Evaluation of the effect MnPASS lane design has on mobility and safety

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Overview

- Project Objectives
- Evaluation of Mobility and Safety of current conditions
- Estimation of future conditions tool for Open Access design
Project Objectives

- Evaluate and compare the two design philosophies of Restricted and Open access design in terms of Safety and Mobility.
  - Define metrics for assessing mobility and safety
  - Specifically, test the hypothesis that the open access design of I-35W produces significantly more "near misses" than the restricted access design of I-394.

- Produce a methodology and tool for the best design of access on shared lane HOT facilities.
  - Methodology and tool to evaluate future conditions on Open Access facilities
  - Methodology and tool to determine Optimal Lane Changing Regions (OLCR)
HOT Lane Access Example

• Two Design Philosophies
  • Restricted Access (shown)
  • Open Access

• % length of double white line vs. % length of dashed line
Research Methodology

- **Observation!!**
  - Collect video from all allowed access sections
  - Focus on areas where GP lanes are congested.

- Count lane changes to/from HOT over time

- Identify and measure shockwaves
  - Shockwave frequency is a surrogate for mobility
  - Shockwave length is a surrogate for safety

- Identify and focus on specific freeway sections of concern.
Observation Locations

I-35W

I-394
Zone 1: I-35W between TH-13 and Cliff Road

Inappropriate Lane Changes per Day

Average Inapp. Lane Changes per Total Lane Changes

Average Percent of Vehicles Affected by Shockwaves
Zone 4: Northbound Highway 62 to 38th street

Average Inappropriate Lane Changes per Day AM

Inappropriate Lane Changes per Day

Camera

Average Percent of Vehicles Affected by Shockwaves AM

Percent of Vehicles Affected / 15 minutes

Average Percent of Vehicles Affected by Shockwaves PM

Percent of Vehicles Affected / 15 minutes

Friday, May 23, 2014
Observed flow breakdowns on the I-35W HOT

Vehicles affected on the HOV facility

Number of vehicles affected

Location

Friday, May 23, 2014
I-394 EB at Louisiana Avenue

Average Inappropriate Lane Change per Total Lane Change AM

Average Inappropriate Lane Change per Total Lane Change PM

Average Percent of Vehicles Affected by Shockwaves PM

Access EB 4 Location

Number of vehicles affected

Percent of Vehicles Affected /15 minutes

Percent of Inappropriate Lane Changes/15 minutes

Percent of Inappropriate Lane Changes/15 minutes

Vehicles affected on the HOV facility

Friday, May 23, 2014
Comparison between facilities on I-394 and I-35W

[Box plots showing the number of vehicles affected on the HOV facility at different zones]
Restricted Access Design vs. Open Access

- Today each works well on its respective freeway
- Shockwave activity similar between sites

- “Gates” attract more lane changes
  - Works well on I-394 since 90% of demand comes from three distinct interchanges.

- Open Access on I-35W gives better service
  - Demand on I-35W spread over more interchanges
  - Interchanges are more frequent.
  - In the future MnDOT may have to restrict access in high congestion areas (or raise the price).
Emulating Shockwave Propagation on MnPASS lanes Under Present and Increased Demand Levels
Segments of interest

- The locations for which data will be presented correspond to the segments of the HOT lane between:
  - TH 13 and Black Dog NB (608 & 6091)
  - 86th street and 90th street SB (6130).
  - 98th street and 106th street SB (6101)
Methodology

1st stage Analysis

Video recordings

- Headway measurements
- Shockwave size distributions
- Accepted and rejected gaps during lane changing activity

Platoon formation

16 Friday, May 23, 2014

2nd stage Analysis

Gap acceptance model

Car-following model

Monte Carlo sampling method

Simulated shockwave size distributions

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Simulated shockwave size distributions
## Sampling Distributions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follower headway</td>
<td>Empirical distribution</td>
</tr>
<tr>
<td>Leader headway</td>
<td>Empirical distribution</td>
</tr>
<tr>
<td>Platoon size</td>
<td>Empirical distribution</td>
</tr>
<tr>
<td>Reaction time</td>
<td>Truncated Normal (1.01,0.37) seconds (Johansson et al (1971))</td>
</tr>
<tr>
<td>Acceleration rate</td>
<td>Normal (5.6,1) feet/sec² (Gipps (1981))</td>
</tr>
<tr>
<td>Deceleration rate</td>
<td>2 * Acceleration rate (Gipps (1981))</td>
</tr>
<tr>
<td>Comfort Deceleration Parameter</td>
<td>Normal(35,2.25) feet (Empirical)</td>
</tr>
<tr>
<td>Speed drop</td>
<td>Normal (50,8) (feet/second) for 6130 SB (Location based. Determined from loop data)</td>
</tr>
</tbody>
</table>
Methodology

3rd stage Analysis

- Shockwave simulator
- “Loading” mechanism construction
- Shockwave size distributions for future traffic conditions
Experiment Description

- A sequence of vehicles is generated given a density time series.
- For the first 5 seconds all vehicles move without any change in speed.
- After selecting a gap, the following vehicle is forced to execute a sampled speed drop followed by an immediate recovery with the given acceleration.
- After the disturbance is introduced vehicles experience the shockwave based on the rules underlined by the shockwave propagation model.
- Repeat
Validation

TH 13 and Cliff Rd NB

86th St and 90th St SB

98th St and 106th St SB

86th St and 90th St SB
TH13 and Cliff Road Northbound

Density ranging between 22.5vpm and 30vpm

Density ranging between 27.5vpm and 35vpm

Density ranging between 30vpm and 37.5vpm

Density ranging between 37.5vpm and 42vpm
TH13 and Cliff Road Northbound
TH13 and Cliff Road Northbound
Questions?