Enhancements to Freeway Facilities Method in the HCM to Enable Reliability Analysis

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Presentation Outline

- Introduction
- Objective
- Enhancements
- Conclusions
Introduction

Source: SHRP2 - L08 Project Proposal
Objective

- Enhance the current HCM 2010 freeway facilities method to enable Travel Time Reliability.
Enhancements

1 - Under-Saturated Regime:

- Use Speed Adjustment Factor (SAF) and Capacity Adjustment Factor (CAF) to Model Sources of Variability.

- Consider **Segment Type** in Segment Speed Estimation for Non-Basic Segments.

2 – Over-Saturated Regime:

- Two-Capacity Phenomenon Incorporation:
Enhancements
Under-Saturated: Basic Segments Model Enhancement

HCM Equation 25-1:

\[ S = (FFS \times SAF) + \left[ 1 - e^{\frac{\ln((FFS \times SAF) + 1) - C \times CAF}{45}} \times \frac{v_p}{C \times CAF} \right] \]
# Enhancements

## Under-Saturated: Merge/Diverge Segments Speed Prediction Models

<table>
<thead>
<tr>
<th>Average Speed in:</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Merge</strong></td>
<td></td>
</tr>
<tr>
<td>Ramp Influence Area</td>
<td>$S_R = FFS \times SAF - (FFS \times SAF - 42)M_S$</td>
</tr>
<tr>
<td></td>
<td>$M_S = 0.321 + 0.0039 \ e^{\left(\frac{v_{R12}}{1,000}\right)} - 0.002(L_A S_{FR} \times SAF / 1,000)$</td>
</tr>
<tr>
<td>Outer Lanes of Freeway</td>
<td>$S_o = FFS \times SAF$</td>
</tr>
<tr>
<td></td>
<td>$S_o = FFS \times SAF - 0.0036 \ (v_{OA} - 500)$  \hspace{1cm} $500 \text{ pc/h} \leq v_{OA} \leq 2300 \text{ pc/h}$</td>
</tr>
<tr>
<td></td>
<td>$S_o = FFS \times SAF - 6.53 - 0.006 \ (v_{OA} - 2,300)$ \hspace{1cm} $v_{OA} &gt; 2,300 \text{ pc/h}$</td>
</tr>
<tr>
<td><strong>Diverge</strong></td>
<td></td>
</tr>
<tr>
<td>Ramp Influence Area</td>
<td>$S_R = FFS \times SAF - (FFS \times SAF - 42)D_S$</td>
</tr>
<tr>
<td></td>
<td>$D_S = 0.883 + 0.00009 \ v_R - 0.013 \ S_{FR} \times SAF$</td>
</tr>
<tr>
<td>Outer Lanes of Freeway</td>
<td>$S_o = 1.097 \ FFS \times SAF$</td>
</tr>
<tr>
<td></td>
<td>$S_o = 1.097 \ FFS \times SAF - 0.0039 \ (v_{OA} - 1,000)$ \hspace{1cm} $v_{OA} \geq 1,000 \text{ pc/h}$</td>
</tr>
</tbody>
</table>
Enhancements
Merge Segments Speed-Flow Diagram

SAF = 0.93, CAF = 0.90 Med Rain
SAF = 0.86, CAF = 0.72 Snow
Enhancements
Weave Segments Speed Flow Diagram

SAF = 0.93, CAF = 0.90 Med Rain
SAF = 0.86, CAF = 0.72 Snow

\[ S_{W} = 15 + \left( \frac{FFS \times SAF - 15}{1 + W} \right) \]

\[ S_{NW} = FFS \times SAF - (0.0072LC_{MIN}) - \left( 0.0048 \frac{\nu}{N} \right) \]
Enhancements
Over-Saturated Model: Two Capacity Phenomenon

One Year Data in 2012 (No Incidents, No Inclement Weather). I-95 near Baltimore, Maryland
Conclusions

Under-Saturated:

- Basic Segment Speed Prediction Model is Enhanced.
- Non-Basic Segments Speed Estimation Models Improve Significantly as The New Method Accounts for The Segment Type.

Over-Saturated:

- The Capacity During The Queue Discharge Mode Is Reduced to Provide More Realistic Prediction.
Thank You!

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“Sajjadi S., B. J. Schroeder, N.M Roupahil, Enhancements to Freeway Facilities Method in the HCM to Enable Reliability Analysis, TRR 2013.”