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ROUNDABOUTS CONTROL, USING THE MAXIMUM ENTRY PATH RADII SPEED
PËRDORIMI I MAKSIMUMIT TË RREZES NË RRUGËN HYRËSE PËR KONTROLLIN E SHPEJTËSISË NË KRYQËZIME

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PËRMBLEDHJE
Në këtë material do të synohet dhënia e kriterit aktual të kontrollit të shpejtësisë nëpërmjet rrethrrotullimeve. Kjo është arritur nëpërmjet parashikimit të "devijimit", i cili është matur si maksimumi i rrezes së mjetit të 100 metrave nëpërmjet karrexhatës qarkulluese. Praktika e tanishme jep kontrollin e shpejtësisë në vendin e karrexhatës qarkulluese. Ajo propozon një metodë për kontrollin e shpejtësisë në rrethrrotullime, bazuar në vlerat maksimale të rrezes hyrëse në to, në vend të kriterit aktual të shmangies. Qëllimi i këtij materiali është të japë një kriter të ri për kontrollin e shpejtësisë në rrethrrotullime, si dhe të bëjë një krahasim e të japë një konkluzion rekomandues për metodat e përdorura.
Fjalet kyce: kontroll, kapacitet, rrethrrotullim, shpejtësi, rreze

SUMMARY
In this paper shall be provided current national criteria for controlling speeds through roundabouts. This is achieved by the provision of "deflections", which is measured as a maximum vehicle path radius of 100 m through the circulating carriageway. The current practice gives the speed control on the entry curve in lieu of the circulating carriageway. This paper proposes a method for speed control at roundabouts, based on maximum setting values of entry path radii for roundabouts, in lieu of the current deflection criteria. The purpose is to detail the development of new criteria for control of speed through roundabouts. At the end will be made a simple comparison of the methods used and a conclusion will be done as well.
Key words: control, capacity, roundabout, speed, radii

INTRODUCTION

This material reviews current methods for the control of speeds in roundabouts in Australia, the UK, the USA and Queensland. There are compared the potential effectiveness in reducing accident. The new method for the control of speeds in roundabouts sets maximum entry path radii for the design of new roundabouts.

Accident studies from throughout the world have identified that similar accident types occur at roundabouts.

CURRENT METHODS FOR THE CONTROL OF SPEEDS IN ROUNDABOUTS

Method of Australia

The current national method is achieved by the provision of "deflection", which is measured as a maximum vehicle path radius of 100 m through the circulating carriageway, given a number of parameters. **[1];** this is the method used until now in Albania as well.

The aim of this radius of 100 m is to limit the driver speed, in order to minimize Entering/Circulating vehicle accidents.

Method of UK

This method is used in the United Kingdom and aims to limit the maximum radius of the entry path curve to 100 m, instead of the vehicle path on the circulating carriageway. **[2]**

Referring the **Figure 2**, the entry path curve is shown from point X to point Y and the radius of this path must be limited to 100 m.

The entry path curve for single and multi-lane roundabouts is the largest radius that can be drawn through the entry curve, based on given offsets to the lane edges.

A UK study identified that as a very important predictor of accidents at roundabouts. It is of approximately 70 m for parallel entries of 5 m width and approximately 30 m for an entry flaring from 5 m to 15 m was found to produce minimum total accident rates.

Site Category	Recommended Maximum Entry Design Speed
Mini Roundabout	25 km/h
Urban Compact	25 km/h
Urban Single Lane	35 km/h
Urban Double Lane	40 km/h
Rural Single Lane	40 km/h
Rural Double Lane	50 km/h

Table 1. USA Criteria for Maximum Entry Design Speeds

Inscribed Circle Diameter (m)	Approximate R1 Value		Maximum R1 Value	
	Radius (m)	Speed (m)	Radius (m)	Speed (m)
Single-Lane Roundabout				
30	11	21	54	41
35	13	23	61	43
40	16	25	69	45
45	19	26	73	46
Double-Lane Roundabout				
45	15	24	65	44
50	17	25	69	45
55	20	27	78	47
60	23	28	83	48
65	25	29	88	49
70	28	30	93	50

Table 2. USA Criteria for Maximum Entry Path Radii to Limit the Decrease in Speed between Entering Vehicles and Left Turning Vehicles to 20 km/h

Method of USA

It provides the following criteria for speed control in roundabouts:

•Maximum entry design speeds for various types of roundabouts (**Table 1)**

The maximum speeds vary from 25 km/h to 50 km/h. The model is intended to minimize the relative speed between conflicting traffic streams. **[3]**

•A speed consistency model which limits the decrease in speed between successive horizontal elements to 20km/h to minimize single vehicle.

Vehicle Path USA Model

The calculation of speed values for a particular roundabout, will provide:

•A vehicle path model

•A speed prediction model

The vehicle path model is based on the following:

•For single and multi-lane roundabouts, a

continuous vehicle path through the roundabout, comprising the largest radius possible on each horizontal element, based on offsets to the lane edges.

•Paths are drawn for all movements (right, through and left).

Speed USA Model

The speed model is based on the point mass formula (refer Equation 1 below) and values of the side friction factor as documented in the AASHTO document. **[4]** The speed model is not based on actual measurements of vehicle speeds at roundabouts.

$$V^2 = 127 \times R \times (e + f)$$

Where

V = design speed (km/h)

R = radius (m)

E = super elevation (m/m)

f = side friction factor

FIGURA "1"
Geometric elements of a roundabout

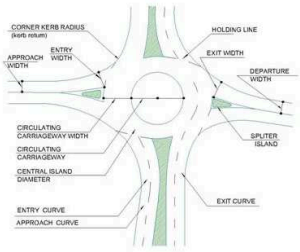
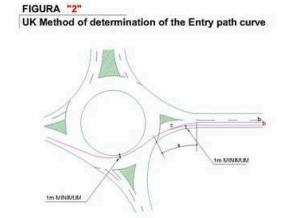


FIGURA "2"
UK Method of determination of the Entry path curve



Method of Queensland

It provides the following speed control limits at roundabouts:

•A speed of entrance maximum 60 km/h to minimize Approaching Rear-End vehicle accidents.

•A decrease in speed between horizontal elements of 20 km/h to minimize single vehicle accidents

•A speed relative between entering and circulating vehicles of 50 km/h to minimize accidents between vehicles.

•A relative speed between exiting and circulating vehicles maximum 35km/h to minimize accidents between these vehicle streams.

•A maximum difference in potential side friction of 0.7 (a measure of the degree that drivers will cut lanes on a multi-lane roundabout)

The comparison of maximum values for a particular roundabout will provide the followings:

•A vehicle path model

•A speed prediction model

Vehicle Path Queensland Model

The vehicle path model requires paths to be drawn for most movements through the roundabout, as follows:

•For single lane roundabouts, a continuous vehicle path through the roundabout, comprising the largest radius possible on each horizontal element, based on offsets to the lane edges.

FIGURA "3"
Queensland vehicle path construction through single lane roundabouts

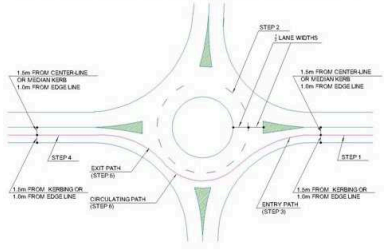


Figure 3 provides details for a through movement

•For multi-lane roundabouts, are given

three separate vehicle path types: staying in the right lane, staying in the left lane, and cutting across lanes.

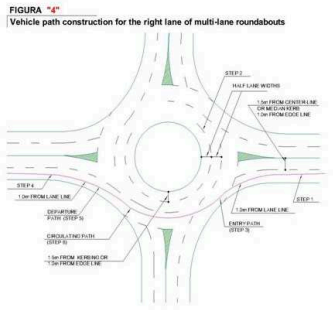
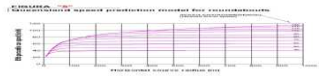


Figure 4 provides details of the construction of vehicle paths for the right lane of multi-lane roundabouts for the through movement.

- Paths are drawn for through and right turn movements only

Speed Queensland Model

It is based on a modified version of the original speed environment model for rural roads. **Figure 5** provides a graph to determine 85th percentile speeds based on the vehicle path radii and the speed environment prior to the approach.



COMPARISON OF THE METHODS USED FOR SPEED CONTROL INROUNDABOUTS

A summary and comparison of the various methods of speed control in roundabouts is given in **Table 3.**

Criteria	Australian Method	UK Method	USA Method	Queensland Method
Speed control methods.	Deflection	Maximum entry path radius	Various maximum entry speeds Max. decrease in speed between elements	Maximum entry speed. Maximum decrease in speed between elements. Maximum relative speeds between entering/circulating and exiting/circulating vehicle paths. Maximum difference in potential side friction.
Effectivity in minimizing overall accident rates	Moderate	Moderate high	High	Very high
Relevant design criteria	Low - moderate	Low moderate	High	Very high
Subjectivity in drawing the vehicle paths	Little	Significant	Significant	Little

Table 3. Summary and Comparison of the Methods of Speed Control

Desired Driver Speed Prior to the Roundabout (km/h)	Maximum Entry Path Radius (m)		
	Single Lane Entries Two-lane Entry - Staying in Correct lane		Two-lane Entry - Cutting
	Desirable	Absolute	Across Lanes
≤40	55	100	1.9 times the actual entry path radius staying in the correct lane
50	55	80	1.8 times the actual entry path radius staying in the correct lane
60	55	80	1.6 times the actual entry path radius staying in the correct lane
70	55	70	1.5 times the actual entry path radius staying in the correct lane
80	55	55	1.5 times the actual entry path radius staying in the correct lane
≥90	55	55	1.5 times the actual entry path radius staying in the correct lane

Table 4. Maximum Entry Path Radii for One and Two lane Roundabouts

Method of Australia

From four approaches described above, the Australian Method is more effective in minimizing total accident rates at roundabouts. This is because, using deflection as a measure to control speeds in roundabouts is less effective.

The United Kingdom based on the deflection criteria before, now uses maximum entry path radius instead. Therefore, it is recommended that, this method must be changed to one that uses criteria for the entry curve, in lieu of the circulating carriageway.

Method of UK

The UK method is the simplest to apply, but is the least comprehensive in dealing with the various accident types that occur at roundabouts. It does not consider criteria to minimize single vehicle and sideswipe accidents. In addition, it relies solely on maximum entry path radius to minimize entering/circulating and exiting/circulating vehicle accidents.

Method of USA

The USA method deals with the various accident types more than the UK method. It presents criteria to minimize single vehicle accidents, by ensuring that, the decrease in speed between successive elements is limited to 20km/h. As in the UK method, however, it relies solely on maximum entry path radius to minimize entering/circulating and exiting/circulating vehicle accidents.

However, gives better results than the UK method, because are given smaller values of maximum entry speed for smaller sized roundabouts.

Method of Queensland

The Queensland method is the most comprehensive in dealing with the various accident types. This is due to the inclusion of the criterion for the relative speed between

entering and circulating vehicles. Basically, the lower relative speeds for these vehicle paths is the primary reason why, roundabouts are generally safer, than all other forms of intersections.

RESULTS AND DISCUSSIONS

All of the current methods discussed in this section have particular limitations. Ideally, a method for the control of speed at roundabouts would comprise the safety advantages of the Queensland method, the simplicity of design effort similar to the UK method and require little subjectivity in drawing of the vehicle paths.

PROPOSED METHOD FOR SPEED CONTROL AT ROUNDABOUTS

The proposed method for the control of speeds in roundabouts will include the following parameters:

- Absolute and desirable maximum entry path radii for various approach speeds and number of lanes based on vehicle path models.
- Absolute and desirable minimum central island radii for various approach speeds and number of lanes.

Briefly, the process used to development the proposed design criteria is as follows:

•Trial many combinations of central island radii and entry curve radii to cater for both the swept path of a single unit truck and a 19 m semi-trailer.

•To determine the absolute limits of the proposed design criteria, identify combinations of minimum central island radii and maximum entry path curvature that meet all of the speed control limits.

•To determine the desirable limits of the proposed design criteria, identify combinations of minimum central island radii and maximum entry path curvature that avoid the use of corner kerb radii and allow sufficient splitter island size for pedestrians, whilst still meeting the speed control limits.

Maximum Entry Path Radius

Design criteria for the maximum entry path radii at roundabouts under the proposed speed control method are given in **Table 4**.

Minimum Central Island Radii

Applying the maximum entry path radii given in the **Table 4** will ensure that, speeds into the roundabout will be minimized. As identified in the previous section, this will lower many of the accident types at roundabouts. However, it will not minimize total accident rates unless combined with a sufficient size of Central Island.

At very small roundabouts will occur:

•The entry and exit legs will overlap creating excessively tight corner kerb radii. This increases the relative speed between entering and circulating vehicles, having a negative impact on the entering/circulating vehicle accident rate.

•Large decreases in speed between the entry curve and the circulating carriageway will occur, increasing single vehicle accident rates.

•An increase in sideswipe vehicle accidents will occur on the circulating carriageway due to the additional advantage to drivers in cutting lanes (less speed lost and a lower driver workload).

RESULTS AND CONCLUSIONS

1.The current national method of the speed control in roundabouts in Australia and Albania is achieved by the provision of 'deflection' in the circulating carriageway.

2.The United Kingdom current method for controlling speeds in roundabouts is to limit the maximum radius of the entry path curve to 100 m.

3.Criteria used in the United States of America for the control of speeds in roundabouts involve the use of maximum entry design speeds and a speed consistency model, decreasing the speed to 20 km/h.

4.The Queensland Method has maximum limits for entry speed, to control speeds through roundabouts.

5.The Australian method of using deflection is more effective in minimizing total accident rates in roundabouts.

The recommendations are as follows:

-The UK method for the control of speed in roundabouts is the simplest to apply but, is the least comprehensive in dealing with the various accident types.

-The USA method is more comprehensive in dealing with the various accident types than the UK method, but also requires a greater design effort.

-The Queensland method is the most comprehensive in dealing with the various accident types. It will potentially produce the safest design, especially for smaller to moderate sized roundabouts..

To overcome these particular limitations, has been developed a new method for the control of speeds in roundabouts.

The design criteria must be considered:

- Maximum entry path radii for various approach speeds and number of lanes (**Table 4)**
- Minimum central island radii for various approach speeds and number of lanes.

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