

Puchberger Straße / Maria Theresien Ring Junction: Technical report

Introduction

The Puchberger Straße / Maria Theresien Ring junction was built in the early 90's as a traffic engineering solution for the intersection between two important roads of Wiener Neustadt; the Puchberger Straße which links the city with the A2 South Autobahn and Maria Theresien Ring that serves as a strategic local road. The traffic survey carried out in 1998 showed that there were some 2000 vehicles passing through the junction during the evening peak period (1630-1730hr). It has been observed recently that the traffic passing through the junction in the morning peak experienced heavy delay and sometime a "Selbstsperreffekt" or a complete junction locking occurred. This phenomenon not only affects general traffic but also the operation of the local buses. In addition, the junction is observed to have unusual high number accidents.

Objective

The objective of this exercise is to undertake a planning study of the junction in order to increasing the efficiency of the junction and rehabilitation of accident black spot.

Existing condition

The Puchberger Straße / Maria Theresien Ring junction located on the west of Wiener Neustadt, some 1 km from the city centre. It is the junction between Puchberger Straße, Maria Theresien Ring road and Dietrichgasse. The Puchberger Straße begins at this junction and forms an east-west corridor road providing connection between the city and the A2 South Autobahn. The road ends at Weikersdorf am Steinfelde. The Maria Theresien Ring situated between the Neunkirchner Straße junction and the Ferdinand Porsche Ring junction.



Figure 1: Puchberger Straße / Maria Theresien Ring corridor

Junction Geometry

The junction takes form of an oval of approximately 70m by 30m. It has a U-turn facility for westbound traffic into Maria Theresien Ring west. The U-turn facility has a flare or queuing area that can accommodate approximately 6pcus. It is understood that the junction took this arrangement due to the paralleling Puchberger Straße and Maria Theresien East. The priorities given to the traffic streams between Puchberger Straße and Maria Theresien Ring west in both directions is possibly due to the high flow of the traffic streams.



Figure 2: Aerial photo and photographs illustrated the junction

Pedestrian and Cyclist facilities

There are two cyclist and pedestrian crossing facilities provided at the junction; a subway which located across the west side of the junction and the level crossing which run across the middle of the junction. The level crossing is a zebra crossing. It is believed that the subway facility is rarely used by the public. Some informal crossings were observed during the site visit across the west arms (Puchberger Straße and Maria Theresien Ring West) and the Maria Theresien Ring east.

Observation made during the site visits

It was observed during the site visits that the junction operates below its capacity during the morning and evening peaks. However, a blocking back of traffic queue on the give-way line into Maria Theresien Ring West was observed during the morning peak. This incident although difficult to quantify from the observation, it often caused the complete locking up of the junction.

It is also observed that due to the high frequency of the local bus passing through this junction during the day (10 bus routes, approximately 18 buses per hour), the waiting area facility is often filled with 2 buses arriving at junction within a close period.



Figure 3: Junction locking up observed during AM peak period

Other observation made during the site visits:

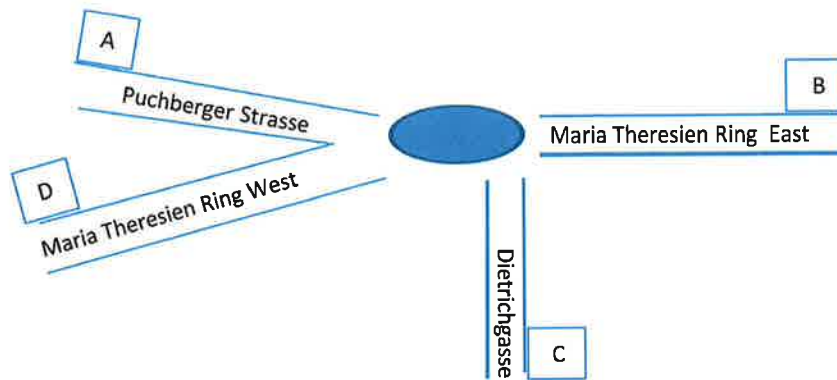
- ▶ There is no capacity problem at the junction i.e. traffic passing through the junction with minimal formation of queue length on approaches during peak periods.
- ▶ The junction locking occurred during AM peak period and is due to the inefficient waiting space for traffic turning into Maria Theresien -Ring West causing the blocking back into Maria Theresien East and subsequently the circulating lane within the junction.
- ▶ Cycle paths on Puchberger Straße Rail Bridge are Hazardous as they are placed next to the safety rail, providing no escape route for cycling out of carriageway in emergency.
- ▶ Speed limit on Puchberger Straße is 70kph. It is recommended that along the road with such speed limit cycle lane should be segregated from road traffic.



Figure 4: Other observations made during the site visit

Traffic Survey

The 1998 traffic survey data was provided by the city council. The survey only included the PM peak results (1630-1730hr). A summary of the survey result is shown below.

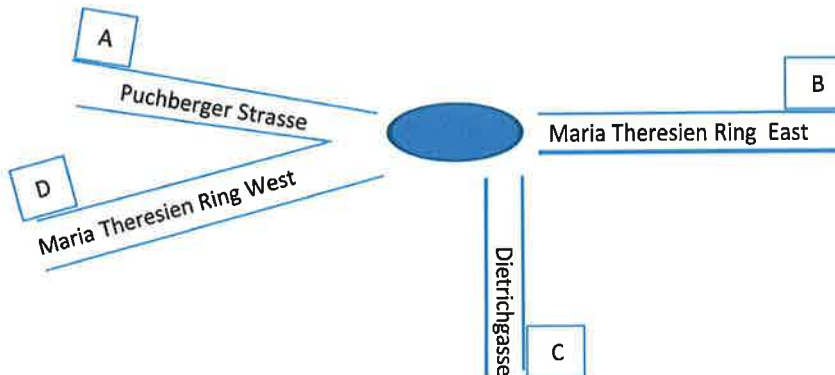


Pm peak (1630-1730hr)

	a	b	c	d	Sum
a	x	534	x	120	654
b	243	x	x	556	799
c	n/a	n/a	x	n/a	0
d	121	538	x	x	659
Sum	364	1072	0	676	2112

Figures 5: Summary of 1998 Traffic survey (Pcus)

As the traffic survey provided was more than 10 years old, it was necessary to undertake a new traffic survey as part of the exercise. The survey was carried out on Tuesday 4th May 2010 between 0800-0900hr for the morning peak period and 1630-1730hr for the evening peak period. A summary of the survey result is shown below.



AM peak (0800-0900hr)

	a	b	c	d	Sum
a	x	489	x	106	595
b	359	x	x	218	577
c	65	20	x	57	142
d	17	141	x	x	158
Sum	441	650	0	381	1472

PM peak (1630-1730hr)

	a	b	c	d	Sum
a	x	582	x	66	648
b	243	x	x	223	466
c	71	24	x	37	132
d	16	312	x	x	328
Sum	330	918	0	326	1574

Figures 6: Summary of 2010 Traffic survey (Pcus)

It should be noted that during the AM peak traffic survey, the occasional locking up of the junction was observed. This reduced the total number of vehicles passing through the junction during the peak period.

The comparison between the 1998 and 2010 PM peak traffic survey shows a decrease in total traffic of approximately 25% (It should be noted that the 1998 survey does not include traffic going into or coming out of Dietrichgasse). The majority of the traffic reduction is of those on Maria Theresien Ring east and west (42% and 50% consecutively). This shows a conflicting trend to the common increasing traffic trends. It is therefore recommended that an additional survey should be undertaken to validate the results.

Existing capacity analysis

As the junction is currently operated similar to a small network of priority junctions rather than a typical roundabout, the capacity of the existing junction layout was calculated using the formula provided in TD42/95 - Geometric Design of Major/Minor, Design Manual for Road and Bridge, volume 6. The diagram and table below summarised the results of the existing capacity using 2010 traffic survey results.



Stop line	Degree of saturation	
	AM	PM
1	0.3	0.65
2	0.71	0.64
3	0.24	0.16
4a	0.49	0.46
4b	0.05	0.05

Figure 7: Existing capacity of Puchberger Straße / Maria Theresien Ring junction

The figures above shows that the junction currently operates within its capacity during both morning and evening peak periods which is in accordance with the observation made during the site visits. The results show a higher degree of saturation on stop line 2 during both peak periods. This indicates that there may be traffic queue forming at this stop line during these peak periods.

However, it should be noted that the capacity calculation method used was only preliminary check. It does not calculate the queue length, the queuing effect at the stop line, or the blocking back effect due to excess queue length at the stop line. It is recommended that advance traffic engineering packages such as PICADY (priority junction capacity analysis) or VISSIM (Micro-simulation program) should be used to improve the accuracy of the results and to model the blocking back effect on the junction.

Accident analysis

The accident report was provided by the city council of Wiener Neustadt in the form of GIS based program. The report shows the accidents occurred on the site for 5 year period ending 31st December 2009. The detailed information of each accident (i.e. Location, type of accident, time and condition of the environment, etc.) are shown graphically. Below is the graphical representation from the GIS based program.



Figure 8: Screenshot taken from the GIS based accidental report program

From the GIS based accidental report, it can be seen that most of the accidents occurred at Maria Theresien ring junction occurred on the west side of the junction where the paralleling roads intersect. The analysis of the accidents record shows that there were 11 accidents occurred over 5 years, 30% of the accident is due to not respecting priority and 40% due to rear end collision (speed).

Speed

It is a common knowledge that a reduction in speed will decrease the possibility of an accident occurring on a road. A study by Department of Transport, UK provides an evident to support this knowledge. The study was carried out between 1992 and 1997 on a site which located mainly, but not exclusively, on trunk roads and included some 56 traffic calming schemes in the UK. The summary of the result from the study is shown on Table 9 below.

% Changes in Injury Accident Frequency by 85th Percentile Speed Reduction	
Speed Reduction	Change in Accidents
(All Severities)	Reduction of accidents
0-5 kph	10%
5-6.5 kph	14%
8-10 kph	32%
11 kph or over	47%

From TAL 11/00

Table 9: The correlation between the reduction in speed and the reduction in accidents from TAL11/00

Further analysis of the accidents on the site and along the whole of the corridor shows that during the road resurfacing in 2009 which the eastbound traffic lane was closed and the speed reduction

was imposed along the corridor, the number of traffic during 2008 and 2009 reduced significantly as illustrated on Figure 10 below.

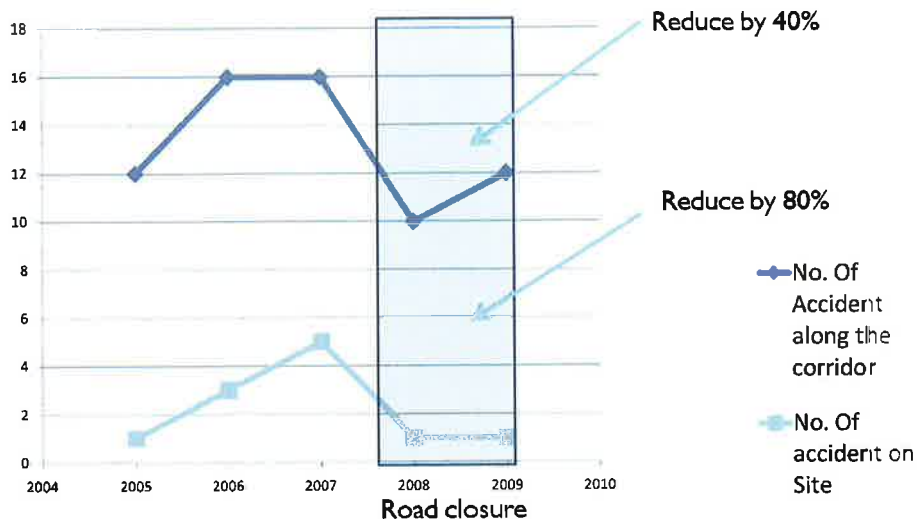


Figure 10: No. Of Accidents on site and along the Puchberger Straße - Maria Theresien-Ring corridor

The evidents above therefore support the case to use speed reduction as a measure to reduce accident rate on Puchberger Straße / Maria Theresien Ring junction.

Priority rules and junction arrangement

Puchberger Straße / Maria Theresien Ring junction has an unusual junction arrangement. It took the shape that similar to a roundabout however, the circulating traffic and traffic on other arms must give priority to the east-west flows between Puchberger Straße and Maria Theresien Ring west. This unusual arrangement can cause confusion to drivers who are unfamiliar with the junction.

The paralleling Puchberger Straße / Maria Theresien Ring east also intersect at a very tight angle and on a sloping level. This further reduces the visibility for the traffic approaching the junction from Maria Theresien Ring East that need to give priority to the traffic on Puchberger Straße. The lack of clear visibility could result in the misjudgment of the traffic gap and contribute toward the high accidents rate at this junction.

Collisions comparative to identify other possibly causes of accidents

In order to undertake a comparative accident analysis to identify other causes of the accidents, 3 random sites with similar arrangement (3 or 4 arms roundabout) located in Wiener Neustadt were selected. The average values of their accident rates were derived and are used to compare with Puchberger Straße / Maria Theresien Ring junction. Table 11 below shows the yearly break down of the accident occurred on the site during the 5 year periods, and the comparison between the site and the average accident rate derived from 3 random sites.

Maria Theresien-Ring / Puchberger Straße Junction Collision data for the 5 yr period ending 31 th Dec 2009							
Collision in the 12 month period ending:	Fatal		Serious		Slight		Total
31-Dec-05	0		0		1		1
31-Dec-06	0		0		3		3
31-Dec-07	0		0		5		5
31-Dec-08	0		0		1		1
31-Dec-09	0		0		1		1
Total collisions	0		0		11		11
Collision totals and accident rate per site per 5 year comparison							
	All accidents	Fatal and serious	Only Private car	Involved 2Wheeler	Involved Ped.	Non Dry	Dark
Number of Collision	9	0	8	2	1	1	1
Comparative collision average of 3 random site	7	0.5	4.33	2	0.67	1	1.67

Table 11: Breakdown of accident yearly and collision rate comparison

The comparison shows that the site has a higher than average accident rate and accident involve pedestrian but a lower than average during dark hour accident rate. This excluded the possibility of the contribution of other factors such as inadequate lighting or slippery surface to the accident rate of the site.

Design Principle

From the result of the Accident Analysis in the previous section, it is can be concluded that the design principle of this junction should seek to

- a) Reduce the speed on Puchberger Straße
- b) Improve the visibility and junction arrangement between Puchberger Straße and Maria Theresien-Ring
- c) Reduce the queue length of the circulating flow and hence eliminate junction blocking phenomenon.

The design should also seek to reduce the number of conflict points between traffic streams, as currently traffic streams between Puchberger Straße-Maria Theresien-Ring east, Dietrichgasse-Puchberger Straße and Dietrichgasse-Maria Theresien-Ring east must pass through 3, 2 and 3 conflict points consecutively as illustrated by Figure 12 below.



Figure 12: Multiple conflict points

Option 1: Provision of road marking and signs

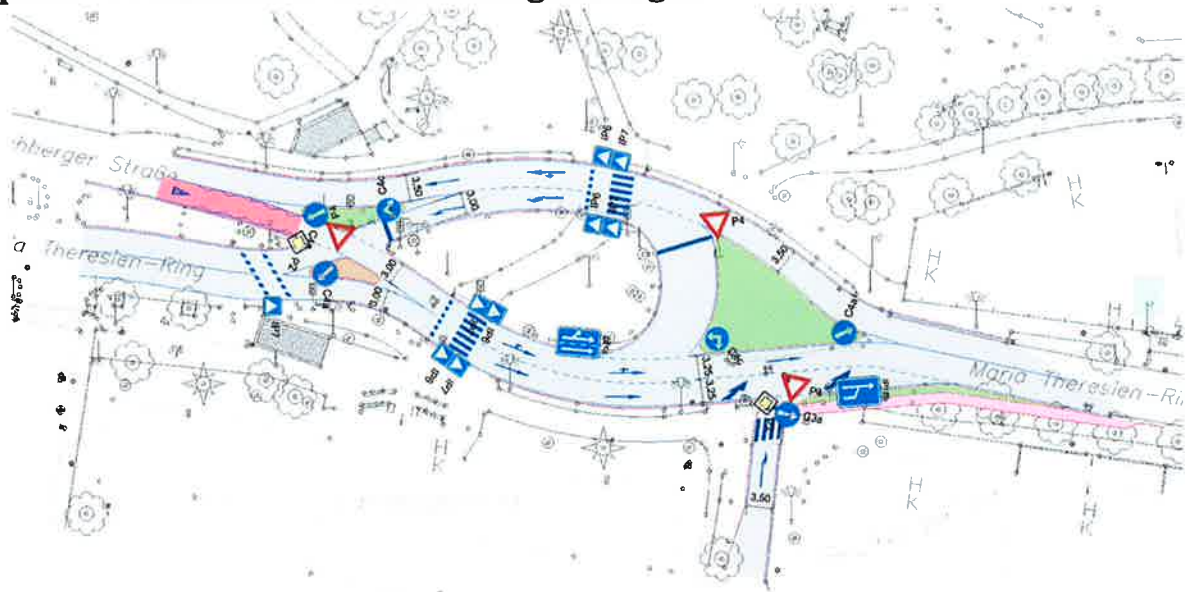


Figure 13: Option 1

Option 1 proposed to maintain the existing junction layout but improve its safety by providing directional road markings and signs. It also proposed to provide a high friction / antiskid surface on the Puchberger Straße approach. The capacity of the junction should remain the same with slight accident reduction. This option looks to reduce the effect of the speed on Puchberger Straße and improve the navigation of traffic through the site. The main advantage of this option is the lower cost of implementation.

Option 2: Roundabout

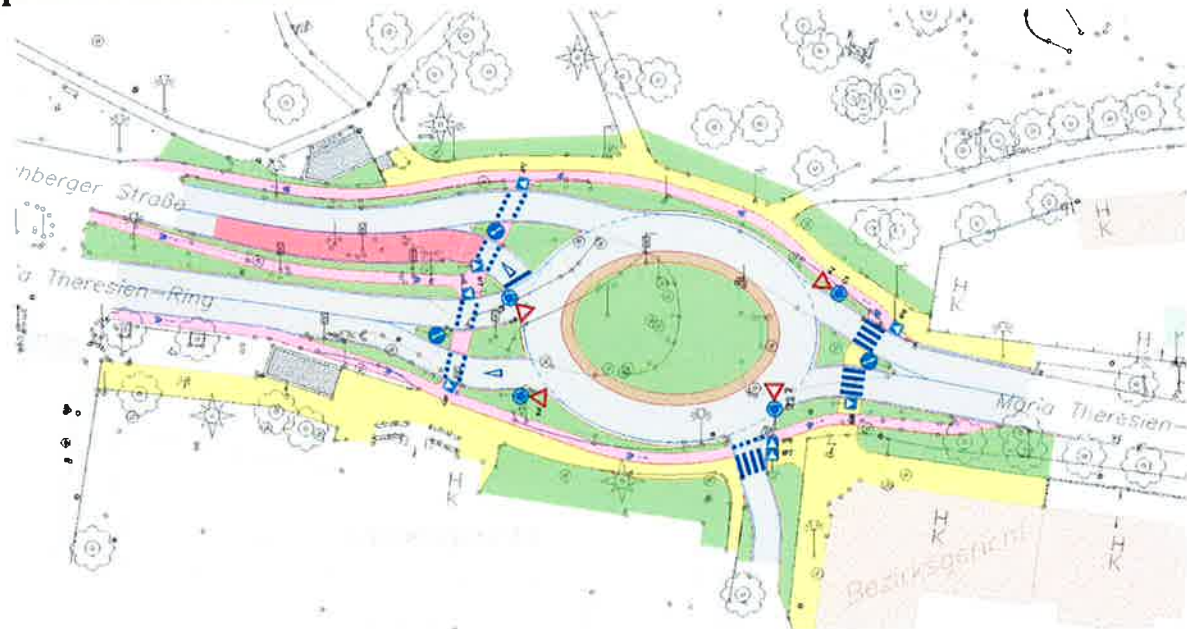


Figure 14: Option 2

Option 2 proposed a Roundabout design with reverse priority on Puchberger Straße and Maria Theresien-Ring west arm. It proposed the provision of hi friction and anti-skid surface Puchberger

Straße approach. Preliminary capacity shows an increase in capacity of around 50%. This traffic arrangement also reduces the number of conflict points mentioned in Design Principle section; hence improve significantly the accident rate at this roundabout. However, it is recommended that a detailed capacity analysis and a micro-simulation model are constructed in order to understand the queuing effects on Puchberger Straße approach. This option also only addresses the effect of the speed on Puchberger Straße in local level.

Supplement option A: Puchberger Straße Rail bridge lane reallocation

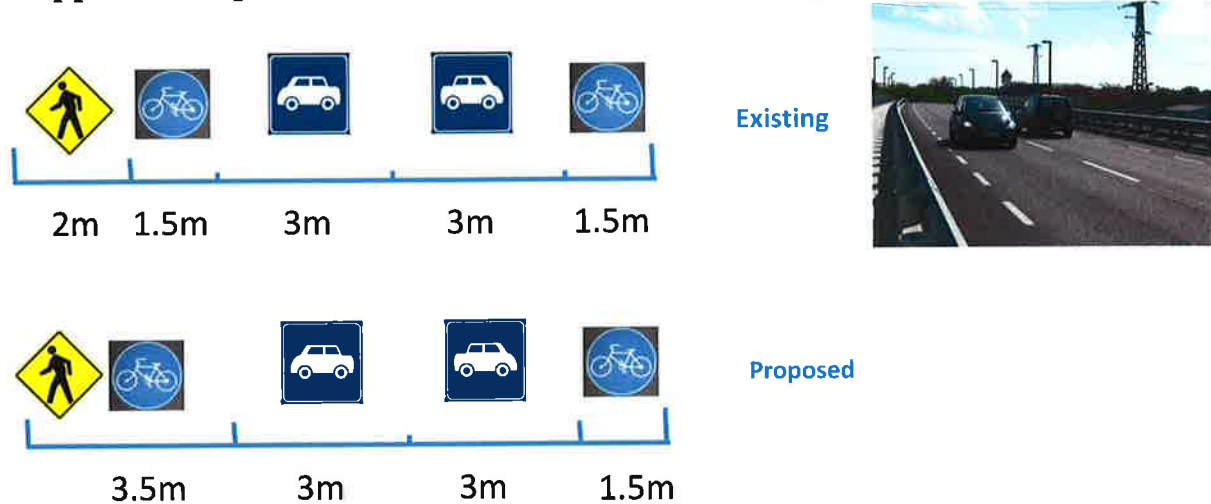


Figure 15: Supplement Option A

This supplement option is proposed to reallocate the lane width on the Puchberger Straße rail bridge which currently provides cycle lane within the carriageway against the guardrail. It is proposed that the cycle lane to be provided inside the guardrail to improve the safety of the cyclist. However, the drainage system of the bridge needs to be considered. Alternatively, the existing arrangement could be kept while the guard rail is removed.

Supplement option B: Gate way entrance



Figure 15: Supplement Option B: Gate way entrance

This supplement option proposed to install Gateways to highlight to drivers that they are entering an area of changed road use. Accompanied of physical measures form such as carriageway markings, signing, or the incorporating of the change of speed limit can also be implemented.



Figure 16: Recommended location of Supplement Option B

Supplement option C: Rumble strips



Figure 17: Supplement Option D

This supplement option proposes to install rumble devices to alert drivers to the approaching hazards or gateways through noise, vibration and visual effect. It is likely to produce only modest reductions in mean speeds of up to 5kph or 10% accident reduction. The effect of the noise produces should also be considered.



Figure 18: Recommended location of Supplement Option C

Supplement option D: Speed limited roundels



Figure 19: Supplement Option D

This supplement option proposed to install coloured patches with speed limit roundels, designed to alert drivers to a change in speed limit and to encourage drivers to reduce their speed. It is likely to produce a reduction of mean speed around 5kph or 10% reduction of accident rate.



Figure 20: Recommended location of Supplement Option D

Supplement option E: Reduction of Speed limited along Puchberger Straße



This supplement option proposed reduce the speed along Puchberger Straße which currently varies between 70kph and 50kph. The proposed speed should be 30kph as the corridor enters the build up area of the city.



Figure 21: Recommended location of Supplement Option E

Not recommended

It is not recommended to use either speed table, raising table, or speed humps as the high volume of HGV along this corridor will destroy these structures.

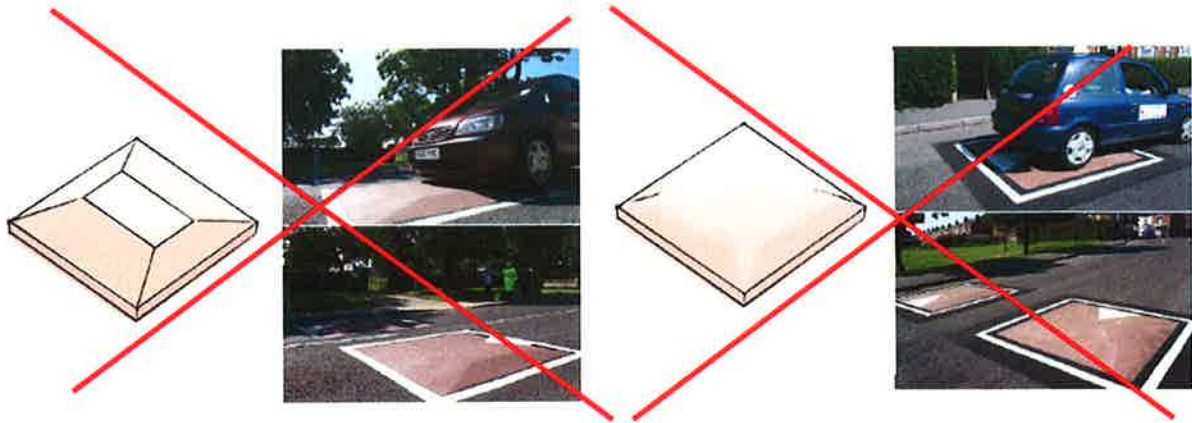


Figure 22: Not recommended speed reduction measure

Recommendation and conclusion

From the study, it can be concluded that the accident rate at Puchberger Straße / Maria Theresien Ring junction is unusually high due to the speed of vehicles along the corridor and the geometry of the junction. The study suggested 2 design options with 5 additional supplementary options to address these problems.

It is recommended that a further calibration and validation of traffic survey results should be carried out to address the high discrepancy between 1998 and 2010 traffic survey results. This can be achieved by commissioning an additional classified survey count during the morning peak and evening peak periods.

It is recommended that a detailed design for each option, together with capacity tests should be carried out. Other factors that may affect the designs such as drainage design and environmental impact assessment should also be considered. In addition micro-simulation models should be constructed for the existing case and Option 2 in order to understand the queuing behaviour of traffic at the junction correctly.

It is recommended that the examination of the behaviour of traffic along the whole of corridor should be carried out. This will enable the identification and the root cause of accidents to be addressed rather than relocating the problems.

It is recommended that the bus and cyclist facilities along the Puchberger Straße should be improved in order to support the future development along this corridor and promote sustainable transport in Wiener Neustadt.