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RESULTS OF A TRAFFIC FLOW SURVEY AT NEW RURAL ROUNDABOUTS IN HUNGARY
Comparison with Four Leg Priority Junctions

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Abstract

A traffic flow survey was made at new rural roundabouts in Hungary with a video camera. The traffic volume, the critical gap and the average circulating speed on the junctions as the most important parameters of traffic flow were examined.

The results include the maximum hourly traffic flow, the largest fictitious hourly traffic flow as the parameters of traffic volume and the average circulating speed of three different types of vehicle such as passenger car, light lorry and heavy truck. The fictitious hourly traffic flow was calculated with neglecting the traffic free periods in the following steps:

- the number of passing through vehicles was summarised at a given period subtracting the inactive time of traffic (inactive time means: there was no vehicle on the whole junction),
- a fictitious headway was determined as a quotient of the busy time and the number of passing through vehicles during this interval,
- fictive hourly traffic was then calculated as a ratio of 3600 seconds and the fictitious headway.

Circulating speeds of the vehicles were examined under two different conditions:

- vehicles starting from standing position,
- vehicles entering the roundabout with flying start.

Keywords: roundabout, capacity analysis, average speed.

Introduction

A survey was made at the junctions of highways number 55, 53 and number 8, 86, respectively. The fact that the latter junction was turned into a roundabout in 1993 gave a fair chance for a comparison of the traffic flow at the two junction types.

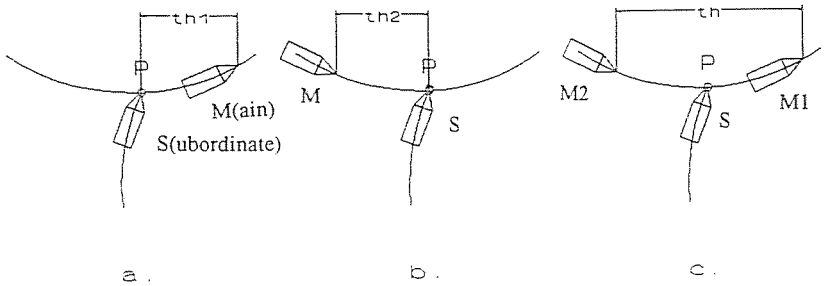
- The traffic flow was recorded by a video camera placed in a basket which was elevated by a special vehicle over the junction. Timer of the video film was as much as 1/10 seconds.
- The sampling interval of the traffic dimension was 1 minute.

- The largest possible traffic transmission was determined upon the traffic free periods.
  - A roundabout was considered to be free of traffic if there was no vehicle either on the circulating carriageway or at the entry of any connecting arms.
  - A four leg priority junction, traditional in Hungary, was considered to be free of traffic if there was no vehicle between the beginning of the left and right turning lanes and the other end of the actual crossing area in the major direction and between the stop line and the other end of the actual crossing area in the minor direction and, at the same time, there was no waiting vehicle either. Simultaneous satisfaction of all these conditions is required.
- The critical gap was determined from the part gaps as shown in *Fig. 1* [1]. The different types of part gaps are also presented in *Fig. 1.*
- At the entry of the convoy the starting delay, arrival time and the intervals between the succeeding vehicles entering the convoy were analysed.
  - Starting delay is the interval between the passing of a vehicle the intersection P in the main direction and the start of a vehicle in the minor direction.
  - Arrival time is the interval between the start of the subordinate vehicle and its passing the intersection P.
  - The headway is interpreted at intersection P.
- The crossing speed at the different junction types was also studied. At the roundabout it was examined whether the vehicle started from a standing position or entered the circulating carriageway with a flying start without stopping. At the four leg priority junction only the speed of vehicles moving straight in the main direction was analysed.

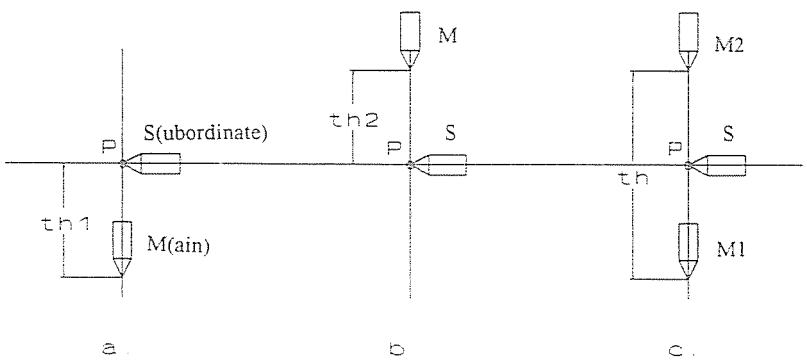
Results

Results of the survey are presented in a series of tables created from the video film. Without going into details, the two most important points are stressed here:

- transmissible traffic and
- crossing speed at the junctions.



Type 1 of part gap | Type 2 of part gap | Type 3 of classical critical gap



Type 1 of part gap | Type 2 of part gap | Type 3 of classical critical gap

Fig. 1. Type of critical gaps

Traffic at the Roundabout

The aim of the survey being the analysis of the traffic flow in heavy traffic conditions, the traffic flow was directed. This way an artificial traffic flow was created, satisfying the above mentioned conditions. Therefore traffic was stopped at all of the four arms at a distance of 80 meters from the entry points until at least 10 vehicles gathered even in the arm of lesser traffic. That way traffic was let to the junction in approximately every 5 – 8

minutes. After the waiting sections and the whole junction had got empty, stopping of the traffic started again. The presence of police influenced the drivers' behaviour, so the directed traffic flow did not produce the same results as an actual roundabout of heavy traffic. Having a very limited number of roundabouts in Hungary, and with a moderate traffic, this was, however, the only way to imitate real conditions.

From the gathered traffic data a fictitious hourly traffic flow was calculated in steps as follows:

- the number of passing through vehicles was summarised at every 20 minutes subtracting the inactive time of stopped traffic,
- a fictitious headway was determined as a quotient of the busy period and the number of passing through vehicles during this interval,
- fictitious hourly traffic was then calculated as a ratio of 3600 seconds and the fictitious headway.

Results are shown in *Table 1.*

Table 1
Measured traffic and practical measured capacity at the roundabout

Time				Traffic flow of the entire junction		Hourly traffic flow at the junction	
hour	minute	total time	effective time	veh	pcu	veh/h	pcu/h
8	20						
		1^{h}06'	22'29.7"	453	576	1208	1536
9	26						
9	29						
		1^{h}18'	21'43.5"	493	621	1362	1715
10	47						
10	52						
		57'	20'27.0"	446	560	1308	1643
11	49						

Due to the directed traffic flow there were waiting vehicles at the entrance of the arms in the busy periods, therefore, the calculated fictitious hourly traffic can be interpreted as a practical capacity of the roundabout.

Traffic at the Four Leg Priority Junction

The maximum traffic for a period of 5 minutes was determined at the junction as a basis for calculating the maximum hourly traffic flow. Morning and afternoon periods were separated. The actual figures of the maximum

hourly traffic flow, calculated on the basis of the 5-minute period are as follows:

- 948 pcu/h in the morning
- 876 pcu/h in the afternoon.

The largest fictitious hourly traffic flow proved to be

- 1152 pcu/h in the morning
- 1188 pcu/h in the afternoon.

Traffic free periods were neglected. The share of the individual roads in the total traffic, calculated on the 5-minute basis, was also studied.

- In the morning the main direction (road number 8) participated with 68% and the minor direction (road number 86) with 32%, respectively.
- In the afternoon the share of the main direction in the total traffic of the junction was 69% and 31% for the minor direction respectively.

Values scattered considerably both in the morning and in the afternoon, which means that traffic in a five–minute period was fluctuating.

Considering the above mentioned facts, the following statements can be made:

- capacity of the roundabout proved to be 1700 pcu/h and
- capacity of the four leg priority junction was 1200 pcu/h.

Share of the main direction in the total traffic was 60% (roads number 8 and 55 were considered main directions at the roundabouts).

Circulating Speeds at the Roundabouts

Circulating speeds of the vehicles were examined under two different conditions:

- vehicles starting from standing position,
- vehicles entering the roundabout with a flying start.

The survey was completed for three different types of vehicle as follows:

- *P* passenger car
- *LGV* light lorry
- *HGV* heavy truck.

Leaving the roundabout through the first exit was considered as 'turning to the right', leaving through the second exit as 'passing through straight' and leaving through the third exit as 'turning to the left', respectively.

Results are presented in *Table 2* where

- $\overline{v}$ (km/h) is the average circulating speed
- σ (km/h) is the standard deviation
- n (pc) is number of observation.

Table 2
Statistical characteristics of speeds measured at the roundabout

Position and type of starting vehicle		Type of movements: 'turning to the right'			'passing through straight'			'turning to the left'		
		$\overline{v}$	σ	n	$\overline{v}$	σ	n	$\overline{v}$	σ	n
from standing position	P	23.4	5.9	14	23.5	4.6	14	24.4	2.6	14
	LGV	18.5	2.2	14	22.1	2.8	14	21.8	2.9	14
	HGV	16.4	2.1	14	17.1	3.4	14	17.1	3.3	14
flying start	P	29.6	4.0	14	26.1	3.8	14	23.5	3.4	14
	LGV	24.1	6.7	14	24.1	3.3	14	24.1	3.3	14
	HGV	22.1	4.6	14	10.9	3.9	14	21.8	3.6	14

Crossing Speeds at the Four Leg Priority Junction

Speed of vehicles driving in the major direction was only determined and for the vehicle types mentioned before (P, LGV, HGV). Results are shown in *Table 3*. Symbols are the same as in *Table 2*.

Table 3
Statistical characteristics of speeds measured at the four leg priority junction

Type of vehicle	Passing through straight in the main direction		
	$\overline{v}$	σ	n
P	52.9	12.1	14
LGV	50.9	9.2	14
HGV	43.4	9.9	14

According to the survey, the average speed of passenger cars starting from a standing position was 25 km/h at the roundabout. In contrast, the average speed of vehicles driving in the major direction at the four leg priority junction was 50 km/h despite the speed limit of 40 km/h due to road works.

Conclusions

The number of new type roundabouts in Western Europe is increasing, Britain, France and Switzerland being the leaders in this area. Its reasons lie in the major goals of the roundabout such as high capacity, low speed due to the small diameter of the central island and the 'give way' sign at the entrance and, consequently, high traffic safety which is the most important.

There are three roundabouts in the rural road network of Hungary. It seems to be worth building more of them. It is, however, necessary to survey traffic flow at existing roundabouts in order to achieve valid functions for indigenous conditions and to decide if roundabouts are more favourable than traditional junctions.

The answer is given in the survey completed.

- An important characteristic of a junction is the practical capacity. This was 1700 pcu/h at the roundabout, much higher than the actual figure of 1200 pcu/h at the four leg priority junction controlled by road signs.
- The value of the full critical gap was considerably higher than expected under Hungarian conditions or the figures given in the literature [2, 3, 4].
- The critical gap was 6.5 seconds when measured at the entrance of the roundabout. In contrast, a value of 5 seconds is given by the Hungarian standard [5] on condition of turning to the right and 'give way' sign if speed in the major direction is equal to 50 – 60 km/h.
- Values for the four leg priority junction and those of the standard [5] for the respective streams are presented in *Table 4*.
- Measured values scattered considerably at both junction types. This may be due to the fact that Hungarian drivers are not familiar with roundabouts yet and, at the four leg priority junction, due to the lack of experience of driving.
- At the roundabout, vehicles leaving directly before the entrance significantly influence the critical gap of the entrance. This fact is considered by the different capacity calculation models.
- Speed analyses have shown that circulating carriageway admits merely low speeds. This is favourable for both the traffic safety and capacity due to entering the traffic flow with low speed. Therefore, roundabouts may function as gates to urban areas, drawing drivers' attention to residential zones. It is remarkable from the survey of crossing speeds at the four leg priority junction that road signs of speed limit by themselves do not reduce speed to the desirable degree.

Table 4
Comparison of measured and literature values of critical gaps at the four leg priority junction

	Measured values	Data of standard KT $v = 50$ km/h	$v = 90$ km/h
Turning to the left from the main direction	13.17	5.0	5.5
Turning to the right from the subordinate direction	—	6.0	7.0
Passing through straight from the subordinate direction	13.32	7.0	8.0
Turning to the left from the subordinate direction	16.97	7.5	9.0

As a summary it should be established that roundabouts are favour able in Hungary as well. As a conclusion it should be stated that roundabouts may work better than original four leg priority junctions in a number of cases in Hungarian conditions as well. There is no need to turn each four leg intersection into roundabouts, but in many cases a roundabout as an alternative with its advantages and disadvantages should also be analysed.

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