Freeway Ramp Weave Performance Evaluation

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Research Study’s Objectives

- Update and enhance the Weave Analysis Performance Matrix developed in previous project (TO 6304) & develop a plan to include it as a design tool for use by Caltrans in the Design Manual

- Update: HCM-2000 to HCM-2010

- Enhance: Perform additional field data collection & weave performance evaluation at multiple California weave sections
Site Selection
- Identify/select Potential Sites: PeMS & Input from Caltrans
- Discussions with Caltrans TAG
- 11 Potential Sites (Orange County, LA, San Diego)
- Field Visits, Caltrans District Input, Scheduled M&R & Lane Closures

Three San Diego Freeway Weaving Sites

Data Collection, Data Processing & Weave Analysis

Findings
Bluetooth Detector Placement

- Rectangular Channel
- Aluminum Angle

Freeway Thru
Freeway to Exit Ramp
Entrance Ramp to Freeway
Entrance Ramp to Exit Ramp
Site #1: Five-Lane Unbalanced Ramp-Weave

Site #1  I-5 SB before SR 52

Data collection (Dec 16-20, 2013)

Bluetooth origin-destination & travel time data

PeMS spot speed & volume & Miovision volume data
Site #2: Five-Lane Unbalanced Ramp-Weave

Site #2  I-5 NB before Sea World Drive

Data collection (Jan 20-23, 2014)

Bluetooth origin-destination & travel time data

PeMS spot speed & volume & Miovision volume data
Site #3: Five-Lane Unbalanced Major-Weave

Site #3: I-805 NB before Governor Drive

- Data collection (Jan 19-23, 2014)
- Bluetooth origin-destination & travel time data
- PeMS spot speed & volume (very limited)
- Wavetronix spot speed & volume data

![Diagram of Site #3: Five-Lane Unbalanced Major-Weave]
Mainline Flows & Bluetooth Samples

Site #1

Site #2

Site #3:
Bluetooth Travel-time (speed) Validation
Site #3 Speed Validation, Wavetronix & PeMS

Site #3: Downstream Freeway
Wavetronix Vs. PeMS Mean Speed
(15 minute traffic speeds, all lanes)
Site #1 Count Validation, MioVision & PeMS

Site #1: Upstream Freeway
MioVision Vs. PeMS Traffic Counts
(5 minute traffic volumes, all lanes)

Traffic Volumes (vols per 5-minute period)

- MioVision
- PeMS
Site #2 Count Validation, MioVision & PeMS

Site #2: Upstream On-ramp
MioVision Vs. PeMS Traffic Counts
(5 minute traffic volumes, all lanes)
Site #2 Count Validation, MioVision & PeMS

Site #2: Weave Freeway Mainline
MioVision Vs. PeMS Traffic Counts
(5 minute traffic volumes, all lanes)
Weekday Average Weave O-D Patterns

Site #1: Freeway Weaving Movements by Time of Day

Site #2: Freeway Weaving Movements by Time of Day

Site #3: Freeway Weaving Movements by Time of Day
### Develop Database for HCM 2010 Analysis

| No. | SITE                  | N | Np | L | Post. Sp Limit (mph) | V (pcph) | V1 | V2 | V3 | V4 | S | V | S | V | Snw | S | V | V | Snw |
|-----|-----------------------|---|----|---|----------------------|----------|----|----|----|----|----|---|---|---|----|----|---|---|----|----|
| 1   | I-5 SB before SR 52  |   |    |   |                      |          |    |    |    |    |    |   |   |   |    |    |   |   |    |    |
| 2   | I-5 NB before Sea World Dr | | | | | | | | | | | | | | | | |
| 3   | I-805 NB before Governor Dr | | | | | | | | | | | | | | | | |

[Excel spreadsheet image]
HCM 2010 Vs. Field Data: Speeds & Densities

Site #1
I-5 SB before SR 52

Site #2
I-5 NB before Sea World Dr

Site #3
I-805 NB before Governor Dr
HCM 2010
Chapter 12
Weaving Capacity

$L_S = 1500$ ft
$N = 5$ lanes
$N_W = 2$ lanes
Site #3: Measured Flows & Densities
Site #3: Measured Flows & Densities
Site #3: HCM & LOS-D Flow-Density Diagram
Site #3: HCM & LOS-D Flow-Density Diagram
Site #2: HCM & LOS-D Flow-Density Diagram
Site #1: HCM & LOS-D Flow-Density Diagram
LIMITATIONS OF THE METHODOLOGY

The methodology of this chapter does not specifically address the following subjects (without modifications by the analyst):

- Special lanes, such as high-occupancy vehicle lanes, within the weaving segment;
- Ramp metering on entrance ramps forming part of the weaving segment;
- Specific operating conditions when oversaturated conditions exist;
- Effects of speed limit enforcement practices on weaving segment operations;
- Effects of intelligent transportation system technologies on weaving segment operations;
- Weaving segments on arterials or other urban streets, including one-way frontage roads;
- Effects of downstream congestion or upstream demand starvation on the analysis segment; or
- Multiple weaving segments.
Findings from Empirical Data Analysis

Findings are consistent with previous (PATH) evaluations

- EVALUATION OF THE HIGHWAY CAPACITY MANUAL 2010
  METHODOLOGY FOR THE DESIGN AND ANALYSIS OF FREEWAY WEAVING SECTIONS
  Alexander Skabardonis, September 2013

- WEAVING ANALYSIS, EVALUATION AND REFINEMENT
  Alexander Skabardonis, February 2010

HCM-2010 Freeway Weaving Method:

- Generally over estimates the densities within unbalanced ramp weaves; may severely under estimate for highly congested weaves

- Very sensitive to free-flow speed input parameter

- Volume based density estimation routines may have difficulty distinguishing between free-flow and congested traffic states

- Averaging across free-flow and congested states might hide important information on range of densities for given volume input