Design, setting up and installation of ramp metering on motorways intersections
On motorway A57 in Germany several Ramp Metering Systems have been deployed to harmonise traffic flow.
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1. **KEY EVALUATION RESULTS**

1.1 **IMPACT ON TRAFFIC FLOW**

During rush hour traffic the average driving speed increases by about 10km/h which results in journey time savings. Moreover the capacity increases by about 5%. During operation of the system a harmonized inflow on the motorway can be observed. Vehicles normally drive until the end of the acceleration line and then merge with traffic on the main lanes.

1.2 **IMPACT ON INCREASED SAFETY**

Improvement in the merging behaviour of traffic is having a positive impact on traffic safety due to less lane changing. The breakup of merging slip road vehicle platoons reduces the incident and congestion potential on the main carriageway as well as the frequency of accidents.

1.3 **IMPACT ON ENVIRONMENT**

Due to the reduction of shockwaves a harmonisation of driving speed can be observed. It is believed that smoother traffic flow resulting in less speed variation on a metered motorway can lead to reduction in emissions and fuel savings.
2. DESCRIPTION OF THE PROBLEM

From 6:30 a.m. the traffic volume on motorway A 57 increases severely. Between 7:00 and 9:00 the traffic flow is tough-flowing with several short breakdowns. Distinctive shockwaves can be observed. Moreover, due to dense traffic, converging vehicles cannot merge in zip-fastener manner. This leads to uncontrolled jostles.

Due to breakdowns on the motorway and high volumes of converging vehicles, tailbacks on the on-ramps can be observed. The average driving speed decreases to about 20-40 km/h.

2.1 SITE

The junction AS Krefeld-Gartenstadt is comparable to a motorway junction (see Figure 1). The crossing main road B 509 is connected to the motorway via two ramps per direction.

Figure 1: junction AS Krefeld-Gartenstadt

The junction AS Krefeld-Zentrum in direction Cologne is a classical interchange (see Figure 2). The ramp of the secondary road is slightly ascending in direction of the motorway. The junction behind the interchange in the secondary network is not operated by traffic light.

Figure 2: junction AS Krefeld-Zentrum
2.2 ISSUES ADDRESSED

The main issue addressed in the evaluation is the testing of the ramp metering systems in terms of their impact on traffic flow.
3. DESCRIPTION OF THE ITS PROJECT

3.1 PROJECT DOMAIN

- Traffic Management,

3.2 KEY WORDS

Ramp Metering

3.3 OBJECTIVES

Contribution for the improvement of traffic conditions by applying ramp metering systems in order to decrease congestion on the motorway.

Related to Easyway objectives and objectives of the project Sponsor

The EasyWay projects overarching objectives which are expected to be achieved by 2020 are as follows:
- 25% improvement in road safety by 2020;
- 25% decrease in congestion, facilitate travel and mobility of people and goods by 2020; and
- 10% reduction in the impact on the Environment by 2020.

The target reductions for 2007 - 2009 which will contribute to the overall objectives are as follows;
- 4-6% target reduction in road safety by 2009;
- 3-6% target reduction in congestion by 2009; and
- 1-3% target reduction of CO2 emissions by 2009.

3.4 SYSTEMS AND TECHNOLOGIES APPLIED

Implementation of seven ramp metering systems; each systems contains of signals installed on the on-ramps and loop detectors installed on the carriageway (upstream and downstream of the on-ramps) as well as on the on-ramps themselves.

3.5 STATUS OF THE PROJECT

All ramp metering systems within this project have been implemented and are in operation since 10th of October 2005.
4. EVALUATION PLANNED

4.1 TIMING AND TYPE OF EVALUATION

The evaluation has been carried out following implementation (ex-post evaluation). No simulation has been involved. The evaluation was conducted by SSP Consult, Beratende Ingenieure GmbH, Bergisch Gladbach.

4.2 OBJECTIVES FOR THE EVALUATION

The objective for the evaluation is to proof the impact of ramp metering systems on traffic flow.

4.3 RESEARCH QUESTIONS

What is the impact of ramp metering on traffic conditions?

4.4 STUDY AREA FOR THE EVALUATION

The study area for the evaluation is confined to the immediate site of the ITS scheme.
5. THE IMPACT OF THE PROJECT - RESULTS

5.1 TECHNICAL PERFORMANCE

The system is working according to expectations.

5.2 RESULTS

AS Krefeld-Gartenstadt

During rush-hour (between 7 and 9 a.m.) an increase in travel speed is noticeable (see table 1).

<table>
<thead>
<tr>
<th>Traffic speed</th>
<th>Control section downstream</th>
<th>Control section upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
<td>Difference</td>
</tr>
<tr>
<td>50 km/h</td>
<td>&gt;60 km/h</td>
<td>&gt;10 km/h</td>
</tr>
</tbody>
</table>

Table 1: increase in traffic speed, AS Krefeld-Gartenstadt

Additionally traffic volume increases by about 5% during rush hour at the upstream control section. Another positive effect is a harmonised entering of vehicles from the on-ramps onto the carriageway during operation of the system. Vehicles drive until the end of the acceleration lane and then merge with traffic. Uncontrolled merging, as happened prior to implementation of the system, is not observed anymore. Furthermore a reduction of shockwaves can be achieved.

AS Krefeld-Zentrum

During rush-hour (between 7 and 9 a.m.) an increase in travel speed is partly noticeable (see table 2).

<table>
<thead>
<tr>
<th>Traffic speed</th>
<th>Control section downstream</th>
<th>Control section upstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
<td>Difference</td>
</tr>
<tr>
<td>60-65 km/h</td>
<td>60-65 km/h</td>
<td>0 km/h</td>
</tr>
</tbody>
</table>

Table 2: increase in traffic speed, AS Krefeld-Zentrum

An increase in travel speed cannot be observed at the downstream control section during operation of the system. But one hour before and after operation an increase of 10km/h can be measured. Furthermore the traffic volume increases between 3 and 5% between 7 and 8 a.m. All together this means a reduction of congestion affected time by about 2 hours.
Further positive effects that can be observed are a harmonized inflow from the on-ramp onto the carriageway and a considerable reduction of shockwaves.

![Traffic volume on motorway after implementation of ramp metering system at AS Krefeld Zentrum](Figure 4: Traffic volume on motorway after implementation of ramp metering system at AS Krefeld Zentrum (in red: operation of the system))

5.3 RELIABILITY OF RESULTS/

The impact of ramp metering is appraised through monitoring of traffic conditions via video surveillance and analysis of traffic data (travel speed and traffic volume).

Furthermore the average travel speed over a period of two week (both prior and ex-post implementation) is being calculated and compared.

5.4 RESEARCH QUESTIONS ANSWERED

The research questions were answered.

5.5 OVERALL ASSESSMENT

5.5.1 Safety

No evaluation

5.5.2 Efficiency

Implementation of ramp metering leads to a decrease in journey time and an increase of traffic volume, travel speed and travel time reliability.

5.5.3 Environment

No evaluation

5.5.4 Financial

No evaluation
5.5.5 User acceptance
No evaluation

5.5.6 Integration
The system can be easily integrated in the local traffic centre or implemented on other sites.

5.5.7 Accessibility
6. **EUROPEAN DIMENSION: TRANSFERABILITY OF THE RESULTS**

The results of the evaluation are applicable to other similar implementation in Germany and Europe.
ANNEX 1: TECHNICAL ANNEX

SELECTED INDICATORS

DATA COLLECTION METHODS

OTHER TECHNICAL ASPECTS E.G. MODELLING