STUDY ON THE FEASIBILITY OF DEVELOPING A LANE RESERVED EXCLUSIVELY FOR BUSES ON THE EMERGENCY LANE OF A MOTORWAY LEADING TO BRUSSELS

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1. ABSTRACT

Keywords: traffic lane reserved, high occupancy vehicles on motorways, typical traffic congestion point, Dutch and US experiences, solution, adaptation of the emergency lane, create an exclusive lane for passenger bus traffic

This present assessment is part of the ongoing studies on measures accompanying the Express Rail Network project for the outskirts of Brussels.

The creation of a special traffic lane reserved for buses and high occupancy vehicles on motorways giving access to Brussels is in fact a proposal put forward as part of the infrastructure works to be undertaken by the Task Force for implementation of the projected Express Rail Network facility for the entire suburbs of Brussels. The aim of this facility is to create or free traffic lanes so that these can be used by high occupancy vehicles or express bus services in conjunction with rail transport facilities.

The study centres upon a 13km segment of motorway between Wavre (a town of 30000 inhabitants on the outskirts of Brussels) and Jezus-Eik (a locality within the Brussels perimeter) in the Wavre-Brussels direction. This trunk line is in effect a typical traffic congestion point in the morning peak hours.

The study sets itself first of all to examine to what extent a High Occupancy Vehicles lane (HOV lane) could prove feasible over the stretch of motorway in question. Analyses have shown that a viable solution must satisfy the following 5 criteria:

1. avoidance of repercussions on the present capacity of the motorway (hence, no modification of existing traffic lanes);
2. provide a solution that can be rapidly and simply implemented ;
3. provide an economically viable solution ;
4. offer a practicable solution from the standpoint of the authorities (and also juridically acceptable, especially as regards any possible revision of the highway code);
5. offer maximum guarantees in terms of road safety, both for private motorists and for bus users.

On the basis of such criteria the solution arrived at in the present study proposes the adaptation of the emergency lane of the motorway segment indicated above so as to create an exclusive lane for passenger bus traffic.

A reserved lane of this kind should assure for bus users the benefit of reduced travel time in accessing the Brussels city centre as also a more regular and punctual commuter service. Implementation of this measure should, in time,

induce other users of the motorway to change their modes of transport and opt for public facilities, in the present case bus services, thereby contributing to a reduction in motorway congestion. Similar undertakings have been successfully implemented in Holland and the United States (the outer suburbs of Minneapolis and Seattle). The consultant in charge of this study has in effect visited the U.S. for the purpose of discussing with a number of authorities on the subject; additionally, he has travelled to Holland for a first hand assessment of the results achieved through the adaptation of certain emergency lane segments of the motorway between Breda and Utrecht for bus transport services.

The feasibility study suggests that modifications required between Wavre and Jezus-Eik would be as follows :

- enlargements of parts of the emergency stopping lane so as to give bus vehicles a lane width of between 3.40 and 3.60 metres, thereby entailing a reduction of 0.20m in the width of each of the normal traffic lanes ;
- the creation of 5 emergency lay-by zones for distressed vehicles ;
- the creation of traffic lights, overhead gantry signs (equipped with signalling preventing access to the reserved lane by vehicles other than buses) and other signalling necessary to regulate traffic flows.

The circulation on the bus lane should be regulated by two speed limits. The maximum authorised limit would be 60 km/hour but such limit may not however exceed the limit to be observed by the adjacent normal traffic lane by more than 25 km/hour.

Travel time between Wavre and entry to Brussels at morning peak hours would be reduced to 19 minutes from the present 30 minutes.

An estimated implementation cost for the stretch of motorway between Wavre and Brussels is conditional upon the volume of traffic to be borne by the emergency lane. On the basis of a volume of less than 20 buses per day overall cost of implementation may be estimated at Euro 1.65 millions.

2. STUDY CONTEXT

Thus study, assigned in 2002 by the Walloon Region (Equipment and Transport Ministry) to the consulting firm of STRATEC S.A., is a continuation of the studies conducted on support measures for the RER (Express Rail Network) project around Brussels.
Indeed, the creation of a lane reserved for buses and high-occupancy vehicles on the motorways accessing Brussels is a measure that was proposed as part of the Task Force’s work in preparing implementation of the RER (Express Rail Network) project serving the Brussels suburbs. It is aimed at creating or freeing up traffic lanes so that they can be utilised by high-occupancy vehicles or express bus services in conjunction with rail services.
The study focused on a 13km section of motorway between Wavre (a city of 30,000 in the Brussels suburbs) and Jezus-Eik (a locality at the entrance to Brussels) in the Wavre-Brussels direction. This axis is characterised by structural congestion during the morning rush hour.

3. ANALYSIS OF THE MAIN FOREIGN EXPERIENCES IN THIS AREA

First of all, the study examined to what extent a high-occupancy lane (HOV lane) would be feasible on the section of motorway in question.
To do this, the consultant in charge of the study spent two weeks in the USA (Washington State and Oregon) in 2002, meeting with various contacts and visiting HOV and bus lanes with them, and participating in an international conference on HOV lanes. The consultant also went to the Netherlands to observe the functioning of the emergency stopping lane on the A27 motorway which can be used (in certain sections) by a bus between Breda and Utrecht.

4. FORMULATION OF DEVELOPMENT AND OPERATING SCENARIOS AND SELECTION OF A SCENARIO

After a review of these foreign experiences, the feasibility study began. Five scenarios were submitted to the members of a Support Committee for their opinion and were analysed together with them.
The five scenarios were formulated as follows:

- Scenario 1: bus taking the emergency lane all along the section studied (bus lane);
- Scenario 2: addition of a convergent HOV lane in the Wavre-Brussels direction;
- Scenario 3: addition of a convergent HOV lane in each direction;
- Scenario 4: addition of a reversible HOV lane;
- Scenario 5: ramp metering and HOV bypass.

The Support Committee proceeded to analyse the five proposed scenarios, believing that the scenario to be explored should meet the following criteria:

- have no impact on the motorway's current capacity (not touch the current automobile lanes);
- be fast and simple to implement;
- not be very costly;
- be acceptable to the authorities (and legally acceptable, especially as regards any revision of the highway code).

Taking these criteria into account, the Support Committee selected Scenario 1 (bus taking the emergency lane along the section studied) for the feasibility study.

5. CHARACTERISTICS OF THE MOTORWAY SECTION STUDIED

The Wavre – Jezus-Eik bridge (at the entrance to Brussels) presents the following characteristics:

- 13,050 m in length;
- 7 bridges;
- 5 on-ramps and 4 off-ramps;
- 2 rest areas;
- 8,750 m of emergency stop lane (9 segments) with 7,750 m of usable emergency stop lane. The bus would thus have its own lane for 60% of its motorway route;
- 1 carpooling area.

The section is characterised by structural congestion at the morning rush hour beginning at 7500 m (see the following figure).
The average speeds observed on the entire section during the surveys done in February 2003 (on weekdays, at morning rush hour) are shown in the following figure:

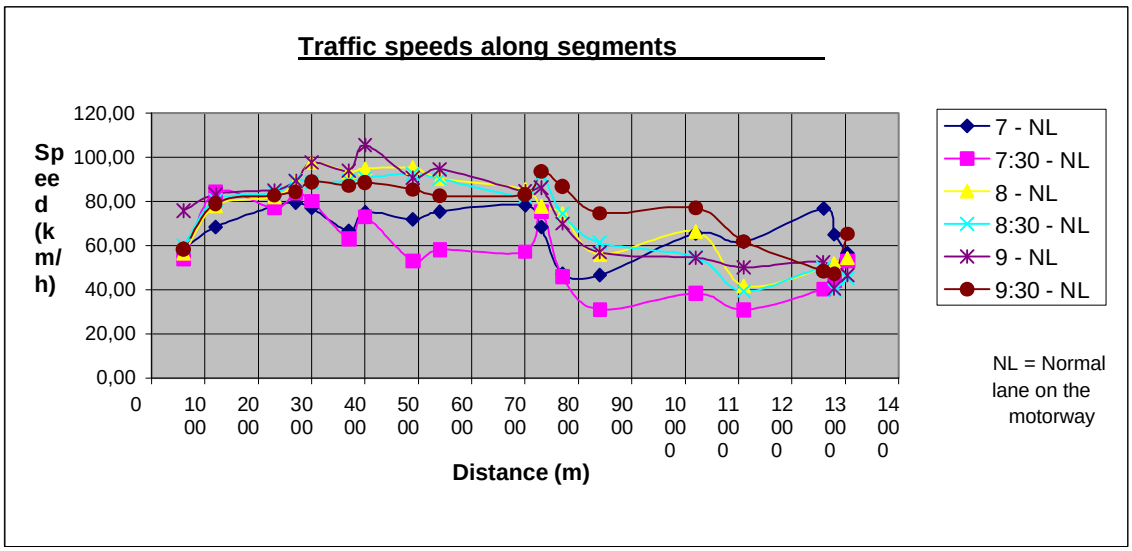

Figure 1: Traffic speeds along segments (NL : normal lane on the motorway)

The curves have their inflection point at km 11.850 (total length: 7500 m, see figure above); the average speeds are then almost systematically *under 50 km/h* until the Jezus-Eik bridge (entrance to Brussels).
These findings enable us to conclude that if the bus lane existed, the bus would take it almost systematically beginning at km 11.850 (total length: 7500 m, see figure above) during the morning rush hour.

6. DEFINING THE NEW CROSS-SECTION

6.1. Selection of a new cross-section

A new cross-section was then defined for the motorway, taking into account a bus lane.

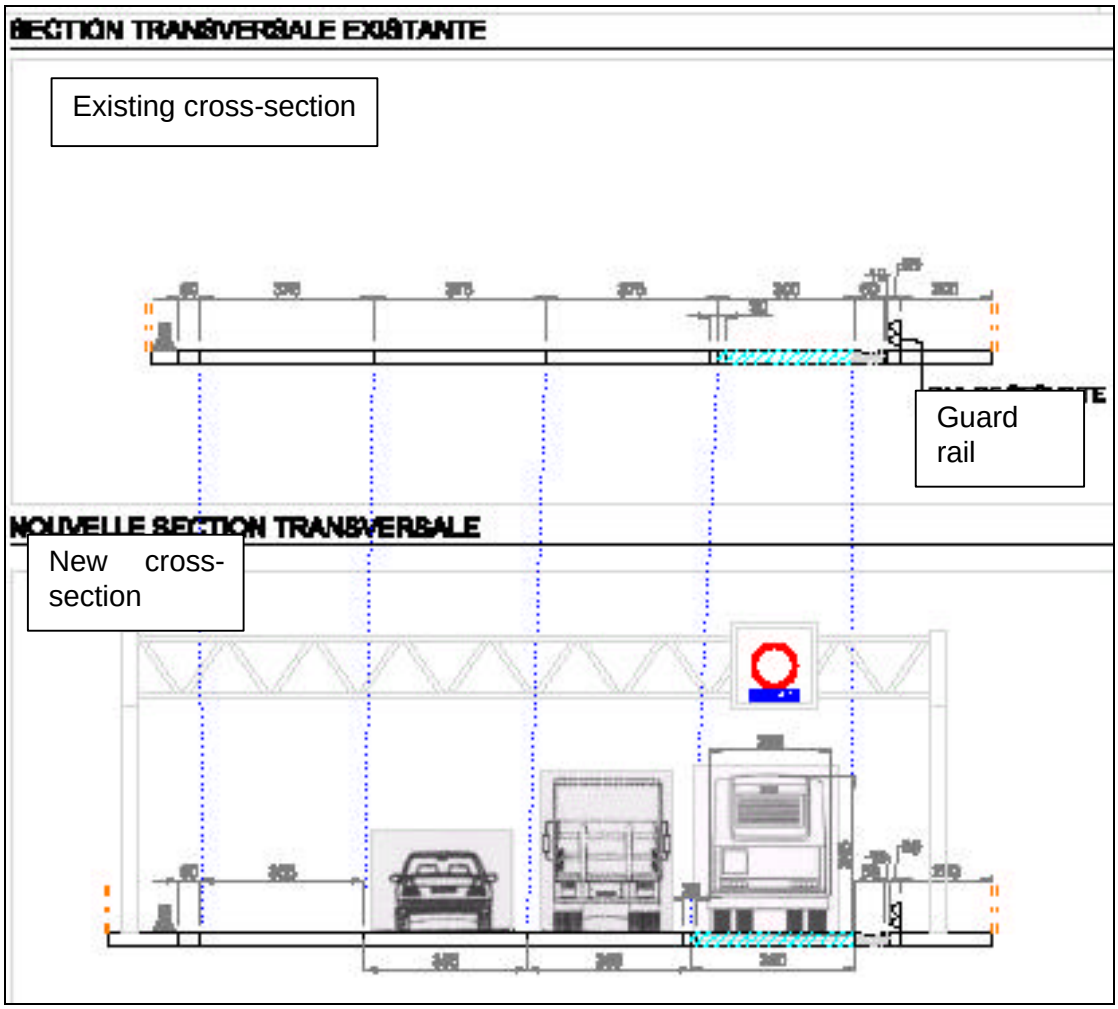

Figure 2: Existing cross-section and new cross-section

This new cross-section makes it possible to meet the criteria formulated in the five premises cited above:

- premise 1: for reasons of cost and speed of implementation, a solution is needed that avoids having to widen the existing emergency lane. Widening would in fact require moving the channels (and revising the drainage system), moving the guard rails, moving the buried fibre-optic cables, asphalting at least a 0.60 meter-wide strip along all segments, and, in addition, certain bridges could no longer be passed unless the piers were moved. Clearly then it is important to define a solution that expands the emergency lanes by shifting them to the left, consequently narrowing the normal lanes;
- premise 2: (highway safety): it is not wise to narrow the fast lanes more than the right-hand “slow” lane;
- premise 3: the width of the normal lanes must remain adequate (for the comfort and safety of motorists); they must not be less than 3.50 m wide;
- premise 4: the normal lanes should be narrowed in just one spot (for simplicity of implementation, so as not to disturb motorists, and for highway safety);

- premise 5: the bus must be able to travel at a speed of 60 km/h on the segments;

6.2. Example of passage under a bridge

Passage under a bridge is illustrated in the following figure.

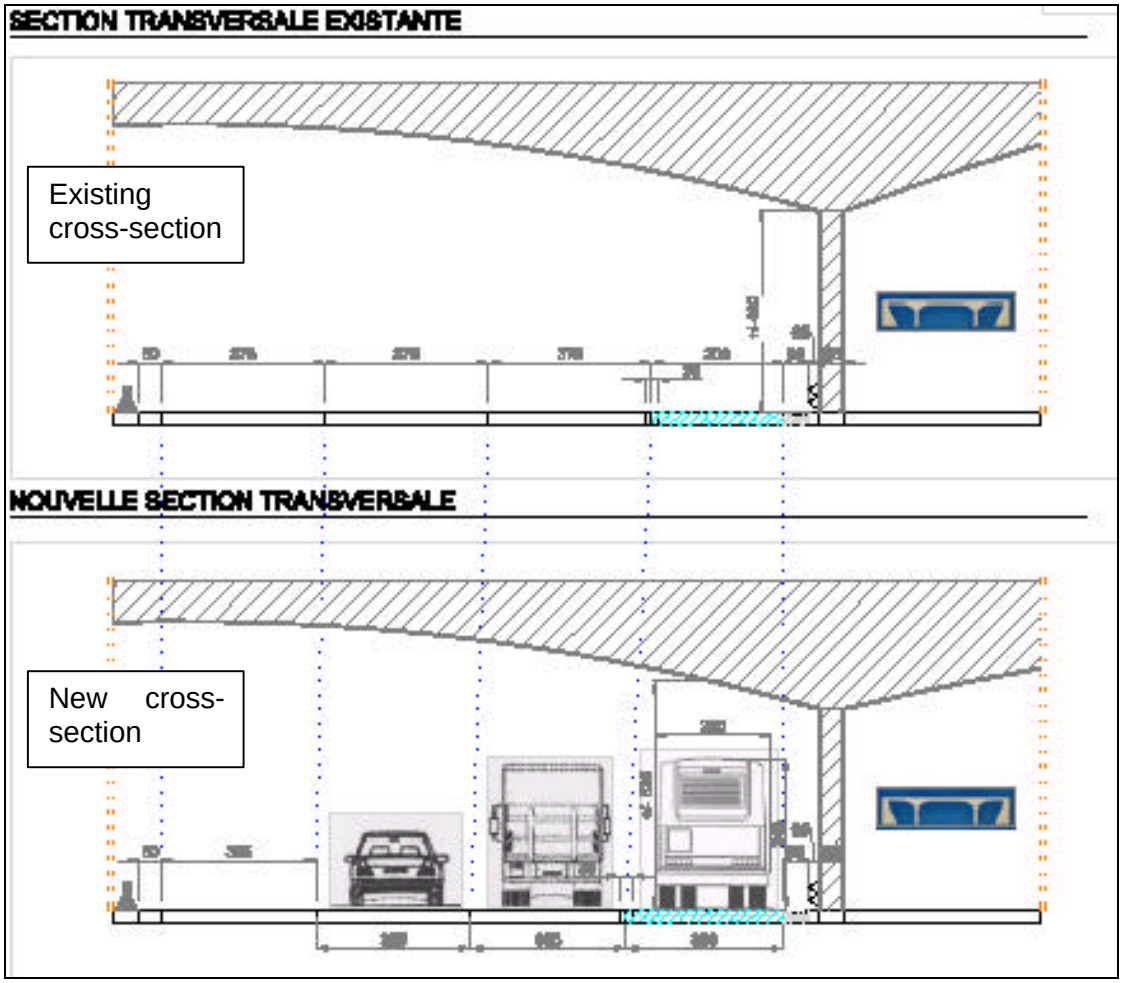

Figure 3: Passage under a bridge (existing cross-section and new cross-section)

6.3. Conflict management at motorway entrances and exits and priority

At the approach to an on-ramp onto the motorway, the bus continues on the motorway's on-ramp (see the figure below).

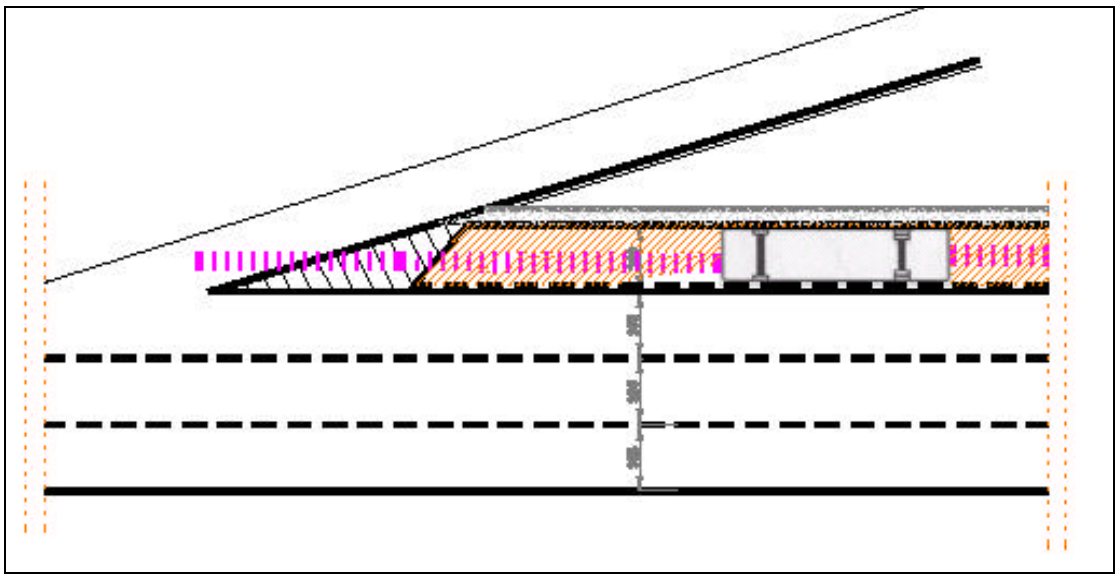

Figure 4: Conflict management at the approach to an on-ramp (see continuation in the following figure).

Signal lights will be installed to stop oncoming traffic and allow the bus to pass without slowing (passing of bus sets off signal light).

At the end of the on-ramp, the bus continues straight ahead (see the following figure).

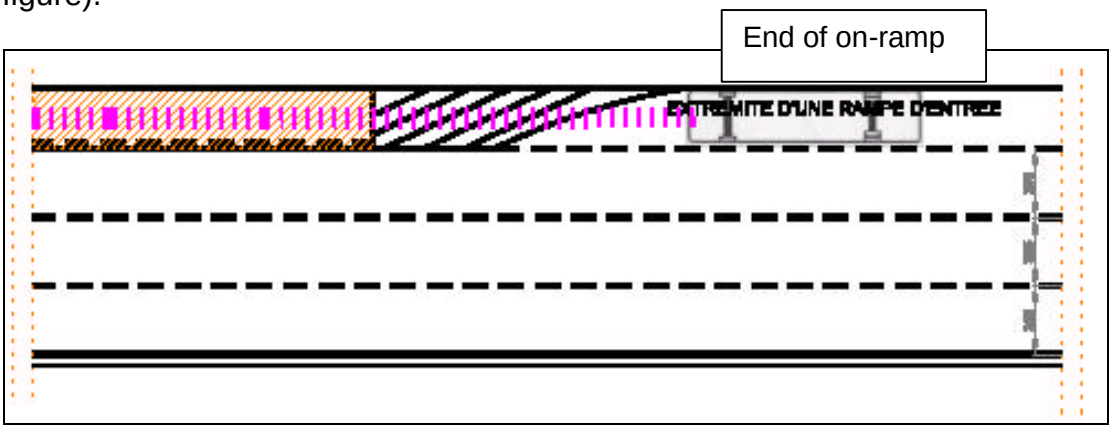

Figure 6: Bus at the end of a motorway on-ramp

At the intersection with an off-ramp onto the motorway, the bus continues on the motorway's off-ramp (see the figure below).

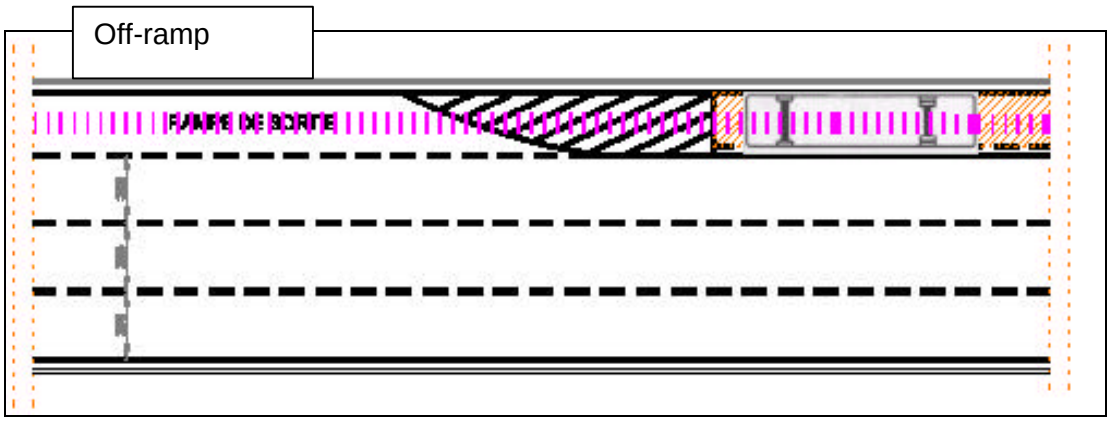

Figure 5: Conflict management at the intersection with an off-ramp

In terms of road markings, there is a continuous white line next to a dotted white line.

6.4. Highway code

A frame placed above the motorway after each on-ramp includes the “Except buses” C3 panel. The emergency stop lane thus officially becomes a bus lane, and this adaptation requires no revision of the highway code.

For motorists in distress, 8 stopping areas (or emergency stop lanes never used by the bus) are planned along the 13,050 m of the segment.

6.5. Emergency lane road foundation

Soil testing was done in order to determine the capacity of the emergency lane’s foundation to support passage of buses. The various surface strata appear to be in good condition for the objective sought. In principle, there is not problem with running 20 buses per day.

7. CONDITIONS FOR USE OF THE BUS LANE

The bus lane may be taken in the event of congestion (traffic speed below *60 km/h*), whatever the time of day or day of the week (but such limit may not however exceed the limit to be observed by the adjacent normal traffic lane by more than *25 km/hour*).
Visibility must be at least 100 m and position lights must be on.
There will be a special permit issued by the Equipment and Transport Ministry.
Training sessions and debriefs will be held for bus drivers.
With regard to police surveillance (enforcement), fixed cameras will monitor the length of the lane (which is allowed by a Royal Decree). There will be a police presence during the first few months and a permanent radio link between the buses and dispatching.

8. EVALUATION OF THE SELECTED SCENARIO

8.1. Calculation of the gain in travel time

The following figure shows that towards 7:30 a.m. the travel time reduction due to the bus lane will be more than 30%.

Departure time	Travel time (hms) on the normal lane	Travel time gain (hms) on the bus lane	
		Smax 50 km/h - Diff S 20km/h (H1)	*Smax 60 km/h - Diff S 25km/h (H2)*
7	0:12:05	0:00:29	0:00:47
7:30	0:18:37	0:04:36	**0:05:49**
8	0:13:09	0:01:42	0:02:25
8:30	0:14:43	0:03:01	0:03:37
9	0:13:01	0:01:45	0:02:14
9:30	0:12:13	0:01:19	0:01:43

Figure 7: Trip times achieved (Wavre - Jezus-Eik, 13050 m). Left-hand column normal lane, right-hand column bus lane, with two speed differentials (20 and 25 km/h)

The following figure illustrates the change in speeds along the Wavre – Jezus-Eik route with and without bus lane at 7:30 a.m. The bus lane fully performs its function beginning with the 7500 m threshold.

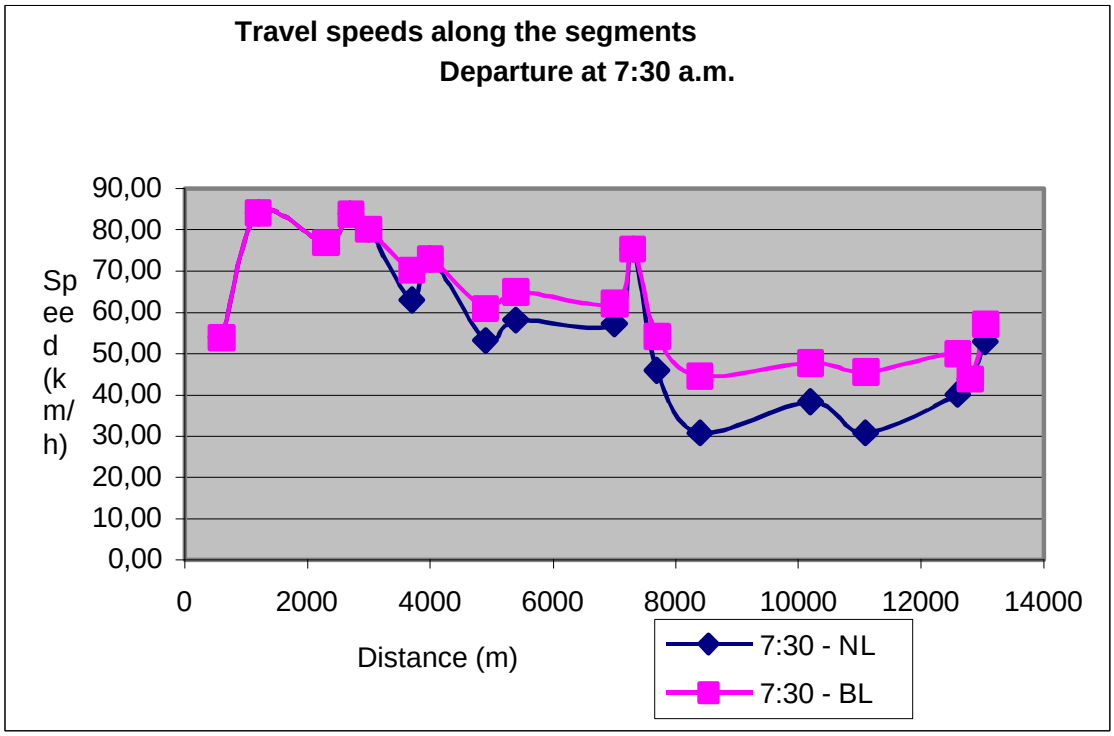

Figure 8: change in speed along the Wavre - Jezus-Eik route with and without bus lane at 7:30 (BL : bus lane; NL: normal lane)

8.2. Dispersion of travel time data

The following figure shows that the reduction in standard deviation with the bus lane makes it possible to get increased reliability in travel time.

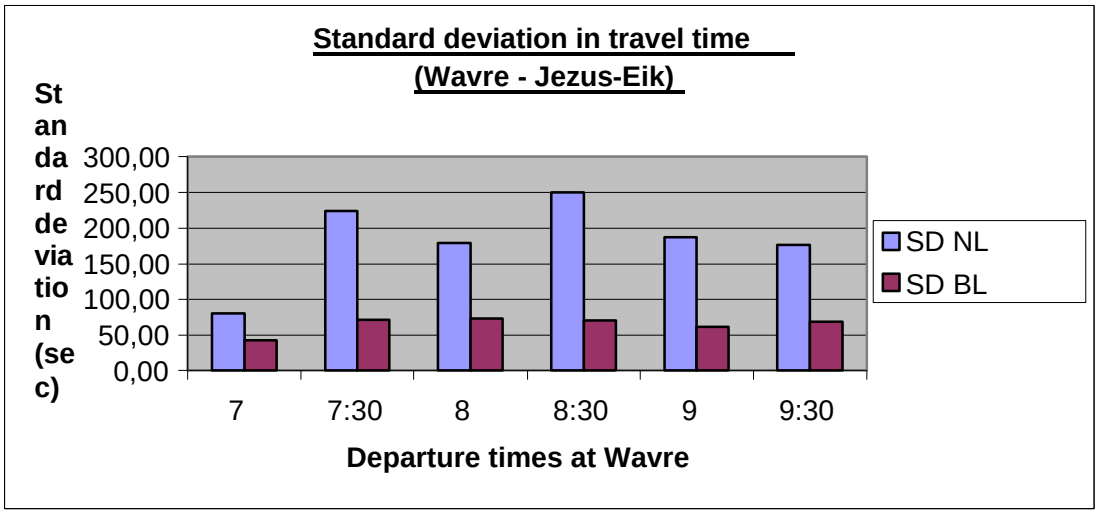

Figure 9: reduction in standard deviation with bus lane (BL : bus lane; NL: normal lane; SD: standard deviation)

The following figure shows that without the bus lane the current bus schedule on the route studied is 30 minutes, because there is a major dispersion of

points (travel time). This current schedule (without the bus lane) can be met in 90% of cases.
The same figure shows that with the bus lane, if the schedule set a travel time of 19 minutes, this could be met in 90% of cases. This enables us to conclude that the bus lane makes it possible to gain 11 minutes over the current timetable, *while maintaining a 90% reliability in schedules.*

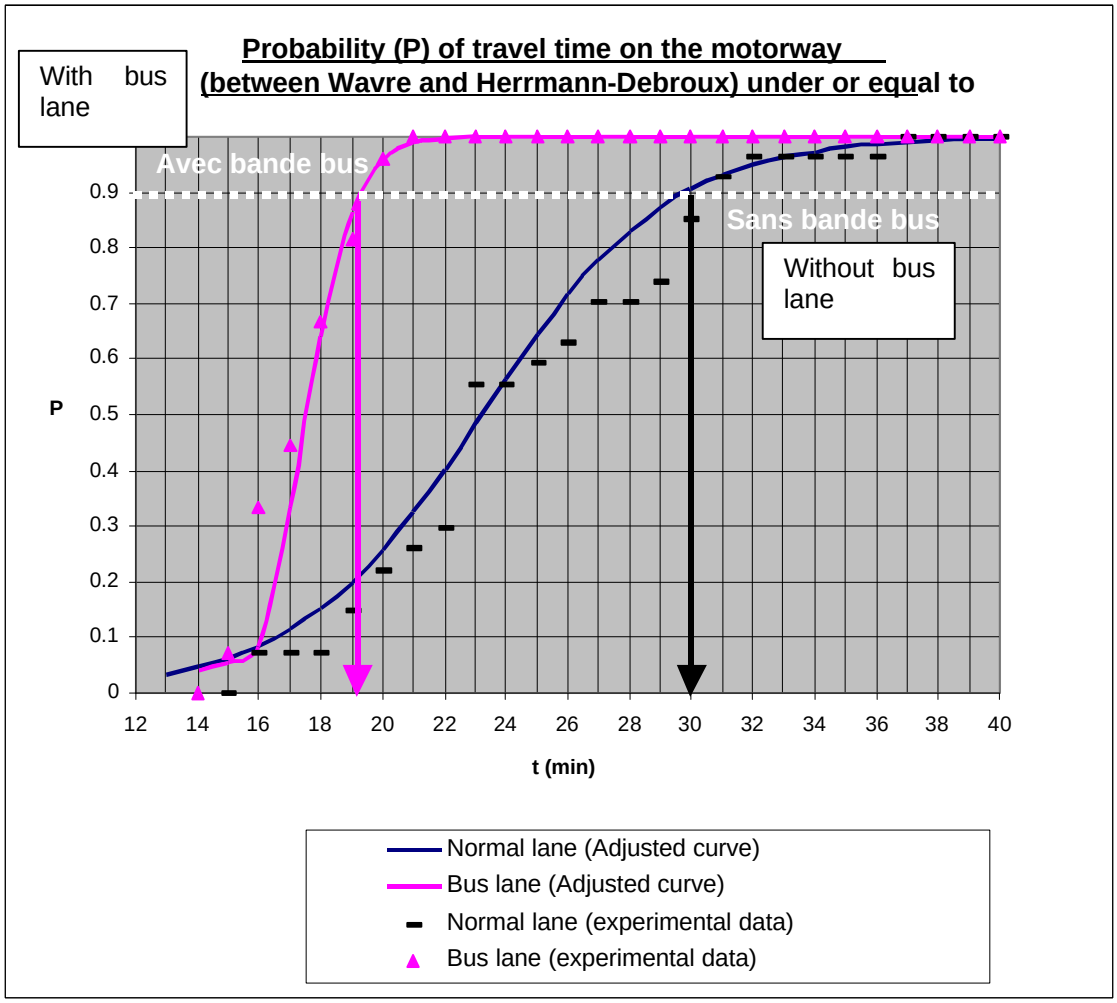

Figure 10: probability of bus travel time on the motorway with and without bus lane

8.3. Project cost analysis

So long as no more than 20 buses per day make the trip, analysis shows that the implementation cost will be about 1.65 million Euro.

9. CONCLUSIONS

The project supported by the study consists of developing the emergency stop lane on Highway E411 between Wavre and Jezus-Eik (entrance to Brussels) so that it can be used exclusively as a bus lane (regular lines). The bus would thus have its own lane for 60% of its motorway route.
This bus lane must enable bus customers to benefit from a shorter travel time to reach Brussels, and to enjoy more regular service. This measure should

eventually encourage other motorway users to change transport mode and to opt for public transportation, in this case the bus, which would make it possible to reduce motorway congestion. Similar projects have been carried out successfully in the Netherlands and the United States (Minneapolis and Seattle suburban lines).

The feasibility study shows that the following work needs to be done between Wavre and Jezus-Eik (entrance to Brussels):

- the emergency lane will be widened in places so as to give the buses a lane width of between 3.40 m and 3.60 m, whereas the normal traffic lanes with be narrowed by 0.20m each.
- 5 stop areas will be available to vehicles in distress;
- traffic lights, overhead signage (equipped with a signal prohibiting access to the right-hand lane except for buses), and other signalling infrastructure will be installed to control traffic.

Traffic in the bus lane will be regulated by two speed limits. The maximum authorised speed will be 60 km/hour, and this speed may not be more than 25 km/h over the speed of users of the adjacent normal lane.

This project has no impact on the motorway's current capacities. It is a solution that can be quickly and simply implemented without major costs (1.65 million Euro for the Wavre - Jezus-Eik section).

This project represents a solution acceptable to the authorities (and legally acceptable, especially as regards any revision of the highway code); it also gives priority to highway safety.

Travel time at morning rush hour on the segment studied will be reduced to 19 minutes from the current 30 minutes, with the same level of reliability.

BIBLIOGRAPHY

Etude des lignes du TEC Brabant wallon pénétrant dans la Région de Bruxelles-Capitale (2002) STRATEC, Bruxelles

Freeway buslanes on motorways around Amsterdam (2003) Directoraat-Generaal Rijkswaterstaat, Directie Noord-Holland, Haarlem

Journal of Public Transportation, vol. **5** (2002) National Center for Transit Research, Center for Urban Transportation Research, Tampa (Florida)

NCHRP Report 414 HOV Systems Manual (1998) Transportation Research Board, National Research Council (USA), National Academy Press, Washington, D.C.

Schijns, S. (2002) *Bus Use of Freeway Shoulders, Overview of Current Practice and Issues*, McCormick Rankin Corporation for Urban Planning Office Ministry of Transportation of Ontario

Verhooren, T. (2002) *Busses on highway safety-lanes*, Rijkswaterstaat, Directie Utrecht, Utrecht