CAPACITY DROP: A COMPARISON BETWEEN STOP-AND-GO WAVE AND QUEUE CONGESTION AT LANE-DROP BOTTLENECK

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Introduction

- For decades, many efforts have been devoted to the research on capacity drop;

However,

- The macroscopic features of capacity drop are still not completely clear;
  - To what extent the capacity can reduce
  - Flow distribution over lanes downstream congestion
Research question:

What are differences between the downstream state of a stop–and–go wave and that of a standing queue?
Research questions

What are differences between the downstream state of a stop–and–go wave and that of a standing queue?

1/4 To what extent can the capacity reduce in the downstream of a stop–and–go wave?
Research questions

What are differences between the downstream state of a stop–and–go wave and that of a standing queue?

2/4 To what extent does the congestion discharge rate vary at the same road section without the other disturbances, such as weather?
Research questions

What are differences between the downstream state of a stop–and–go wave and that of a standing queue?

3/4 What is the downstream flow in each lane in the queue discharge conditions?
Research questions

What are differences between the downstream state of a stop–and–go wave and that of a standing queue?

4/4 What is the flow distribution over lanes in the downstream of a bottleneck with compulsory merging behaviours?
Outline

✓ Introduction

• Methodology

• Data and study site

• Results

• Conclusions
Methodology

- Traffic scenario at a lane-drop bottleneck

Introduction | Methodology | Data | Results | Conclusions
---|---|---|---|---
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Methodology

- Traffic scenario
- Analytical solution – Shock wave analysis
Methodology

- Traffic scenario
- Analytical solution – Shock wave analysis
- Quantitative solution – Slanted cumulative counts
- Data handling
Methodology

- Traffic scenario
- Analytical solution – Shock wave analysis
- Quantitative solution – Slanted cumulative counts
- Data handling

* From Knoop et al. (10)
Data & study site

1. Freeway A4 in the Netherlands
2. 1-min aggregated
3. Time mean speed and flow in each lane
4. Keep Right Unless Overtaking
Data & study site

8 locations, 4 km

10 locations, 5 km

M: Median Lane
C: Center Lane
S: Shoulder Lane

Traffic flow

Bottleneck
Data & study site

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2. 1-min aggregated
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4. Keep Right Unless Overtaking
Data & study site

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Data & study site

18 May 2009

28 May 2009
Results
– State Identification

Traffic flow
N206
N206
Exit 7
Bottleneck

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>16:00</td>
</tr>
<tr>
<td>Location 2</td>
<td>16:30</td>
</tr>
<tr>
<td>Location 3</td>
<td>17:00</td>
</tr>
<tr>
<td>Location 4</td>
<td>17:30</td>
</tr>
<tr>
<td>Location 5</td>
<td>18:00</td>
</tr>
<tr>
<td>Location 6</td>
<td>18:30</td>
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<tr>
<td>Location 7</td>
<td>19:00</td>
</tr>
<tr>
<td>Location 8</td>
<td>19:30</td>
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</tbody>
</table>

5400 vph
6040 vph
6040 vph
6040 vph
6040 vph
6040 vph
6040 vph
6040 vph

Speed (km/h) 0 20 40 60 80 100 120
12 km
10 km
8 km
6 km
4 km
2 km
0 km

<table>
<thead>
<tr>
<th>X</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>12 km</td>
<td>N206</td>
<td>N206</td>
<td>Exit 7</td>
<td>Bottleneck</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

16:00 16:30 17:00 17:30

1
2
3
4
5
6
7
8
9
10

18 | 27

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Results

– Discharge rates

TABLE 1 Speed and Flow in Different Traffic State Points

<table>
<thead>
<tr>
<th></th>
<th>18 May 2009</th>
<th>28 May 2009</th>
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<tr>
<td></td>
<td>(km/h)</td>
<td>(veh/h)</td>
</tr>
<tr>
<td>State 5</td>
<td>98.73</td>
<td>5400.00</td>
</tr>
<tr>
<td>State 6</td>
<td>98.32</td>
<td>6040.00</td>
</tr>
</tbody>
</table>
Results

- Discharge rate in each lane

Introduction

Methodology

Data

Results

Conclusions
Results

– Flow distribution

Introduction
Methodology
Data
Results
Conclusions
Results

– Flow distribution

In congestion states, flow difference among lanes is due to the density.
Results

– Flow distribution

Downstream capacity of median lane which is close to the lane-drop bottleneck is temporarily increased due to merging behaviours
Results

– Flow distribution (4-lane)

a) Location 10, 18 May

b) Location 9, 18 May
Conclusion

• The discharge rate at the same location varies in a wide range, from 5220 veh/h to 6040 veh/h;

• The stop-and-go wave discharge rate is much higher than the standing queue discharge rate;

• The various discharge rate could be strongly related to the congestion states;
Conclusion

- Features of queue discharge rate in each lane differ from each other;

- Flow distributions shows in congestion states the capacity in the shoulder lane is largely wasted, due to the large spacing;

- Merging behaviours temporarily increase the capacity of the median lane;
Thank you!