CAPACITY OF TRAFFIC SIGN CONTROLLED JUNCTION

- based on the number of vehicles which can drive through a junction at a certain time interval
- determined by calculating capacity of minor traffic flows and the resulting traffic delays at the minor roads
- limited by capacity in every collision point of the junction where traffic flows connect, disconnect or intersect *fig. 0430*

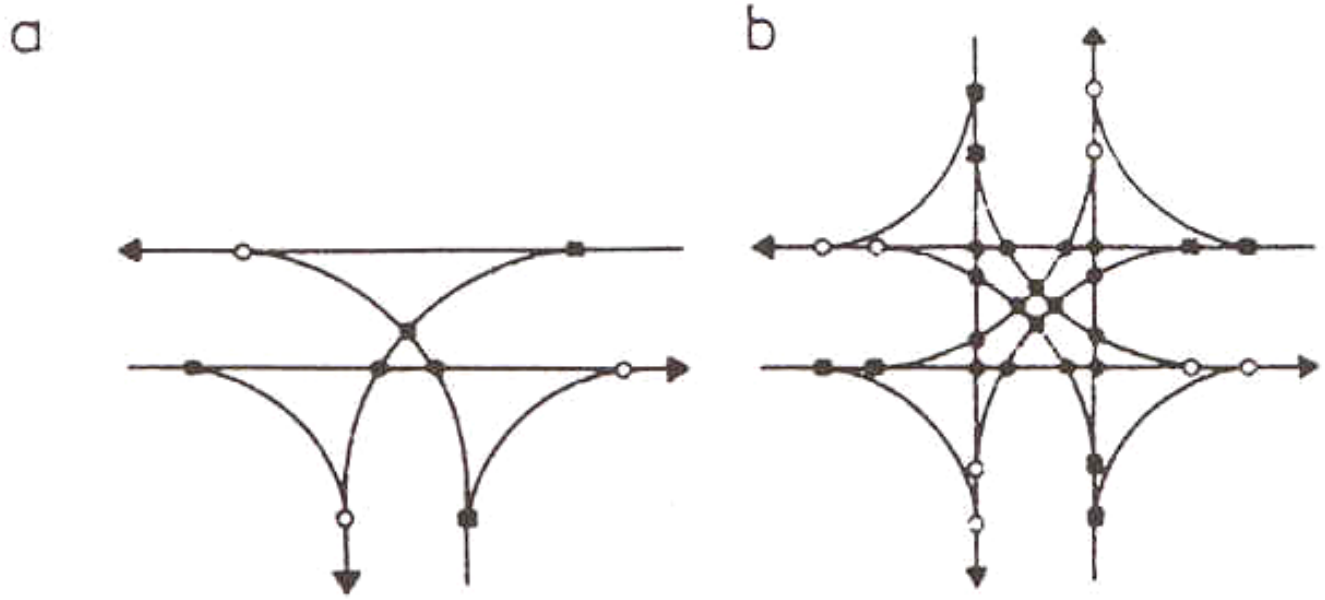


fig. 0430 (collision points at junctions)

a) **T-junction** – 3 legs (entries/approaches)

b) **crossroads** – 4 legs (entries/approaches)

- the unfavourable combination of traffic flows is critical for total junction performance (labelling in *fig. 0440*)

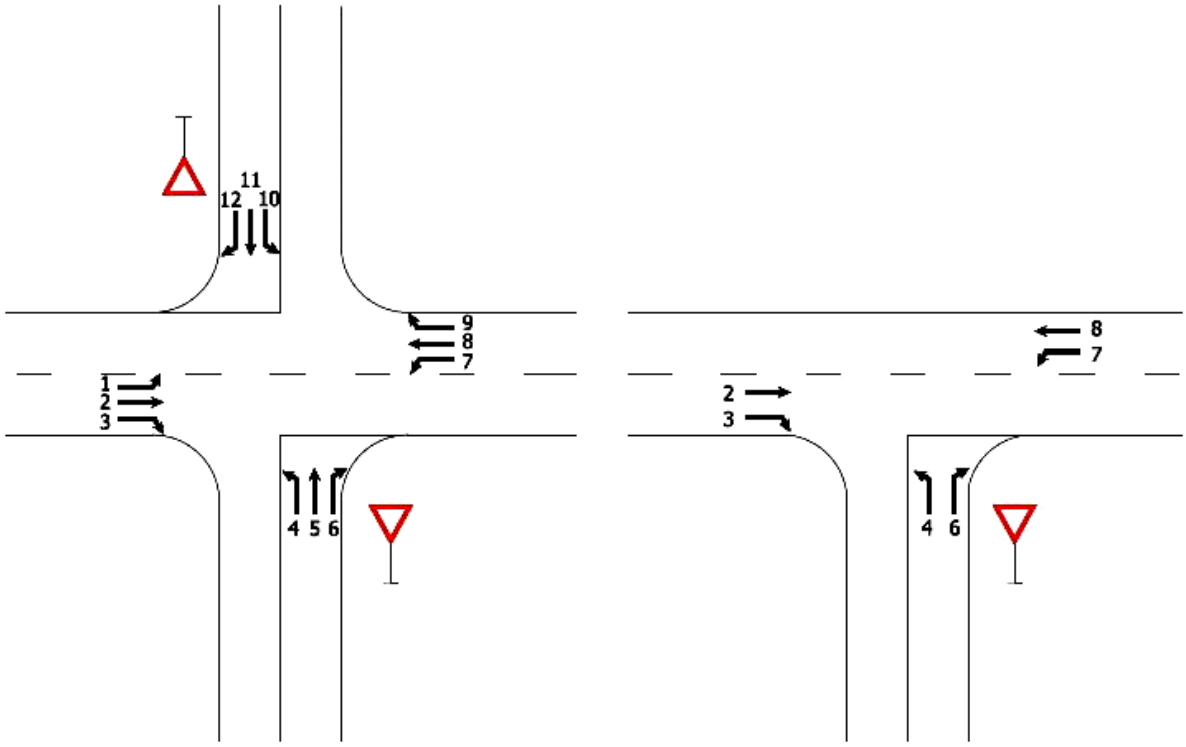


fig. 0440 (labelling of traffic flows in a junction)

❖ We consider T-junction in our case

Diagram of traffic flows in *fig. 0450* ⇒ stages („k“):

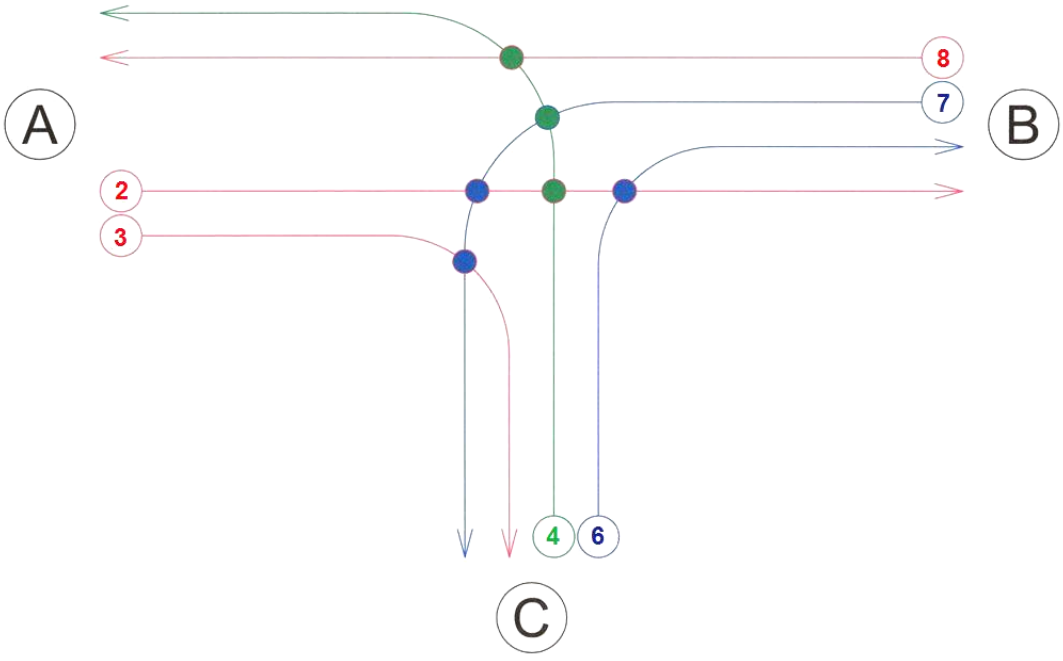


fig. 0450 (diagram of traffic flows of T-junction)

- *1. stage ..... flows 2, 8, 3*
- *2. stage ..... flows 6, 7 (first inferiority)*
- *3. stage ..... flow 4 (second inferiority)*

Determining the junction model:

- sets solution of right turn (corner or a slip road – *fig. 0460*) on the basis of classes of the crossing roads

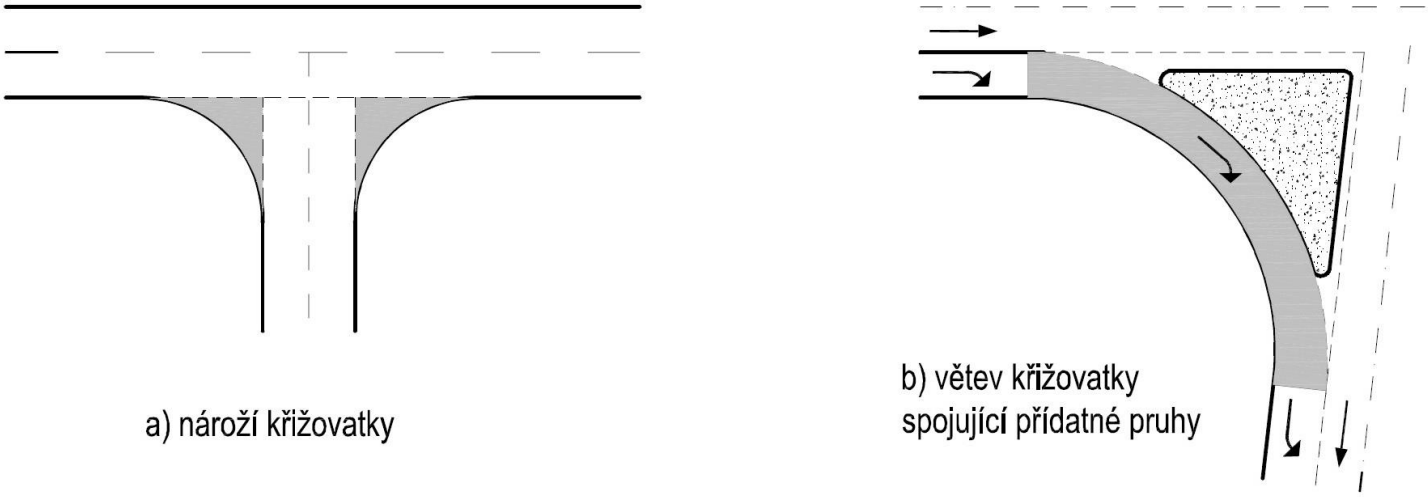


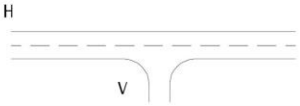
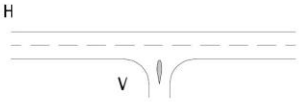
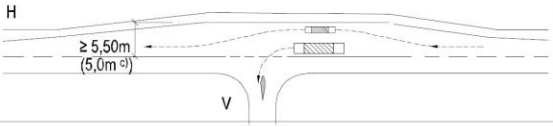
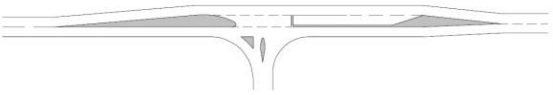
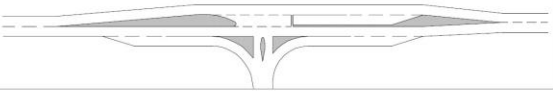
fig. 0460 (corner and slip road of at-grade junction)

- determine the class of both roads and then the junction model („SÚK“) according to the following table (the table is based on preliminary determination of roads category in ČSN 736101 – simplified and adapted for the needs of the exercise)

Determining the junction model of at-grade T-junction („SÚK“)			**Minor road**	
			S 6,5	**S 7,5**
			Third-class	Second class
Major road	**S 7,5**	Second-class	SÚK **IV**	SÚK **V**
	S 9,5	Second-class	SÚK **III**	SÚK **V**
	S 11,5	First-class	SÚK **III**	SÚK **VI**

Junction model (defined in table in *fig. 0470* – mention in the technical report !!!) **provides:**

- solution of the right turn
- existence of the auxiliary turning lanes (simplified for needs of the exercise)

Označení křižovatky	Schéma typu	Usměrnění dopravy na hlavní silnici H[a)]	Usměrnění dopravy na vedlejší silnici V[b)]	Třídy křižijících se silnic H/V
SÚK I		—	—	a) III tř. / III tř. b) II tř. / III tř.[c)]
SÚK II		—	dělicí ostrůvek	a) III tř. / III tř. b) II tř. / III tř. c) II tř. / II tř.[c)]
SÚK III		—	dělicí a směrovací ostrůvek	a) II tř. / II tř. b) I tř. / II tř.[c)]
SÚK IV		rozšíření zpevněné krajnice pro objíždění vozidel odbočujících vlevo	—	a) II tř. / III tř. b) II tř. / II tř. c) I tř / II tř.[c)]
SÚK V		dělicí ostrůvky a odbočovací pruhy pro levé odbočení	dělicí a směrovací ostrůvek	a) II tř. / II tř. b) I tř. / II tř.
SÚK VI		dělicí ostrůvky, odbočovací pruhy a připojovací pruhy	dělicí a směrovací ostrůvky	a) I tř. / II tř. b) I tř. / I tř.

a Hlavní komunikace
b Vedlejší komunikace
c Při nízké intenzitě dopravy

fig. 0470 (recommended models of at-grade T-junction on two-lane roads)

Draw the diagram of junction lanes arrangement (according to the example in *fig. 0480*):

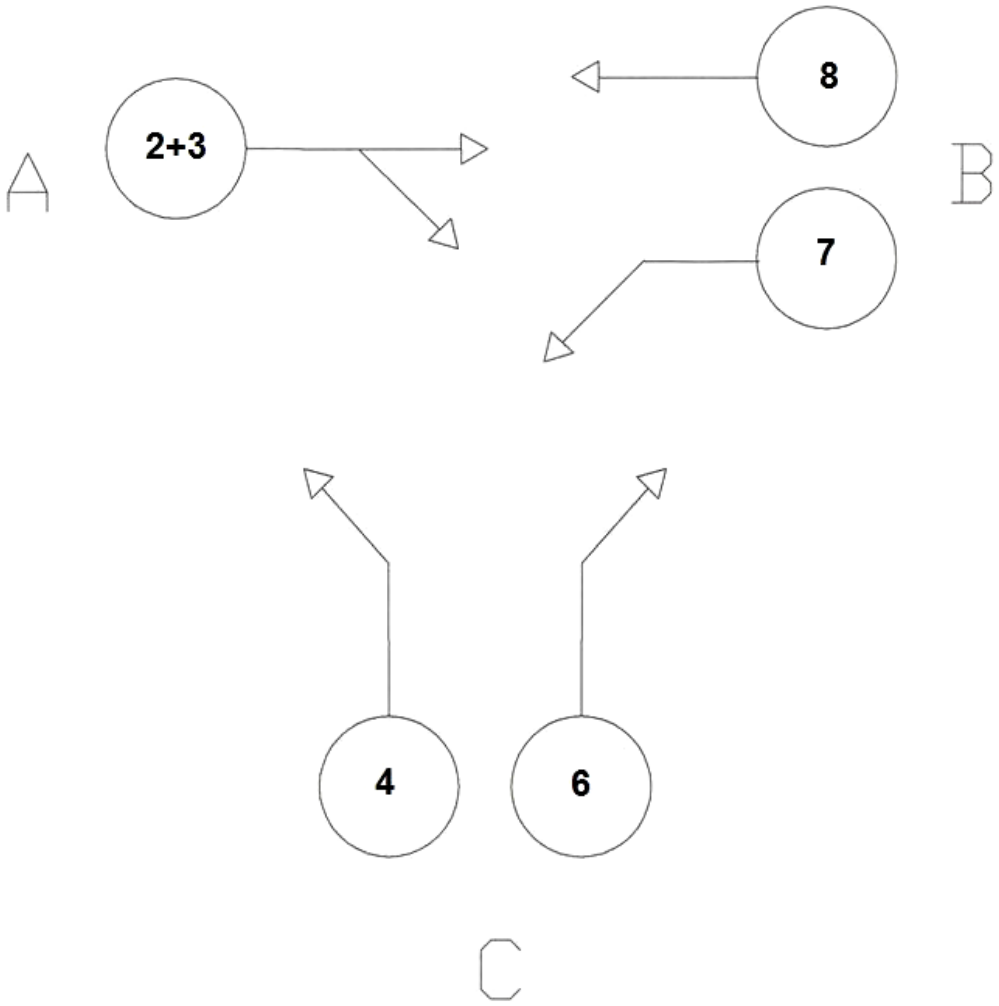


fig. 0480 (example of diagram of junction lanes arrangement)

Draw the traffic load (volume) diagram – scale 1 mm ≅ 20 vehicles/hour (according to *fig. 0490*):

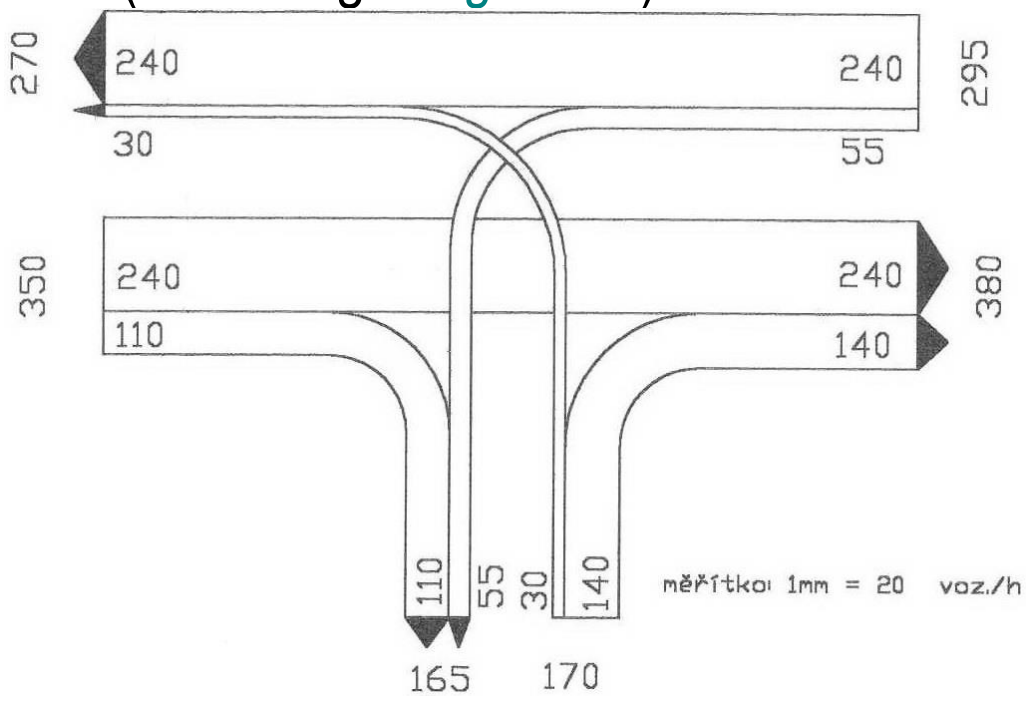


fig. 0490 (an example – the traffic load diagram)

Input – real vehicles + percentage of slow vehicles (on major and minor roads) ⇒ convert to so-called „pveh/h“ (converted vehicles / hour) according to the formula:

$$I_i[pveh/h] = I_i[veh/h] \bullet \left(\frac{100\% - ppv[\%]}{100\%} + \frac{k_{pv} \bullet ppv[\%]}{100\%} \right)$$

- *consider „ppv“ according to the road (major / minor) from where the traffic flow exits*
- *coefficient „k_{pv}“ is generally obtained from the table in fig. 0500 ⇒ use value k_{pv} = 1,5 for the purpose of exercise (we consider lorries and busses only)*

Typ křižovatky	Jízdní kola	Motocykly	Osobní vozidla [a]	Nákladní vozidla, autobusy [b]	Nákladní soupravy, kloubové autobusy
Průsečné a stykové bez SSZ	0,5	0,8	1,0	1,5	2,0
Průsečné a stykové se SSZ	0,5	0,8	1,0	1,7	2,2
Okružní	0,5	0,8	1,0	2,0	3,0

[a] Včetně nákladních vozidel do 3,5 t celkové hmotnosti.

[b] Nákladní vozidla nad 3,5 t celkové hmotnosti mimo nákladních souprav a autobusy mimo kloubové autobusy.

fig. 0500 (recommended converting coefficients of the traffic mixes)

The capacity calculation is based on:

- the number of space-time gaps between vehicles of traffic flow with the right of way priority (superior flow „j“) which are acceptable for merging or crossing with vehicles of inferior traffic flow so their manoeuvres are smooth, safe and without loss of time ⇒ percentage ($P^{k(j)}$) of time of

free traffic flow „j“ of stage „k“, if the flow „j“ is inferior to the other traffic flows of stage „k-1“ at the same time

- determining the critical time headway „t_g“ between vehicles of superior traffic flow „i“ (the first waiting vehicle)
- determining the mean time headway „t_f“ between vehicles of superior traffic flow „i“ (the second and another waiting vehicles)

The calculation is based on the following values:

- I_i [pveh/h] ..... design (outlook) traffic volumes of traffic flows „i“ (from the input values „I_i“ [veh/h] a „ppv” [%])
- $t_{g,i}$ [s] ..... critical vehicle time headway of traffic flows „i“ (see the table)

Value „t_g“ According to the type of junction movement and speed of vehicles on the major road „v_h“ [km/h]		
Type of traffic flow („i“)		**t_g [s]**
Left turn from major road	7	$3,4 + (0,021 \bullet v_h)$
Right turn from minor road	6	$2,8 + (0,038 \bullet v_h)$
Left turn from minor road	4	$5,2 + (0,022 \bullet v_h)$

  - ***set „t_g“ for** each of traffic flows **4, 6** and **7***
  - ***„v_h“ = 90 km/h** (rural area)*
- $t_{f,i}$ [s] ..... average vehicle time headway of traffic flows „i“ (see the table)

Values t_f according to **the type of junction movement** and **type of giving way to vehicles on the major road**			
Type of traffic flow („i“)		P6 STOP	P4 ▽
		t_f [s]	
Left turn from major road	7	2,6	
Right turn from minor road	6	3,7	3,1
Left turn from minor road	4	4,1	3,5

- ***set „t_f“ for** each of traffic flows **4, 6** and **7***

- I_{Hi} [veh/h] ..... sums of traffic flow volumes superior to flows „i“ (calculate according to the table , take the existence of off lanes into account)

Calculation of I_{Hi}		
Inferior flow „i“		I_{Hi} [veh/h]
Left turn from major road	7	$I_2 + I_3$
Right turn from minor road	6	$I_2 + 0,5 \bullet I_3$ [1)]
Left turn from minor road	4	$I_2 + I_8 + I_7 + 0,5 \bullet I_3$ [1)]
[1)] separate diverging lane for flow 3 (right turn from major road) $\Rightarrow I_3 = 0$		

- G_i [pveh/h] ..... basic flow capacity
- C_i [pveh/h] ..... capacity of flow „i“
- Rez_i [pveh/h].... performance reserve of flow „i“
- $t_{w,i}$ [s]..... mean time loss of flow „i“
- $p_{0,7}$ [-]..... probability of free flow of traffic flow 7 (left turn from major road)

DETERMINING THE TRAFFIC FLOW CAPACITY

Basic capacity „G_i“ of flow „i“:

$$G_i = \frac{3600 \bullet e^{-\frac{I_{H,i}}{3600} \bullet \left(t_{g,i} - \frac{t_{f,i}}{2} \right)}}{t_{f,i}}$$

$[G_i]$ = pveh/h $[I_{H,i}]$ = veh/h

Determining capacity „C_i“ of flow „i“:

1. **stage one flows (2, 3, 8)** – do not assess (they are not delayed)
2. **stage two flows (6, 7) – first inferiority**

$$C_{6,sam} = G_6 \qquad C_7 = G_7$$

3. **Stage three flows (4) – second inferiority:**

$$p_{0,7} = 1 - \frac{I_7}{C_7}$$

$[I_7] = [C_7]$ = pveh/h

$$C_{4,sam} = p_{0,7} \bullet G_4 \Rightarrow C_{4,sam} = G_4 \bullet \left(1 - \frac{I_7}{C_7} \right)$$

4. **Consideration of impact of the common lane for two inferior flows (4, 6):**

$$A_{4+6} = \frac{I_4}{C_{4,sam}} + \frac{I_6}{C_{6,sam}}$$

$[I_4] = [I_6] = [C_{4,sam}] = [C_{6,sam}] = [C_4] = [C_6]$ = pveh/h

$$C_4 = I_4 \bullet \left(\frac{1 - A_{4+6}}{A_{4+6}} \right) \qquad C_6 = I_6 \bullet \left(\frac{1 - A_{4+6}}{A_{4+6}} \right)$$

DETERMINING PERFORMACE RESERVE AND TIME LOSS

Determine the **performance reserve „Rez_i“** for each traffic flow „i“ of stage two and higher:

$$Rez_i = C_i - I_i$$

$$[Rez_i] = [C_i] = [I_i] = pveh/h$$

Determine **mean time loss „$t_{w,i}$** according to the knowledge of capacity reserve „Rez_i” according to the graph in *fig. 0510* (deduct the dependency of „Rez_i“ and „$t_{w,i}$“ according to the curve that corresponds as close as possible to the flow capacity „C_i“):

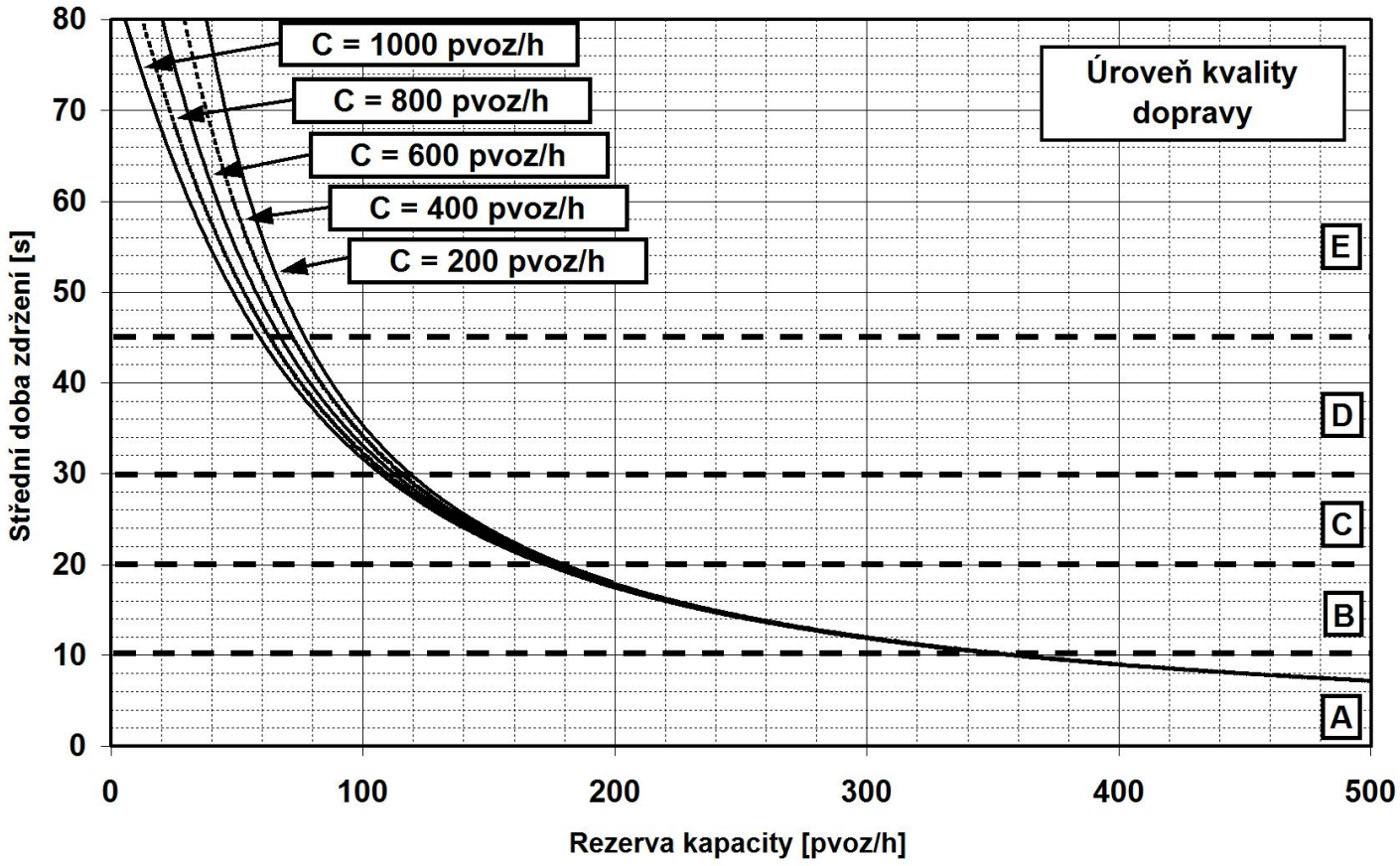


fig. 0510 (graph for determining the mean time loss)

FINAL ASSESSMENT AND RESULTS ARRANGEMENT

- Determine the **level of service „LOS“** for each traffic flow of stage two and more according to the knowledge of mean time loss „$t_{w,i}$“:

LOS		$t_{w,i}$
label	Verbal description	[s]
A	Time loss is very small	0 – 10
B	Delay is without queues	10 – 20
C	Sporadic short queues, noticeable time loss	20 – 30
D	Stable state with high losses ⇒ vehicle queues	30 – 45
E	Unstable state (queue), time loss is not decreasing, sensitive behavior of dependency of traffic loads and losses	> 45
F	Capacity is exceeded, overloaded junction, vehicle queue grows	$Rez_i < 0$

ASSESSMENT

- standard ČSN 73 6102 requires following LOS_p:
  - *S I..... LOS_p = C*
  - *S II..... LOS_p = D*
  - *S III.....LOS_p = E*
- For the purpose of the exercise ⇒ the junction meets capacity requirements if $LOS \leq LOS_p$ for each traffic flow according to the road class

- Arrange the result into the clear table:

Flow (i)	**2 + 8**	**3**	**7**	**6**	**4**
Stage (k)	**1**	**1**	**2**	**2**	**3**
INPUT AND WORKING VALUES					
I_i [veh/h]					
I_i [pveh/h]					
$t_{g,i}$ [s]					
$t_{f,i}$ [s]					
$I_{H,i}$ [veh/h]					
$p_{0,i}$ [–]					
DETERMINIG THE CAPACITY, RESERVES, AND LOS					
G_i [pveh/h]					
C_i [pveh/h]					
Rez_i [pveh/h]					
$t_{w,i}$ [s]					
$LOS_{p,i}$ [A/B/C/D/E]					
LOS_i [A/B/C/D/E/F]					
Meets capacity requirements [Y/N]					

- Write the complete calculation and verbal conclusion into the technical report
- Pay attention to units !!!