TRAFFIC CALMING ON URBAN ROAD IN OSTRAVA-PORUBA

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Summary: The paper deals with problems of traffic calming on four-lane divided urban road which is influence by parking maneuvers and two-lane roundabout. There are shows proposals of modifications of sections between intersections of this road and also capacity evaluation of roundabout after modification on roundabout with one-lane circulating roadway and one-lane entries and exits according to new methodology of capacity calculation which solves also capacity of exits which are influenced by pedestrian flows.

Key words: Road Transport, Traffic Calming, Parking, Roundabout.

INTRODUCTION

The traffic calming on urban roads is very important in road traffic where is danger of mutual influencing of various traffic participants – usually vehicles and pedestrians. The basis is adapting of road traffic to needs of all participants (if it is possible). Safety, improving of environment and increase of utility value of urban road must be secured. Motor road transport must not be sole preferred item of street area. Last but not least, we try to improve the aesthetics of public space.

On the other hand, we must keep in mind that it's necessary to arrange traffic flow continuity and traffic flow quality of demanded degree. On the basis of capacity evaluation it's necessary to find a solution which will accommodate these demands.

This paper presents selected results of surveys of traffic problems on an urban road in Ostrava-Poruba. Under the terms of research project we must make evaluation of traffic behavior of drivers and other traffic participants. Attention was aimed to influence of parking maneuvers on traffic flow continuity and also to influence on capacity after modification of two lane roundabout on one-lane roundabout. The next text shows some proposals of modifications of this road and also capacity evaluation of mentioned roundabout.

1. DESCRIPTION OF LOCALITY

The monitored urban road Hlavní třída is located in historic centre in Ostrava-Poruba (see Fig. 1 and 2). It's an urban road with two traffic lanes for each direction and with a wide dividing strip (including the footpath and bicycle path as well). In some places there are

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perpendicular parking places (see Fig. 3) situated, which are tolled (parking meters, working days from 8 a.m. to 6 p.m.). On the right side of the traffic strips (practically throughout its length) there are parallel parking places situated (see Fig. 3 again) which aren't tolled. Roundabout Hlavní třída – Porubská is shown in Fig 4.

Source: www.mapy.cz

Fig. 1 - Hlavní třída in Ostrava-Poruba (part 1)

Source: www.mapy.cz

Fig. 2 - Hlavní třída in Ostrava-Poruba (part 2)

Source: https://maps.google.cz

Fig. 3 - Parking places of various type on Hlavní třída in Ostrava-Poruba

Source: www.mapy.cz

Fig. 4 - Roundabout Hlavní třída – Porubská in Ostrava-Poruba

There was a survey of traffic flow volumes and static transport survey carried out. The traffic flow volumes are variable due to occurrence of six intersections in the monitored section of road. The peak traffic volume is shown in Fig. 5, 6 and 7. The majority of vehicles (about 90 %) were passenger cars (or vans), about 5 % buses and the rest of 5 % is formed by trucks or the other vehicles (motorbike etc.). The traffic of heavy trucks with weight above 3.5 tons is excluded on this road.

Source: www.mapy.cz + authors

Fig. 5 - Traffic flow volumes (veh/h) in Hlavní třída in Ostrava-Poruba (part 1)

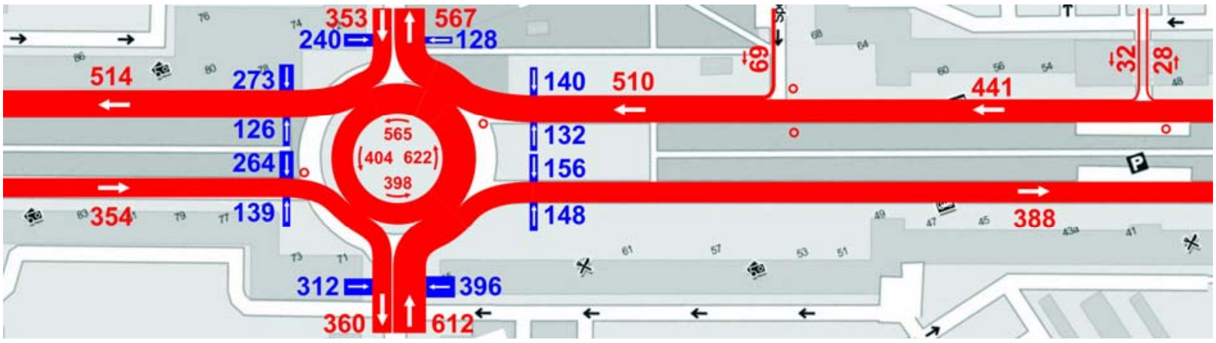

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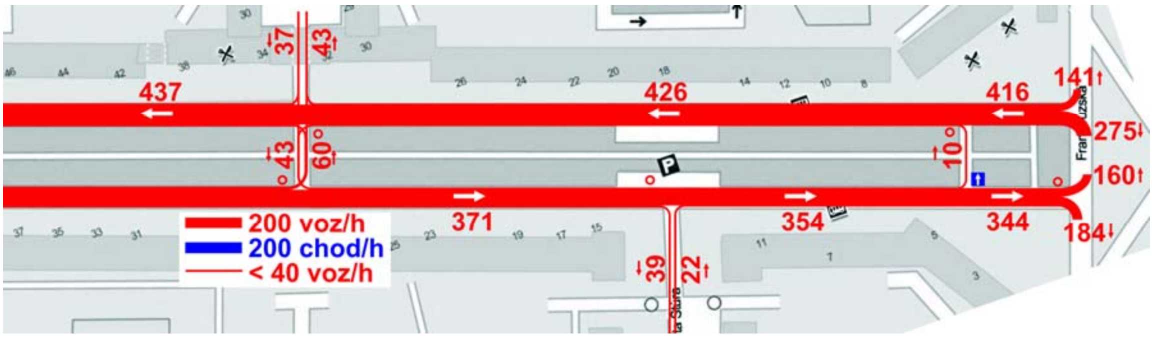
Fig. 6 - Traffic flow volumes (veh/h) and pedestrian volumes (ped/h)
in Hlavní třída in Ostrava-Poruba (part 2)



Source: www.mapy.cz + authors

Fig. 7 - Traffic flow volumes (veh/h) in Hlavní třída in Ostrava-Poruba (part 3)[4]

2. TRAFFIC CALMING

At present there are following basic problems on this street:

1. problems with parking maneuvers:
   a. influencing of passing vehicles by vehicles which are making the parking maneuver; it's refers especially to parallel parking which is almost on whole of length of road – on the right side of traffic strip,

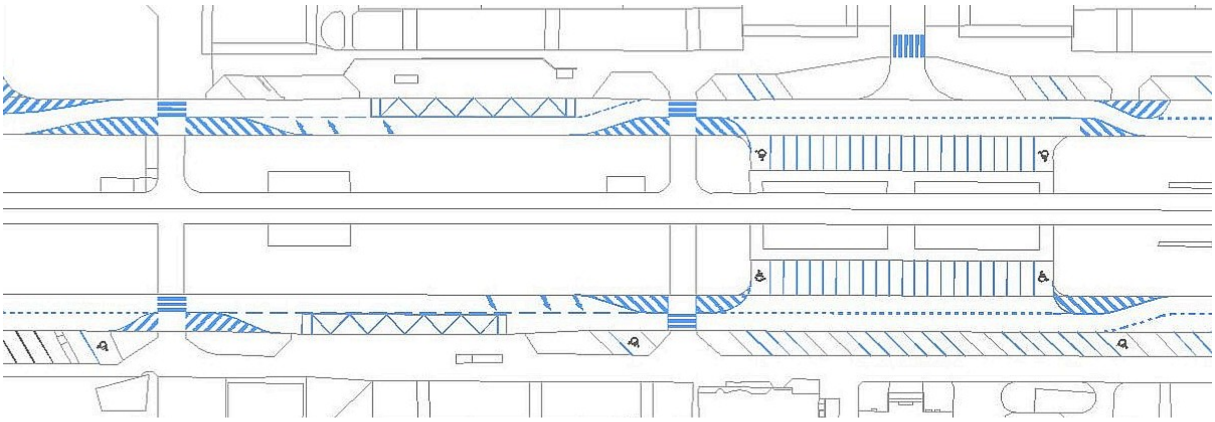
[4] voz/h = vehicles per hour, chod/h = pedestrians per hour

   b. using especially the left traffic lane for the reason of frequent stopping of vehicles in the right traffic lane – it's caused either by absence of empty parking places (without charge) or there are supply vehicles (usually larger vehicles, i.e. vans or trucks),

2. problems with great speeds of vehicles, especially motorbikes – their drivers use the long straight section of this road,
3. problems of roundabout.

2.1 Problems with parking maneuvers

Thanks to low traffic volumes we can reduce the number of traffic lanes for each of traffic strips – from two traffic lanes to one traffic lane (see Fig. 8). This running lane will serve to vehicles passing and in front of intersections, where there are higher traffic volumes of turning vehicles, we can again increase the number of traffic lanes and use them also as turning lanes. The second lane between intersections will serve as maneuver space for vehicles parking. Besides, this lane will be used by drivers/pedestrians who are getting off a car or getting into a car.



Source: Authors

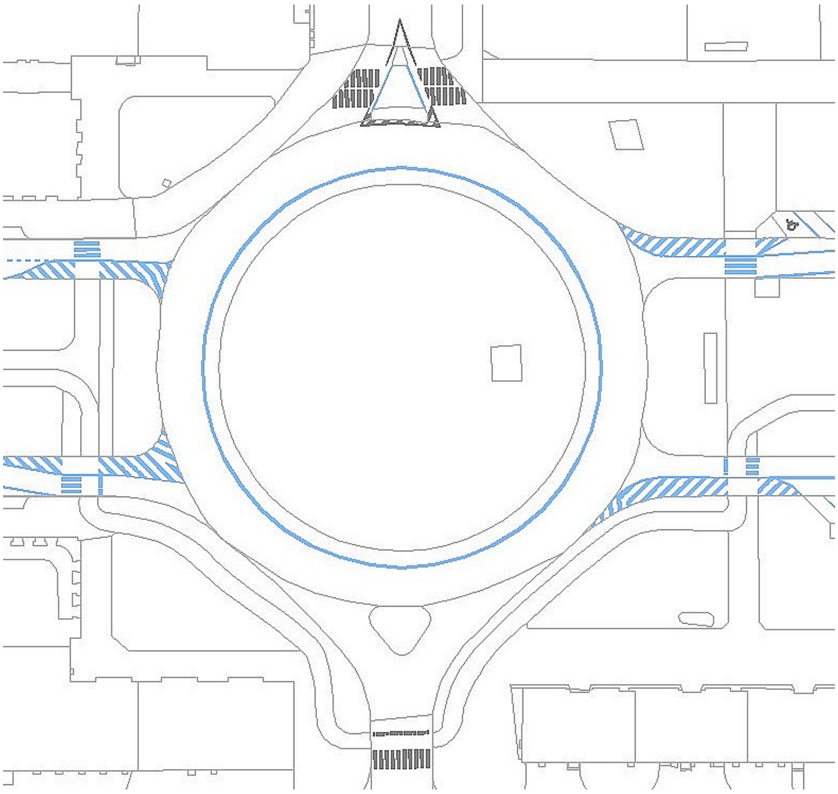
Fig. 8 - The measures for reduction of speed of passing vehicles

2.2 Problems with speed

The solution of this problem (i.e. the necessity of speed reduction) can be reached by alternate use of the origin left and right traffic lane for a newly made running lane (see Fig. 8).

2.3 Problems with roundabout

Roundabout with two-lane circulating roadway and with some two-lane exits isn't safe solution of this type of roundabout. Two-lane roundabouts include danger cross-points of crossing. On the countrary the one-lane roundabout includes only points of access and turning points of crossing. Figs. 9 and 10 show various designs of solution. In the next chapter is made capacity evaluation of these designs.



Source: Authors

Fig. 9 - The modified roundabout – variant A

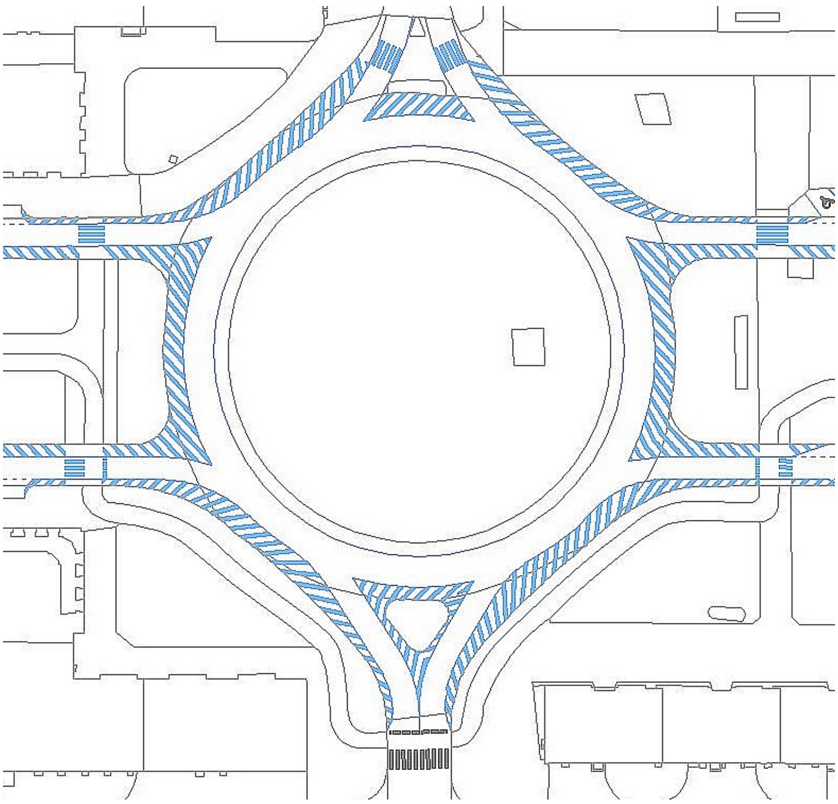


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Fig. 10 - The modified roundabout – variant B

3. CAPACITY EVALUATION OF ROUNDABOUT

3.1 Theory of calculation

Capacity evaluation of individual solutions of roundabout was made by valid methodology according to TP 234 validated since 2011 (1). In comparison to earlier methodologies of calculations there are solved not only entry capacities, but also exit capacities. Besides, the exits are influenced by pedestrian crossings (or by pedestrians). For calculation the volumes in veh/h have to be recalculated to so-called unit vehicles (u.v./h).

Capacity of entry C_i [u.v./h] according to TP 234 (1):

$$C_i = 3600 \cdot \left(1 - \frac{\Delta \cdot I_k}{n_k \cdot 3600}\right)^{n_k} \cdot \frac{n_{i,koef}}{t_f} \cdot e^{-\frac{I_k}{3600} \cdot \left(t_g - \frac{t_f}{2} - \Delta\right)} \qquad (1)$$

where:

I_k traffic flow volume on circulating roadway [u.v./h]
n_k number of traffic lanes on circulating roadway [-]
$n_{i,koef}$ coefficient of number of traffic lanes on entry [-]
t_g critical gap [s]
t_f following gap [s]
Δ minimal gap between vehicles on circulating [s]

Capacity of exit (influenced by pedestrian crossing) C_e [u.v./h] according to TP 234 (1):

$$C_e = \frac{3600 \cdot n_{e,koef}}{t_f} \cdot e^{-\frac{I_{ch}}{3600} \cdot \left(t_g - \frac{t_f}{2}\right)} \qquad (2)$$

where:

I_{ch} pedestrian volume [ped/h],
$n_{e,koef}$ coefficient of number of traffic lanes on exit [-],
t_f following gap [s],
t_g critical gap [s]:

$$t_g = \frac{d_p}{v_p} + \frac{d_v}{v_v} + t_{bezp} \qquad (3)$$

where:

d_p length of pedestrian crossing [m],

v_p pedestrian speed [m/s],

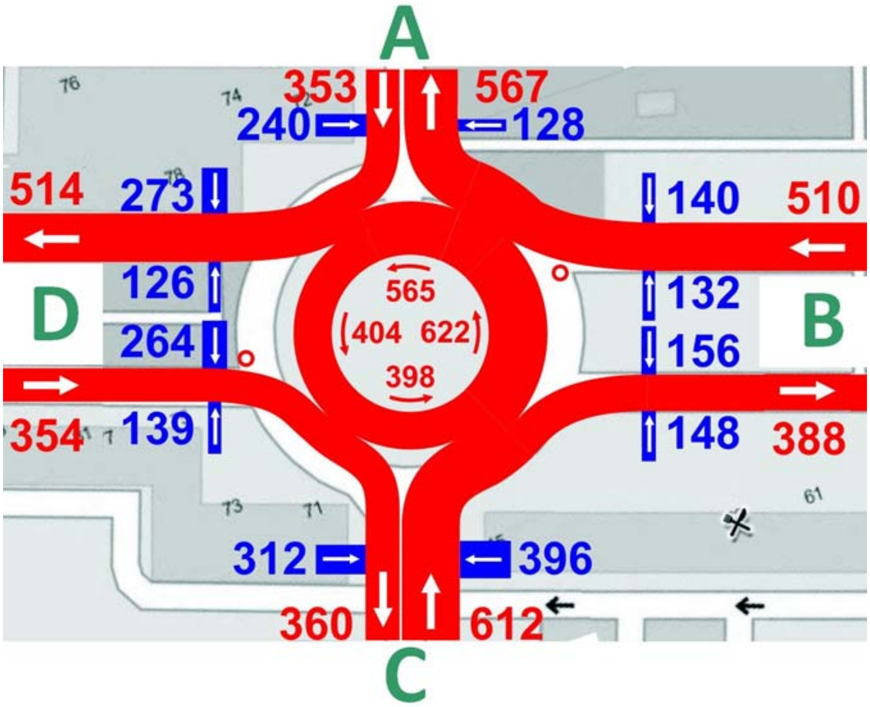
d_v vehicle length [m],

v_v vehicle speed [m/s],

t_{bezp} safe distance between vehicle and pedestrian [m].

Detailed calculations – see TP 234 (1).

In follows text is the capacity evaluation of present roundabout (variant 0) and designed variants A and B. Tables include entry/exit capacities, their reserves and traffic flow quality (UKD). Figure 11 shows traffic flow volumes (veh/h), pedestrian volumes (ped/h) and marking of legs (A – D). For calculation the volumes in veh/h were recalculated to unit vehicles (u.v./h) – by TP 234 (1).



Source: Authors

Fig. 11 - Traffic flow volumes (red, veh/h) and pedestrian volumes (blue, ped/h) on roundabout

3.2 Variant 0 (present roundabout)

Present roundabout have two-lane circulating roadway, and two-lane entries and exit on legs B and D. Capacity evaluation of entries is in Tab. 1 and of exits in Tab. 2.

Tab. 1 - Capacity evaluation of *entries* – variant 0 (two-lane circulating roadway)

Entry (number of lands)	Traffic flow volume of entry	Capacity of entry	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane)	385.2	900.4	515.2 (52.7)	A
B (2 lanes)	548.0	1 294.6	746.6 (57.7)	A
C (1 lane)	631.0	1 021.8	390.8 (38.2)	A
D (2 lanes)	366.6	1 528.8	1 162.2 (76.0)	A

Source: Authors

Tab. 2 - Capacity evaluation of *exits* – variant 0 (two-lane circulating roadway)

Exit (number of lanes; length of pedestrian crossing)	Traffic flow volume of exit	Capacity of exit	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane, 25.5 m)	600.2	215.1	**-385.1 (-)***	**F***
B (2 lanes, 6.5 m)	420.6	1 185.9	765.3 (64.5)	A
C (1 lane, 10.0 m)	373.0	295.3	**-77.7 (-)**	**F**
D (2 lanes, 6.6 m)	535.2	1 095.3	560.1 (51.1)	A

Source: Authors

*) This considerable negative reserve (or traffic flow quality of degree F) is caused by great length of pedestrian crossing (25.5 m), which isn't interrupted in place of refuge island. In case of interrupting the length of pedestrian crossing on exit would be shorter. For example for length 7.5 m (traffic lane width of exit) the exit capacity is 679.3 u.v./h, reserve 79.1 u.v./h (or 11.6 %) and traffic flow quality of degree D.

The present roundabout doesn't accommodate on exits A and C. The small capacities of these exits are caused by inappropriately pedestrian crossings (see note below Tab. 2).

3.3 Variant A

In this variant is roundabout designed as one-lane roundabout. The entries and exits are also with one lane. Capacity evaluation of entries is in Tab. 3 and of exits in Tab. 4.

Tab. 3 - Capacity evaluation of *entries* – variant A (one-lane circulating roadway)

Entry (number of lanes)	Traffic flow volume of entry	Capacity of entry	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane)	385.2	875.1	489.9 (56.0)	A
B (1 lane)	548.0	816.8	268.8 (32.9)	B
C (1 lane)	631.0	1 012.8	381.8 (37.7)	A
D (1 lane)	366.6	1 009.9	643.3 (63.7)	A

Source: Authors

Tab. 4 - Capacity evaluation of *exits* – variant A (one-lane circulating roadway)

Exit (number of lanes; length of pedestrian crossing)	Traffic flow volume of exit	Capacity of exit	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane, 7.5 m)	600.2	823.4	223.2 (27.1)	B
B (1 lane, 3.5 m)	420.6	895.5	474.9 (53.0)	A
C (1 lane, 10.0 m)	373.0	348.0	**-25.0 (-)**	**F**
D (1 lane, 3.5 m)	535.2	1 032.8	497.6 (48.2)	A

Source: Authors

The roundabout of variant A doesn't accommodate only on exit C. The small capacity of this exit is caused by long pedestrian crossings (10.0 m).

3.4 Variant B

In this variant is roundabout designed also as one-lane roundabout. The entries and exits are also with one lane. In comparison with variant A, the variant B has different radii of entries and exits, and different length of pedestrians crossing on leg A. Capacity evaluation of entries is in Tab. 5 and of exits in Tab. 6.

Tab. 5 - Capacity evaluation of *entries* – variant B (one-lane circulating roadway)

Entry (number of lanes)	Traffic flow volume of entry	Capacity of entry	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane)	385.2	875.1	489.9 (56.0)	A
B (1 lane)	548.0	816.8	268.8 (32.9)	B
C (1 lane)	631.0	1 012.8	381.8 (37.7)	A
D (1 lane)	366.6	1 009.9	643.3 (63.7)	A

Source: Authors

Tab. 6 - Capacity evaluation of *exits* – variant B (one-lane circulating roadway)

Exit (number of lanes; length of pedestrian crossing)	Traffic flow volume of exit	Capacity of exit	Reserve	UKD
	u.v./h	u.v./h	u.v./h (%)	-
A (1 lane, 4.0 m)	600.2	1 029.8	429.6 (41.7)	A
B (1 lane, 3.5 m)	420.6	937.1	516.5 (55.1)	A
C (1 lane, 10.0 m)	373.0	296.7	**-76.3 (-)**	**F**
D (1 lane, 3.5 m)	535.2	1 032.8	497.6 (48.2)	A

Source: Authors

The roundabout of variant B doesn't accommodate only on exit C again – influence of long pedestrian crossings.

CONCLUSION

Both proposed variants (A and B) accommodate by capacity according to TP 234 (1) – with exception of exit C. The pedestrian crossing of this leg has length 10.0 m and it causes decrease of this exit to traffic flow quality of degree F (i.e. exceeded of capacity or negative reserve). For increase of capacity we must make some building modifications of this pedestrian crossing – i.e. for example by its decreasing. By calculation we can prove that pedestrian crossing length 8.0 m improves traffic flow quality to degree E (for both variants). The second eventuality of modification is the building of refuge island – the pedestrian crossing has to be interrupted in place of this island. The length of pedestrian crossing then will be additionally shorter (according to width of refuge island).

Important information is fact, that present methodology of capacity evaluation of roundabouts solves also capacity of exits (in comparison to earlier methodologies of calculations). Use of older calculation gives very biased and incorrect results.

Just in case it's necessary to make verification of passage through modified street and also through modified roundabout by rupture curves is indispensable. Generally it's important to verify if in this locality can be use to exceptional load transport (2).

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