EVALUATION OF VARIANTS (CONTINUATION)

INVESTMENT COSTS (IN) (CONTINUATION)

- 2. The costs of land P:
- Include costs of lands for the road construction and the settlements of dispute
- Only necessary land is purchased (will constitute the rightof-way) = land required for the construction process (besides the road construction itself) is rented (temporary occupation)
- total price of land is influenced by:
 - location (a different unit price in urban area / rural area, a town / village)
 - area size of the road construction
 - *type of land (arable land, forest, building land, ... etc.)*
- are size of the road structure extent of expropriation (see *fig. 0290*) – is influenced by:
 - road category (crown width)
 - extent of earthworks



fig. 0290 (expropriation elaborate processed by authorized land surveyor)

$P = Z \bullet JC$

- Z extent of expropriation for construction ([Z] = m²)
- JC..... unit price m² ([JC] = CZK/m²)

a) extent of expropriation – Z:

- approximate calculation of extent of expropriation "Z" according to the width of the crown of the road "b + constant" and "∆h"
- influenced by the shape of the road structure ⇒ width of the expropriated area is not identical for the same "b" and "∆h" in the cut and in the fill (see *fig. 0300*)



fig. 0300 (road structure in fill and cut)

- input value calculation:
 - *b*.....category width road ([b] = m)
 - Δh elevation difference "vertical alignment terrain" \Rightarrow see longitudinal profile ([Δh] = m)
 - $\Delta h \ge about 0.75 m \Longrightarrow fill:$

$$\mathbf{x}_{(i)} = 4 \bullet \Delta \mathbf{h}_i + \mathbf{b} + \mathbf{2}$$

• $\Delta h \leq about \ 0.75 \ m \Rightarrow cut:$

$$\mathbf{x}_{(i)} = 3,5 \bullet \left| \Delta \mathbf{h}_{i} \right| + \mathbf{b} + \mathbf{6}$$

• *x*_(*i*) width of the expropriated area at the site of the cross-section "i"

• ATTENTION $!!! \Rightarrow$ check:

- section at the zero point $(\Delta h_i = 0) \Longrightarrow \mathbf{x}_{(i)} = \mathbf{b} + \mathbf{6}$
- section at the beginning and end of the bridge ⇒ x_(i) = b + 2 (do not take in consideration the area of bridge wings and abutments)
- there is no land to be expropriated in the tunnel ⇒ do not count
- total extend of expropriation for the construction Z ([Z] = m²):

$$Z = \sum_{i=2}^{n} \frac{(X_{(i)} + X_{(i-1)}) \bullet I_{p(i)}}{2}$$

- total extend of expropriation for the construction = sum of the trapezoidal shape areas identified by
 - width of expropriated area "x_(i)" in various locations of cross-sections "i"
 - mutual distances cross-sections "lp"
- calculation organized to a table (see fig. 0310)

i	staničení km	∆h		Šířka z	záboru	vzdál. příč.	zábor
				x(i)		řezů	7
		násyp	výkop	násyp	výkop	lp(i)	4
		m	m	m	m	m	m2
1	0,00000	STATE -	0,00	1000	15,5	anver	anotoor
2	0,05000	l l	-1,63		21,2	50,00	917,63
3	0,20346	Ĵ.	0,00		15,5	153,46	2 816,37
4	0,37898	2,23		20,4	0	175,52	3 152,34
5	0,45000	1,23		16,4	0	71,02	1 308,19
6	0,47838		0,55		17,4	28,38	480,26
7	0,51055		0.00		15,5	32,17	529,60
8	0,57838		-0,46		17,1	67,83	1 105,97
9	0,65000		-0,96		18,9	71,62	1 288,09
10	0,73864		0,00		15,5	88,64	1 522,84
	2221	2428	1944) ()	1222			2243
n	KŬ	1	8	14.5	3 (444	646	4440
Σ7						13 121 28	

fig. 0310 (calculation of the expropriated area)

b) unit price – UP:

 unit price "UP" per m² of land for construction depends on the class of the road and some other factors ⇒ minimum price m² (the Price Journal 2013 – *Ministry of Finance of the Czech Republic*)

Class of the road	Unit price "UP" [CZK/m ²]
RI	70
RII	50
R III	40
motorway	100
railway	75

- exact value "UP" for each one purchased land is determined by expert opinion (simplified in the exercise ⇒ minimum price according to the Price Journal 2013)
 - BLEU (bonding land ecological unit)
 - cadastral area
 - distance from the town
- 3. <u>Costs of project preparation PD:</u>
- impact on the costs for project preparation:
 - total investment costs of the project (entry value to determine the price of project works ⇒ price list UNIKA)
 - the requirements of the authorities concerned in the permitting process (reports, verification, project updates, more printing)
 - *time length of preparation (labour costs)*

simplified calculation in the exercise \Rightarrow numeration of "PD" of the construction according to *fig. 0320*:

- interpolate between the lines of the 1. column according to the calculated value of "SN" (data in the table in millions of CZK)
- Choice of the zone
 - I. class road.....zone III
 - II. and III. class roadszone II

םי —	C_{max} +	C_{\min}	
U —	2		
ΓPΓ)] = C.7	K	

makisdy	PÁSMO I.		PÁSMO II.		PÁSMO III.		PÁSMO IV.		PÁSMO V.	
ITTL. PLC	Cmin	Cmax	Cmin	Cmax	Crein	Cmax	Cmin	Cmas	Cmin	Cmax
42,0	629 800	734 800	1 394 200	1 626 600	2 434 400	2 840 200	5 371 000	6 266 100	9 608 100	11 209 500
44,0	647 300	755 100	1 438 300	1 678 000	2 518 500	2 938 300	5 592 900	6 525 000	9 961 100	11 621 300
46.0	664 400	775 100	1 481 700	1 728 600	2 601 600	3 035 200	5 813 500	6 782 500	10 310 600	12 029 000
48,0	681 200	794 700	1 524 500	1 778 500	2 683 700	3 131 000	6 033 000	7 038 400	10 656 600	12 432 700
50,0	697 700	814 000	1 566 600	1 827 800	2 764 900	3 225 700	6 251 200	7 293 000	10 999 400	12 832 700
55,0	737 900	860 900	1 669 800	1 948 000	2 964 200	3 458 200	6 791 900	7 923 900	11 843 400	13 817 3D
60,0	776 600	906 000	1 769 800	2 064 800	3 158 600	3 685 100	7 326 300	8 547 300	12 670 300	14 782 000
65,0	813 900	949 600	1 867 100	2 178 300	3 348 700	3 906 800	7 854 900	9 164 100	13 481 800	15 728 800
70,0	850 100	991 800	1 962 000	2 289 000	3 534 900	4 124 100	8 378 300	9 774 700	14 279 500	16 659 400
75,0	885 300	1 032 800	2 054 600	2 397 100	3 717 500	4 337 100	8 896 900	10 379 700	15 064 400	17 575 200
80,0	919 500	1 072 700	2 145 200	2 502 800	3 896 900	4 546 400	9 411 000	10 979 500	15 837 700	18 477 400
85.0	952 800	1 111 600	2 234 000	2 606 300	4 073 300	4 752 200	9 921 000	11 574 500	16 600 200	19 367 000
90,0	985 300	1 149 500	2 321 000	2 707 900	4 246 900	4 954 700	10 427 000	12 164 900	17 352 800	20 244 900
95,0	1 017 100	1 186 600	2 406 500	2 807 600	4 417 900	5 154 200	10 929 500	12 751 100	18 096 000	21 111 900
100,0	1 048 200	1 222 900	2 490 500	2 905 600	4 586 500	5 350 900	11 428 500	13 333 300	18 830 400	21 968 800
150.0	1 330 000	1 551 600	3 266 200	3 810 600	6 166 700	7 194 500	16 265 500	18 976 400	25 789 500	30 087 700
200,0	1 574 700	1 837 200	3 959 100	4 618 900	7 608 100	8 876 100	20 615 300	24 376 200	32 236 600	37 609 40
250,0	1 795 200	2 094 400	4 596 200	5 362 300	8 954 400	10 446 800	25 034 800	29 602 000	38 328 000	44 716 000
300.0	1 998 000	2 331 100	5 192 300	6 057 600	10 229 400	11 934 300	29 340 500	34 693 100	44 150 100	51 508 500
400.0	2 365 700	2 760 000	6 293 700	7 342 700	12 620 400	14 723 800	37 689 300	44 565 100	55 187 200	64 385 10
500,0	2 696 900	3 146 400	7 306 600	8 524 400	14 853 600	17 329 200	45 769 200	54 119 000	65 615 300	76 551 200
600,0	3 001 700	3 502 000	8 254 100	9 629 700	16 968 600	19 796 700	53 640 900	63 426 700	75 582 500	88 179 600
700,0	3 286 100	3 833 800	9 150 400	10 675 400	18 990 100	22 155 100	61 343 500	72 534 600	85 181 900	99 378 900
800,0	3 554 100	4 146 400	10 005 100	11 672 600	20 934 900	24 424 000	68 904 500	81 474 900	94 477 400	110 223 600
900,0	3 808 600	4 443 400	10 825 000	12 629 200	22 815 000	26 617 500	76 343 600	90 271 200	103 515 100	120 767 600
1 000,0	4 051 700	4 726 900	11 615 200	13 551 100	24 639 400	28 745 900	83 676 200	98 941 400	112 329 700	131 051 400
1 500.0	5 140 800	5 997 600	15 233 100	17 772 000	33 128 600	38 650 000	119 091 000	140 817 100	153 842 900	179 483 300
2 000.0	6 086 900	7 101 400	18 464 600	21 542 100	40 872 100	47 684 100	152 978 600	180 886 900	192 302 200	224 352 500

fig. 0320 (price list UNIKA 2012 for calculating the price of design works for engineering and water works - not for the railroad !!!)

INVESTMENT COSTS (IN) (RECAPITULATION) (calculate for both variants)

IN = SN + P + PD

- SN building costs
- P.....land costs
- PD project preparation costs

Valorisation IN

- valorisation of investment costs "IN":
 - comparison of prices in one price level (in exercises in the price level of commissioning \Rightarrow 2025)
 - take into account inflation (rise in the price level over the time)
- price adjustment "IN":
 - use of inflation indices ČSÚ (ICSP = price index of construction works)
 - previous calculation are considered to be:
 - SN..... price level 2017
 P..... price level 2013
 PD.... price level 2012
 - annual increase in construction industry:
 - so far (2005 2016)..... −0,7 ~ 4,5 %
 - prediction for the years $2017 2025 \dots 2,4 \sim 3,3 \%$

Vear "i"	ICSP _i [%]			
	(previous year = 100)			
2005	103,0			
2006	102,9			
2007	104,1			
2008	104,5			
2009	101,2			
2010	99,8			
2011	103,6			
2012	99,3			
2013	101,4			
2014	100,4			
2015	101,1			
2016	101,2			
2017	102,4			
2018	103,3			
2020	103,3			

calculate "IN_{val}" according to the formula:



• IN_{val} determines:

- total costs of investments in 2023 ~ 2025
- total cost of land purchase in 2022
- total costs of project preparation in 2021 (excl. VAT)

OPERATION COSTS (PN)

(calculate for both variants)

- operation costs denominated here will cover the costs of routine maintenance of roads (winter and summer):
 - cleaning of roads, canalization, culverts and road signs and winter maintenance (gritting)
 - cleaning garbage
 - minor fixes related to operation e.g. crash barriers, traffic signs (e.g. renewal of road markings) or even road surface
- existence of complicated objects (bridges and tunnels)
 ⇒ operating expenses include maintenance (inspections, revisions, video surveillance, fire safety, lighting, ventilation, etc.).
- calculate annual operating costs "PN_R" according to the formula:

$$\mathsf{PN}_{\mathsf{R}} = 1000 \bullet \big| \mathsf{X}; \mathsf{Y} \big| \bullet \mathsf{NU}_{\mathsf{k}} + \sum_{i=1}^{\mathsf{n}} \big(\mathsf{I}_{\mathsf{M},i} \bullet \mathsf{NU}_{\mathsf{m}} \big) + \sum_{j=1}^{\mathsf{m}} \big(\mathsf{I}_{\mathsf{T},i} \bullet \mathsf{NU}_{\mathsf{t}} \big)$$

- [X;Y].....section length
- I_{Mi}.....Iength "i-th" bridge
- I_{Tj}length "j-th" tunnel
- *NU_k.....specific annual maintenance costs of road*
- *NU_m*.....specific annual maintenance costs of bridges

• *NU*_t specific annual maintenance costs of tunnels

- units:
- [|X;Y|] = km
- $[NU_k] = [NU_m] = [NU_t] = CZK/m$

• $[I_{Mi}] = [I_{Ti}] = m$

year	NU _k	NUm	NUt
2017	4 000	38 400	52 600

- average lifetime is assumed 20 years
- increase in operating costs over time are not considered for simplicity
- inflation is also not considered (we are unable to predict the amount for so long in advance) ⇒ operating costs over the whole lifetime (PN):

$PN = 20 \bullet PN_{R}$

OVERALL ASSESSMENT AND COMPARISON

• for generous and economical variant calculate CN CN = IN + PN

 $CN = IN_{val} + PN$

As preferable we consider the variant that has a lower total costs CN at the end of the lifetime of the structure (after 20 years) \Rightarrow conclusion write verbally to the technical report !!!

- additional costs, rising from the operation on the road, are not quantified
 - not decisive for the selection of variants
 - these costs pays the user not the founder of the road
 - e.g. fuel costs, the cost of consumption of time, the consequences of accidents, etc.