PERIODICA POLYTECHNICA SER. CIVIL ENG. VOL. 36, NO. 1, PP. 37–55 (1992)

A GENERAL METHOD FOR THE DETERMINATION OF THE CAPACITY OF HIGHWAY INTERSECTIONS CONTROLLED WITH TRAFFIC SIGNS

I. Fi

Department of Highway Engineering
Technical University, H–1521 Budapest

Received: December 5, 1991.

Abstract

The measurements performed in practice with the aim of revealing the rules of traffic flow are very limited in time and extremely expensive, too, and therefore they are suitable only for the short-time observation and analysis of traffic. Today these difficulties can already be eliminated with the help of the up-to-date computing technique and its advanced hardware base. Traffic situation changing arbitrarily can be created on a plain roadway of arbitrary cross-section, or in an intersection of arbitrary complexity, respectively, on the basis of which examination of any optional difficulty can be carried out. In the following, the algorithms and the program developed for this special purpose will be introduced. Using it the capacity and the traffic flow conflicts could be estimated analysed with the arrangement and control system of intersections.

Keywords: simulation, intersection, capacity analysis.

Introduction

Highway intersections are the most sensitive points of the road networks. Their arrangement has a determining importance from the point of view of the volume of the multidirectional traffic, of the level of service and of the security. Technical dealing with highway intersections is almost contemporaneous with motorization, being one of the central fields of the traffic engineering interest in our days, too.

It is characteristic for the size of the task that even in the less than moderately dense network of Hungary, the number of highway junctions is over hundred thousand, included the junctions of the roads inspected by the municipalities.

Approximately 40.000 of them are to be found on the national road network. The number of those highway junctions, where every connecting component is a part of the national highways is appr. 5000. (In comparison, the number of the highway intersections regulated by traffic lights is very few, appr. 350.)

It is reasonable to claim to two main requirements in the field of highway intersections. On the one side they should fulfil the maximal traffic requirements on a good level of service (see làter), on the other side they should be safe. The importance of the last problem sphere is explained by the very high accident rate in Hungary (28.000 accidents having as result personal injuries in 1990, and appr. the 30 % of the accidents incurred in a highway junction or near to it. (The safety of a highway junction is a complex question, connected with the recognizability of the junctions / if it can be recognized from bigger distance in time, that there is a junction on the respective place /, with their visibility / if the suitable sight distances are guaranteed /, with their clear systems / if the arrangement of the lanes are fit to priority system / as well as with their practicability / if the geometry of the intersection is adequate to the traffic demand.)

It is obvious that safety cannot be separated from the capacity problem which was mentioned at first, as on the one side an accident can be provoked by impatience due to long waiting in consequence of lack of capacity, on the other side nevertheless the deficiencies of the arrangement can reduce the volume of the transmissible traffic. The problem sphere dealt with in the following (capacity) depends in all of elements on the safety, which I don,t want now to analyse.

The order of succession for the examination of the part fields mentioned during dealing with the subject sphere is as follows:

- characteristics (parameters) of the major traffic flow
- movements in the intersection and their time requirements
- capacity calculating method of the Highway Capacity Manual (HCM) 1985
- local capacity calculation for the roundabouts
- presentation of a general calculating method and its comparison with the above mentioned one
- summary.

Characteristics of the Major Traffic Flow

The intersection traffic is settled in case of crossings in a way to use the sufficiently large headways of the major traffic for the maneuvers of the vehicles in the minor traffic. In case of roundabouts every vehicle uses the headways of the vehicles moving in the major direction rotary traffic connect to the rotary traffic. The realization of connection depends on the headways. The headway / its classical definition is:

Time passing between the crossing of the identical points of following in vehicles a given cross-section / is an important parameter of the traffic flow. The equation of a mathematical distribution function fits exactly to the distribution of headways is being continuously researched, nevertheless no complete solution could be found yet.

It seems to be certain that for headways longer than 2 s the negative exponential distribution fits well to the measured headway values. It is practical nevertheless to take in consideration the distribution of the actual headway values under 2 s in the suitable category of traffic volume [1]

The function is as follows:

$$p(t) = 1 - c_1 \exp(-c_2 \cdot t); \quad t2\text{s}$$

$t < 2$s is not determined
$p(t)$ = distribution function of the headways
t = headway
c_1, c_2 = constants

Table 1

Measuring place	Traffic V/h	All regist. headway (pc)	Average head-way (s)	Headways less than 2s (pc%)	Average following distance (m)
Highway No. 2					
right lane	800	3573	4.5	1549(43.3%)	76.8
left lane	707	3753	5.1	1758(47.0%)	86.2
Highway No. 4					
right lane	259	1095	13.9	212(19.4%)	292.1
left lane	301	2265	12.0	604(26.7%)	252.1
Highway No. 9					
rigth lane	358	2077	10.1	631(30.4%)	266.8
left lane	348	2021	10.3	842(41.7%)	248.7

A characteristic of traffic flows, especially for a heavy traffic and a considerable number of slow vehicles is the platoon formation. According to the accepted definition by the OECD the headway of the platoon is less than 5 s and the relative speed of the vehicles in the platoon compared with the first vehicle (in the platoon) is less than 10 km/h.

The characteristic influencing most the intersection traffic of vehicle platoons passing in the main direction is the platoon length. The analysis having yet but a short past seems to make probable the fact that also the distribution function of the platoon lengths follows the negative exponential distribution [1]: $p(h_0) = 1 - C_3 \exp(-C_4 \cdot h)0$
where $p(ho)$ = platoon lengths (pc of vehicles) distribution function
ho = platoon length
c_3 c_4 = constants

We can be informed on the development of the parameters belonging to the respective distribution functions by the result of an examination realized upon basis of the traffic data of two Hungarian highways (No. 2. and No. 4.) as well as of a highway in the Netherlands (No. 9.) resp. of their analysis. The most important measurement result are shown by *Table 1.*

(The distribution functions of headways in the major direction were determined in the 100–1000 E/h traffic volume categories on the base of the measurements of the Highway Engineering Department in 1990.)

For roundabouts — also according to Hungarian regulations — the circular movement is the major direction, in between of their vehicles of which all the traffic reaching the intersection should connect in. In lack of roundabout traffic flow measurements in highway in Hungary the following Australian measurement results can be accepted as a first approach s to the real values of the headways (*Table 2.*):

Table 2

	One-lane circular path	Two or more lane
Hedway in the major direct.	2s	2s
critical gap	4s	4s
headway within the vehicles travelling in platoons in the major direction	2s	2s

Time Requirement of Different Movements

The movements in the intersections in different directions, the crossings, the turns to left, the joinings-in to right should be settled both for the highway and the circular path by using their headways.

The values of the minimum time requirement for the motions (as gaps) spread the most largely in the professional literature and in the dimensioning practice are published in HCM [3]. According to the respective *Table 3* the time requirements are as follows (*Table 3*);

Table 3
Criticalgap volues

Vehicle movement and its regulation	Basic gap values (in S) for passenger cars. Average speed on the highway: 48.3 km/h (30 miles/h), Lane no.of highway 2	48.3 km/h (30 miles/h), Lane no.of highway 4	88.5 km/h (55 miles/h), Lane no. of highway 2	88.5 km/h (55 miles/h), Lane no. of highway 4
Right turning from minor road				
STOP	5.5	5.5	6.5	6.5
Yield sign	5.0	5.0	5.5	5.5
Left turning from highway	5.0	5.0	5.5	5.5
Crossing the highway				
STOP	6.0	6.5	7.5	8.0
Yield sign	5.5	6.0	6.5	7.0
Left turning from minor road				
STOP	6.5	7.0	8.0	8.5
Yield sign	6.0	6.5	7.0	7.5

The table shows, that are given gap values for only two kinds of speed by the method / for example the 80 km/h limit in the outside of towns or the 60 km/h speed limit in the field of highway intersections cannot be taken in consideration. /

There is no way either to consider the differences relating to the traffic in the different lanes of a 4-lane highway. Neither can we analyse the

Table 3 (continued)
Modification of critical gap (s)

Conditions	Modification
Right turning from minor road: – radius > 15.2m (50 feet) – or angle < 60°	–0.5
Right turning from minor road: – (accelerator lane)	–1.0
Every movement: population 250.000	–0.5
Reduced sight(1) distance	from +1.0

Note: The critical gaps can be reduced by 10s at most. The maximum value of critical gap is 8.5s. In between values 48.3 and 88.5 km/h (30 and 50 miles/h) an interpolation should be made in function of the average speed used on the highway.
[1] Only where movement is influenced by the lack of sight distance.

main types of traffic (workday, weekend, holiday), (The table values refer fundamentally to traffic in a city and near city area.) Mr. András Bényei determined gap time values in consideration of the local situation of outside intersections upon base of traffic dynamical theory. The results are summarized by *Table 4*.

From the F1 and F2 values indicating the traffic by directions on the highway smaller index means the nearer flow (their dimension is pcph).

The gap analysis made by the author in 1990 in three outside intersection in Hungary resulted in the following values (*Table 5*):

These data show the time of the analysed movement types requiring longer time than the HCM values. The most recent gap values in the international professional literature — considerable for the similarities of the highway regulations were published by Werner BRILON. The values shown by *Fig. 1* are to be drawn in function of the speed [5].

BRILON dealt also with the gap values of the movement in the intersection of a vehicle group coming from the minor direction and wanting to pass in the same direction. *Fig. 2* is giving the volume and time requirement of a vehicle group wanting to turn right at a 60 km/h highway speed [5].

Table 4
Critical gap values determined by a method based on traffic dynamics

Basic situation	Type of crossing or connecting vehicle	Volume ratio in the main direction	Speed in km/h of vehicles passing in the main direction: 30 km/h		40 km/h		50 km/h		60 km/h	
			Width of path of vehicles passing in the main direction in m: 7.20	10.80	7.20	10.80	7.20	10.80	7.20	10.80
Crossing	pc	F1 = 0.6F2	5.8	5.9	6.0	6.1	6.2	6.4	6.6	6.7
		F1 = F2	5.5	5.6	5.7	5.8	6.0	6.0	6.4	6.4
		F1 = 1.4F2	5.3	5.3	5.5	5.5	5.8	5.8	6.1	6.1
	truck	F1 = 0.6F2	7.1	7.1	7.2	7.2	7.5	7.5	7.8	7.8
		F1 = F2	6.8	6.8	6.9	6.9	7.2	7.2	7.5	7.5
		F1 = 1.4F2	6.6	6.5	6.7	6.6	7.0	6.9	7.3	7.2
	motorbyke	F1 = 0.6F2	4.4	4.6	4.7	4.9	5.0	5.2	5.4	5.6
		F1 = 1.0F2	4.2	4.4	4.5	4.6	4.8	5.0	5.2	5.4
		F1 = 1.4F2	4.1	4.2	4.4	4.5	4.7	4.8	5.1	5.2
Turning at small radius	pc	–	9.4	9.5	11.5	11.6	13.5	13.6	15.1	15.2
	truck	–	10.2	10.3	12.1	12.2	14.1	14.2		
	motorbyke	–	8.2	8.3	11.4	11.5	12.4	12.4		
Turning at large radius	pc	F1 = 0.6F2	6.9	7.2	7.8	7.9	8.6	8.8	9.4	9.5
		F1 = F2	6.9	7.1	8.0	8.1	0.1	9.2	10.1	10.1
		F1 = 1.4F2	6.8	7.0	8.2	8.2	9.4	9.4	10.4	10.4
	truck	F1 = 0.6F2	8.0	8.1	8.8	8.8	9.5	9.6		
		F1 = F2	8.0	8.0	8.9	8.9	9.9	9.9		
		F1 = 1.4F2	7.9	7.9	9.0	8.9	10.2	10.0		
	motorbyke	F1 = 0.6F2	5.8	6.0	6.7	6.8	7.5	7.6		
		F1 = F2	5.9	6.0	7.0	7.0	8.0	8.8		
		F1 = 1.4F2	6.0	6.0	7.2	7.1	8.4	8.2		

Capacity Calculating Method of HCM

The first step of the method HCM is the unification of the minor traffic by using of the equivalent factors specified in function of the gradients. The factors of the respective vehicle unit are specified by *Table 6.*

Table 5

Type of movement	Type of vehicle	Number of vehicles (pc)	Critical gap (s)	Number of evaluated movements
To left from major direction	pc	1	5.79	82
	pc	2	11.76	30
Right turning from minor direction	pc	1	8.92	115
	truck	1	11.26	69
	pc	2	10.10	37
	truck	2	16.63	75
Left turning from direction	pc	1	7.37	60
	truck	1	9.53	20
	pc	2	11.45	57
Crossing from minor direction	pc	1	6.50	20
	truck	1	8.50	18
	pc	2	9.62	14

Equivalent factors for highway inter sections controlled with traffic signs.

The second step would be the determination of the major traffic flows (v/h) conflicting with the minor traffic flows (pcph). The kinds of major traffic flows of different types, in connection with movements of minor roads are summarized by *Fig.3.*

It should be noted as follows:

x V_t represents only the traffic of the right-side lane

xx When there is a separate lane on the highway for right turning, values V_r and V_{ra} need not be taken in consideration.

xxx When the turning radius of those turning right from the major road is large and/or this movement is regulated by a traffic sign too, V_r and V_{ra} and/or V^{rb} should not be taken in consideration, V_{rb} need not be considered, when having a separate lane.

The third step after determining of conflicting traffic would be to read the value of the so-called potential capacity from the diagram of *Fig. 4* using the gaps of different movements.

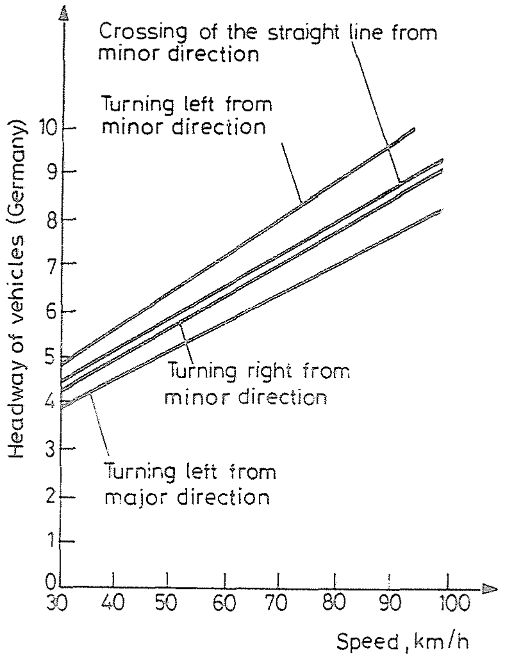

Fig. 1.

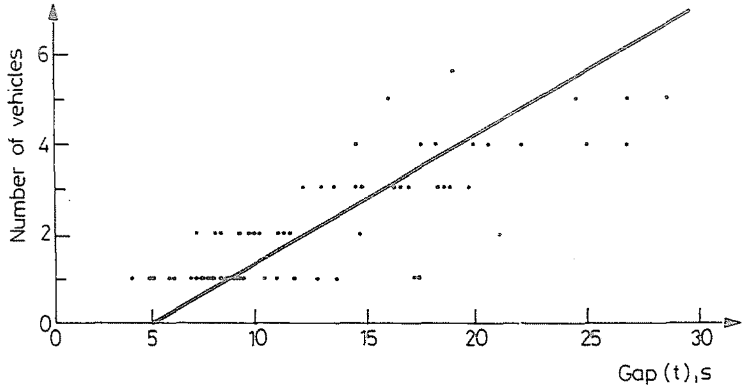

Fig. 2.

As a fourth step, the values read from the diagram should be reduced in consequence of the traffic jam in the large traffic of the highway intersection according to the rate of the impedance that is to say that not every

Table 6

Type of vehicle	Grade conditions				
	–4%	–2%	0%	+2%	+4%
Motorbyke	0.3	0.4	0.5	0.6	0.7
Passenger car	0.8	0.9	1.0	1.2	1.4
Truck without trailer and caravan	1.0	1.2	1.5	2.0	1.0
Truck with trailer. tractor	1.2	1.5	2.0	3.0	6.0
All vehicles of different kinds[x]	0.9	1.0	1.1	1.4	1.7

[x] This composition of vehicles is unknown. as an approach the last values may be applied

The type of movement	V_{cl}	Conflicting traffic flow.
1. Turning right from minor direction	$1/2\, V_r^{**} - V_t^{*}$	V_t, V_r, V_i
2. Turning left from major direction	$V_r^{***} - V_t$	V_i, V_r, V_t
3. Crossing	$1/2^{**} V_{ra} - V_{ta} - V_{tb} - V_{la} - V_{rb} - V_{lb}$	V_{tb}, V_{ra}, V_{ta}, V_{lb}, V_{ra}, V_{ra}, V_i
4. Turning left from minor direction	$1/2^{**} V_{ra} - V_{ta} - V_{la} - V_{rb}^{***} - V_{tb} - V_{lb} - V_o - V_{or}$	V_{cr}, h/o, V_{ra}, V_{tb}, V_{la}, V_{lb}, V_{ra}, V_i, V_{tb}

Fig. 3.

possible headway would be utilized, only a part of them. The impeding movements and how they would be taken in consideration are shown by *Fig. 5.*

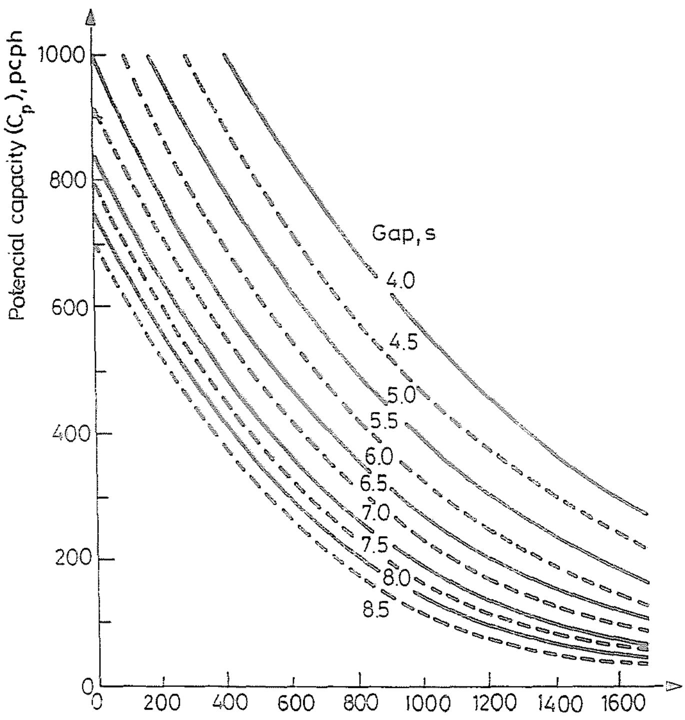

Fig. 4.

The impedance factor is given in the function of the potential capacity (*Fig. 6*).

The final operation of the method is to decide the capacity reserve (difference in capacity and traffic requirement) relating to every one of the controlled lanes, and afterwards to decide according to these values the level of service using (*Table 7*).

When traffic requirement is bigger than the capacity, waiting time would be very long and a very long queue is generated, which is impede traffic movements in other directions.

Table 8 produces an example for the results reached by this method, where the capacity of the crossing of a two-lane highway and a two-lane controlled road was examined with increasing traffic flows. The distribution of the traffic is as follows:

- 60 % of the traffic incoming from the main direction passed straight on. 20 % turned left from a separate lane, 20 % turned right according to the first variant from a separate lane, according to the second variant from the straight lane.

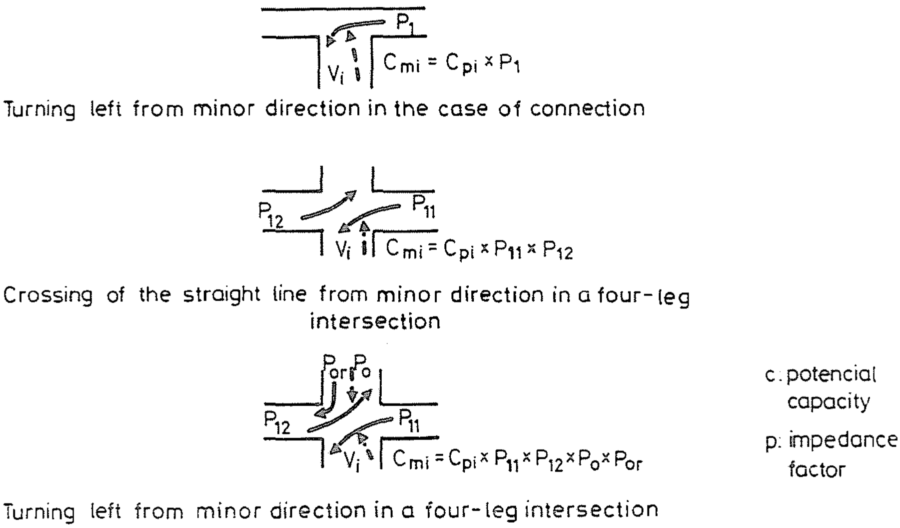

Fig. 5.

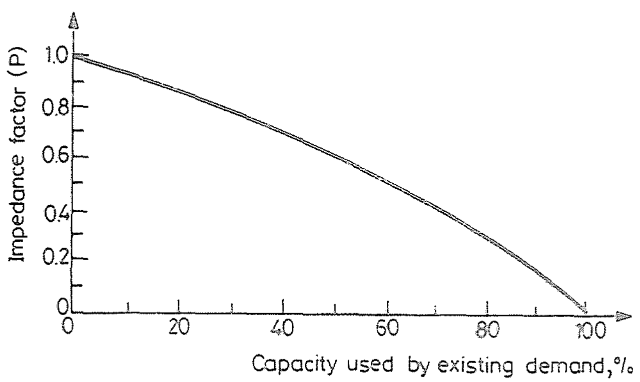

Fig. 6.

- 80 % of the traffic from minor direction passed straight on. 10 % turned left from a separate lane. 10 % turned right.

According to the table maximum 1400 incoming vehicles are able to go through the junction at the very low level of service according to HCM method.

Table 7
Limit values of service level conditions

Reservedcapacity E/h	Level of service	Delay in controlled direction
≥ 400	A	small or none
$300 - 399$	B	short
$200 - 299$	C	average
$100 - 199$	D	long
$0 - 99$	E	very long
x	F	x

Table 8

Traffic volume from major direction 60 % straight 20-20 % turning pc/ph	Traffic volume from minor 80 % straight 10-10 % turning pc/ph	Design speed km/h	Service level Separate lane in main direction existing	 not exist.
300	100	90	C	C
300	200	90	D	D
300	300	90	D	E
400	100	90	D	D
400	200	90	D	E
400	300	90	E	E
400	400	90	F	F
500	100	90	D	D
500	200	90	E	E
500	300	90	F	F
600	100	90	E	E
600	200	90	F	F
700	100	90	E	E
700	200	90	F	F
800	100	90	F	F

Capacity Calculation of Roundabouts

Roundabouts came in the practice in Europe, beginning also to spread in our country. For their dimensioning Mr. András BÉNYEI gave method upon ground of French measurements [6]. His method can be summarized as follows:

On the circular path. the major traffic (F) in a connection point depends on the traffic $F1$ passing on along the circular path and on the traffic $F2$ leaving at the connecting

$$F = mF1 + \alpha F2.$$

(m value depends on the radius of the circular path. At $R > 15$ meter $m = 0.9$. $R \geq 30$ m_ϵ $m = 0.7$ between the two R-s there is a linear

$$\alpha = 0.2.$$

The basic value of the connecting traffic Ca/pcph can be read in function of major traffic F (Vph) from the diagram of *Fig. 7.* The Figure is valid. when the connecting vehicles are passenger cars and the roundabout is in vertical position and when subordinate traffic is connecting only on one lane. Deviation from validity conditions should be taken in consideration multiplied by correction factors.

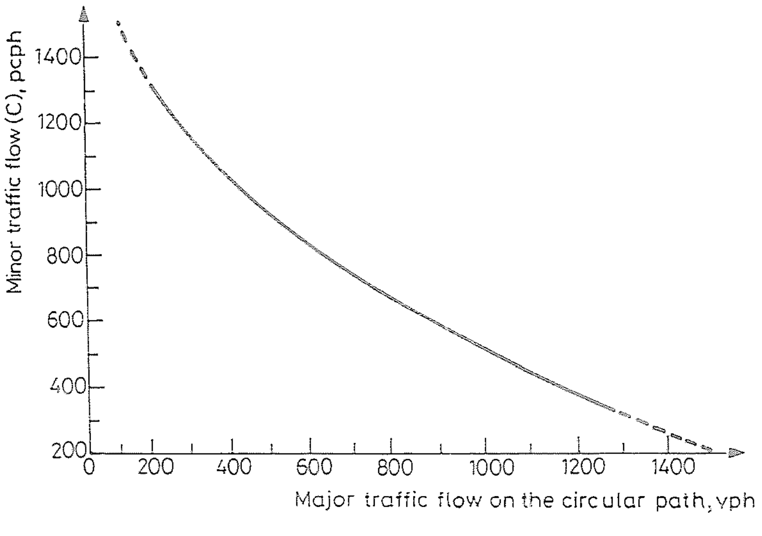

Fig. 7.

The correction factors for other vehicles types (no passenger cars) are contained by *Table 9.* for up- and down grades by *Table 10.* For a double-lane circular path can use bigger basic capacity. that is Cm = Ca . 1.4.

The adequacy of the junction can be measured by help of value of reserved capacity $C = (Cm/1.1) - f$. After having made some calcula-

Table 9

Type of vehicle	Correction factor
pc	1
small and medium trucks	1.4
heavy trucks	1.8
all vehicles/together if composition is unknown	1.1

Table 10

Type of vehicle	-4%	-2%	+2%	+4%
		grade values		
pc	0.80	0.90	1.20	1.4
small and medium (size) trucks	0.64	0.79	1.36	2.00
heavy trucks	0.61	0.78	1.50	3.00
All vehicles	0.82	0.91	1.27	1.55

Table 11

Total incoming traffic (vph)	Reserved capacity (vph)
1440	1018
1920	715
2040	564
2400	373
2640	257
2760	98

tions for a four-leg roundabout, all capacity reserve values depending on connecting traffic can be found in *Table 11.*

As for a reserved capacity less than 200 vph waiting time is quickly increasing, the value 2600 vph total incoming traffic (from *Table 11*) can be considered as the limit of application of roundabouts.

General Computing Method for Capacity Calculation of One Level Intersections

A complete analysis of the traffic flows incoming area of intersections is possible by way of the exact modelling and accelerated simulation of the existing processes. The development of computers gave an assistance for this solution. This is proved by the fact that in the most developed part of the world the simulated modelling processes come to be born one after the other on the special field of traffic in the respective universities and institutes.

The essence of the process to be dealt with here [7] is the production of multiple random numbers, the independence of number series being guaranteed by the fact that the random number generated at last in a previous process establishes the basic data of the following generating.

The aim of the simulations is to be able to produce a vehicle flow, the volume, compositions and the first vehicle type of its columns of which can be specified. In this theoretical traffic the vehicles decelerate or accelerate, try to observe the speed limits. overtake, show the upgrades and downgrades. The tool of the manipulation is based upon the division of road area into fields (vehicle units) and on ground of the calculation of the engagement of the respective fields, upon the modification of this engagement. The engagement can be calculated in function of the new vehicle positions.

Three kinds of vehicles are participating in the process: passenger cars, small and medium trucks and heavy trucks.

The strong side of the method lies in the fact that the distribution of the headways of the simulated traffic can be traditional (according to the so-called Poisson distribution, or negative exponential function fit to the effective measurements It should be noted here that Werner BRILON is using for the new German highway intersection regulation the 'Poisson distribution'.

The method is general because usable for the examination (testing) of all level highway intersection (joining-in, crossing, combined crossing (Lupa-Island), roundabout). The data and information necessary to the calculations are the following:

- Type of intersection (4 types)

- Average speed of the major and minor connecting roads (for a roundabout the speed means vehicle speed on the circular path)
- Method of the traffic regulation
- Values of the critical gaps (in lack of these the gaps of HCM should be used)
- Volume of traffic by lanes in vph dimension
- Percentual distribution of the vehicle types of the respective directions
- Average length of the vehicle platoons formed in the respective directions and type of the first vehicles of the respective vehicle platoons
- Arrangement of the separted section (every possible variation can be specified)
- Time of the simulation.

The result of the calculation is not exact in the general meaning of the word, it does specify any lack of capacity or level of service. The result has a lot of 'from where–to where' matrixes showing the average and extreme values characterizing of going through traffic in the intersection area.
These are as follows:

- total incoming traffic
- total leaving traffic
- 'from where–to where' traffic matrix at the end of the simulation
- maximum. — minimum– and average speed matrixes
- speed distribution
- maximum. minimum and average waiting time
- waiting time distribution
- maximum. minimum and average stationary time

(Interpretation of stationing: 500 m before the intersection, area of the intersection, and 500 m after having the intersection.)

- distribution of the stationary time.

As a numerical result the simulation of the crossing of a two-lane major road and a two-lane minor is shown by *Table 12*. The vehicles of the incoming traffic volume are represented in the first half of the table by passenger cars, in the second half by 80 % passenger cars and 20 % heavy trucks, (50 % of the vehicles are travelling in platoon.)

The distribution by directions agrees with the previous. The table is showing two parameters:

- maximum of average stationary time
- deviation from the specified traffic.

At the interpretation of stationing it should be considered that the length of the examined road section is 1 km and the average speed of the minor direction traffic is 30 km/h. That is to say that the time requirement of the free travel is appr. 120 s.

Table 12

Crossing of major road and minor road, having each two lanes

Traffic major-minor	Av. max stat.time (s)	Dev.from spec.traffic (pc)	Av.max. stat.time (s)	Dev.form spec.traffic (pc)
500–300	100	− 12	176	+ 50
500–400	118	− 15	199	+ 54
500–500	169	− 37	206	+ 29
600–400	191	− 36	262	+ 2
600–500	225	− 84	283	− 49
600–600	230	− 47	354	− 96
700–400	180	− 60	338	− 73
700–500	296	− 78	345	−334
700–600	270	−124	420	−197
700–700	299	−126	489	−260
Note.: All vehicles are pc			20 % are trucks and 50 % are travelling in platoon	

In case of a big traffic, accepting appr. a 90 s crossing and connecting time and summarizing it with the 120 s passing time it means that under a 210 s average maximum stationary time the intersection is still working, consequently it has some capacity. The table shows that the crossing of maximum appr. 2000 passenger cars/hour can be realized under the initial conditions.

Consequently in comparison without the previous *Table 8.* the HCM values can considerably be exceeded. It is nevertheless proved by columns 4 and 5 that the method is very sensitive to heavy traffic, and to the platoon formation. The transmission time increases more actively in ratio of the traffic volume, than earlier.

Table 13 was made with same initial data and construction as *Table 12*, summarizing the results of the simulation of the four-leg roundabout of a major road and of a minor having two lanes each. Here the maximum of the traffic flow able to go through is 1800 pcph and 1600 vph (20 % heavy truck added to a 50 % platoon formation).

Table 12
Roundabouts (four-leg)

Traffic major-minor	Av. max stat.time (s)	Dev.from spec.traffic (pc)	Av.max. stat.time (s)	Dev.form spec.traffic (pc)
500–300	143	– 45	148	– 82
500–400	144	– 86	152	– 97
500–500	146	–101	154	–139
600–300	144	– 77	150	–149
600–400	145	– 97	151	–163
600–500	148	– 71	170	–218
600–600	151	–107	155	–260
700–300	154	– 74	152	–193
700–400	159	– 78	155	–128
700–500	163	–116	151	–316
700–600	202	–113	159	–323
700–700	228	–185	159	–406
Note: All vehicles are pc 0 % are travelling in platoon			20 % of the incoming vehicles are heavy truck 50 % are travelling in platoon	

Summary

The characteristic specialities of the traffic in Hungary, the obsolete, old-fashiones vehicles park representing an out-of-date technical level and the very important ratio of truck in the traffic (20–25 %) makes necessary to develop methods dimensioned upon ground of special researches, respectively for adoption the dimensioning processes of other countries we cannot miss to carry out appropriate ability tests. The simulated calculation previously presented is appropriate to reproduce intersection traffic flow processes in different sizes and compositions.

It is also appropriate to analise the effect on the permeability made by the variation of the intersection arrangement (length, number of separated lanes). Of course the main parameters characterizing the traffic speed, headways and the critical gaps determining definitely the capacity can be adjusted to the actual situation. For new type or more important intersections (four-lane. combined intersections, roundabouts) the use of the method can absolutely be recommended in order to carry out the more important controls.

For other less important designs the practical application of HCM is acceptable (or rather the method of Mr. András BÉNYEI is recommendable) as this dimensioning has yet important reserves and so its use means neglect for sake of the safety.

References

1. BOTMA. H. – FI. I.: Traffic Operation on 2-lane Roads in Hungary and in the Netherlands. Highway Capacity and Level of Service. Brannolte (ed) 1991 Balkema. Rotterdam ISBN 9054100117.
2. BRILON. W.: Leistungsähigkeit von Kreisverkehrsplätzen. Siebentes Deidesheimer Seminar 21/21 April. 1989.
3. Highway Capacity Manual. Washington. DC 1985.
4. Tests for Determining the Capacity of Outside Intersections Regulated by Traffic Signs. Budapest Technical University Highway Engineering Department. Scientific Information, 1986.
5. BRILON. W. – GROSSMANN. M.: The New German Guideline for Capacity of Unsignalized Intersections. Intersections without Traffic Signals II. Springer Verlag. 1991.
6. BÉNYEI. I. – FI. I. – CSORJA. ZS. – CSANÁDI. J.: Roundabouts on outskirts.
7. FI. I.: Simulation of Road Section and Intersection Traffic Capacity Analysis. News Letter. TUB 1991. 2.

Address:

Dr István FI
Department of Highway, and Traffic Engineering;
Technical University H–1521, Budapest
Hungary