Road Roughness versus Ride Comfort which Considers Road Users

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Outline

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• HPMS, PSR and IRI
• IRI Measures and Statistics
• Roughness Related to Panel Ratings
• Performance in Network Level Systems
• Considering the Road User in PMS
• Conclusions
Introduction

- Performance is of interest to everyone
  - Measured in schools
  - Measured at work
  - Increasing emphasis on performance in governing
  - Pavement performance is the foundation of pavement design since the 1960’s

- We contend that pavement performance must encompass the road user’s perception of serviceability
History

- Early road tests and design methods did not have consistent definitions for condition or failure of pavements
- Mr. Bill Carey and Dr. Paul Irick developed the means to measure pavement condition and performance
- The Serviceability-Performance concept
  - Supported the AASHO Road Test definition of failure
  - Key component of design used since 1962
  - Supported pavement load equivalency concepts
  - Defines pavement performance
Serviceability

• Five Assumptions by Carey and Irick
  – Highways are built for the comfort, convenience and safety of the travelling public
  – User’s opinions highway service are subjective
  – Objective measurements are directly related to the users subjective opinions
  – The “serviceability” may be expressed as the mean rating (evaluation) given by all highway users.
  – Performance is then defined as the serviceability history of a pavement.
Serviceability Ratings and Index

• The Present Serviceability Rating (PSR) is an estimate of the mean rating obtained by a user survey.

• The Present Serviceability Index (PSI) is an estimate of the PSR obtained by measuring critical characteristics of the road and correlating those measurements to the PSR.

• AASHO Road test initial equations found that PSR could be estimated by measurements of:
  – Roughness
  – Cracking and Patching

• Since that time PSI is generally computed only from measures of roughness.
Serviceability-Performance

Varies by class of road and traffic

PSI History

Area under Curve = Performance

Level of acceptability

\( \sum \text{Traffic or Time} \)
PSR, HPMS and IRI

- Original HPMS reporting required estimates of PSR for pavements
  - PSR estimates widely acknowledged to be poor
  - No original requirement for an objective PSI measure
- The International Roughness Index (IRI) was adopted as the HPMS reporting standard
- PSR/PSI has since faded as network condition rating and performance monitoring tool
- Relating roughness, however measured, to mean panel rating is no longer a common practice
IRI as a Condition Indicator

- IRI is derived from a simulated quarter car passing over a measured profile
- IRI is an open ended scale with condition categories that vary across agencies
- 5 categories often used to describe IRI

<table>
<thead>
<tr>
<th>IRI Category</th>
<th>WSDOT</th>
<th>FHWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>&lt;= 95</td>
<td>&lt;= 60</td>
</tr>
<tr>
<td>Good</td>
<td>96 - 170</td>
<td>61 - 95</td>
</tr>
<tr>
<td>Fair</td>
<td>171 - 220</td>
<td>96 - 120</td>
</tr>
<tr>
<td>Poor</td>
<td>221 - 320</td>
<td>121 - 170</td>
</tr>
<tr>
<td>Very Poor</td>
<td>&gt; 320</td>
<td>&gt; 170</td>
</tr>
</tbody>
</table>

Shaded areas deemed unacceptable
Mean Panel Ratings Related to Roughness Statistics

- Other efforts to relate roughness to MPR have occurred
- Janoff et.al. performed basic research into a Ride Number (RN)
  - Computed from measured profiles
  - Purpose was to estimate Mean Panel Ratings
  - Provided better estimates than IRI for MPR
  - Difficulty in computing RN for different lengths
Modern Network Level PMS Systems

- At a network level pavement management systems frequently separate “performance” from distress
- Distress deterioration controls engineering decision making
- Distresses impact the pavement leading to changes in performance over time
- Many practitioners have foregone utilizing PSI or Roughness to drive network level decision making
  - lack of connection between distress deterioration models and PSI for network level use
  - Roughness/PSI is seen as a lagging indicator and not suitable to be an analysis objective
PMS Concept

Inputs → Models → Behavior (deflection) → Distress → Roughness

Safety → Traffic

Costs → Ordered Set of Choices

Decision Criteria → Implementation

PERFORMANCE
Considering the Road User in PMS Systems

• Key Concepts must be considered
  – The purpose of the road as stated by Carey/Irick
  – Estimated user perceptions provide key to understanding highway performance
  – Analysis should utilize projections of performance as captured by the area or trend in PSI
  – Models needed, especially at the network level, that relate distress deterioration to projected pavement performance through roughness
  – Then ‘performance’ becomes a suitable analysis driver
  – Distress remains primary decision criteria
Conclusions

• The ‘serviceability’ and thus over time the ‘performance’ of pavements are a subjective quantity
• Objective measures relate to the user estimated serviceability and performance
• Further develop relationships between panel ratings and roughness measures
• Need to develop usable network level frameworks that relate deterioration/distress to pavement performance
• Meaningful ratings on a 5 point scale are a good communications tool to all, including legislators and the public
• PSI is a simple scale understood by all stake holders and over time a good measure of performance
Questions