Evaluating Effect of Preservation Treatments on Pavement Performance and Service Life

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Outline

- Background
- Performance measures
- Modeling the effects of preservation
  - Performance
  - Service Life
  - Life Cycle Costs
- Conclusions

Background

- Based on research conducted under NCHRP Project 14-33 to:
  - Identify and/or develop pavement performance measures that consider contributions of preservation to performance, service life, and life-cycle costs
  - Prepare guide document to facilitate implementation of measures by highway agencies

Background, Cont'd

- Preservation treatments are applied to:
  - Preserve an existing roadway
  - Slow future deterioration
  - Maintain and improve its functional condition
- No substantial increase to structural capacity of pavement

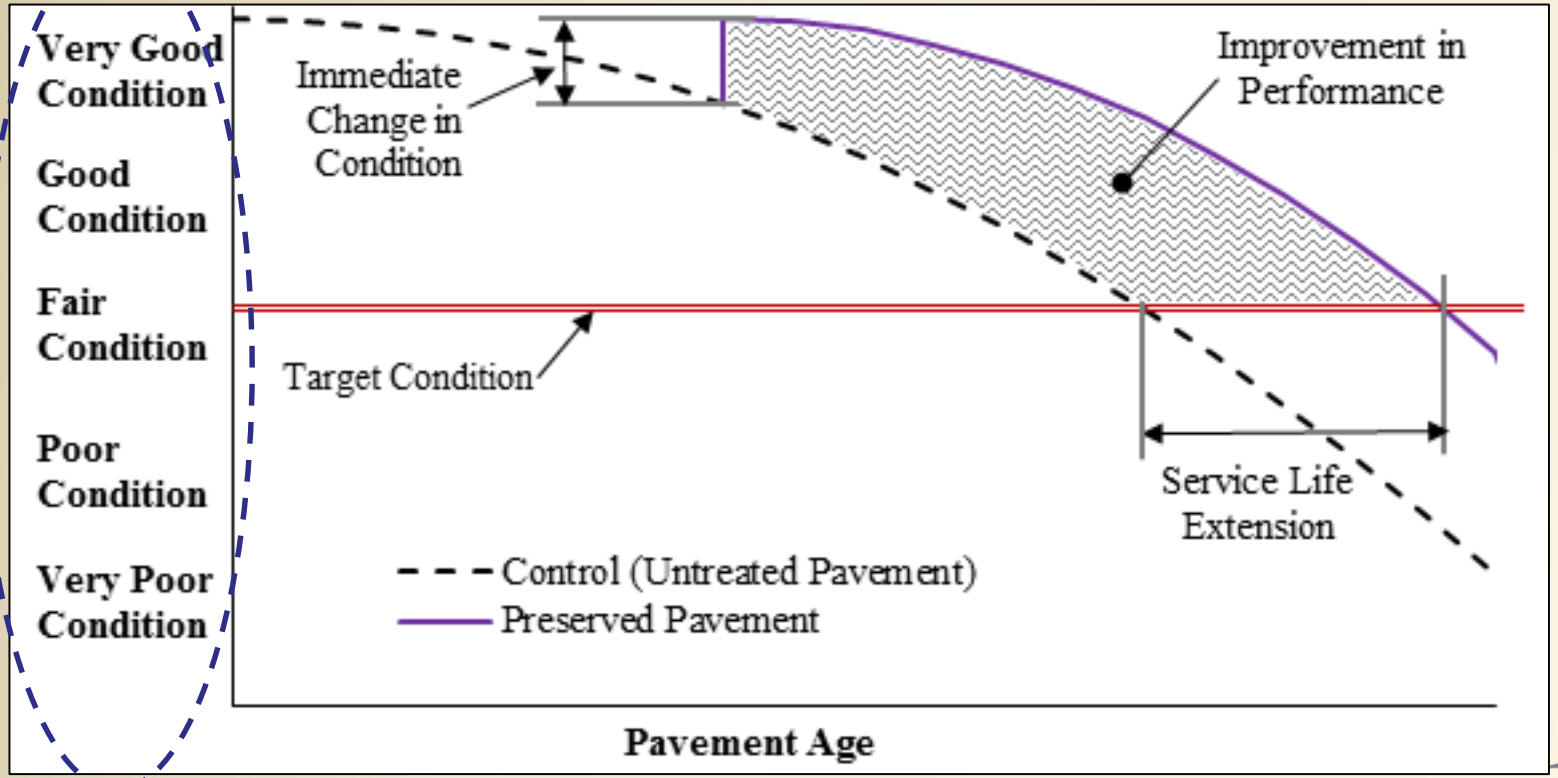
Performance measures provide means for assessing effectiveness of preservation

Background, Cont'd

- Considerable amount of literature
  - Mamlouk and Dosa (2014) show performance of chip seal is function of initial condition and climate
  - Carvalho et al. (2011) compared control and treatment sections from SPS-3 study in LTPP database
  - Pierce and Muench (2009) evaluated long-term effect of DBR in State of Washington

Data does exist to support performance evaluation (LTPP and State PMS)

Background, Cont'd



Performance Measures

Defined as:

Metrics that reflect degree of achievement of pavement asset towards meeting specific goals

- Evaluation of current condition of pavements
- Long-term trends in pavement condition
- Assessment of decisions made to achieve specific goals (e.g., minimize LCC)

Performance Measures, Cont'd

- Many measures in current use
  - Individual distresses
  - Composite indexes
  - Cost based
    - e.g., Asset Sustainability Index, etc.
  - Others
    - e.g., friction, Remaining Service Interval, etc.

Performance Measures, Cont'd

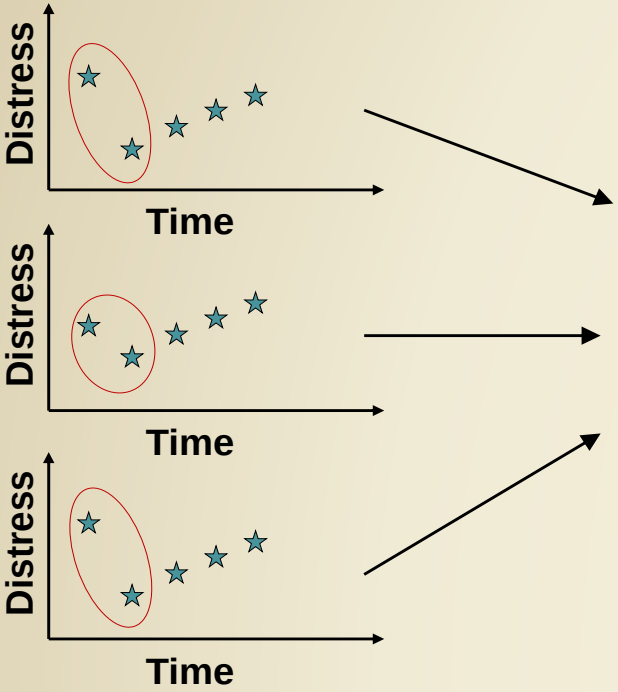
- For the purposes of this presentation
  - Demonstrate; cracking, roughness (IRI), rutting (AC) and faulting (PCC)
  - **Why?**
    - Measured by most agencies,
    - Required HPMS elements,
    - NPRM resulting from MAP-21
    - Captures many decision factors

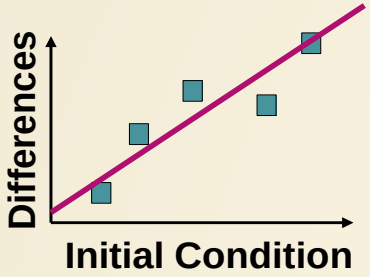
Modeling Effects of Preservation Treatments

- Assessed:
  - Immediate change in condition
  - Changes in performance
- Use data to assess effects of preservation on service life and LCC
- Data from State agencies and LTPP program will be presented

Modeling Effects of Preservation, Cont'd

Change in condition modeled as a function of initial values of performance measures



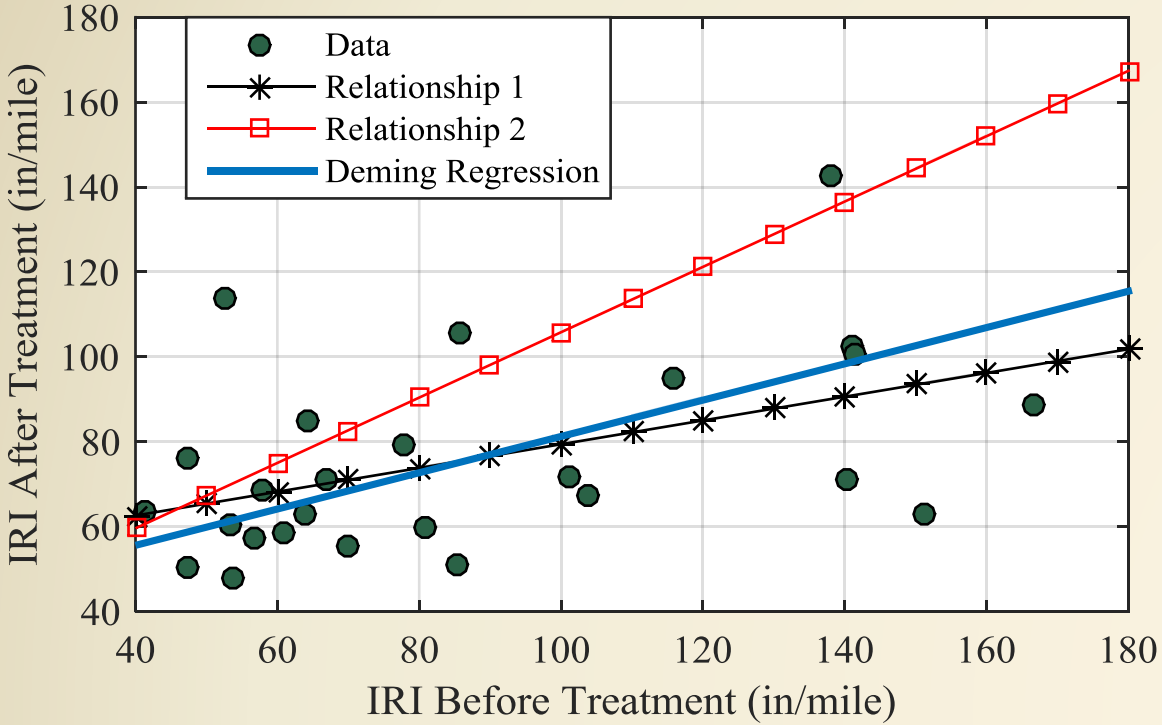


Considerable variance in both dependent and independent variables

Used Deming Regression to account for this

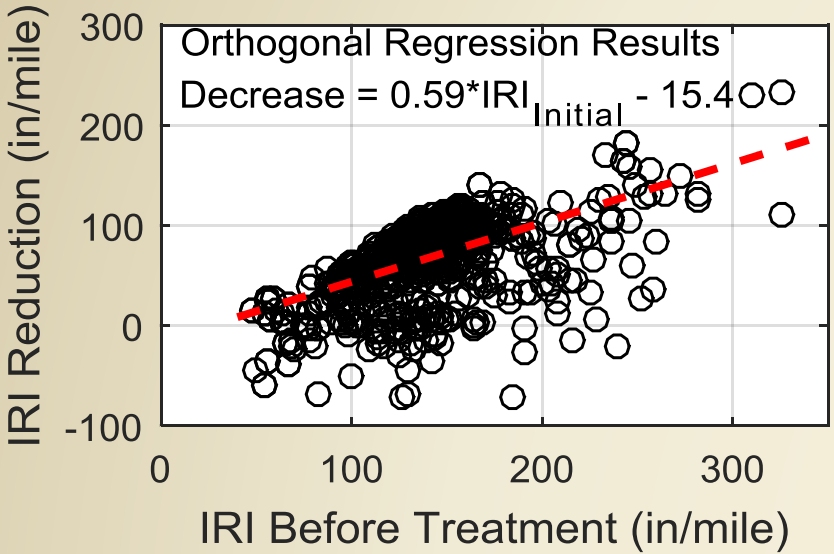
Modeling Effects of Preservation, Cont'd

Accounting for errors in condition data

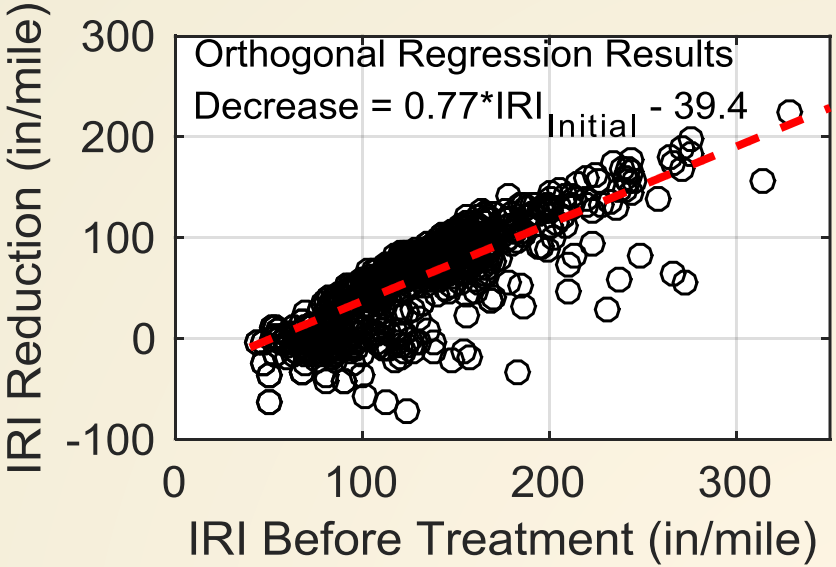


Modeling Effects of Preservation, Cont'd

Examples: assessing change in IRI



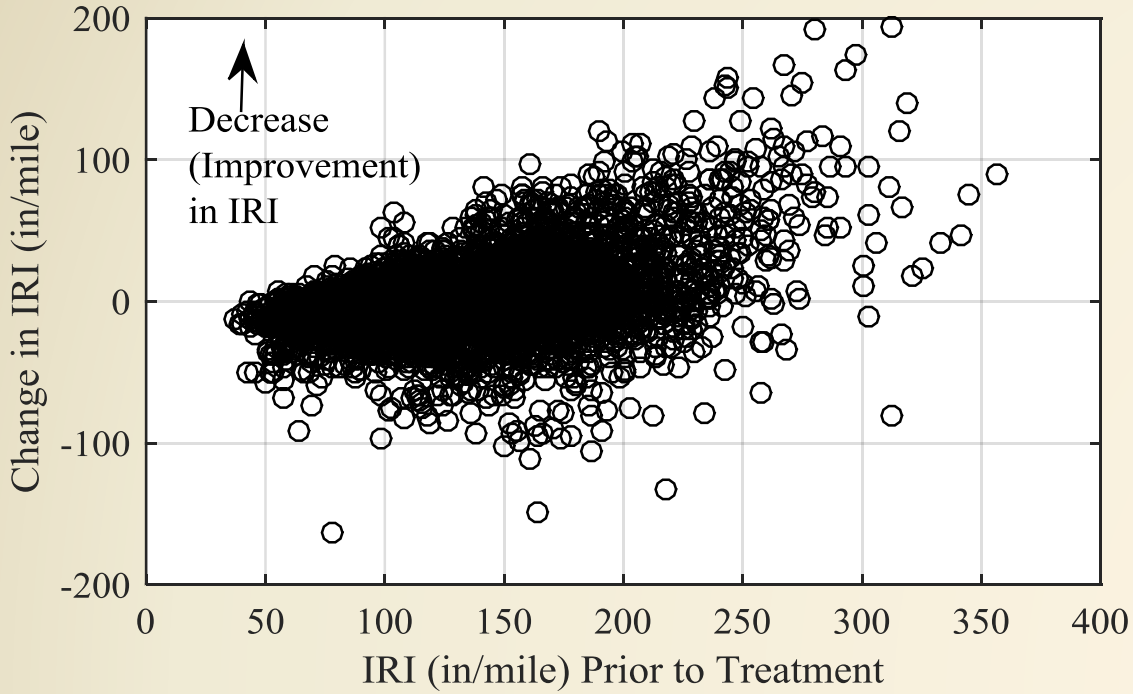
Diamond Grind



Diamond Grind W/ DBR

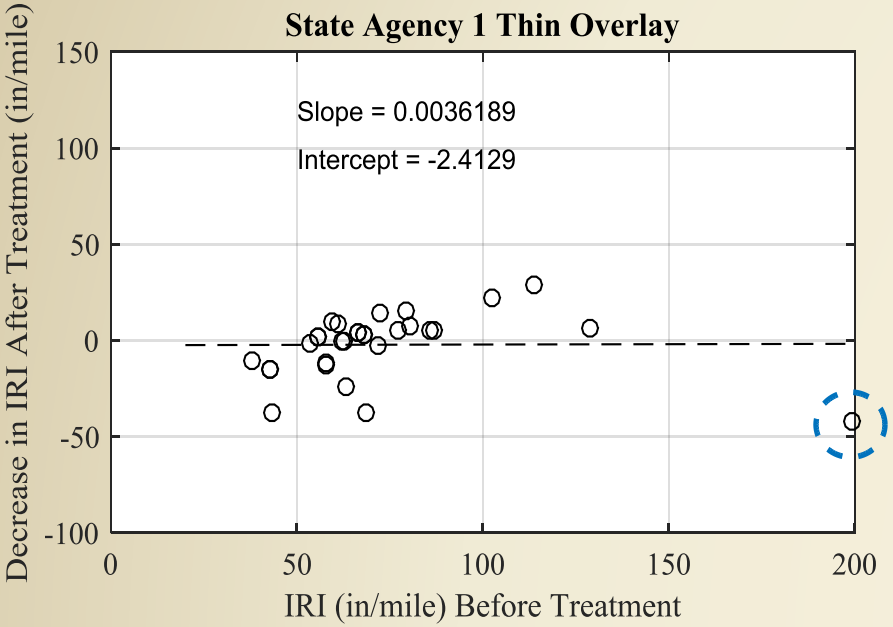
Modeling Effects of Preservation, Cont'd

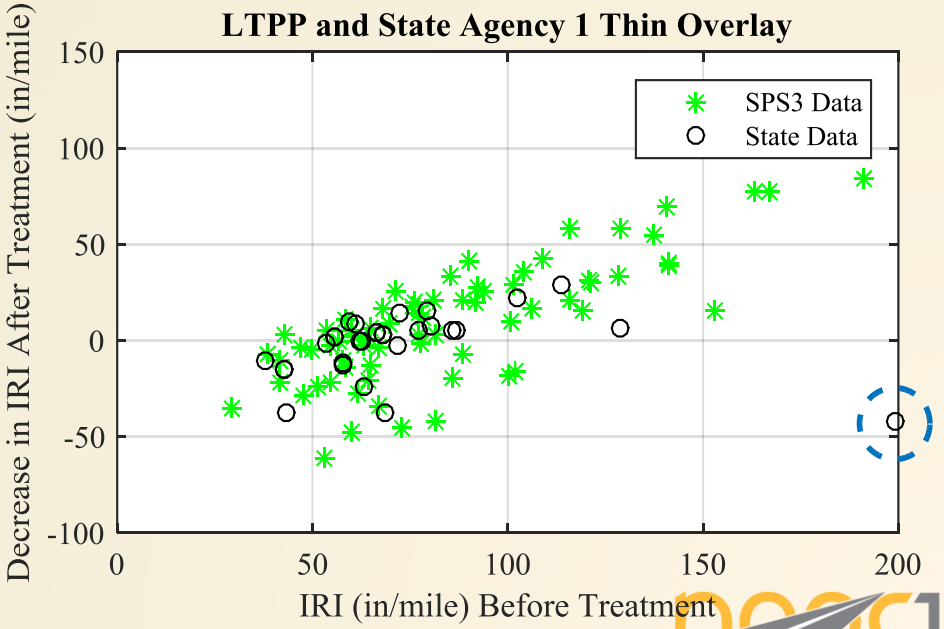
Examples: assessing change in IRI



Modeling Effects of Preservation, Cont'd

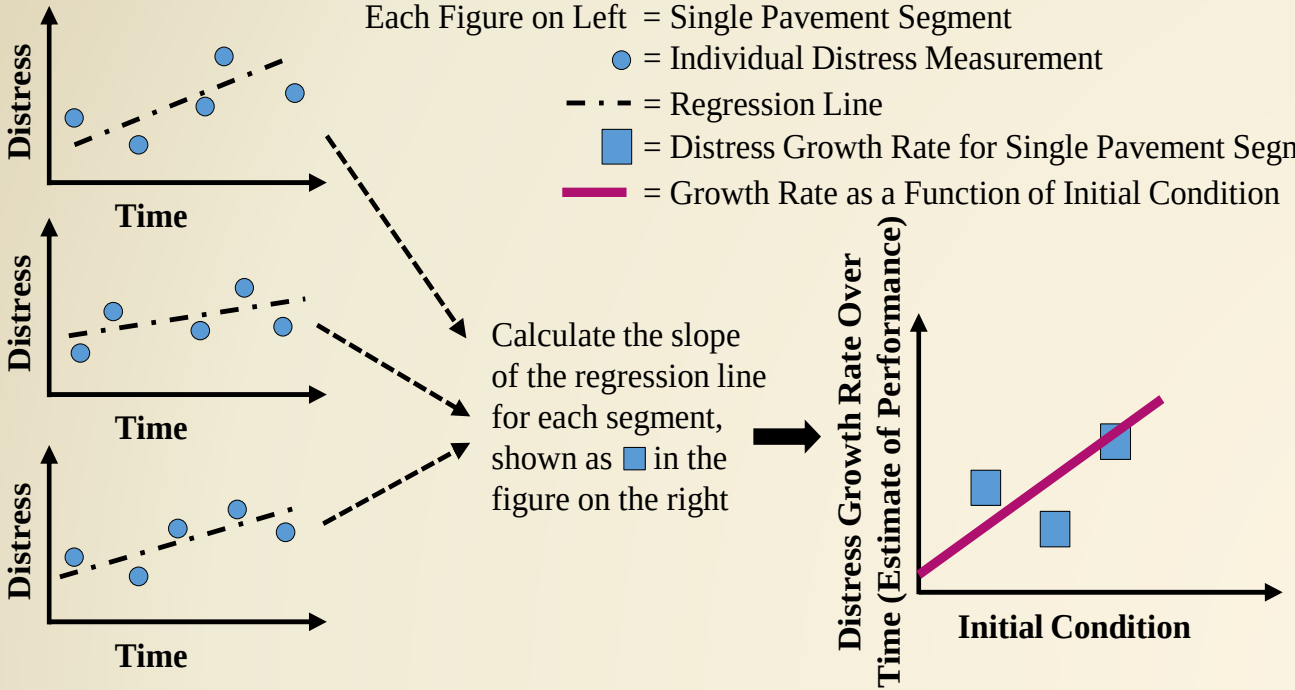
Effect of variance in data





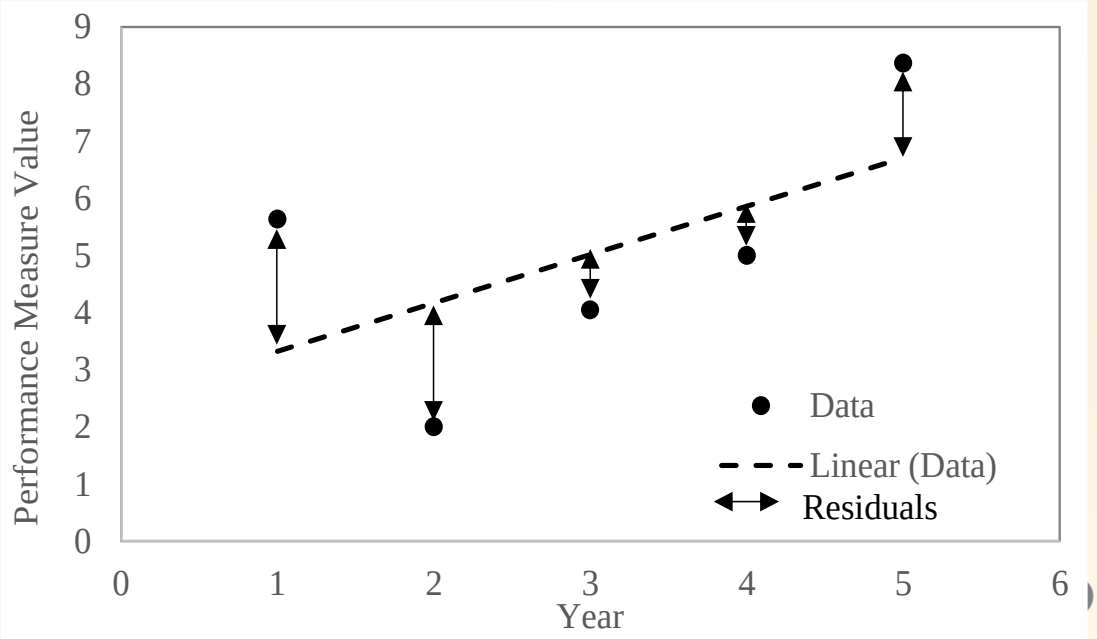
Modeling Effects of Preservation

Change in performance – function of many variables



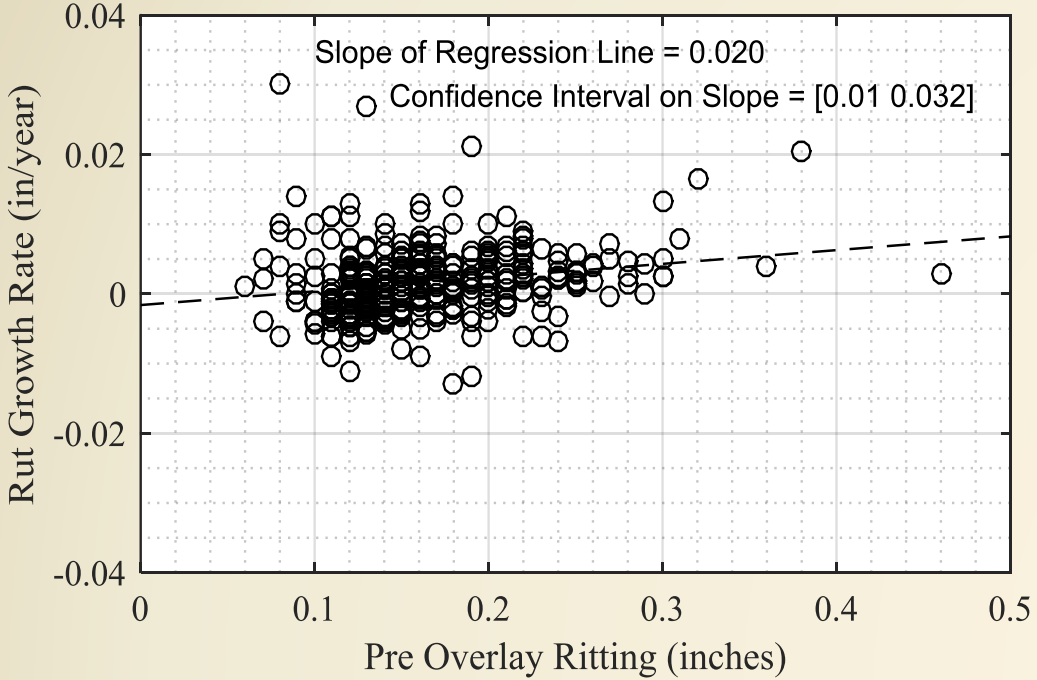
Modeling Effects of Preservation, Cont'd

- Robust regression used to model distress growth over time for each segment
  - Used to account for potential outliers



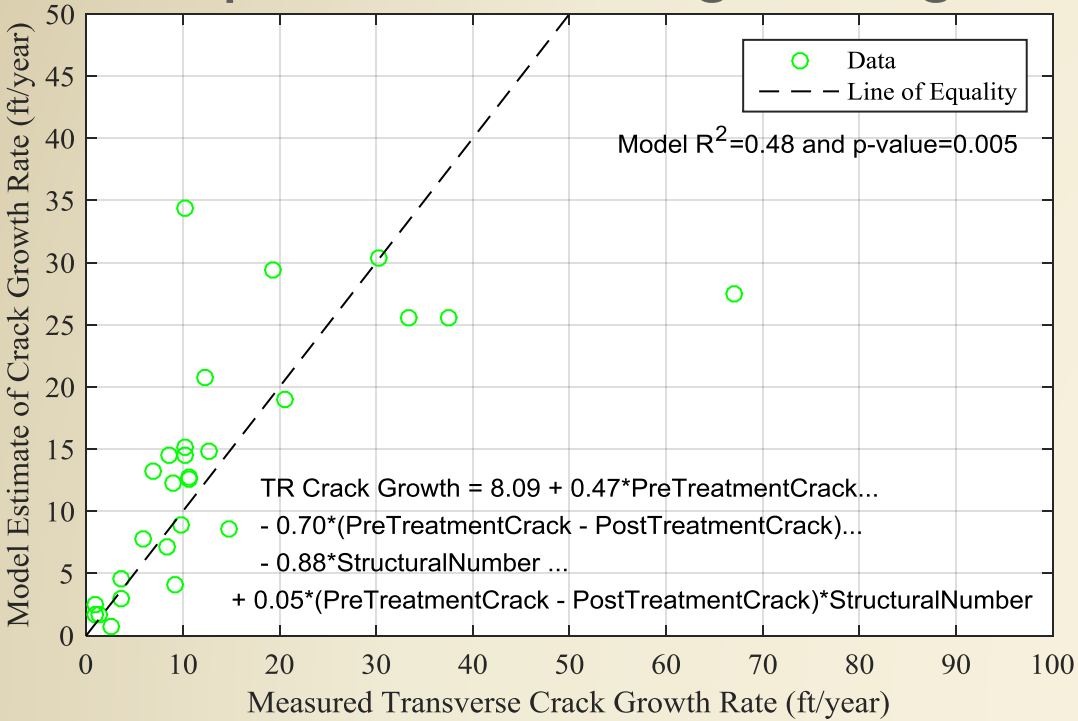
Modeling Effects of Preservation, Cont'd

Examples: assessing change in rutting performance



Modeling Effects of Preservation, Cont'd

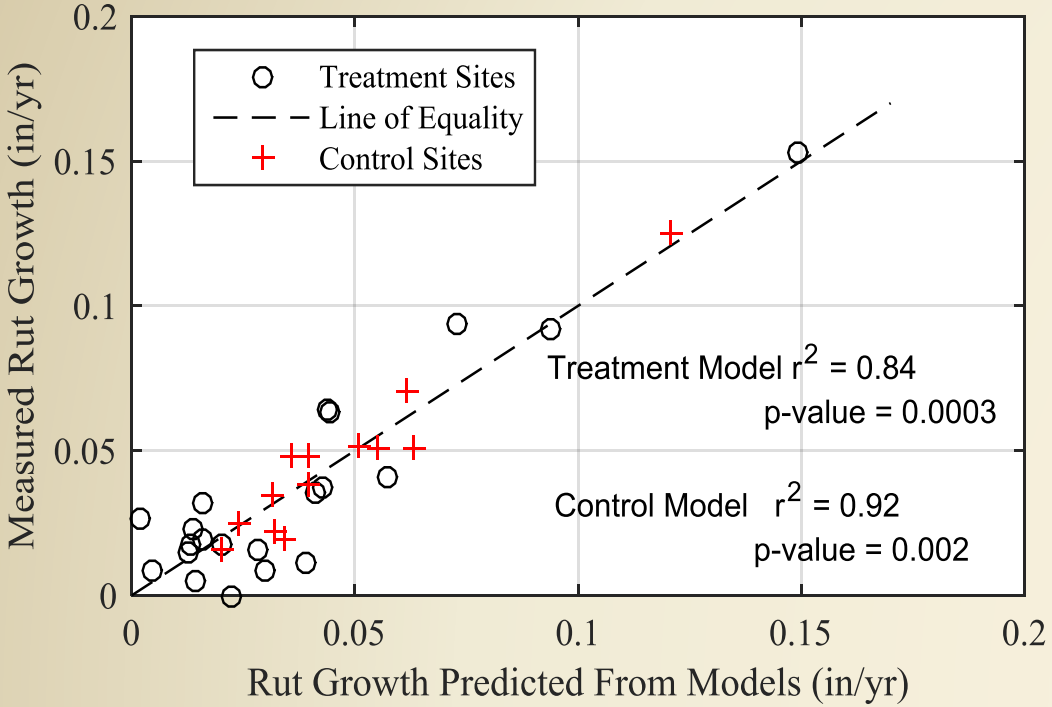
Examples: assessing change in performance



Transverse Crack Growth Rate as a Function of Many Variables

Modeling Effects of Preservation, Cont'd

Examples: assessing change in rutting



Rut Growth Rate Following Thin Overlay Using LTPP Data

Function of precipitation, freeze-thaw cycles, Average Temperature ESALS & Structural Number

Modeling Effects of Preservation, Cont'd

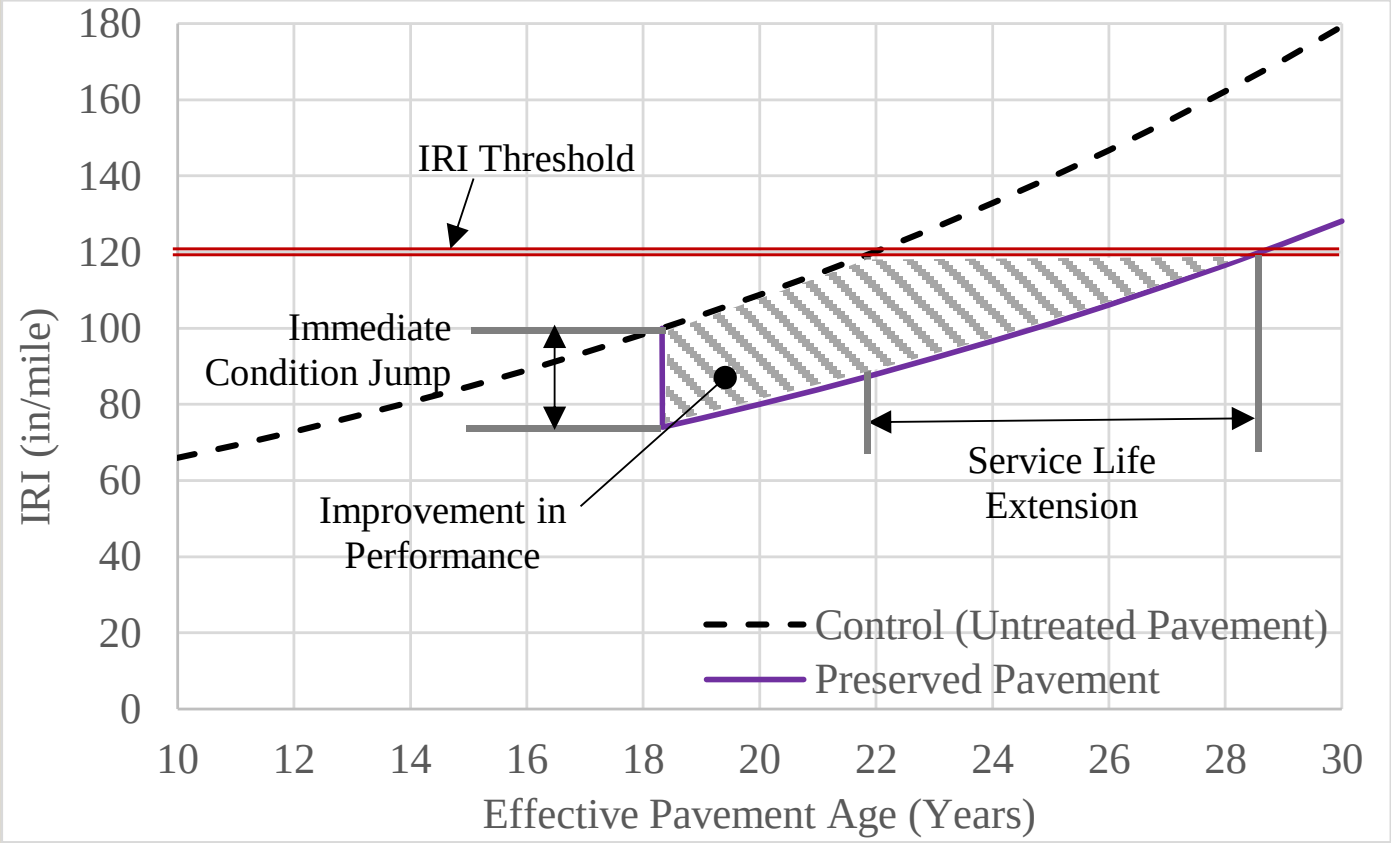
Pavement Type and Preservation Treatment	Roughness (IRI)		Cracking (at least one cracking Type)		Rutting	
	Initial Cond. Change	Long-Term Perf.	Initial Cond. Change	Long-Term Perf.	Initial Cond. Change	Long-Term Perf.
Asphalt Pavements						
Thin Asphalt Overlay	Both	LTPP	Both	Both	Both	State DOT
Chip Seal	None	LTPP	Both	Both	None	None
Micro Surfacing	None	DNA	Both	DNA	DNA	DNA

Modeling Effects of Preservation, Cont'd

- Changes in immediate condition and performance can be used to assess:
  - Effect of preservation on service life
  - Effect of preservation on life cycle costs

Example using State data to calculate change in service life and LCC following a thin overlay – using only IRI as performance measure

Modeling Effects of Preservation, Cont'd



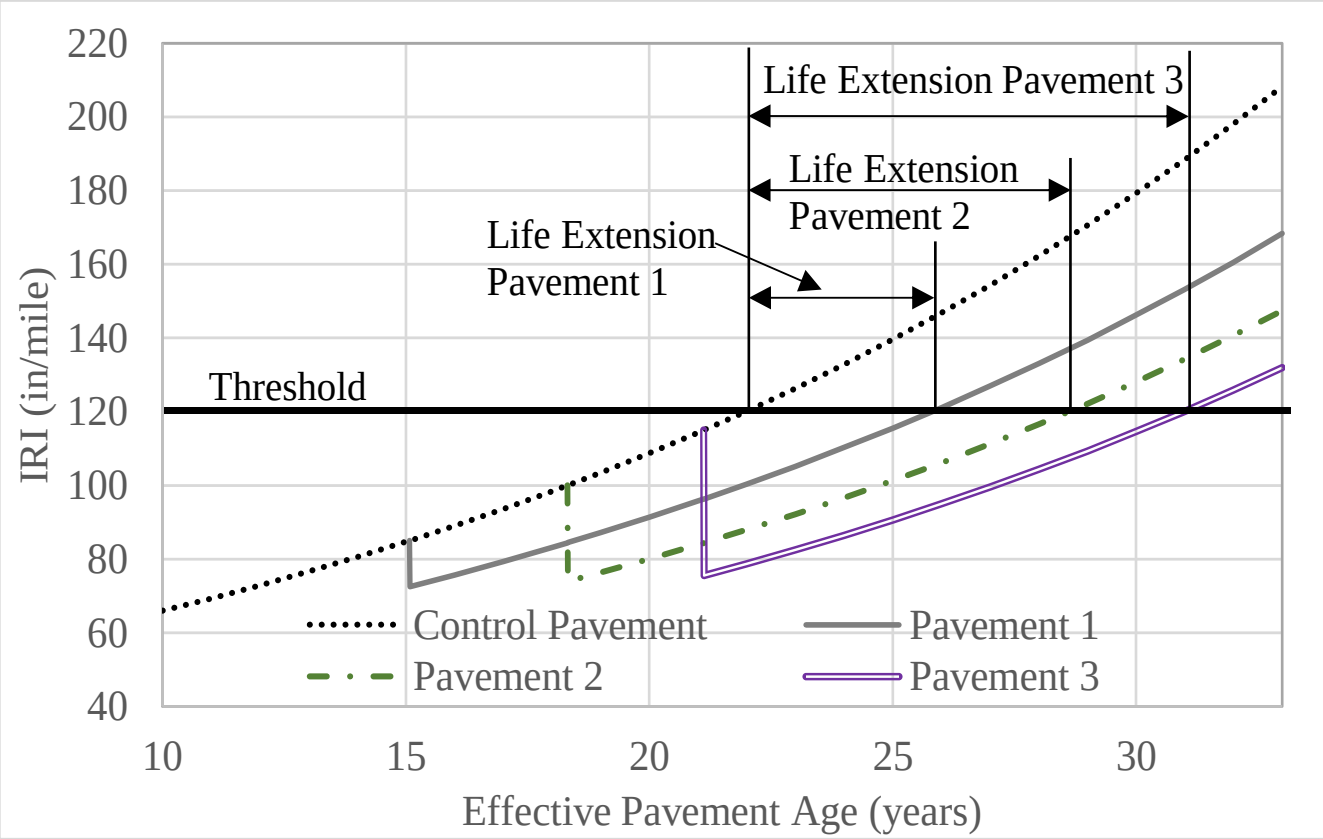
Modeling Effects of Preservation, Cont'd

- IRI performance model from agency

$$IRI(t) = 40e^{0.05t}$$

- Change in condition calculated using agency data
- No change in performance found from data
- Compare service life and equivalent annual uniform costs for 3 pavements with differing initial IRI values: 85, 100 and 115 in/mile

Modeling Effects of Preservation, Cont'd



Modeling Effects of Preservation, Cont'd

Initial IRI (in/mile)	Effective Pavement Age When OL is Applied (years)	IRI After Overlay (in/mile)	Effective Pavement Age After Overlay (years)	Effective Age When IRI of 120 in/mile is Reached	Life Extension (years)
85	15.1	72.5	11.9	25.9	3.9
100	18.3	74.0	12.3	28.9	6.7
115	21.1	75.5	12.7	31.0	9.1

$$EUAC = Cost\,\frac{r * (1+r)^t}{(1+r)^t - 1}$$

r = discount rate (3 percent)

t = analysis period (varies)

$$EUAC_{85} = \$20{,}715$$

$$EUAC_{100} = \$12{,}506$$

$$EUAC_{115} = \$9{,}577$$

Conclusions

- Many agencies collect and store data required to assess effectiveness of preservation. Other sources of data (e.g., LTPP) can be used to supplement agency data
- Analysis of pavement condition data requires techniques not traditionally in pavement literature
- Definition and implementation of performance measures, including development of models, are key steps for evaluating effects of preservation treatments

Thank You!

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