Pavement Uniformity Index

A METHOD TO EVALUATE PERFORMANCE UNIFORMITY FOR HIGHWAY PAVEMENTS
Iowa DOT Pavements

• 11,092 miles of “Primary” pavements (Interstates, US & Iowa Highways)
  ◦ Backbone of state transportation network (total of 115k miles including streets and county roads)
  ◦ Carries 63% of all vehicle traffic in the state
• Asset value - $14.2B
• 3,922 management sections
  ◦ Vary 0.1 mile up to 18+ miles
  ◦ Limits based on construction history
• Extensive section data available
Opportunity

Detailed data available
- Data collected every 1/100th mile (52.8 ft)
- 1M+ records each cycle
- 30+ attributes
- Typically aggregated to management section
- Data too dense to be used for most purposes
Project Goals

1. Dig into the detailed pavement measurements
2. Make something useful

I learned from talking to our engineers that it might be useful to gain an understanding of performance variability within management sections

I set out to create a Pavement Uniformity Index
Data

The easy part?
- Managed in DOT Oracle database
- Collected since late 1990’s

Used FME to obtain data
Section data - Excel
Quality questions
Data

Key Attributes
- Ride (IRI)
- Rutting
- Cracking
Exploration

Sampling

- Random sample of 392 management sections and their associated data (105,479 points)
- For some visualizations, subsamples were generated
Exploration
Exploration

Findings:

- Remove newer segments (0-2 years)
- Eliminate city segments (1,811 segments, 3,140 miles)
- All distresses have different scales
  - Rutting - 0.1 inch
  - IRI - inches/mi
  - Cracking - mix of length and area
- Some differences by pavement type (rigid, flexible, composite)
Pavement Types

Iowa DOT mix:
- Rigid (Concrete) - 33%
- Flexible (Asphalt) - 16%
- Composite - Asphalt over Concrete - 51%

Trivia Time - Iowa is unusual in having a high percentage of rigid pavements
Cracking

Four major types
- Transverse, Longitudinal, Wheelpath, Fatigue

Four classifications
- Low, Medium, High, Sealed

Variations depending on pavement type

Engineers say: \( \frac{L \times 2 + A}{\text{total area}} = \% \text{ Cracking} \)
Methods

Use Coefficient of Variation since

- SD often depends on mean value
- Scales all different

Formula: \( c_v = \frac{\sigma}{\mu} \)

- Calculated for EACH section
Index Calculation Method

Raw Score

\[ PUI_{\text{raw}} \begin{cases} \frac{c_v[IRI]+c_v[Crack\%]}{2}, & \text{Pavement Type} = \text{Rigid} \\ \frac{c_v[IRI]+c_v[Crack\%]+c_v[RUT]}{3}, & \text{Pavement Type} = \text{Flexible} \end{cases} \]

Final Pavement Uniformity Index value (PUI) on 1-10 scale

- Based on deciles of the empirical distribution of PUI_{raw}
- Highest 10% of all values have PUI score of 10
Results

Risk Matrix

- High Risk (red shading): 1,383 mi
- Medium Risk (yellow): 3,046 mi
- Low Risk (green): 3,522 mi

Provides information regarding level of investigation needed to design a treatment
Results

1. Aid in researching needs for a given segment
2. Use to help evaluate pavement deterioration models
3. Easily implemented in SQL - will be in “production” in near future
Future Work

1. Distribution of cracking percent by pavement type
2. Spatial component
3. Temporal component