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

Kai Yuan¹, Victor L. Knoop¹, Ludovic Leclercq², Serge P. Hoogendoorn¹

¹ Department of Transport and Planning (TP), Delft University of Technology
² IFSTTAR / ENTPE, LICIT, Université de Lyon
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 behaviour?
Outline

☑ Introduction

• Methodology

• Data and study site

• Results

• Conclusions
Methodology

- Traffic scenario at a lane-drop bottleneck

![Diagram showing traffic patterns and speed over time](image-url)
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
- 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

18 locations, 4 km

8 locations, 5 km
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

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

18 May 2009

28 May 2009
Results

– State Identification
Results

– Discharge rates

TABLE 1 Speed and Flow in Different Traffic State Points

<table>
<thead>
<tr>
<th>State</th>
<th>18 May 2009</th>
<th>28 May 2009</th>
</tr>
</thead>
<tbody>
<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

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Methodology</th>
<th>Data</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
</table>

a) Median lane, location 1, 18 May 2009
b) Median lane, location 1, 28 May 2009
c) Center lane, location 1, 18 May 2009
d) Center lane, location 1, 28 May 2009
e) Shoulder lane, location 1, 18 May 2009
f) Shoulder lane, location 1, 28 May 2009
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!