

# Evaluation summary of “Pilot trial with Hard Shoulder Running on the Hillerød Motorway”

Summary of a Danish evaluation report issued in March 2016

## Background and objective

Congestion on motorways in Denmark is getting worse due to increasing traffic demands. For that reason the Danish Ministry of Transport decided to carry out the first trial with hard shoulder running (HSR) in Denmark.

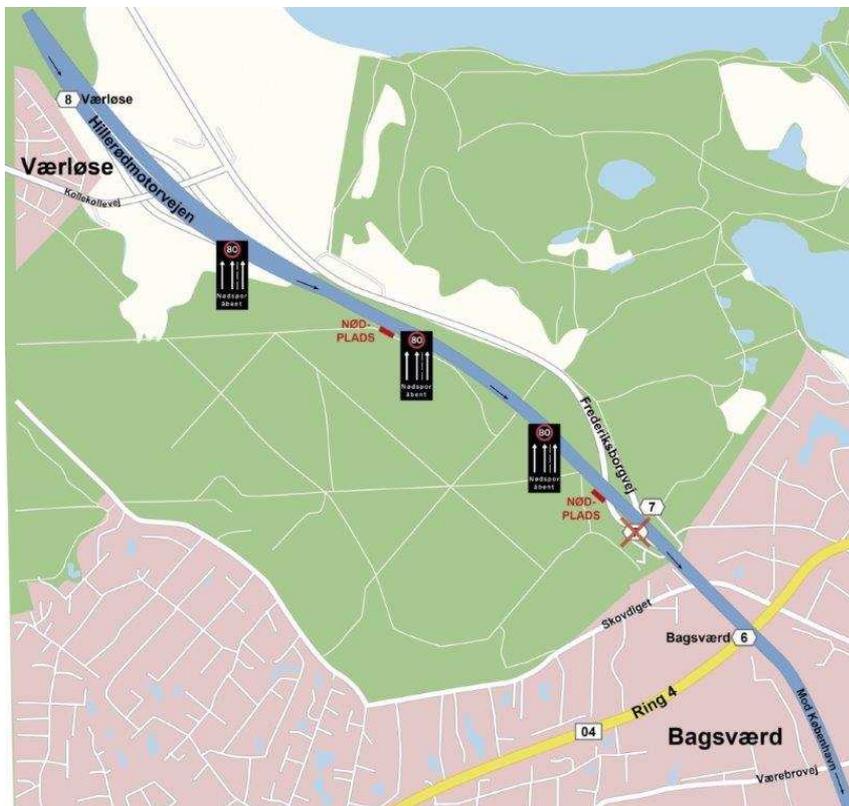


Figure 1. HSR on the M13 between junction 8 and junction 6

A two kilometre section of the Hillerød Motorway (M13) about 10 kilometres North of Copenhagen is a bottleneck with daily congestion, especially in the morning rush hour.

The section between junction 8 (Værløse) and junction 6 (Bagsværd) is a motorway with 2 x 2 lanes and an AADT of approximately 66,000. It is congested every morning towards Copenhagen.

Before the trial there were often 4-7 km long queues and average speeds below 50 km/h for 1½ hour every day.

The overall objective of the pilot trial is to improve traffic flow without compromising traffic safety. It is also an objective to develop and test a concept for hard shoulder running in Denmark.

The objective of the evaluation is two-fold:

1. What can be learned from the pilot trial as a concept for hard shoulder running on Danish motorways?
2. What can be learned from practice about the local solution and its functionalities?

## Description of the HSR system

The system comprises:

- Reinforcement of hard shoulder and construction of two safe havens (every 1 km)
- 6 variable message signs for opening and closing hard shoulder running placed in 3 cross sections (every 750 m); information on the VMS is set manually
- Newly developed principles of road markings and signs (see photo below)
- 10 PTZ cameras every 200-250 m and 3 fixed cameras with infrared lighting for monitoring the hard shoulder (also when it is dark). Monitored from the national Traffic Control Centre (TCC)
- Automatic incident detection (AID) of slow and stopped vehicles and ghost drivers
- Cost: 3.6 M € incl. 4 years of operation.

The system and the motorway are monitored by the TCC 24/7.



## **Evaluation – timing, type and methods**

The evaluation is an ex-post evaluation comparing traffic data from two comparable time periods: Autumn 2013 without HSR versus autumn 2014 with HSR in operation. The HSR system was put into operation in December 2013.

Further evaluation methods include a road user survey, video analysis of road user behaviour, analysis of system logs including AID logs and false alarms as well as traffic data from the motorway and local roads in the corridor.

## **Results**

Taking into account all the analyses performed the **overall key result** of the pilot trial is that use of the hard shoulder as a traffic lane in the morning rush hour has generally improved traffic flow, increased capacity, reduced travel times, reduced the variation in travel times, resulted in shorter queues and shorter duration of queues. Further, it has reduced traffic on the local roads along the M13. It is too early to point out any effects on traffic safety, but so far there is no indication neither on positive nor negative effects.

In addition, the road users are in general satisfied with the introduction of hard shoulder running on the M13.

### **What can be learned from the pilot trial as a concept for hard shoulder running on Danish motorways?**

The overall conclusion is that hard shoulder running as a concept is an effective measure and could be advantageous to implement on other motorways in Denmark with similar congestion problems.

The assessment clearly shows that hard shoulder running is a new concept by Danish standards and it has required extra information to the road users via information campaigns and as well an adaptation period for the road users to get accustomed to the new type of system.

The full effect of introducing HSR can only be obtained if it is ensured that there is sufficient capacity downstream of the HSR section and also on any relevant motorway exits. (In addition, see below in relation to the chosen solution).

An appropriate coverage with video cameras is needed to enable HSR throughout the year and to allow the TCC to monitor the motorway and its technical equipment. It should be considered whether AID is necessary dependant on the local conditions.

If the hard shoulder is already reinforced to handle heavy traffic and/or there is already ITS equipment installed on the motorway, the cost of establishing HSR can be significantly reduced.

The benefit of the HSR system can be increased by using the variable message signs to display other information, e.g. queue warnings and road work warnings.

### **What can be learned in practice about the local solution and its functionalities?**

The very positive overall key results are mentioned above and this section will elaborate further on various results.

In 2013 before the HSR, the average travel time was 22 minutes on a 15 km section from Allerød to Motorring 3. The local solution has reduced the average travel time by 1-3 minutes and up to 5 minutes towards junction 6 (12 km).

The busiest part of the morning rush hour with queuing and very low speeds start 20 minutes later and stops 20 minutes earlier with HSR.

Traffic volume on the motorway between 7 am and 8 am has increased with 18 % ~ 700 vehicles/h, from 3800 to 4500 vehicles/h with HSR. Traffic has shifted from the local roads to the motorway, from 1150 to 750 vehicles/h (7 am to 8 am). The changes in traffic volumes mean that bottlenecks in the southern end of the HSR section have become more visible.

There are some challenges with more queueing on the exit at junction 6 after the HSR section and at the exit towards Motorring 3 further south on the M13. The Danish Road Directorate is looking into what can be done. If the capacity and traffic flow can be improved at these two locations, the positive effects from the HSR trial are expected to increase even more.

A road user survey was carried out in November 2014 and resulted in about 650 replies (response rate on 38 %) and the following main results:

- 86 % of the respondents are satisfied or very satisfied with the HSR trial
- 81 % think that traffic flow has improved and travel times have been reduced while 7 % think that traffic flow has worsened
- 80 % feel safe/comfortable using the HSR section while 4 % feel unsafe/uncomfortable

The AID system has been a great help for the TCC and has given some valuable insights in the driver behaviour on the HSR section and the system performance:

- In average 5.5 cars stop per day and 66 % use the two safe havens
- The duration of a stop is in average 3:36 minutes
- Satisfactory reaction time for alarms regarding stopped cars (99 % alarms < 2 minutes)
- Too many false alarms and missed detections (false alarm rate 67 %)

A socio-economic assessment conducted according to the DRD guidelines and model for cost-benefit analysis of ITS systems with a 10-year time frame gave positive results:

- Investment costs: 3.1 M €
- Annual operation costs: 0.1 M €
- Net present value: 8.0 M €
- Internal rate of return: 26.8 %

Note that the assessment includes effects on traffic flow only. Safety and environmental effects are not included.

Some potential for improvements have been identified:

- More information to the road users on how to use and not use HSR is needed
- Possible adjustments of road markings and VMS displays should be considered
- If possible, capacity further south of the HSR section on the M13 and at exit 6 should be improved
- Added value can be achieved if the system and the VMS are used for other purposes than HSR
- Further analysis of the safety related aspects of HSR should be carried out.

Many more results and details on methods and data etc. are available in the references given below.

### **Transferability**

The overall result that HSR as a concept is an effective and beneficial measure is assessed to be transferable to other sites with similar bottleneck problems, but of course dependent on the local network and traffic conditions and other local characteristics. The detailed results are not transferable to other sites, since they depend to a large extent on the local factors.

### **References and further information**

“Forsøg med kørsel i nødspor på Hillerødmotorvejen. Evaluering”, Rapport 558, 10. Marts 2016, Vejdirektoratet (In Danish).

[http://vejdirektoratet.dk/DA/viden\\_og\\_data/publikationer/\\_layouts/delegate/pages/GetPublication.aspx?id=1292381633](http://vejdirektoratet.dk/DA/viden_og_data/publikationer/_layouts/delegate/pages/GetPublication.aspx?id=1292381633)

“The first experiences with hard shoulder running on motorways in Denmark”, Claus Lund Andersen, Danish Road Directorate. 22<sup>nd</sup> ITS World Congress, Bordeaux, France, 5 – 9 October 2015.

Contact information: Please refer to the front page of this document.