TRAFFIC MANAGEMENT FOR AN URBAN MOTORWAY TUNNEL IN BERLIN

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ABSTRACT
Tunnels in Berlin were planned - due to the current standards - to be operated without periodic congestion. But often during morning peak hours traffic demand exceeded capacity in the TOB-tunnel (Tunnel Ortskern Ortsteil Britz) on the motorway A100 with the result that the tunnel had to be closed. To avoid this situation – at least to reduce the duration or the number of closings – a three level strategy was developed. By these means the number of complete tunnel-closings could be fixed to about 10 closings a year although the motorway is connected in the meanwhile to the Berlin Motorway Ring and traffic has grown.

Keywords: city tunnels, traffic control

1. INTRODUCTION
Since 2000 the TOB-tunnel is part of the Berlin urban motorway ring and has a daily flow of about 60,000 vehicles in each direction with three lanes (total cross section 120,000 veh/24h). The first years in operation daily traffic volume grew and the congestion extended more and more often into the tunnel, e.g. 200 times in the year 2009. Especially during morning peak hours the downstream interchange AD Funkturm is often congested for northbound traffic. Considering the actual German guidelines RABT 2006 the tunnel has to be prevented from periodic congestion and the standard mean is to close the tunnel upstream to avoid vehicles from entering the tunnel. Typical closure duration has been 20 minutes. The southbound direction doesn’t have this problem because the afternoon peak usually isn’t so high as the morning peak. But this approach had some disadvantages. On the one hand the road users considered the closure as very unpopular and on the other hand it took a too long time for the new congestion at the tunnel entrance for dissolving. A third reason for activity was the extension of the motorway A113 southwards (carried out 2008) and the planned prolongation of the A100 to the east with expected growing traffic on the highway. The new motorway projects A100 are discussed intensively in public, therefore it is very important to show that the already existing links still are able to manage daily traffic.

2. REQUIREMENTS AND SITUATION
In RABT 2006 it is required that a tunnel is free of congestion in normal use. Considering the volumes and speeds of a typical day downstream (figure 1) and upstream (figure 2) there is a significant risk for congestion between 7:00 and 8:30. This observation corresponds to the closure times and durations shown in table 1. The prognosis for the year 2025 (GVP 2025, 2009) shows a significant increase of traffic demand compared with 2006 but the main reason is the commissioning of the motorway A113 in 2008, compared with the present day there will only be small changes and we needn’t expect that the situation gets worse. On the other hand, the congestion’s cause is the oversaturation of the interchange A100/A115 AD Funkturm in the morning peak. There will be only minimal changes within the next 15 years, too. Thus solutions have to be cheap and first to be found in operation actions with already existing systems because the problem will not grow in the future.
Figure 1: Typical volumes and speeds downstream (11.11.2009)

Figure 2: Typical volumes and speeds upstream (11.11.2009)
Table 1: Typical tunnel closure time and duration

<table>
<thead>
<tr>
<th>Date</th>
<th>begin</th>
<th>date</th>
<th>end</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.11.2009</td>
<td>07:34</td>
<td>11.11.2009 08:12</td>
<td>A100 -&gt; N AS Britzer Damm gesperrt, erh. Verkehrsaufkommen</td>
<td></td>
</tr>
<tr>
<td>11.11.2009</td>
<td>07:36</td>
<td>11.11.2009 08:18</td>
<td>A100 -&gt; N AS Buschkrugallee gesperrt, erh. Verkehrsaufkommen</td>
<td></td>
</tr>
</tbody>
</table>

The tunnel has opened in 2000 and has up-to-date equipment for ventilation, safety and traffic control. A scheme of the traffic control equipment at the eastern ramp equipment is shown in figure 3.

![Traffic control in the eastern ramps](image)

Figure 3: Traffic control in the eastern ramps

All motorways in Berlin have Variable Message Signs for speed limits, congestion warnings, black ice warnings and lane control. According to the tunnel requirements there is closing equipment consisting of signals, booms and illuminated ground marks und dynamic route direction signs.

An emergency or congestion-caused tunnel closing procedure consists of

- closing the tunnel at the portal
- closing the lanes
- closing the ramps and
- activation of information signs at surrounding roads.
A typical traffic situation in the entering directions after some minutes of closure is shown in figure 4.

Figure 4: Traffic situation at the TOB during tunnel closure

If the traffic situation improves downstream operation staff identifies the time of re-opening an after about 10-30 minutes the upstream congestion is dissolved.

3. STRATEGY

To avoid tunnel closure by capacity overload there are two starting points: the first is to increase capacity downstream and the second to reduce entering volumes upstream. Increasing output capacity is very difficult to achieve because of the close interchange, missing alternative routes and missing technical equipment for e.g. ramp metering. Reducing entering volumes is easier because the standard motorway equipment can be used for the closure of single lanes to generate a bottleneck and reduce capacity. If three lanes are passed by up to 5700 veh/h closing one lane will reduce capacity to about 3800 veh/h. Also the emergency booms can be used not only in the case of tunnel closures but also for a kind of ramp metering. A closure of the ramps Buschkrugallee and Britzer Damm may reduce entering traffic by up to 700 veh/h in the morning peak. To reduce the impact of a more intensive use of ramp closures to secondary roads signal plans for 8 signalised intersections along the alternative route have been developed to increase capacity. In average the capacity can be temporary increased of 25 per cent (from about 1000 veh/h to 1200 veh/h) at the expense of lower level directions by the new signal plans. Because of several crossing bus lines this capacity increase may only be very moderate.
4. IMPLEMENTATION

The actions
- lane closure to drop capacity,
- ramp closure without tunnel closure and
- activation of special signal plans for the alternative route
- activation of dynamic direction signs
- generation of a TMC-message for broadcasting and dynamic route guidance systems

have been integrated into the existing central control system. A geographical overview is shown in figure 5.

![Traffic management infrastructure TOB northbound](image)

**Figure 5:** Traffic management infrastructure TOB northbound

All actions are undertaken by the operation staff in the Berlin traffic control centre manually. As soon as staff expects a tunnel congestion one lane in upstream direction will be closed outside the tunnel, as a consequence the congestion will increase on the motorway A113 instead of the tunnel. Usually some minutes later staff is able to decide on a ramp’s closure. The last suitable action is the closure of the tunnel.

5. RESULTS

Strategies were implemented in November 2007 and had been activated 6 times in 2007. By intensive traffic observation the staff’s experiences has grown and the actions are now activated up to several times a week. In May 2008 the new motorway section A113 was opened and an increase of tunnel closures was expected in public due to increased traffic. Exact volumes, numbers of tunnel closures (northbound) and numbers of staff actions are shown in table 2.
Table 2: Volumes, tunnel closures and activated strategies

<table>
<thead>
<tr>
<th>Year</th>
<th>Veh/24h</th>
<th>Tunnel closures of capacity lack</th>
<th>Strategy activations</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>90,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>110,000</td>
<td>9</td>
<td>6</td>
<td>11/2007: start of strategies</td>
</tr>
<tr>
<td>2008</td>
<td>118,000</td>
<td>3+8</td>
<td>19+52</td>
<td>5/2008: new motorway</td>
</tr>
<tr>
<td>2009</td>
<td>120,000</td>
<td>8</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

Although there is an increase in traffic an increase of tunnel closures could be avoided as a result of strategy activations, the public’s expectation didn’t fulfill.

6. CONCLUSIONS AND OUTLOOK

German RABT 2006 guidelines have to be applied for all tunnels in Germany. Because of different conditions in the surrounding road network in addition more actions have to be undertaken to guarantee free-flow traffic.

Especially in city regions tunnel safety doesn’t stop at the tunnels’ portals. Congestion is also dangerous on motorway and has to be avoided by all means of traffic control infrastructure (e.g. direction signs, ramp metering and signals) and also by updated information for passengers.

Pre-emptive traffic control by several means has improved traffic in Berlin very often and avoided a lot of tunnel incidents. These positive experiences will be assigned to more tunnels in Berlin.

REFERENCES

GVP 2025, Gesamtverkehrsprognose 2025 für die Länder Berlin und Brandenburg, Senatsverwaltung für Stadtentwicklung, Berlin, 2009