ASESSMENT OF PROPOSED VARIANTS

(Do for both variants!!!)

1. Influencing variables

a) Longitudinal gradient and travel speed „v_j“ [km/h]:

- Course of travel speed „v_j“ of a standardized slow vehicle is determined by the length of consecutive sections with constant longitudinal gradient „s [%]“ (from the graph in *fig. 0330*)
- Graph is based on driving characteristics of average standardised slow vehicle:
  - *Engine power ..... 370 kW*
  - *Number of gears..... 16*
  - *Efficiency of the transmission 0,8878*
  - *Air resistance coefficient 0,7*
  - *Wheel radius ..... 0,526 m*
  - *Total weight..... 44 t*
  - *Front area..... 8,5 m^2*

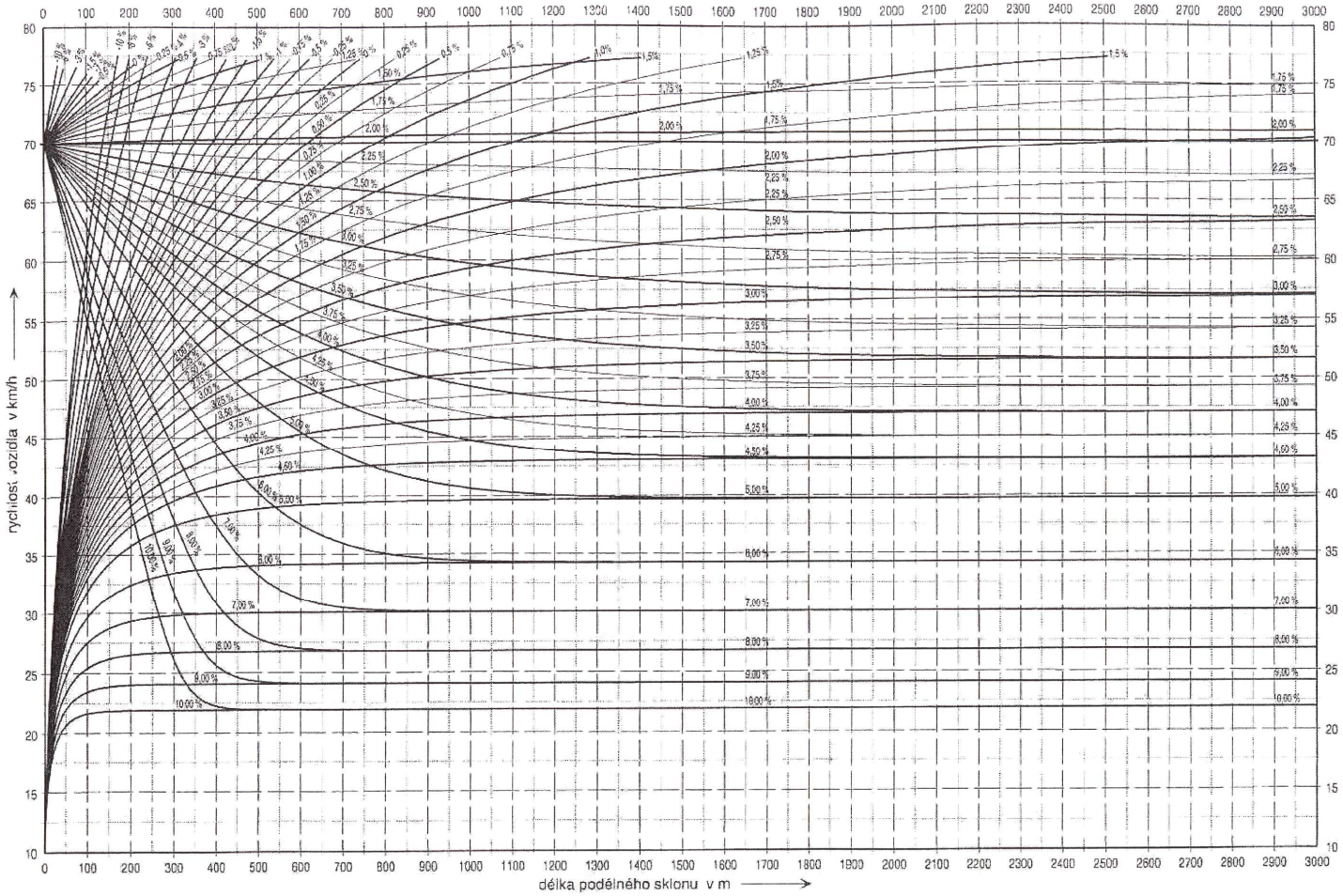

fig. 0330 (the graph to determine the travel speed of average standardized slow vehicle)

- Instructions for using the graph (the procedure is indicated in *fig. 0340*):

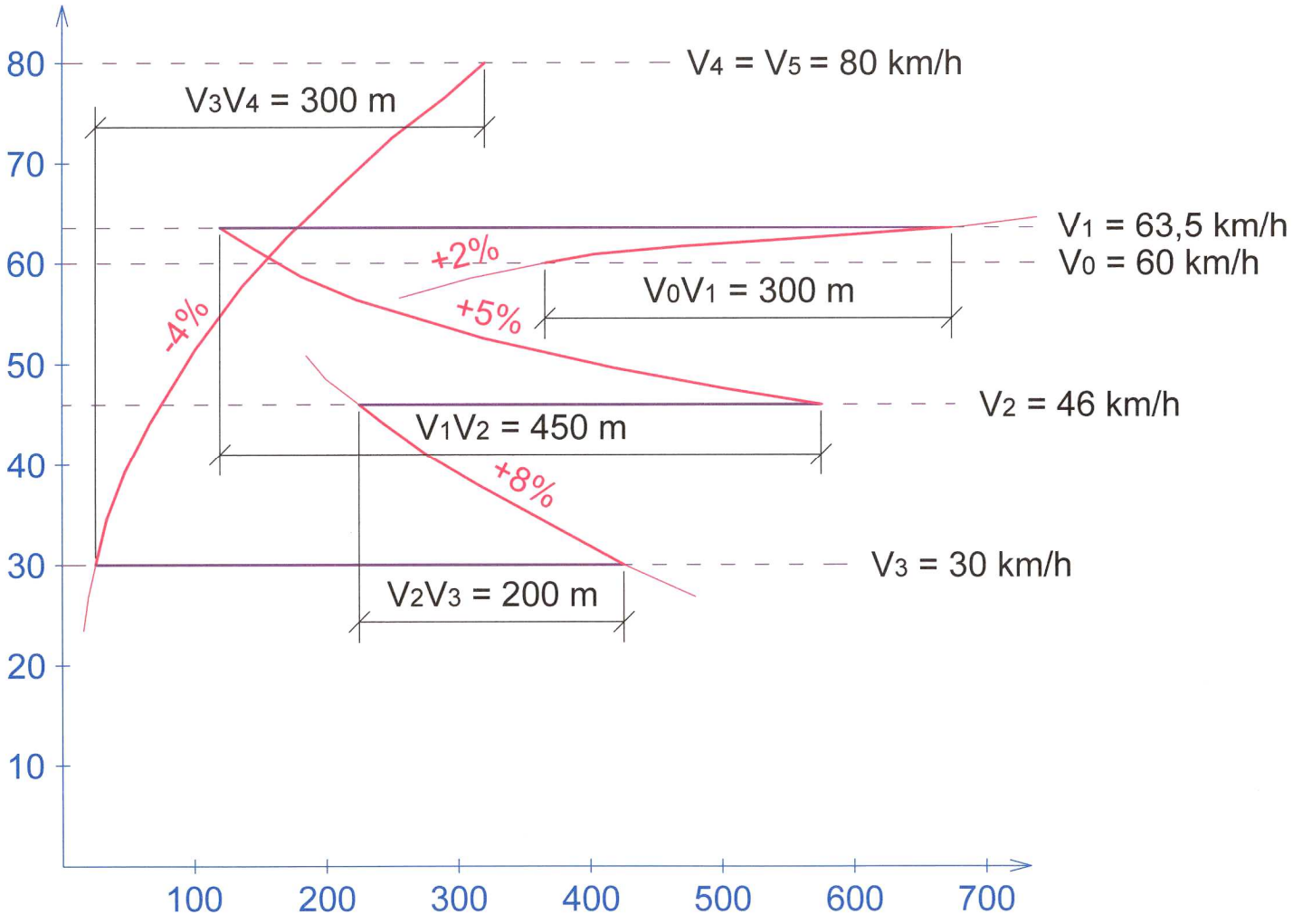

fig. 0340 (procedure for identifying the course of travel speed of average standardised slow vehicle based on the graph in fig.0330)

- *determine* ***the initial speed at the beginning of every*** *assessed* ***section*** *(the previous section must have been already evaluated and* v_j *at its end known)*
- *always consider the speed* $\boldsymbol{v_j}$ ***= 70 km/h*** *at* ***the beginning of the route*** *(applies to all two-lane roads)*
- ***the intersection of initial travel speed with curve of*** *corresponding* ***longitudinal gradient*** *is the starting point in the graph* $\Rightarrow$ *the length of assessed* ***longitudinal gradient*** *is* ***plotted horizontally*** *from this point and its end point is determined*

- ***end point** of longitudinal gradient length **is projected** in vertical direction onto **the curve of longitudinal gradient** and **the speed value v_j** is **determined** from **the intersection on the vertical axes** (the speed becomes the initial speed for the next section)*
- *if it is necessary, **it is possible** to **interpolate** between the values in the graph*

Example of using the graph (according to *fig. 0340*):

- previous evaluation ⇒ start of the route – v_j = 60 km/h
- identified sections with constant longitudinal gradient „s“ (according to the relevant longitudinal profile ⇒ including longitudinal gradients „s_1´“ and „s_2´“ replacing vertical curvature):

	V_0V_1	V_1V_2	V_2V_3	V_3V_4	V_4V_5
l_i	300 m	450 m	200 m	300 m	250 m
s [%]	+ 2	+ 5	+ 8	- 4	- 3

- course of speed „v_j“ is read from the graph at the beginning and end of each section
- same procedure applies in the opposite direction
- it is possible to create one resulting graph for both directions – plot the data from the left side in the direction “THERE” – in the direction “BACK” always plot data from the right side ⇒ common axis of chainage (2 graphically or differently coloured curves for each direction should be than used) – example of two separate graphs in *fig. 0350*

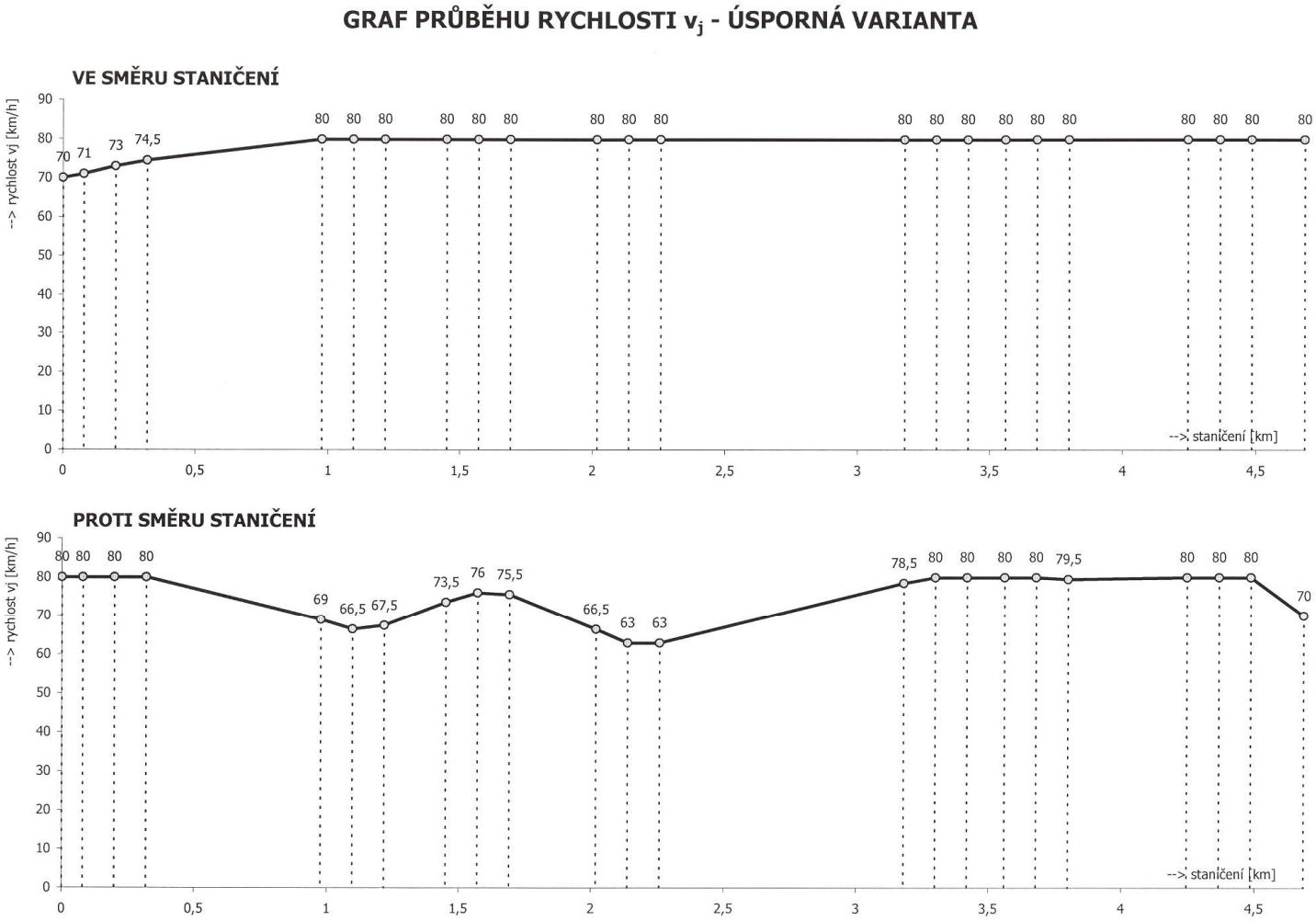

fig. 0350 (graph of course of travel speed „v_j“ for both directions)

b) class of ascending gradient:

- determine the minimum value of travel speed ($v_{j,min}$) on the route in both directions for both variants (see *fig. 0350*)
- according to *fig. 0360* determine for each variant the **class of ascending gradient** which depends on $v_{j,min}$

Nejmenší střední rychlost návrhového pomalého vozidla (km/h)	Třída stoupání
> 70	1
55 – 70	2
40 - 55	3
30 - 40	4
< 30	5

fig. 0360 (assigning classes of ascending gradient to classes of travel speed)

c) overall bendiness „CK“:

- determine bendiness „K“ [g/km] (already calculated separately for each variant):

$$K = \frac{\sum_{i=1}^{n}\left(\frac{\alpha_i}{0{,}9}\right)}{|X;Y|}$$

  - α [°] ..... central angle of i-th horizontal curve (measure by protractor in degrees) – *fig. 0070*
  - n ..... number of horizontal curves on the route (within stretch |X;Y|)
  - |X;Y| [km].... length of assessed variant
- Determine the proportion of the route with prohibited overtaking „A_{ZP}“:

$$A_{ZP} = \frac{\sum_{i=1}^{m} l_{ZP}}{10 \bullet |X;Y|}$$

  - l_{ZP} [m] ..... length of the individual sections „i“ with prohibited overtaking in longitudinal profile (*fig. 0370*)

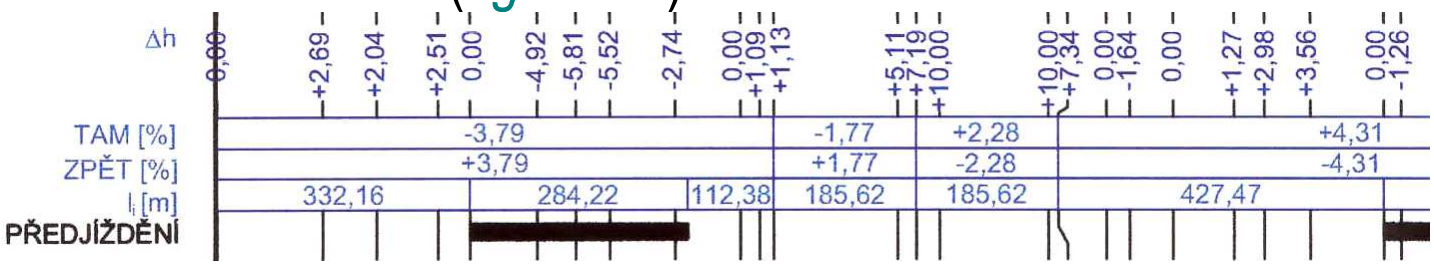

fig. 0370 (marked sections with prohibited overtaking in longitudinal profile)

  - |X;Y| [km].... length of assessed variant

- m ..... number of sections with prohibited overtaking on the route (in stretch |X;Y|)

- determine overall bendiness „CK“ which depends on „A_{ZP}“:

$A_{ZP} \leq 30 \Rightarrow \boxed{CK = K + 5 \bullet A_{ZP}}$

$A_{ZP} > 30 \Rightarrow \boxed{CK = K + 150 + \frac{A_{ZP} - 30}{0,7}}$

d) width coefficient „k_s“ – two-lane roads:

- S 11,5 ..... k_s = 1,00
- S 9,5 ..... k_s = 0,85
- S 7,5 ..... k_s = 0,60
- S 6,5 ..... k_s = 0,60

e) Average travel speed of passenger cars „v_C“ [km/h]:

- v_c is determined on the basis of knowledge of travel time (possibility of overtaking is taken into account) and the length of the section
- table for calculation of travel time (calculate for both variants and both directions – table example in *fig. 0380*):

VÝPOČET DOBY JÍZDY									
T - TAM - ve směru staničení					Z - ZPĚT - proti směru staničení				
L_i [m]	sklon [%]	v_o [m/s]	v_{on} [m/s]	$č_o$ [s]	L_i [m]	sklon [%]	v_o [m/s]	v_{on} [m/s]	$č_o$ [s]
700	4,25	20,63		33,93	400	-4,47	21,75		18,39
221	4,25		14,84	14,89	171	-3,20	22,20		7,70
279	2,50		16,90	16,51	171	-0,30	22,20		7,70
279	-1,78		19,40	14,38	594	0,80	22,20		26,76
820	-3,20	22,20		36,94	124	0,80		19,40	6,39
180	-2,50	22,20		8,11	116	0,80	22,20		5,23
180	-1,22	22,20		8,11	180	1,22	22,20		8,11
116	-0,80	22,20		5,23	180	2,50	21,85		8,24
124	-0,80		20,16	6,15	820	3,20	21,36		38,39
594	-0,80	22,20		26,76	279	1,78		17,71	15,75
171	0,30	22,20		7,70	279	-2,50		19,40	14,38
171	3,20	21,36		8,01	221	-4,25		19,18	11,52
400	4,47	20,47		19,54	700	-4,25	21,96		31,88
			$\Sigma č_{ot}$	206,25				$\Sigma č_{oz}$	200,44

fig. 0380 (table for calculation of travel time)

- speeds (v_O and v_{ON}) of a typical vehicle is determined depending on the gradient and possibility of overtaking $\Rightarrow$ interpolate in the next table according to the longitudinal gradient in %:

gradient	speeds	
s	v_O	v_{ON}
[%]	[m/s]	
- 6	20,2	17,6
- 4	22,2	19,4
- 2	22,2	20,1
0	22,2	20,1
+ 2	22,2	20,1
+ 4	20,8	19,4
+ 6	19,4	17,3

- v_O ..... speed of a passenger car [m/s] in section with possibility of overtaking of a length of l_i [m]:

$$\check{C}_{O_i} = \frac{l_i}{v_{O_i}}$$

- v_{ON} .... speed of passenger car [m/s] in section with impossibility of overtaking of a length of l_i [m]:

$$\check{C}_{O_i} = \frac{l_i}{v_{ON_i}}$$

- $\check{C}_{Oi}$ .... time consumption of passenger car in section [s]

$$\overline{\check{C}_O} = \frac{\sum \check{C}_{ot} + \sum \check{C}_{oz}}{2}\,[s] \Rightarrow \boxed{v_C = \frac{3600 \bullet |X;Y|}{\overline{\check{C}_O}}\,[km/h]}$$

- $\Sigma\check{C}_{ot}$ [s]..... time consumption of passenger car on the route (in stretch |X;Y|) in direction THERE
- $\Sigma\check{C}_{oz}$ [s] ..... time consumption of passenger car on the route (in stretch |X;Y|) in direction BECK
- |X;Y| [km].... length of assessed variant

f) **Required level of service „UKD_p“** – according to the designed road (already designed):

- motorways (D) .....UKD_p = C
- first-class roads (S I).....UKD_p = C
- second-class roads (S II) UKD_p = D
- third-class roads (S III) ...UKD_p = E

2. Assessment of quality of service

a) **Assessing the traffic density „H“ [vehicle/km] according to the level of quality of service „UKD“**

- determine traffic density „H“ [vehicle/km]:

$$I_V^{50} = \left(I_O^{X\to Y} + I_O^{Y\to X}\right) \bullet k_{V,O} + \left(I_N^{X\to Y} + I_N^{Y\to X}\right) \bullet k_{V,N} \Rightarrow \boxed{H = \frac{I_V^{50}}{v_C}}$$

- I_V^{50} [vehicle/h] ...volume of all traffic in peak hour in both directions (already calculated)
- $I_O^{X\to Y}$, $I_O^{Y\to X}$.....volume of passenger traffic (see the assignment paper)
- $I_N^{X\to Y}$, $I_N^{Y\to X}$.....volume of freight traffic (see the assignment paper)

- $k_{V,O}$ .....growth rate of passenger traffic for 2040 (see the assignment paper)
- $k_{V,N}$ .....growth rate of freight traffic for 2040 (see the assignment paper)
- v_C [km/h].....average travel speed of passenger cars (already calculated)

- determine the actual level of service „UKD“ depending on traffic density „H“ according to *fig. 0390*

UKD		Hustota dopravy (voz/km)
označení	charakteristika kvality dopravy	
A	velmi dobrá	≤5
B	dobrá	≤12
C	uspokojivá	≤20
D	dostatečná	≤30
E	nestabilní	≤40
F	nevyhovující	> 40

fig. 0390 (traffic density limits for different levels of service)

- assessment:
  - **$UKD \leq UKD_p$**.....designed road **meets requirements**
  - **$UKD > UKD_p$**.....designed road **does not meet requirements**
  - numerically demonstrate for both variants
  - specify units during the entire assessment !!!

b) assessment of level of traffic volume „I_p“ / road capacity „C“ [vehicle/h] according to level of service „UKD“

- determine share of slow vehicles „b_{pv}“ [%] in the traffic flow:

$$b_{pv} = \frac{100 \bullet k_{2040,N} \bullet \left(I_N^{X\to Y} + I_N^{Y\to X}\right)}{\left(I_O^{X\to Y} + I_O^{Y\to X}\right) \bullet k_{2040,O} + \left(I_N^{X\to Y} + I_N^{Y\to X}\right) \bullet k_{2040,N}} [\%]$$

- determine it according to UKD_p depending on the class of ascending gradient (group of rows according to the first column), total bendiness „CK“ (row according to the second column) and the share of slow vehicles „b_{pv}“ (columns – interpolation of values in the table between columns according to value „b_{pv}“ in the header of the column):
  - $UKD_p = C \Rightarrow$ level of traffic volume „I_p“ acc. to *fig. 0400*
  - $UKD_p = D \Rightarrow$ level of traffic volume „I_p“ acc. to *fig. 0410*
  - $UKD_p = E \Rightarrow$ road capacity „C“ according to *fig. 0420*

Třída stoupání	Celkové křivolakosti (grad/km)	**Úrovňové intenzity C (voz/h)** v závislosti na podílu pomalých vozidel - skladbě (%)					
		0	5	10	15	20	25
1	0 - 75	1540	1435	1410	1395	1380	1365
	75 - 150	1265	1235	1230	1225	1225	1220
	150 - 225	1185	1155	1150	1145	1140	1135
	>225	1155	1085	1075	1065	1055	1045
2	0 - 75	1540	1385	1350	1325	1305	1290
	75 - 150	1265	1215	1210	1200	1195	1190
	150 - 225	1185	1150	1140	1135	1125	1120
	>225	1155	1080	1060	1045	1035	1020
3	0 - 75	1540	1305	1250	1215	1205	1195
	75 - 150	1265	1155	1135	1120	1105	1095
	150 - 225	1185	1105	1085	1065	1045	1030
	>225	1155	1050	1030	1020	995	980
4	0 - 75	1540	1195	1120	1090	1065	1050
	75 - 150	1265	1080	1040	1010	985	975
	150 - 225	1185	1030	990	960	940	925
	>225	1155	995	950	920	900	885
5	0 - 75	1540	1045	970	915	880	855
	75 - 150	1265	970	905	860	825	795
	150 - 225	1185	935	865	820	785	760
	>225	1155	900	835	790	755	730

fig. 0400 (levels of traffic volume in both directions on two-lane roads for UKD_p = C)

Třída stoupání	Celkové křivolakosti (grad/km)	**Úrovňové intenzity D (voz/h)** v závislosti na podílu pomalých vozidel - skladbě (%)					
		0	5	10	15	20	25
1	0 - 75	2110	1945	1905	1880	1855	1835
	75 - 150	1750	1705	1695	1690	1685	1675
	150 - 225	1650	1605	1595	1585	1580	1570
	>225	1610	1505	1485	1470	1455	1440
2	0 - 75	2110	1860	1810	1770	1745	1720
	75 - 150	1750	1675	1660	1645	1640	1630
	150 - 225	1650	1590	1580	1565	1555	1545
	>225	1610	1495	1465	1445	1425	1405
3	0 - 75	2110	1740	1655	1605	1590	1580
	75 - 150	1750	1580	1545	1525	1500	1485
	150 - 225	1650	1520	1490	1460	1430	1410
	>225	1610	1450	1420	1405	1370	1340
4	0 - 75	2110	1580	1465	1425	1385	1365
	75 - 150	1750	1465	1400	1355	1320	1300
	150 - 225	1650	1410	1350	1300	1270	1250
	>225	1610	1370	1305	1255	1225	1210
5	0 - 75	2110	1360	1250	1175	1125	1085
	75 - 150	1750	1300	1200	1130	1080	1045
	150 - 225	1650	1260	1165	1095	1045	1010
	>225	1610	1230	1130	1065	1015	985

fig. 0410 (levels of traffic volume in both directions on two-lane roads for UKD_p = D)

Třída stoupání	Celkové křivolakosti (grad/km)	Kapacity E (voz/h) v závislosti na podílu pomalých vozidel - skladbě (%)					
		0	5	10	15	20	25
1	0 - 75	2500	2365	2310	2275	2245	2220
	75 - 150	2165	2105	2090	2080	2075	2065
	150 - 225	2050	1985	1975	1960	1950	1940
	>225	2005	1865	1840	1820	1800	1780
2	0 - 75	2500	2255	2180	2130	2095	2060
	75 - 150	2165	2060	2040	2025	2015	2000
	150 - 225	2050	1970	1955	1940	1925	1910
	>225	2005	1850	1815	1785	1760	1735
3	0 - 75	2500	2090	1980	1915	1895	1880
	75 - 150	2165	1930	1890	1860	1825	1805
	150 - 225	2050	1880	1835	1795	1755	1725
	>225	2005	1790	1755	1730	1685	1650
4	0 - 75	2500	1880	1735	1680	1630	1610
	75 - 150	2165	1775	1695	1635	1590	1565
	150 - 225	2050	1725	1645	1585	1545	1520
	>225	2005	1685	1600	1540	1500	1475
5	0 - 75	2500	1600	1460	1370	1305	1260
	75 - 150	2165	1560	1435	1345	1280	1235
	150 - 225	2050	1535	1405	1320	1255	1210
	>225	2005	1505	1380	1290	1230	1190

fig. 0420 (road capacities in both directions on two-lane roads for UKD_p = C)

- assessment:
  - $I_V^{50} \leq k_s \bullet I_p$ or $I_V^{50} \leq k_s \bullet C$..... designed road **meets the requirements**
  - $I_V^{50} > k_s \bullet I_p$ or $I_V^{50} > k_s \bullet C$ ..... designed road **does not meet the requirements**
  - numerically demonstrate for both variants
  - specify units during the entire assessment !!!