Support
  - High Moisture During Spring Thaw



Note: Load at LJ.

Durability of Materials and Mixes

- **Durability Related to Quality of Materials**
  - Likely Biggest Issue for Long-Term Performance
  - Specifications Must Address Material Quality
- **Mix Designs**
  - Quality Mixes (PCC, AC, Stabilized Materials) Critical to Long-Term Performance
  - Responsibility of Contractor versus Owner Developed Mix Design
  - PG Grades and Polymer modified asphalts improve temperature susceptibility and increase shear strength of Asphalt Mixes
  - Concrete Mix Designs for Workability and Coarseness
  - Must Consider Alkali Silica Reaction and other Detrimental Reactions
- **Aggregate Sources versus Specifications**
  - Quarry with History of Quality Aggregate Production
  - Quality Sand
  - Limit Sand in Asphalt Mixes
  - Coarse Aggregate Impacts Performance

Plans and Specifications

- **Plans Must Reflect the Design**
- **Plans Show Contractor What is to be Constructed**
  - Details and Dimensions Important for Clear Understanding
- **Specifications Describe Requirements and Processes for All Aspects of Construction**
- **Plans and Specifications Must be Coordinated (not contradictory)**

Construction

- **Poor Construction Practices Major Cause of Early Distresses**
- **Variability versus Uniformity**
  - Subgrade
  - Material Quality
  - PC and AC Mixes
- **Poor Practices (Workmanship)**
  - Hand finishing PCC Resulting in Scaling
  - Segregation of Asphalt Mixes
  - And the list goes on ………..
- **Inadequate Equipment**
  - Mixing Plant Operations
  - Laydown and Placement
  - Finishing
  - Vibrators
  - Rollers
  - And the list goes on…………
- **Improved Specifications**
- **Warranties on Work**

Quality Control/Quality Assurance

- **Contractor Responsible for Quality Control of Construction**
  - Contractor Quality Control (CQC) Plan
  - Qualified QC Staff
  - Qualified CQC laboratory
  - Daily Reports on Production Quality
- **Owner Responsible for Quality Assurance**
  - Full-Time Inspection by Qualified Independent Source
  - Sampling and Testing to Ensure Compliance with Specifications
  - Survey Checks (Dimensions, locations, offsets, grade, etc)
  - Coordination with Owner and Contractor

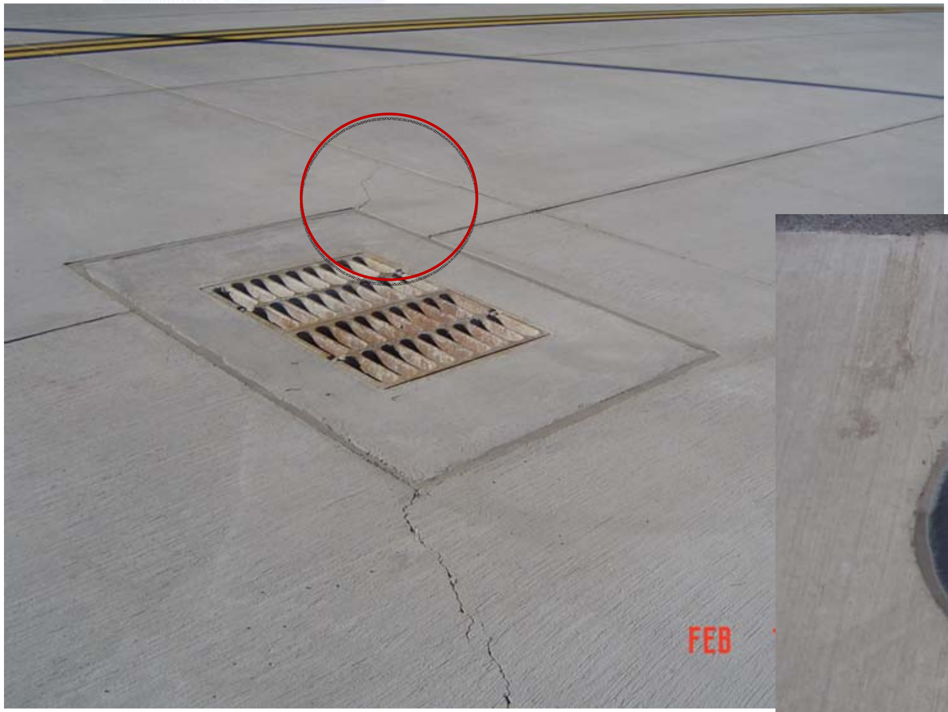
Improper Dowel Alignment/Spacing

Contractor Boo -Boos

Construction of Asphalt Pavement

- Mix Properties Critical
- Poor Compaction of Longitudinal Joints Results in Raveling & Cracking

Light Fixtures and Drainage Structures



Effective Maintenance

- **Timely Maintenance Retards Rate of Deterioration**
- **Rigid Pavements**
  - Timely Spall Repairs
  - Effective Patching Materials
  - Crack Sealing
  - Joint Resealing
  - Slab Replacements
- **Flexible Pavements**
  - Crack Seals
  - Patches
  - Mill and Overlay
- **Surface Characteristics**
  - Friction – Rubber Removal, Polishing Aggregates
  - Grooving
  - Roughness

Summary

- **Extended Service Life Can Be Achieved**
- **Identify and Understand Critical Performance Parameters**
  - Design Aspects – Thickness, Joints. and other Details
  - Traffic Demands – Current and Future
  - Durability – Material Quality, Mixes, Uniformity
  - Climatic Impacts
  - Quality Construction – QC/QA
- **Long-Life Airfield Pavements Require "Best Practices" in All Aspects of Design, Materials Selection, Formulation of Mixes, and Construction**
- **FAA Initiative for 40-Year Life Studying Performance Parameters from Runways Across the US**