TRUCK WIDTHS AND PATHS

René Berard, Paris Rhin Rhone Motorway Company
Alain Bourion, Professor - University of Quebec

Knowledge of the widths of heavy goods vehicles and determination of the paths they follow constitute vital information for the operator of a highway or motorway network.

These data are used in planning the widths of road and toll station lanes and have a definite impact on journey comfort and safety.

The data presented come from measurements made in a number of countries of the European Community (France, Germany and Belgium).

TRUCK WIDTHS

Stationary Static Width

This value is obtained simply by measuring the width of trailers :

- Mean width: 2.52 meters
- Maximum width: 2.68 meters
- 8% of trucks are between 2.60 and 2.68 meters wide

Instantaneous Dynamic Width

An observer on a bridge overlooking a road will observe that many trucks move "crabwise".

Video investigation of this fact shows that out of 1500 trucks (83% semi-trailers, 17% truck-trailers):

- 58 are perfectly aligned 3.9%
- 1157 are offset to the right 77.1%
- 285 are offset to the left 19.0%

The offset values vary according to the type of truck and the longitudinal profile of the road. On the average, the offset is of the order of 15 cm to the right and 10 cm to the left. Exceptionally it can reach 1 metre and 10% of trucks have an offset between 0.17 and 1 metre.

Paths Followed by Trucks

An experiment was carried out at 19 sites along 6-lane motorways to determine the transverse positions of vehicles in their lanes. The study took the following into account :

- various geometrical and other features : lane width, straight sections, bends to the right, bends to the left, absence or presence of embossed road markings.

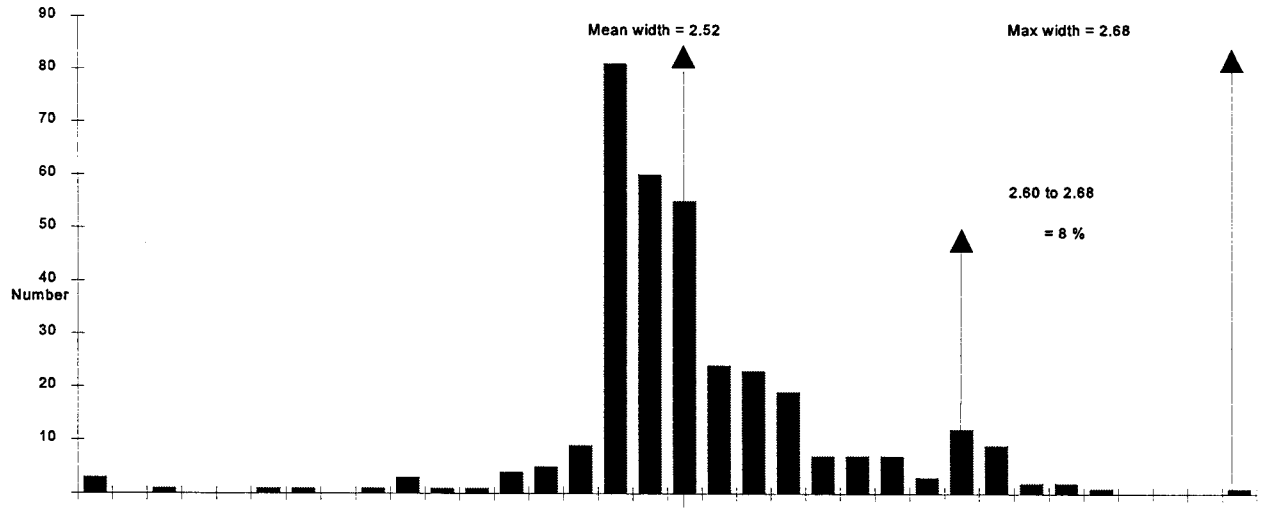

FIGURE 1 Truck's Static Widths

- the following different situations :

  * ISOLATED : Truck running in the slow lane without being overtaken and with a time interval of more than 4 seconds from the following and/or preceding vehicle.

  * TT : Truck running in the slow lane overtaken by a truck in the middle lane.

  * CTT : Previous situation with a car in the fast lane.

  * CT : Truck running in the slow lane overtaken by a car in the middle lane.

  * CCT : Previous situation with a car in the fast lane.

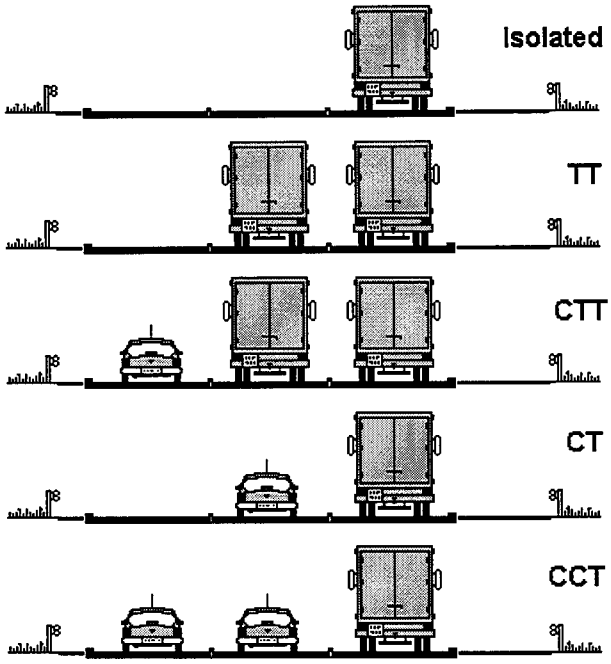

FIGURE 2 Study Situations

The lateral position of the vehicles was also noted using the following criteria

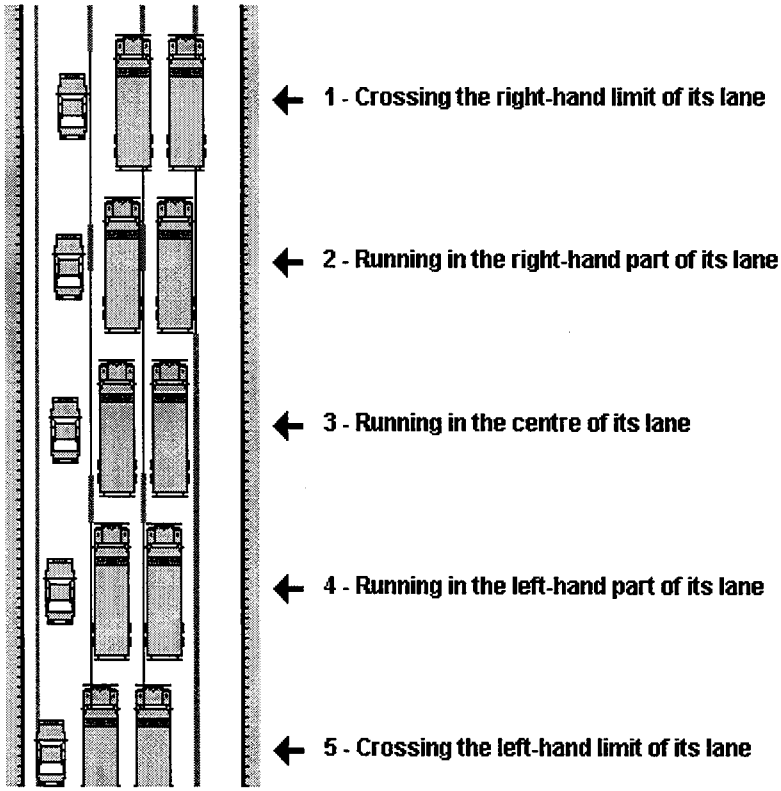

FIGURE 3 Study Situations

An initial analysis of lateral positioning in the different lanes leads to the following conclusions, excluding certain special cases:

- The "isolated" trucks follow a sinusoidal path and occupy a "dynamic width" of the order of 3.30 - 3.50 meters. Most run on the right-hand side of the slow lane (65%).

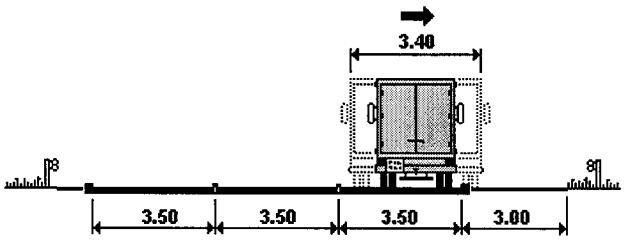

FIGURE 4 Study Situations

When they are overtaken by another truck, they reduce the amplitude of the sinusoid and together occupy a dynamic width of the order of 6.80 - 7 meters. The TT and CTT situations cause the overtaken trucks to move to the right with a high proportion running on the hard shoulder although to a lesser extent on highways.

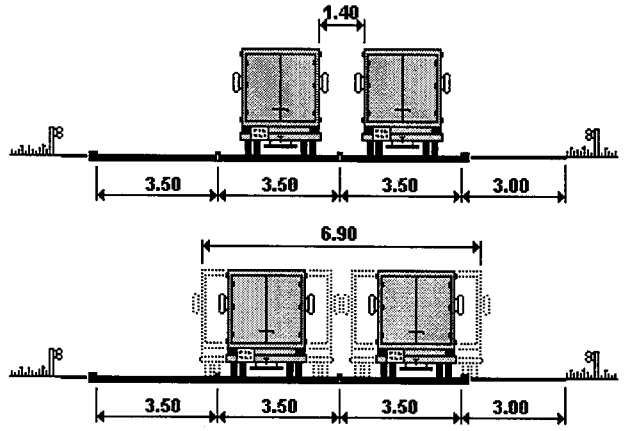

FIGURE 5 Study Situations

- The CT and CCT overtaking manoeuvres do not show any appreciable movement of the overtaken trucks towards the right. In this configuration, most of the vehicles in the middle lane are positioned on the left (CT : 85% - CCT : 71%). The same applied to vehicles in the fast lane (CCT : 52% - CTT : 79%).

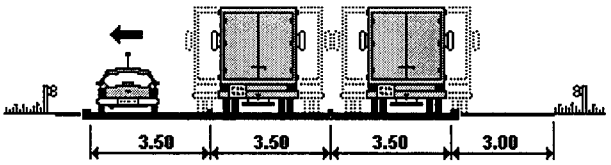

FIGURE 6 Study Situations

Interviews with truck drivers have confirmed that these observations are "normal" : the path is sinusoidal, in the isolated situation,with an amplitude of the order of ±0.50 m, lateral positioning in the lanes depending on the different situations.

LATERAL POSITION OF TRUCKS - FEATURES INFLUENCE BINARY FACTORIAL ANALYSIS

To permit an evaluation of features that may influence the lateral position of trucks, a binary factorial analysis was carried out using:

- As individuals: 19 motorway sites (France, Germany, Belgium)
- As variables: the lateral position expressed as a frequency (%) with 5 positions (Hard; Shoulder; Right; Center; Left; Middle).

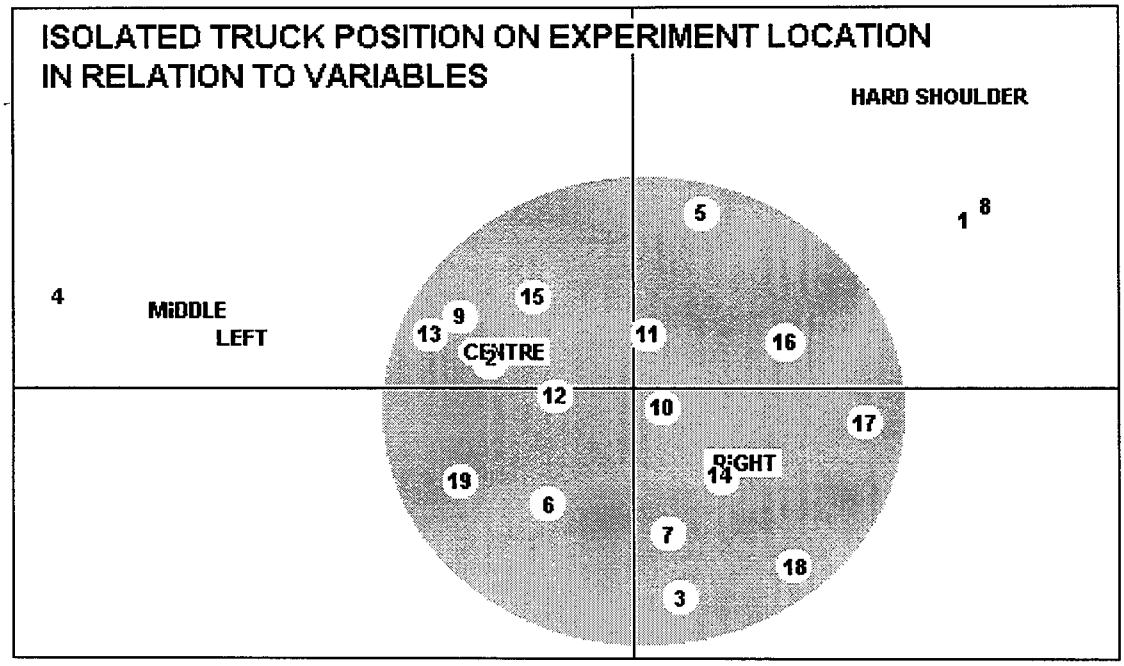

FIGURE 7 Isolated Truck Position on Experiment Location in Relation to Variables

The following graphs illustrate the variables and the sites for isolated trucks. The "LEFT" variable makes the biggest contribution to the abscissa axis in the factorial plane. The "HARD SHOULDER" variable and, to a lesser extent, the "RIGHT" variable contribute to the ordinate axis in the factorial plane.

This graphical presentation shows three sites which differ appreciably from the principal group of points:

- **Site No. 4**

This site shows a discontinuity of line in the immediate vicinity of the measurement point.

- **Sites 1 and 8** are close to the "hard shoulder" variable. Site 1 is a low radius bend to the right in which trucks tend to "straighten out" the curve. Site 8 is the end of a descending bend to the left with a movement towards the outside of the curve.

An appropriate statistical analysis was done in order to verify whether the positions encountered are significantly different. This leads to the determination of a coefficient C which is then compared with the two values given below, which depend on the chosen risk and which must be exceeded for it to be concluded that the situations tested are in fact different.

TABLE 1 Statistical Analysis

	Statistical test significance table	
Level of risk	5 %	1 %
Coefficient C	1.36	1.63

For two samples A and B

A = B if C < 1.63 (risk level 1 %)

A = B if C > 1.63 (risk level 1 %)

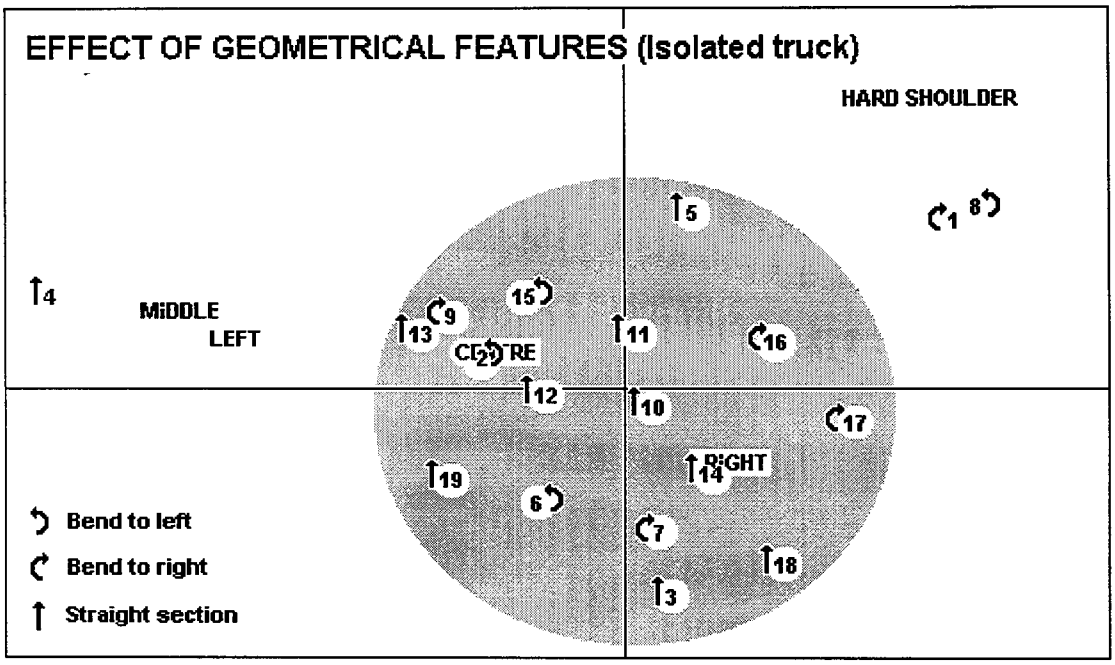

FIGURE 8 Effect Of Geometrical Features

TABLE 2 Study Results

Samples compared	Bend to right Bend to left	Bend to right Straight section	Bend to left Straight section
Coefficient C	6.61	4.78	4.68

The transverse positioning of isolated trucks in the slow lane depends on the road layout.

The following table summarizes all the measurements made on the sites with the same layout (except for the three different sites previously mentioned).

TABLE 3 Study Results

	HARD SHOULDER	RIGHT	CENTRE	LEFT	MIDDLE
Bend to left	7 %	51.5 %	21.8 %	19.2 %	1.5 %
Bend to right	10.2 %	61.1 %	19.6 %	8.8 %	0.3 %
Straight section	6.5 %	56.6 %	23.1 %	13.0 %	0.8 %

- For bends to the left; the "LEFT" and "MIDDLE" variables are larger than on the other sites.
- For bends to the right; the "HARD SHOULDER" and "RIGHT" variables are larger than on the other sites.
- For straight sections; the "RIGHT" and "LEFT" variables both lie between the bends to the left and bends to the right.

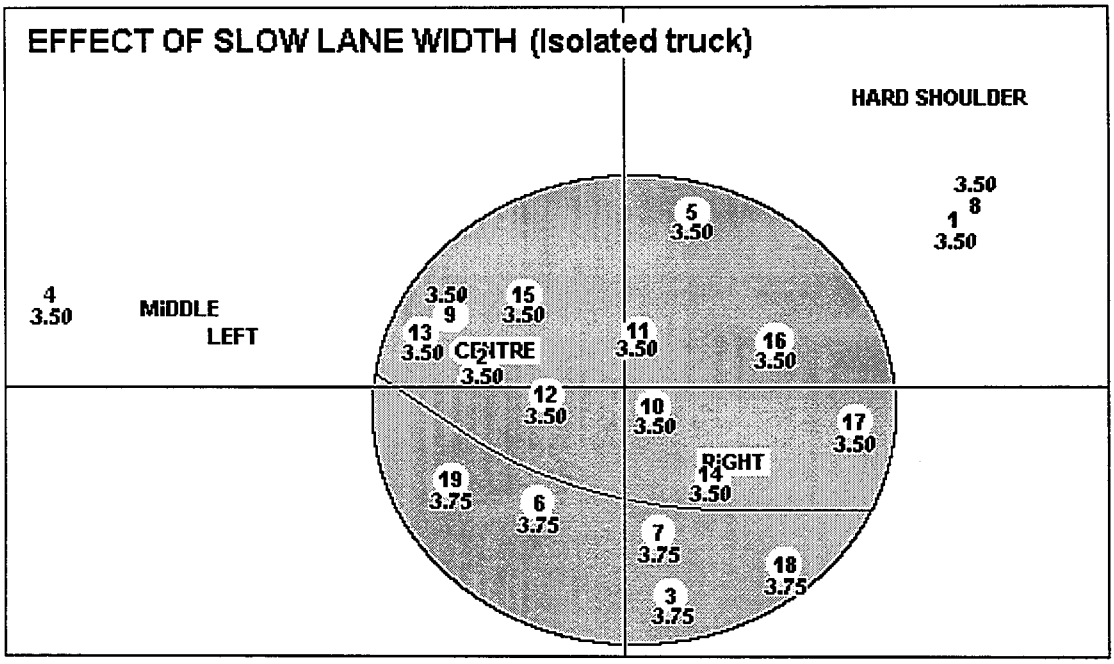

FIGURE 9 Effect Of Slow Lane Width

TABLE 4 Study Results

Samples compared	Slow lanes 3.50 and 3.75 meters wide
Coeff. C	6.16

The transverse positioning of isolated trucks also appears to be appreciably influenced by the width of the slow lane.

By grouping the sites according to slow lane width (except for the three differing sites) the proportions given in the following table are obtained.

TABLE 5 Study Results

Slow lane width	HARD SHOULDER	RIGHT	CENTRE	LEFT	MIDDLE
3.50 m	9.8	50.7	24.1	14.5	0.9
3.75 m	2.8	65.7	18.0	12.7	0.8

Sites with slow lanes 3.75 m in width are characterized as having a low proportion of vehicles crossing onto the hard shoulder but, on the other hand, a high proportion of trucks run on the right of the slow lane.

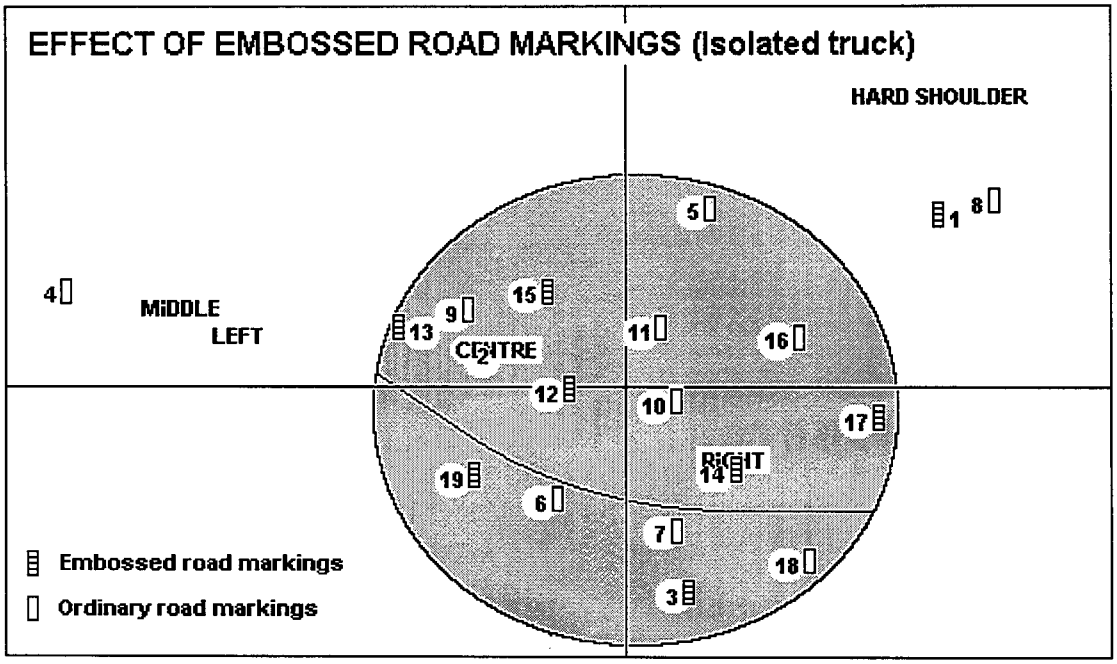

FIGURE 10 Effect Of Embossed Road Marking

TABLE 6 Study Results

Samples compared	All sites : with marking without marking	COURTENAY site : 10/12 Paris → Lyon bound with marking without marking	COURTENAY site : 11/13 Lyon → Paris bound with marking without marking
Coefficient C	6.89	1.63	4.50

The transverse positioning of isolated trucks in the slow lane is also appreciably influenced by the presence of embossed markings between the slow lane and the hard shoulder.

This fact, observed on all the sites, results in practice in a movement to the left of all the positions as the following table shows:

TABLE 7 Study Results

	Positioning of isolated trucks	
Position	with embossed markings	without embossed marking
HARD SHOULDER	6.8 %	7.9 %
RIGHT	51.8 %	60.9 %
CENTER	24.8 %	18.7 %
LEFT	15.5 %	12.0 %
MIDDLE	1.1 %	0.6 %

Special case of COURTENAY

Of all the sites observed, it is possible to pick out two particular sites, those numbered (10/12) and (11/13).

Video observations of the BEFORE/AFTER type were made on these sites.

- On site No. 10, embossed markings were laid in the conventional manner – site 12.

- On site No. 11, embossed markings were laid on the slow lane. These markings, black in colour, were laid inside the slow lane between the existing white markings – site 13.

The following table gives the "BEFORE/AFTER" positioning measurements for these particular sites:

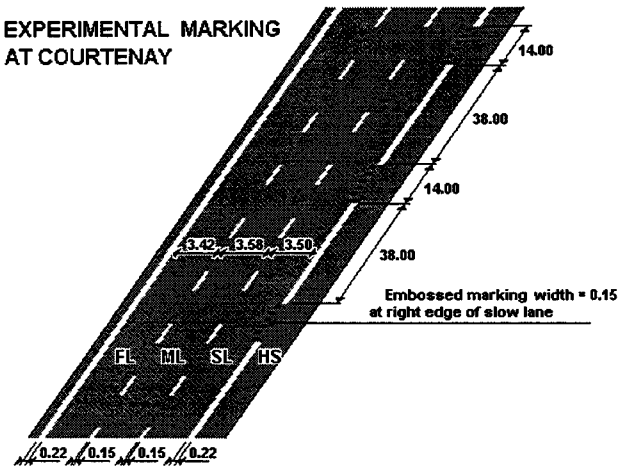

FIGURE 11 Experimental Marking at Courtenay

TABLE 8 Study Results

Sites	HARD SHOULDER	RIGHT	CENTRE	LEFT	MIDDLE
10 - Before marking	8.6 %	55.1 %	24.4 %	11.6 %	0.3 %
12 - After marking	7.1 %	50.5 %	25.6 %	15.8 %	0.9 %
11 - Before marking	11.9 %	50.8 %	22.0 %	14.9 %	0.4 %
13 - After marking	7.1 %	40.8 %	29.7 %	21.7 %	0.7 %

In view of the size of the sample, the significance test appears limiting for the "BEFORE/AFTER" site (10/12). On the other hand, site (11/13) clearly shows the effectiveness and value of the experimental marking mentioned.

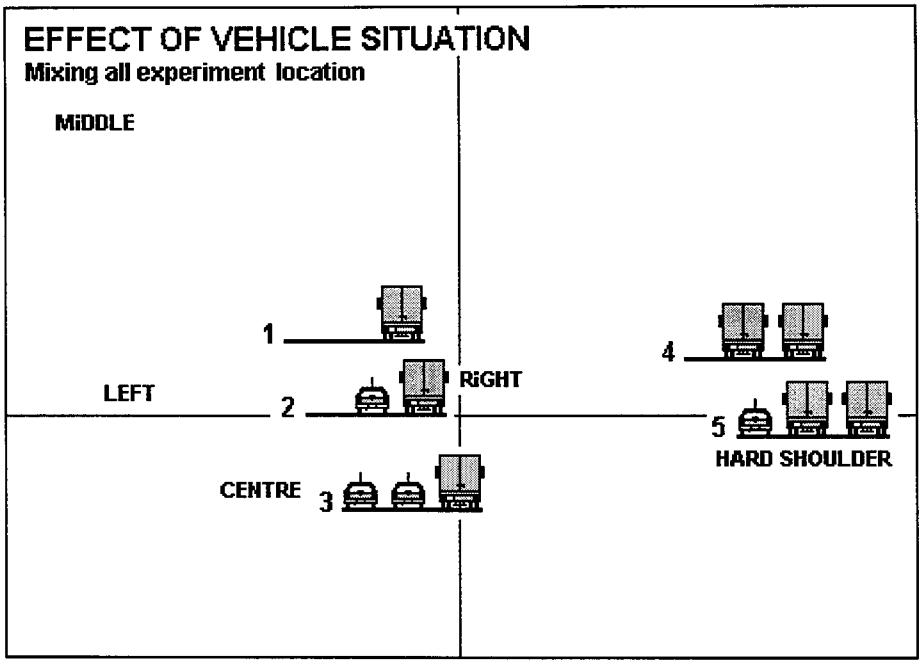

FIGURE 12 Effect Of Vehicle Situation

TABLE 9 Study Results

Samples tested	Isolated CT	CT CCT	CT TT	TT CTT	CCT CTT
Coefficient C	2.58	1.17	8.35	0.89	4.56

- The CT and CCT overtaking manoeuvres only slightly affect the path of the overtaken truck.

- The TT and CTT overtaking manoeuvres cause the overtaken truck to move significantly to the right.

CONCLUSIONS

- This report shows that TT and CTT situations - truck running in the slow lane overtaken by a truck in the middle lane and previous situation with a car in the fast lane - cause the overtaken trucks to move to the right with a high proportion running on the hard shoulder.

- The CT and CCT overtaking manoeuvres - truck running in the slow lane over taken by a car in the middle lane and previous situation with a car in the fast lane - do not show any appreciable movement of the overtaken trucks towards the right.

- The transverse positioning of trucks in the slow lane is appreciably influenced by the presence of embossed markings between the slow lane and the hard shoulder. These ones reduce significantly the number of trucks crossing the right-hand limit of the slow lane and encroaching upon the hard shoulder.

- The 3.50 meters wide lanes seem a little narrow during the overtaking manoeuvre. A 7.25 meters width as for the whole slow lane and middle lane reduce with a significant way the overrunning on the hard shoulder and on the middle lane.