PRAGOPROJEKT

ROADPAC´14

PROGRAM RP44

Cross section arrangement of roads and motorways according to CSN 73 6101 (2004)

User guide

25.02.2014

1.   Introduction

Program Cross section arrangement of roads and motorways is part of ROADPAC system. Program is used as the first program of end-to-end road design processing for calculation of crosswise arrangement of a road.

The program prepares fundamentals for corridor cross section design compliant with principles of new Czech national standard (CSN) 736101- issued in 2008) based on already calculated horizontal and vertical alignment.   For selected category and design speed the program generates complete information (input data) for general program RP43, which then performs the calculation of cross section arrangement followed by a calculation of corridor cross-sections by program RP51.

The program is designated for design of cross section arrangement for single and dual carriageway roads and motorways. Local (rural) roads (according to the Czech national standard (CSN) 73 6110) are not subject of this program.

1.1   Program features

1)   Verification of submitted input parameters and horizontal and vertical alignment of road with regard to requirements of CSN 736101

2)   Correction of input data and design elements in the event that verification does not comply with parameters required in specification.

3)   Assessment of road capacity, if is requested

3)   Collection of input data for program RP 43 (cross section arrangement calculation)

Output file V43, generated by program, can be used subsequently for cross section arrangement calculation by RP43 program. Output Data can also be modified or amended by further parameters, like specification of widening, crossfall or acceleration lanes, climbing lanes, additional lanes of junctions etc. (See Manual of RP42 program) Likewise widening in areas of bus stops, individual modifications of formations and drainage, individual modifications of special shapes (footways, cycling tracks) etc. Designated for this purposes is system program RP43. Output file V43 respects all requirements of this program.

The program creates the first design of cross section arrangement of road, from basic parameters which are for instance: Road category, type of landscape, pavement surface gradients and formation gradients like that. If some of basic values changes in the course of the road, it is recommended to compute such sections as separate roads up to a level of corridor cross-sections (RP51, RP53) creation. Input files of horizontal alignment (SHB) and vertical alignment (SNI) may be common. Sections, in which is given data calculated, are defined by chainage range. (See Chainage tab)

Other data may change in the course of the road: superelevation method for each particular horizontal curve, prospective intensities of traffic stream for each direction or for sections between junctions. Initial velocity of slow vehicle can be specified by sections so that it would reflect local speed limit (in municipality or by traffic signs).

1.2   Processed files

Input files:

  .V44   - input data

  .SHB   - horizontal alignment (required)

  .SNI   - vertical alignment (required)

  .SSS   - chainage (optional)

  . STR   - either existing terrain cross section

  .SPP   - or longitudinal terrain profile (for chart generation use)

Output files:

  .V43   - input data for RP43, main result

  .L41   - program journal

  .SSS   - chainage (optional)

  . O44   - graphical representation of longitudinal section, travelling velocity of slow vehicle and possible additional lanes in ascending gradient

2.   Input data

Input data of the program requires some information, which are necessary for design of cross section arrangement only. Input data are collected by direct filling of tables placed on the form or by clicking on individual controls located on tabs of the form. Forms handling is described in detail in "System Introduction Guide".

2.1   Block of control data and parameters of communication

The form will be displayed after selection of button INPUT DATA in the main program menu: It is necessary to fill all required data in the upper part:

Explanation of individual items:

Date   date of entering input data.

Project title and Road title text that is used in headings of output reports and files.

Input File names are not required. If files are processed according to below stated requirements and no file name is specified, the program will use default name 'road' from the main program menu. If a filename is specified in those textboxes, then this name will replace default name 'road'. If output file V43 already exists, it will be overwritten. If user wants to maintain current 'road'.V43 file, then he must enter any (meaningless) name for a new V43 file (e.g. XXX); data file is then created but it does not overwrite current 'road'.V43 file.

Drawing file for creation of longitudinal section chart the program will use terrain profile from STR or SPP file. If none of the files exists, longitudinal chart is plotted without terrain. If both files exist, file SPP is preferred.

Road category: program will check, whether specified combination conforms to CSN 736101. If not, program will be terminated.

Design speed: program will check, whether specified combination conforms to CSN 736101. If not, program will be terminated.

Class of road used only for single carriageway roads. Enter 1, 2, or 3

Number of additional traffic lanes forward/backward: can be specified only for widths of 20.75 and more (R, D) – according to Table 4 of CSN, Comment ***. In case of significantly different traffic volumes in both directions you can specify additional traffic lane for one direction only.

Type of landscape Performs checking of velocities and falling gradients according to Table 9 of CSN. You can select one of codes 1, 2, 3 or 4 (i.e. flat, wavy, hilly, mountain).

Basic pavement crossfall basic formation crossfall and Pavement thickness:
The specification depends on used road construction solution and on properties of subgrade. The program will perform check according to Articles 8.9 and 10.1.4 of CSN.

Table Basic method of superelevation and sign distances

Basic method of superelevation: The program will perform basic method of superelevation everywhere except for curves listed in following table. Modification can be applied only on entire curve including its transition curves. It is necessary to specify one chainage, which is situated anywhere on curve or its transition curve range. On single carriageway roads you can specify methods according to Fig. 7a) to 7f) - Article 8.12.2 of the Standard. On dual carriageway roads you can specify methods of superelevation according to Fig. 7g to 7l - Article 8.12.3 of the Standard. The codes correspond to similar codes in program RP43.

Fig. 7a, 7c, 7e	code 8	along the inner road edge
Fig. 7b, 7d, 7f	code 9	along road axis (C1 = 0.)
Fig. 7g	code 1	along the inner edge of traffic lane
Fig. 7h	code 2	along the centers of traffic lanes
Fig. 7i	code 3	along the outer edge of traffic lane
Fig. 7j	code 4	along the edge of central reserve

Fig. 7k   code 5   combination: inner traffic lane along outer edge, outer lane along axis

Fig. 7l   code 6   combination: inner traffic lane along axis, outer along inner edge

Last two combinations will be converted to code 0 for program RP43 with specified values C1 and C2.

Stopping sight distance (DCZ): It is assumed that there is side visibility ensured according to scheme in Fig. 12 CSN (e.g. by dealing with embankment area at inner part of curve or that widening will be completed as a special shape in data of program RP43 or as a widened shoulder in data of RP51. Specified road widening will be considered at diagnostics of sight distance for stopping. DCZ is measured from basic free width of roadway.

Decision of sight distance for overtaking (DCP): It is assumed that there is side visibility ensured according to scheme in Fig. 11 CSN (e.g. this is an embankment area at inner part of curve or that widening will be completed as a special shape in data of program RP43 or as a widened shoulder in data of RP51. Specified road widening will be considered at capacity calculations for given road category. DCP is measured from basic free width of roadway.

DCZ and DCP values are considered fixed throughout full length of a curve on the inner side of curve, for which they were specified.

Program task can be performed in two basic calculation modes:

Required mode can be activated by checking corresponding checkbox:

Design mode: Program generate new file V43 according specified parameters.

Checking mode: Program checks existing file V43, after potential user-defined changes, according CSN standard.

Block of required data supervision and data correction:

> Required verifications and corrections can be activated by checking corresponding checkboxes:

> Automatic corrections are available only for gradients of superelevation run-offs (it will perform deflected superelevation run-offs or prolonged superelevation run-offs) and for generation of additional traffic lanes in ascending gradient if request for capacity calculation is checked. In this case is necessary to enter data at corresponding table.

Run-off gradient: The program will perform verification according to Article 8.13 of CSN (Table 16). If gradient of superelevation run-off located in transition curve is not satisfactory and correction is requested, the program either extend superelevation run-off according to principles described in Article 8.13.1 and 8.13.2 or cut short length of superelevation run-off according to scheme in Fig. 8.of the Standard.

Total gradient: Crossfall in curves will be designed as minimal according to Tables 12 and 13 of CSN. The program will perform verification of total gradient according to Article 8.11 of CSN.

> Program feature of automatic correction of total gradient is currently suppressed. Usually it can be achieved only by modification of vertical alignment or by a change of curve crossfall.

Crest and sag curves the program will perform following checks:

> a) Radiuses of summit curves according to Article 8.16 of CSN

> b) Sight distances according to Article 8.5 of CSN.

> Corrections can be performed only by a new design of vertical alignment or by changes of basic road parameters. It is not possible neither in RP44 nor RP43.

Sight distance in horizontal curve: The program will perform diagnostics of sight distance for stopping according to Article 8.18 of CSN.

> Program feature of automatic correction of sight distance by widening of road shoulder or central reserve is currently suppressed. User can perform required modification either by **median safety fence width** value specification or by modification of parameters in following program RP51- corridor cross section, if this would guarantee improvement of visibility.

Additional traffic lanes in ascending gradient: The program will perform diagnostics of sections, where it is necessary to increase number of traffic lanes in ascending gradient. (Climbing lanes) If correction is entered then the program will create additional traffic lane according to one of two rules, which are further detailed in CAPACITY CALCULATIONS tab.

Comment: for assessment, whether it is necessary to establish next traffic lane, it is required to perform capacity calculation according to Annexes A, K and L of the Standard Therefore it is necessary to enter data in CAPACITY CALCULATIONS table.

2.2   Additional lanes

RP	Direct. forth or back (F/B)	Start of section (km)	No overtaking percentage (%)	Prospective traffic density (vehic./hr)	Slow vehicle percentage (%)	Influence of urbanization (Y/N)	Local speed limit (Km/hr)	Sectional speed limit (Km/hr)
▶	F ▼	0,000000	23,0	10000	12.00	no	70	70
	B	4,695650	23,0	10000	12.00	no	70	70

Construction Type of tapers
◉ Reconstructed road
○ Newly constructed road

About additional lanes

About capacity calculations

Parameters for establishment of additional traffic lanes are located on ADDITIONAL LANES tab as a table.

Radio button (Construction type of tapers) must be set to one of methods for establishment of additional traffic lane for dual carriageway roads:

1   to establish DJP according to Fig. 9a CSN for **new construction**

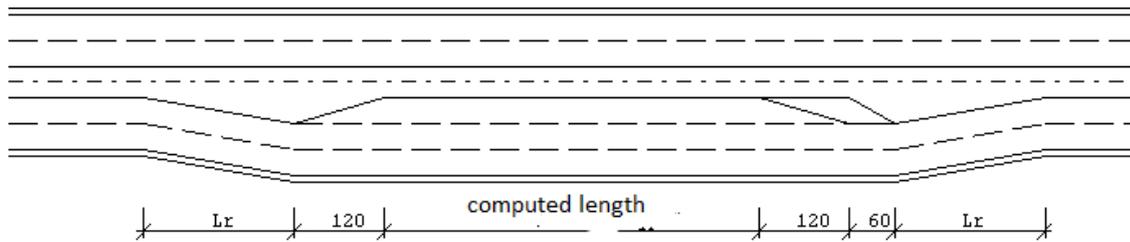2   to establish DJP according to Fig. 9b of the Standard for **reconstruction** at current central reserve

computed length

Lr   120   120   60   Lr

Fig. 9a new construction

computed length   120   60   Lr
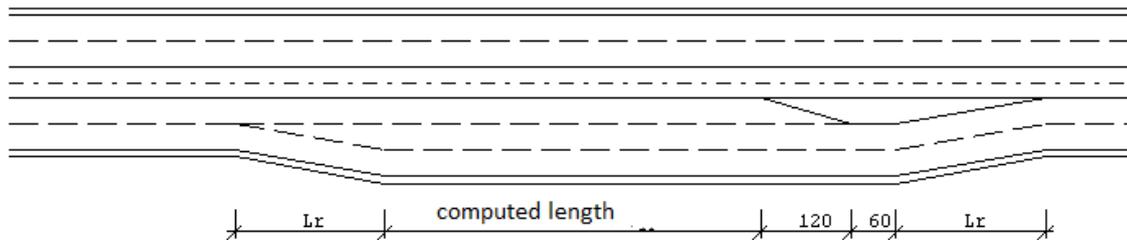
Lr

Fig 9b reconstruction
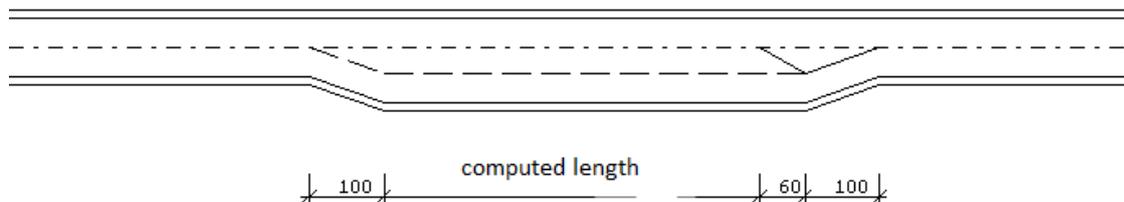
computed length   60   100

100

Fig 10
carriageway road

For roads with unlimited access are tapers always generated according to Fig. 10 of CSN 73 6101

For capacity calculations and for assessment, whether it is necessary to establish additional traffic lanes, it is necessary to enter eight items on one row for each section in direction of increasing chainage and eight items for every section in opposite direction. It is necessary to enter data for at least 1 section in direction FORWARDS and 1 section for direction BACKWARDS.

Explanation of individual items:

Direction: you can specify either "F (forwards)" or "B (backwards)"

Start of section: It is necessary to starts with specification of sections with identical traffic volumes for direction "forward" (ascending order), follows with sections with identical traffic volumes for direction "backward" (descending order). Unspecified chainage (or 0.00) means beginning of road for direction "forward" or end of road for direction "backwards". It is necessary to submit new section always, when you change any of items in table.

% of prohibit overtaking

Only for dual carriageway categories (up to S11.5) it is possible to specify used percentage of prohibit overtaking for every section; the program will use it for calculation of overall bending rate (Article A.2.3.2). If 0 is specified, the program will calculate this percentage itself on a basis of specified horizontal and vertical alignment and specified width parameters. This category should be considered namely in cases when you expect total (100 percent) prohibition of overtaking expressed by traffic sign.

Prospective traffic volume (vehicle/ hour) and slow vehicles % are data collected from competent authorities on a basis of traffic census and forecasts. As they can differ in individual sections between junctions, they are specified per sections. Dimension of all entered data is **vehicles per hour.** (Prospective fifty times stroke intensity). For two-lane categories it represents sum of both directions (section boundaries and specified intensities in both directions must be the same), for four- and more-lane categories it is independently for every specified direction.

Influence of urban agglomeration (City/town influence Y/N)

It is only for motorways and roads with limited access, where by entering code (Y/N) you can require calculation and use of positional criterion according to Article A.4.3.3 a A.4.5.3.

Local speed limit

It is used at the beginning of a section. This is the way how to enter local speed limit valid for all vehicles (e.g. railway level crossing), or initial velocity of slow vehicle (in a spot, where road starts in ascending gradient or at exit from crossroads). The program will use this velocity in construction of chart of travelling velocity of slow vehicle. If not specified, the program will use final velocity from previous section for slow vehicle drive modeling, for the first section just 70 km/h for category S and 80 km/h for categories R and D. If there is some stopping required, specify velocity 10 km/h for acceleration period - in harmony with Charts K1 and K2. If preceding section was in ascending gradient with no other limitations, specify steady velocity of slow vehicle for beginning of section according to Chart K1 or K2 for corresponding ascending gradient.

Speed limit in segment

Specification of this figure may reflect local arrangement given by traffic limitation or by traffic regulations (e.g. in municipality). It is reflected in diagram of travelling velocity of slow vehicle. If specified value is lower than design speed submitted for a section of motorway (e.g. 100 or 80 km/h), than the program will use tables A.4-3, A.4-4, A.4-6 or A.4-7 for capacity calculations instead of standard tables A.4-2 a A.4-5 for velocities 120 or 130 km/h.

2.3   Chainage

It is precise analogy of the same block in RP43 program. Block of data can be omitted, if a list of detail chainage is taken or will be taken from SSS file (Chainage).
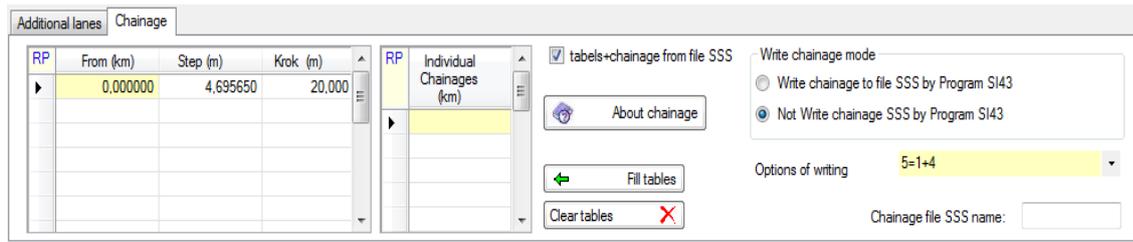
Read chainage from SSS file:

   ✓   means that chainage data will be read from SSS file. Or that will be acquired by combination of data from SSS file and data from "chainage specification" block data tables.

   This coding style is valid both for program RP44 and program RP43.

Write chainage mode:

   ✓   means that chainage table will be written to .SSS file during run of following program SI43.

          means that chainage table will not be written to .SSS file during run of following program SI43.

Use chainage of Main point of alignments options: [0/1/2/3/4/5/6/7]

   0   only specified chainages in tables will be under consideration

   1   indicate that list of chainage will be added by chainage of all main points of vertical alignment SNI file.

   2   indicate that list of chainage will be added by chainage of all main points of horizontal alignment SHB file.

   3   1 + 2

   4   all sections of chainage table + beginnings and ends of widening + chainage of beginnings and ends of sectors of special shapes will be added. Chainages of such points are collected from completed "Widening" and "Special formations" tabs.

   If SSS file included points at ends of widening from former runs and Chainage file is read, then they will be deleted and replaced by points from the last run of program SI43

   5   like 4 + 1

   6   like 4 + 2

   7   like 4 + 3, i.e. all points that can be considered

Range of input horizontal alignment file (SHB) and Vertical alignment file (SNI) must be greater or equal to road range specified in chainage tables. From first chainage to last chainage specified in tables.

Table CHAINAGE GIVEN BY STEP may include any number of rows. In one row it defines one section with regular pitch. The first item identifies **initial chainage** in kilometers, second **final chainage** in kilometers and the third is **step** in meters, which will be used for creation of new chainages from initial chainage to final chainage. End of section will be used only if it is a multiple of a step.

Table INDIVIDUAL CHAINAGE may include any number of rows. In one line it includes arbitrary chainage in kilometers. The program then creates a chainage table, which is a combination of both previous tables.

Use of CHAINAGE file may be combined with entering the above described tables. The program will work with chainages in following manner: The program will read SSS file, then it reads chainage tables and after merger of all chainages it will exclude duplicate chainages and save resulting table in SSS file. **Maximum number of chainages is 8000.**

Button **"Fill according to road length"**

If there is file "road". V44 in a database of the job, the dialogue program works as editor of the file and entered input data will be displayed in Chainage tab, where they can be modified. If there is no "road".V44 file but "road". SHB file exists, you can start supporting program by clicking on "Fill according to road length", which will enter beginning and end of road to chainage tables according to SHB file range with partitioning of cross-sections by 20 m. Data may be further modified.

3.   Used methods

Below we provide just a review of used methods. The program will successively perform following calculations:

Input data validation, whether they comply with CSN 73 6101

Calculation of superelevation in curves and design of superelevation run-offs

Verification of resulting gradients

Verification of radiuses of sags and crest curves (assessment of sight distance)

Verification of sight distance in horizontal curves

Capacity calculations

Assessment of necessity to add additional traffic lanes in ascending gradient

Generation of input data for RP43 (calculation of cross section arrangement in sections)

Generation of graphical output (chart of travelling speed and chart of additional traffic lanes)

3.1   Verification of input data

Review of validations of input data - compliance with the Standard:

	What is checked:	Conditions:
1.	KATZAK	permitted characters S, R, D of road categories description
2.	KATSIR	just following widths permitted:
		4.0, 6.5, 7.5, 9.5, 11.5, 20.75, 24.5, 25.5, 27.5, 33.5
3.	VN	only permitted design speeds: 50, 60, 70, 80, 90, 100, 120
4.	Combinations	for category S permitted widths are from 4.0 to 24.5
		for category R permitted widths are from 25.5 to 33.5

for category D permitted widths are from 25.5 to 33.5

for S 4.0 permitted velocities are from 30 to 40

for S 6.5 are permitted velocities from 50 to 60

for S 7.5 are permitted velocities from 50 to 70

for S 9.5 permitted velocities are from 60 to 80

for S 11.5 permitted velocities are from 70 to 90

for S 20.75 permitted velocities are from 70 to 90

for S 24.5 permitted velocities are from 70, 80 100

for R 25.5 and more permitted velocities are from 80, 100 and 120

for D permitted velocities are 80, 100 and 120

5.	PDJPL, PDJPP	number of additional traffic lanes:
		value 1 or 2 can be specified only for KATSIR 20.75 and more
6.	KDU	type of landscape: permitted values 1, 2, 3, 4
7.	ZSV	basic pavement crossfall gradient
		min. 2.0, max. 10.0 (Article 8.9 of the Standard)
8.	ZSP	basic formation gradient
		min 2.0, max. 10.0 (in reality)
9.	ZTV	basic pavement thickness
		min. 0.10, max. 2.0
10.	ZMK	basic superelevation method
		for KATSIR from 4.0 to 11.5 only 8, 9
		for KATSIR from 20.75 to 33.5 only 1 to 6
11.	CURVE	specified chainage that defines curve must be between ST and TS of the same curve (is checked only after SHB file is consider)
12.	CURVE	on 1 curve can be situated just 1 CURVE value
13.	DCZU, DCPU	if DCP specified (widening for overtaking), it must be greater or equal to specified DCZ (widening for stopping)
14.	OMKU	different superelevation method identical to ZMK
15.	KFUN	functional codes: only 1 or 0, for KFUN(1), (3), (7), (9) equal 0 must be KFUN(2), (4), (8), (10) also equal 0.
		Taper type for corrections of additional traffic lanes: type 2 is permitted only for four-lane roads
16	TRIDA	Class for category S only 1, 2 or 3.
		Categories R, D - checking is not performed
17	KSDP	direction code: only characters F or B
18.	KSDP	first F than B must be entered. At least 1 section in direction forward and 1 backward is required
19.	SZU	chainage of section beginning:

chainage for F must be ascending, for B descending.

But first it replaces 0.0 ZTRASY (forward direction) or KTRASY (back direction)

20.   SZU   must be situated between ZTRASY and KTRASY

Note: To always ensure compliance with this verification it is recommended to code beginning and end of road by specification chainage 0

21.   VIDPU   prospective traffic intensity:

A positive number (> 0) , maximum is not tested

22.   PPVU   percentage of slow vehicles: within 1- 100 (percentage)

23.   PRPVU   initial speed of slow vehicle at a beginning of section:

min. 10 max. 70. for category S, max. 80 for categories R, D

24   chainage of cross-sections: STANK $>$ STANZ

The program will, before any further calculations, calculate nominal velocity according to principles stated in Article 8.3 of the Standard. Resulting velocity will be used according tables no. 10, 11, 12, 17 and 18.

3.2   *Crossfall and superelevation run-offs*

This program will always design superelevation run-offs in curves according to Table 12 or 13 of CSN and the preliminary design of superelevation run-offs according a length of transition curves. If calculated nominal speed is greater than design speed, the testing is performed for nominal speed. Then the program will verify grading of superelevation run-offs (if required) according to Article 8.13 of the Standard. If the verification fails and correction is requested, the program will adjust position and shape of superelevation run-off with regard to a curve.

Londitudinal gradient of superelevation run-off

Used formulas correspond to formulas in the Standard (Annex F) and express an average gradient of superelevation run-off (paved road edge) in more exposed edge - as if road edge would be a connecting line of both ends. In reality it is not the case in situations, where the point of superelevation is shifting moving (e.g. schema 8), or where the edge is deflecting. For more information see Section 3.3

Methods of superelevation 1 to 6 and 8 to 9 correspond to individual images in CSN 73 6101:

Fig. 7a, 7c, 7e   code 8   along the inner road edge

Fig. 7b, 7d, 7f   code 9   along road axis (C1 = 0.)

fig. 7g   code 1   along the inner edge of traffic lane

Fig. 7h   code 2   along the centers of traffic lanes

Fig. 7i   code 3   along the outer edge of traffic lane

Fig. 7j   code 4   along the edge of central reserve

Fig. 7k   code 5   combination: inner traffic lane along outer edge, outer along axis

Fig. 7l   code 6   combination: inner traffic lane along axis, outer along inner edge

For entire length of superelevation run-off is considered even change of crossfall on principle.

For methods 1, 2, 3, 4, 5, 6 and 9 is reference point of superelevation the same for full length of superelevation run-off and thus gradient of superelevation run-off is constant (in part of run-off , which is not superelevated it is, naturally, equal zero).

Just for method 8 is reference point of superelevation moving within superelevation run-off range from axis towards inner edge of curve, therefore progress of superelevation run-off is for constant derivation of crossfall according to x (DPRISKL) deflected. Deflection origins in cross-section, where it balances a screw plane crossfall to one-sided. In area of small crossfall (between +ZSV and - ZSV) is gradient of edge half of gradient in remaining superelevation run-off part. The standard requires rather opposite solution (to minimize section of crossfall between +ZSV and -ZSV). Such solution will be performed automatically in module "correction of superelevation run-offs" if corresponding request is checked.

Correction of superelevation run-offs

If londitudinal gradient of superelevation run-off does not conform to limits according to Table 16 of the Standard, the program will perform correction.

If longitudinal gradient Δs is greater than permitted maximum, it will cause extension of superelevation run-off in proportion Δs: Δs max. The extension will be located in direction of circular curve start/end. Would such extensions for any reason overlap on both sides of a short a curve than the overlap will be replaced by contact.

If a longitudinal gradient Δ is smaller than minimum and crossfall in a curve is exactly equal to basic crossfall of a road (2% or 2.5%), then superelevation run-off on a side of a curve will be shortened to length, so its londitudinal gradient corresponds to minimum gradient.

If crossfall in a curve is greater than basic crossfall of a road than superelevation run-off will be divided in two with different parameters: in part of transition from basic crossfall to specified one-sided crossfall (2% or 2.5%) will be provided minimum permitted londitudinal gradient according to Table 16, in the remaining part the program will perform transition to one-sided crossfall to a final value at the point of beginning/ending of a circular curve.

For length of part of superelevation run-off in section, where crossfall is deflected around zero and where minimum londitudinal gradient of superelevation run-off must be maintained, we derived a simple relation based on formulas in Table 16 (min $\Delta s = 0.1$ a', or $\Delta s = 0.07$ a') and formula in Article 8.13.2:

for transition from roof-shaped crossfall to one-sided: $L = 20.0$ p_0 (for a' < 4.25 m), or $L = 28.57$ p_0 (for a' > 4.25 m)

for transition from zero crossfall to one-sided (in screw): $L = 10.0$ p_0 (for a' < 4.25 m), or $L = 14.285$ p_0 (for a' > 4.25m)

(p_0 is value of basic crossfall in percentage,   L is results in meters). For ordinary crossfall of road 2% is resulting value 40 m for single carriageway, or 57.14 m for dual carriageway road, for transition from screw plane to one-sided crossfall results the same length for both paved part of road (transition from one-sided crossfall +2% to one-sided crossfall -2%)

Deflected superelevation run-off will be coded in input data for program RP43 as next fictitious curve of zero length in reference point of superelevation run-off deflection, i.e. will create a new row in input V43 file. Such generated data can be viewed by system module Input data RP43.

3.3   Total gradient

The program will perform calculations of total pavement gradient according to Article 8.11 of the Standard for both marginal positions of traffic lanes.

Correction of total gradient is not performed automatically yet (corresponding code is blocked).

Used formulas calculate londitudinal gradient of superelevation run-off in 3 or 4 points of cross-section and in step 2.0 m they calculate current gradient of edges or axis (with consideration of deflections caused by moving of reference points during crossfall changes).

Crossfall uses sign convention: positive - water flows to an edge, negative - water flows over an axis to opposite side (in case of dual carriageway road to a central reserve). Longitudinal gradient uses following convention: descending gradient is negative, ascending gradient is positive (in direction of ascending chainage).

In axis of single carriageway road is during determination of total gradient taken as crossfall an average gradient of both one-half of a road. If roof-shape run-off is consider, than crossfall is 0% in sag and gradient will never conform to requirement of minimum gradient 0.5% (0.3%), but in axis it is not tested. (Concerns just a narrow stripe, from which water flows to both sides). If gradients on left and right hand side are different, the program will calculate their average on axis. Sign will be assigned depending on side with greater value.

For calculation of gradient of superelevation run-off are used no formulas specified in the Standard (Appendix F), but precise formula DELTAX = DPRISKL * ASC

where DPRISKL is derivation of crossfall (%) along x(m)

          ASC is distance of tested edge form axis of rotation a'.

ASC is measured from axis of rotation to the left for the left edge and from axis of rotation to the right for the right edge. In case of dual carriageway road for left edges of left pavement to the left and for the right pavement to the right is under consideration. With method 8 has road axis negative value for superelevation along outer edge(is measured to the left) while ASC of opposite edge is positive (is measured to the right).

3.4 Radiuses of sags and crests

Program will assess designed radiuses of summit curves according to principles specified in Article 8.16 of the Standard (stopping and overtaking, Tables 17 and 18). If calculated nominal speed is greater than design speed, the testing is performed for nominal speed. If design of vertical alignment does not comply with requirements of the Standard, the program will issue a message with conditions for vertical alignment correction. The correction can be performed only by modification of vertical alignment; it is beyond capabilities of the program. See program Viaaxi/ RP31.

Results of assessment of sight distance for overtaking will be saved for further proposal design of additional traffic lanes (Percentage of possible overtaking)

3.5 Sight distance in horizontal curves

The program will perform assessment of horizontal curves from perspective of sight distance for stopping and overtaking according to Article 8.18 of the Standard and according to tables 10 and 11. If calculated nominal speed is greater than design speed, the testing is performed for nominal speed. At the same time the program reflects specified values of side sight area for individual curves. If the sigh distances not conform to assessment and is possible to improve sigh distances by a widening, user will notify about this possibility (issues a message with specification, how extent the side visibility should be enhanced). Correction of sight distance is not performed automatically yet (corresponding code is blocked). It is on designer's decision to propose necessary measures (widening shoulder, composite profile of cuts, removing of vegetation) and to specify values of ensured sight distance in a next run.

Results of check calculation of sight distance for overtaking will be saved for further proposal design of additional traffic lanes (percentage of possible overtaking)

3.6 Calculations of road capacity

If capacity calculation is required, the calculation is then performed by sections into tables according to principles in Annex A of the Standard. In this case it is necessary to fill data in Capacity calculations in at least one row for direction FORWARD and one row for direction BACKWARD. Results of calculations are intensity levels in every section for degrees C, D and E of traffic quality (= capacity) and classification of specified prospective intensity in corresponding category.

For single carriageway roads with unlimited access is the calculation performed according to Articles A.2.1 to A.2.7. Assessment will be performed in a table common for both directions, because entered prospective intensities are sum of intensities for both directions. Division to partial sections according to principles stated in Article A.2.2.3 is common for both directions. Each section will be classified according to average traveling speed of slow vehicle into category of ascending gradient= 1 to 5 and according to average sinuosity and ,   is then interpolated to levels C, D and E according to specified percentage of slow vehicles. For each row is then assessed critical direction of traffic, which usually corresponds to higher class of ascending

gradient. In the event that there was an additional traffic lane designed for this direction the calculation is repeated with class of ascending gradient= 1.

For dual carriageway roads with unlimited access is the calculation performed according to Articles A.3.1 to A.3.6.   Calculations are performed for each traffic direction separately. Specified prospective intensities for each direction may vary. Division of a road to partial sections according to principles stated in Article A.3.2.3 is common for both directions. Results are printed in two separate tables. It is interpolated in tables for horizontal gradient of a section, length of section and percentage of slow vehicles. If speed in a section is lower than design speed, corresponding tables for lower speed will be used instead. Intensity levels for levels C and D will be calculated from tabulated capacities (level E) with use of stage of traffic load according to table A-3.1.

For motorways and expressways is the calculation performed according to Articles A.4.1 to A.4.6.   Calculations are performed for each direction of traffic separately. Specified prospective intensities for each direction may vary. Division of a road to partial sections according to principles stated in Article A.4.2.3 is common for both directions. Results are printed in two separate tables. It is interpolated in tables for horizontal gradient of a section, length of section and percentage of slow vehicles. If speed in a section is lower than design speed, corresponding tables for lower speed will be used instead. Intensity levels for levels C and D will be calculated from tabulated capacities (level E) with use of stage of traffic load according to table A-4.1.

In the event that there was designed additional traffic lane for any direction, the calculation will be repeated with use of tables for three traffic lanes.

3.7   Additional traffic lanes in ascending gradient

In following text we will use abbreviation ZPJP (i.e. Increased Number of Traffic Lanes) for solution according to Fig. 9 and 10 of the Standard (additional traffic lane for fast vehicles is established, slow vehicles are transferred to outer traffic lane by traffic signs).

1.   Diagnostics will be performed separately for direction forward (in direction of ascending chainage) and then for opposite direction.

2.   For each direction will be first created a chart of velocity of slow vehicle. The calculation is based on vertical alignment of road and on specified speed limits. In position, where is speed limit set, there will be speed in chart broken. Then the program proceeds according to Annex K of the Standard, Diagram K2. (Diagram K1 is identical but it has moved beginning of curved lines with velocity of 70 km/h). The program will use tabulated charts.

Scheme of diagram K2 used for interpolation of dependency of slow vehicle speed and gradient and travelled distance:
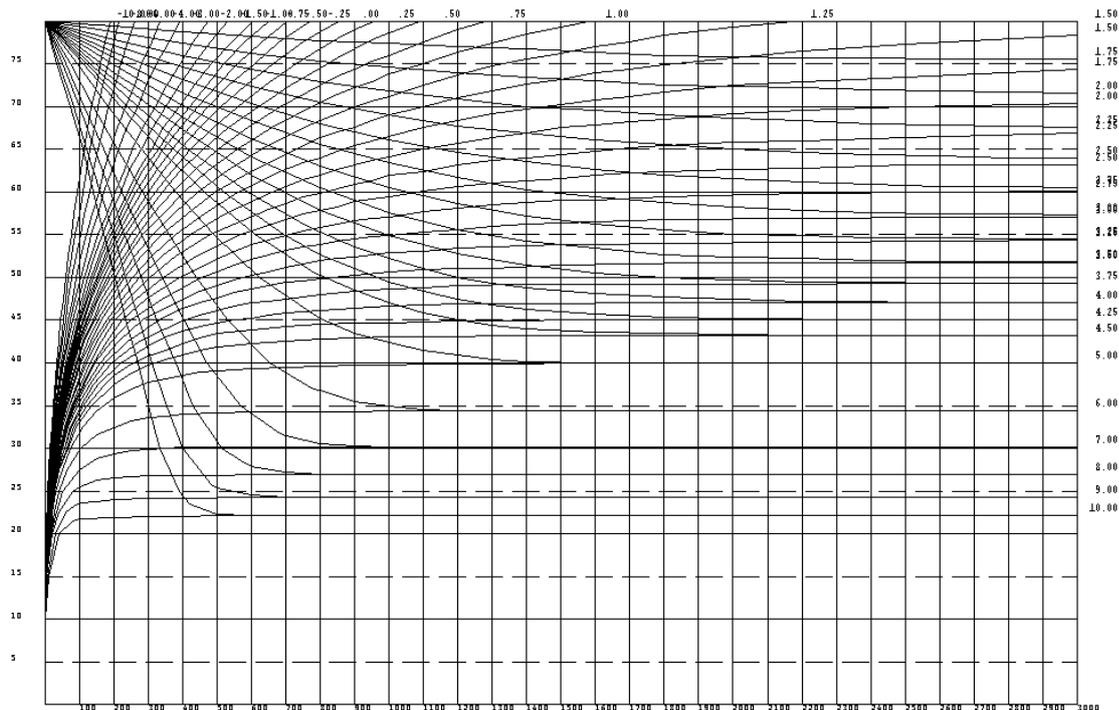
3.   Critical places of the velocity diagram are in localities, where speed approaches minimum. Critical places include also beginnings of sections, where reduced initial speed or reduced speed in partial section was specified.

It is necessary to assess, whether in critical places should be established additional traffic lane. The program will identify partial section, in which is critical place located, and continues in following manner:

3.1   For S4.0 category (single lane) capacity calculations are not performed

3.2   For single carriageway roads the calculation is performed according to Article 8.17.3:

3.2.1   If it is category of road equal 3, no additional traffic lanes (DJP, i.e. additional lanes) will be designed.

3.2.2   If there is ascending gradient of class 1 or 2 in the critical location, additional traffic lane will not be established (velocity is higher than 55 km/h there - see definition of category of road equal 2)

3.2.3   Than there is ascending gradient of class 3 or more, i.e. speed of slow vehicle decreased below 55 km/h. If there is in critical area 100% UIC exceeded for category of road equal 1 or 100% UID for category of road equal 2, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **55 km/h** (see definition of class 3 velocity)

3.2.4   If there is in critical area 80% UIC exceeded for class of road equal 1 or 80% UID for class of road equal 2 and the section is classified in class 4 ascending

gradient, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **50 km/h** (see Article 8.17.3.1 letter b)

3.2.5 If there is in critical area 60% UIC exceeded for class of road equal 1 or 60% UID of road equal 2 and the section is classified in class 5 ascending gradient, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **50 km/h** (see Article 8.17.3.1 letter c)

3.3 For dual carriageway roads (S20.75 and S24.5) is the calculation performed according to Article 8.17.3.

For such categories, user does not know class of ascending gradient so he will use known minimum speed of slow vehicle instead. This category is not likely to be designed for class of roads equal 3; than the calculation should proceed as with 3.2.1.

3.3.1 If there is in critical locality speed of slow vehicle higher than 55 km/h, additional traffic lane is not to be established (see definition of class 2 road)

3.3.2 Then the speed of slow vehicle is lower than 55 km/h. If there is in critical area 100% UIC exceeded for category of road equal 1or 100% UID for category of road equal 2, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **55 km/h** (according to definition of class 3 velocity)

3.3.3 If there is in critical area 80% UIC exceeded for class of road equal 1 or 80% UID for class of road 2 and speed of slow vehicle is less than 40 km/h, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **50 km/h** (see Article 8.17.3.1 letter b)

3.3.4 If there is in critical area 60% UIC exceeded for class of road equal 1 or 60% UID for class of road equal 2 and speed of slow vehicle is less than 30 km/h, than additional traffic lane is designed. Its length is determined from diagram of velocity as intersection points with velocity **50 km/h** (see Article 8.17.3.1 letter c)

3.4 For categories R and D the procedure is according to Article 8.17.2.

3.4.1 If speed of slow vehicle in critical locality is higher than 70 km/h, additional traffic lane is not established (Article 8.17.2.1)

3.4.2 Then the speed of slow vehicle is lower than 70 km/h. If UIC in critical area exceeds 100%, the program will design additional traffic lane. Its length is determined from diagram of velocity as intersection points with velocity **70 km/h** (Article 8.17.2.3)

3.4.3 If for R category speed of slow vehicle drops in critical place below 50 km/h, additional traffic lane will be created without reference to capacity calculation. Its length in this case is determined from diagram of velocity as intersection points with velocity **50 km/h** (8.17.2.4) The condition is not tested for category D.

4.   The program will assess exception according to Article 8.17.2.6 or 8.17.3.3 (omission in case of too short additional lane, at least 300 m for category S2, at least 500 m for categories S4 and R and D).

5.   If two traffic lanes follow one after another, the program will assess their conjunction according to Article 8.17.2.7 or 8.17.3.4. The program generates review of designed ZPJP.

6.   In this place diagnostics ending. If a correction is prescribed, program designs widening of pavement according to Fig. 9 or 10 of the Standard. Methods of widening are described in section Data generation.

7.   After establishing ZPJP (additional lanes) the program will repeat capacity calculation for categories S2 (single carriageway road) and R or D. For that the program will use procedure valid for similar category with number of traffic lanes increased by 1. For category S4 (dual carriageway road) repeated calculation is not performed as the Standard does not give sources for calculation of capacity of road with 6 traffic lanes.

3.7   Data generation for RP43 (V43 file)

3.7.1 Control data generation

The program will create xxx. V43 file and generates control rows according to rules of program "RP43- Cross section arrangement" of road. Names of CHAINAGE and ALIGNMENT files will be taken from control data of program RP44. The same is true about data and reading and writing in Chainage file and code of selection of points from chainage list. Code of writing to "Cross section arrangement" file will be set to 1 (write). Name of Cross section arrangement file is not required (basic name of road will be used). Equally it is not necessary to enter name of Side limitation file .SOM and code of use of Side limitations file will be set to 0 (not used).   If side limitations should be considered in certain sections, designer must appropriately adjust input data.

Listing creation code should be set to 0 (with this code program RP43 creates just abbreviated report that contains only sorted list of input parameters). If more detailed output from program RP43 is required, it is necessary to re-set appropriate code in input data before running the program.

Submission date will be current date of run of program RP44.

Before subsequent run of program RP43 the data generated in V43 file can be checked, corrected of amended by pre-program controlling Input data of program RP43. With that you can add further requests.

3.7.2 Generation of data for cross section arrangement

The program will generate rows 431 (it concerns content of tab Basic widths in program RP43). Data will be written separately for left and right side of road to facilitate possible

modification of data. For values A1 and A2 the program will encode standard solution according to sample lists and figures 14 to 18 of the old Standard.

3.7.3 Generation of data for widening

The program will generate rows 432 (it is a content of widening tab of program RP43). Data will be written for right and left side of road separately. Data will include widening in curves and widening resulted by design of additional traffic lanes.

Widening of curve can be applied on one traffic lane in each direction (Article 9.3.1) and on additional traffic lane in ascending gradient (Article 9.3.3).

As mutual widening in curves overlaps with widening in location of additional traffic lanes, the program used code 5 for horizontal curves and code 2 for widening in area of additional traffic lanes. Code 5 is an innovation. It has the same function as code no. 2, but it can overlap mutually.

Code 5 cannot be combined with code 3 (shoulder widening) when using taper method 5 (narrowing shoulder with simultaneous widening of road). In case of pavement widening in curves this can never be used, therefore code 5 was used for pavement widening in curves. For additional widening in junctions (manually) you can use code 2 and 5; it is necessary to ensure that it would not overlap with some automatically generated widening.

Condition of Article 8.17.2.7 or 8.17.3.4 excludes possibility that there could be overlapping of two additional traffic lanes one after another. In extreme case, when distance between them would be almost at critical point, tapers of central reserve may slightly overlap. In such event the overlapping would be corrected by RP43.

.

Shapes of widening tapers depend on user selected method.

In data specifications of program RP44 you can differentiate by switch "Type of taper construction of additional traffic lane", whether the program should generate solution according to Fig. 9a or 9b for four-lane and more-lane roads.

You can decide between two types of tapers:

1 according to Fig. 9a for new works

2 according to Fig. 9b for reconstruction at current central reserve

For single carriageway roads the program will generate solution according to Fig. 10, variant in ascending gradient.

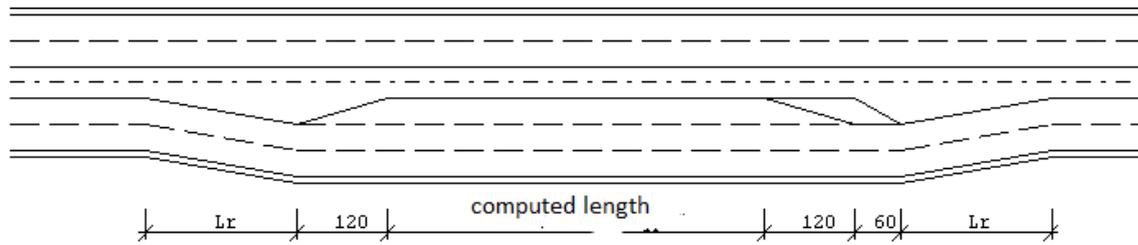Following illustration contains scheme of all used solutions:
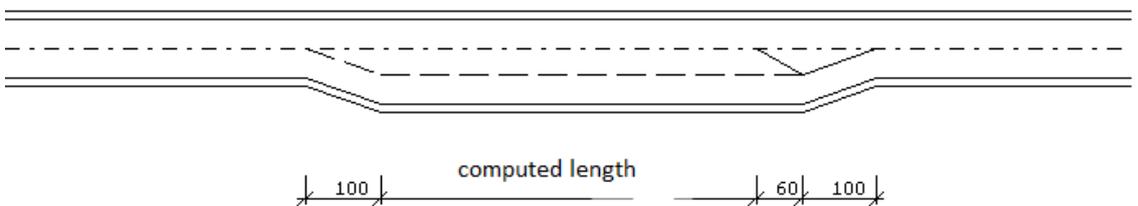
Fig. 9a new construction
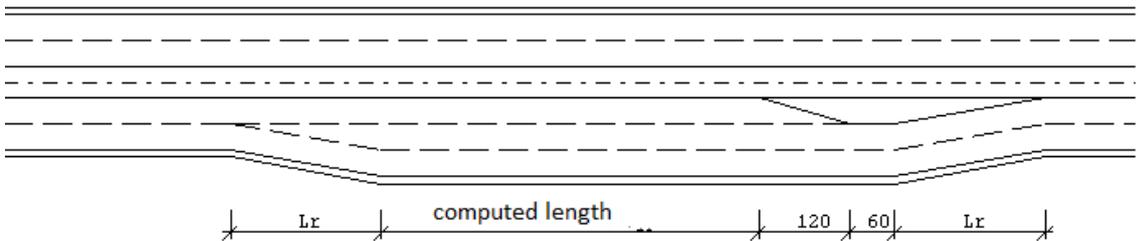
Fig 10

carriageway road

Value of Lr according to Fig. 9 is 225 m for design speeds greater than 100 km/h, or 200 m for design speed 100 km/h and lower.

Geometry of widening and narrowing tapers is in all cases coded by method 6 (S-line with 1/3 tangent) according to Fig. 13 in CSN 736102 - see Note at Fig. 10 in CSN)

In segments, where is road widening in curve located together with increase of number of traffic lanes, the program will use following solution:

Width in curve and width in taper of additional traffic lane will be generated independently on each other: widening in curve with part code 5, width in taper of additional traffic lane with code 2

If there is at least 20 m of horizontal curve length or 50% of hor. curve length in area of additional taper lane, the program will perform widening in curve also for additional traffic lane.

Length of taper Lr of roads is derived from design speed and from offset, which is 3.00 m for category S, for other categories 3.50 m; if a taper is situated in curve, width of an additional traffic lane and thus a offset is increased by widening in curve. Therefore length of taper wedge is increased too.

3.7.4 Generation of data for superelevation method

The program will generate rows 433 (it is content of Methods of superelevation tab in program RP43). Method of superelevation is taken from input data of program RP44 from corrections of superelevation invoked by modification of resulting minimum crossfall.

3.7.5 Generation of data for superelevation run offs and crossfall of curves

The program generates lines 434 (it concerns content of Superelevation in curves tab in program RP43). Crossfall and positions of superelevation run-off will be recorded from results of diagnostics and corrections of superelevation run-offs. Screw crossfall superelevation in areas of connecting horizontal curves will be coded by method according to Fig. 17 in user guide of program RP43 (with specification of values V1 and V2 so that from entered data it could be ascertained chainage of cross-section with zero crossfall).

In case of performing correction of superelevation run-off, some superelevation run-offs will be prolonged, shortened or deflected. The program will generate superelevation run-offs after correction. Deflected superelevation run-offs will be generated so that another fictitious curve of zero length will be inserted in a point of deflection and where one-sided crossfall equal to value of basic crossfall of a road in straight.

3.7.6 Generation of data about chainage

Block of Chainage data (rows 001, 002 and 999) will be taken from data in V44 file without any changes.

4. *Graphical output - scheme of travelling velocity and scheme of additional traffic lanes (O44 file)*
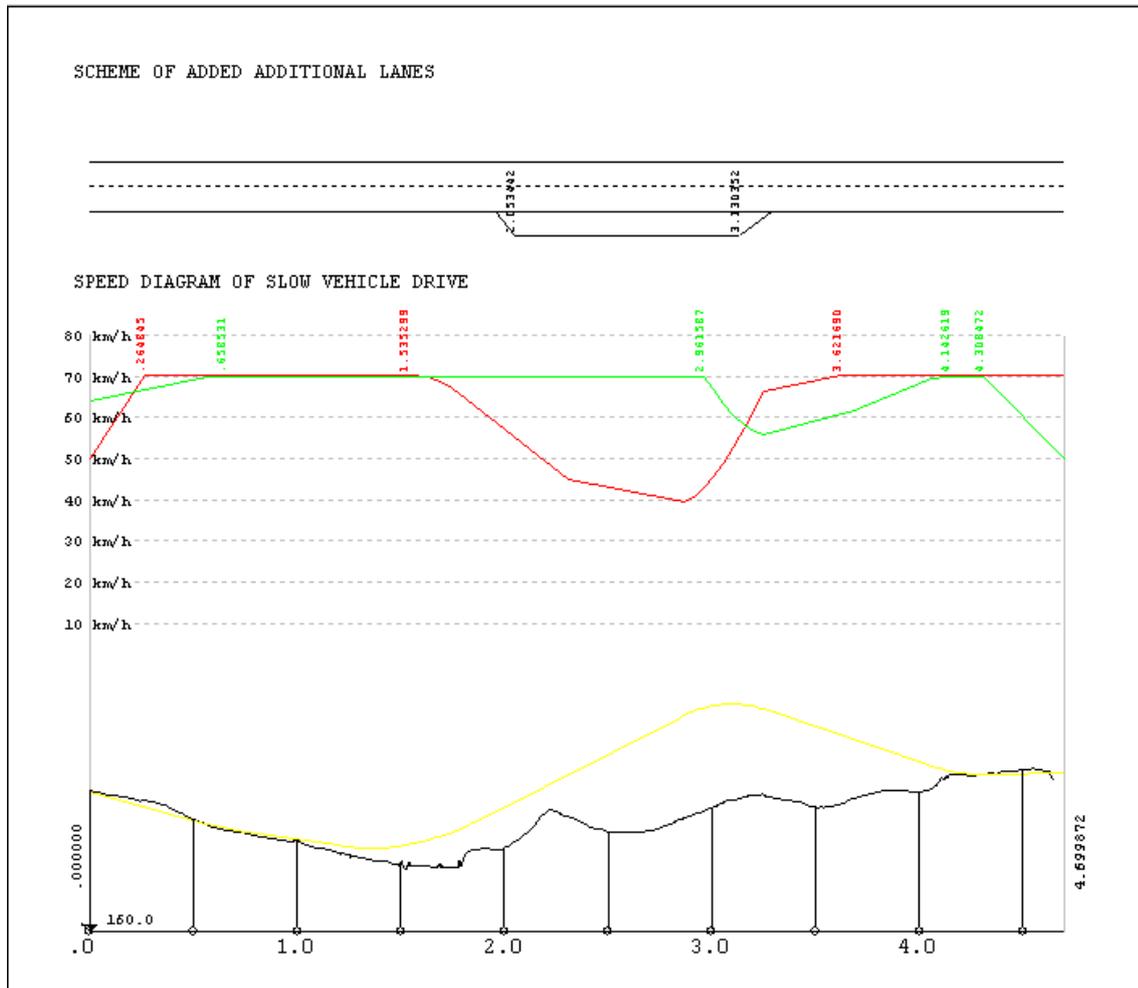
The chart that is generated by each run of the program, where capacity calculations are required, diagrammatically depicts horizontal section of a road (vertical alignment and existing terrain), chart of velocity of slow vehicle (the original copy has direction FORWARD in red, direction BACK in green) and in the event that the program designed additional traffic lanes in ascending gradient, also scheme of such lanes is drawn. Dimensions of the chart are fixed and they cannot be changed in specification.

5. **Output listing (xxx.L44)**

Output listing 'road'.L41 file is always generated during data processing. It can be viewed in WORDPAD, which also enables printing, further modification and archiving.

Program journal will include results of all performed validity checking and diagnostics results. All results come with detail comments.

Results are well categorized in introductory information and eight parts.

Introductory information: task identification, identification of input files and error messages in specification, which can cause program termination or which are corrected in standard manner (for list of error messages see Chapter 6)

A   Specified data

There are transparently repeated all specified data (after possible corrections) and also data about range of the road in files SHB (horizontal alignment), SNI (vertical alignment) and specified chainage (SSS file or submitted list of chainages). Range of road, where solution is performed, is intersection of all such ranges. There are also listed all required validations and corrections of individual partial tasks.

B   Derived data and information about road

a) Diagnostics of curves on a road: review of chainage of main points of horizontal alignment, radiuses, substitute lengths and angular changes for calculation of sinuosity and general sinuosity. Substitute lengths are measured from the middle of incoming transition curve to the middle of outgoing transition curve.

b) Diagnostics of vertical alignment curves: review of chainage of main points of vertical alignment, radiuses.

c) Calculated nominal speed (Article 8.3), sinuosity (Article 8.3.2) and required level of quality of traffic according to Article 6.3.5.

C   Basic dimensions of cross-section (contents of V43 file)

Width of all parts of cross-section, review of all horizontal curves and designed widening in curves.

D   Assessment of superelevation run-offs, correction of superelevation run-offs

The first table contains list of horizontal curves and chainage of starts and ends of superelevation runoffs located precisely in point of transition curves:

ZVZ = beginning of superelevation run-off at the beginning of curve

ZVZ = end of superelevation run-off at the beginning of curve

ZS = beginning of superelevation run-off at the beginning of curve (see also superelevation run-off situated at the end of proper curve)

KS = end of superelevation run-off situated at the beginning of curve (KVZ)

Types of superelevation run-offs situated at the beginning of proper curve (superelevation run-off situated at the end of proper curve):

A = transition from screw crossfall to one-sided:

B = smooth transition of two one-sided crossfall of the same direction (at a change of radius)

C = transition of two one-sided crossfall of opposite direction (screw plane)

0 = beginning or end of **road** (without superelevation run-off)

Space= curve of large diameter without crossfall and without superelevation runoffs (screw plane)

The second table includes results of assessment of londitudinal gradient of superelevation run-offs according to Article 8.13.1 a 8.13.2.

VZ = superelevation run-off situated at the beginning of proper curve

S = superelevation run-off situated at the end of proper curve

SVZ= intermediate transition between two gradients of the same direction

P = right-hand curve

L = left-hand curve

Type of superelevation run-off (A, B, C, 0), see above

a´ = offset distance of lane edge from axis of superelevation (Article 8.13.2)

Ds = calculated londitudinal grade

Min Ds, max Ds = ultimate gradients according to Table 16 of the Standard

Proposed measure: compliant, not tested, break (shorten), extent

If correction of londitudinal gradients is required, the program will print the third table identical to the first one with performed corrections. There are listed shifted chainages of beginnings and ends of superelevation run-offs according to requested corrections and in case of broken run-off the program will insert additional fictitious curve with zero length and with one-sided crossfall in values of basic road crossfall. The broken run-off is performed in the event that crossfall of adjacent curve is greater than basic one, shortening is performed in case of identical crossfalls.

E   Assessment of total gradient

The table contains sections of road with 2.0 m step, in which total slope of a road:

 a) Exceeds maximum value according to Table 15 of CSN

 b) Does not reach minimum value of 0.5%

For some categories it is possible to permit exceptional slope 0,3 according to Article 8.11.2

There are four assessed points for dual carriageway road:

    1   Left edge of road

    2. Left edge of central reserve

    3. Right edge of central reserve

    4. Right edge of road

There are three assessed points for single carriageway road:

    1. Left edge of road

    2. Axis of a road

    3. Right edge of road

The tables contain longitudinal gradient in axis, cross fall, londitudinal gradient of superelevation run-off and total gradient.

F Assessment of vertical alignment curves - sight distance

The table contains list of sags and crests curves, their parameters and assessment according to Article 8.16 (Tables 17 and 18):

For convex curves Crests:

meets criterion for overtaking

meets criterion for stopping

DOES NOT MEET criterion for stopping; required radius = xxxx

DOES NOT MEET criterion for overtaking; no overtaking!

For concave curves Sags:

meets criterion of recommended radius

meets criterion of permitted radius

DOES NOT MEET criterion of permitted radius; required radius = xxxx

All assessments relate to nominal velocity (which naturally can be equal to design velocity).

G Assessment of horizontal curves - sight distance

For single carriageway roads is first assessed sight distance for stopping, then sight distance for overtaking. For dual carriageway roads the program performs assessment of sight distance for stopping only.

The program performs assessment of all horizontal curves in sequence in every cycle. Adjacent curves of the same direction are assessed separately.

For dual carriageway roads is every direction assessed separately. For single carriageway roads is assessed only direction with right-hand curve (sight distance is always better in opposite direction).

For each assessment of a curve the program generates brief report that describes situation in a curve and results of assessment.

Examples of curve assessments on two-lane road for stopping:

```
CURVE ASSESSMENT ON STOPPING SIGHT DISTANCE - single carriageway

  1. Curve in km   .046145 up to   .900816  R=      1250.00m  spare
curve length   670.51m

 Drive in direction of ch: right turn curve, average gradient -2.18%,
 specified enlargement of sight width   .0m
 Dz = 120.0m,   deltaR = 1.75 Nx = 4.00 Rx =      452.00
 *   Curve R=     1250.00m acceptable
*   Curve R=     1390.00m acceptable
```

```
Note: Enlargement of lateral field of view  can be done by widening
area inside the curve above elevation
        0.90 m above the pavement edge. Measured out of the basic free
width of the carriageway.
```

Examples of curve assessments on two-lane road for overtaking:

```
CURVE ASSESSMENT ON SIGHT OF OVERTAKING - single carriageway

  1. Curve in km   .046145 up to   .900816  R=      1250.00m  spare
curve length   670.51m

 Drive in direction of ch: right turn curve, average gradient -2.18%,
 specified enlargement of sight width   .0m
Dp = 550.0m,    deltaR = 1.75 Nx = 4.00 Rx =       9455.13
 *** Curve R=      1250.00m UNACCEPTABLE.
     Necessary enlargement of sight width on     26.67m or no
overtaking !

 Note: Enlargement of lateral field of view  can be done by widening
area inside the curve above elevation
        0.90 m above the pavement edge. Measured out of the basic free
width of the carriageway.
```

Examples of assessment of curve in horizontally divided road:

```
4. Curve in km  3.167726 up to  4.368184  R=       900.00m  spare
curve length 1050.24m

 Drive in direction of ch: right turn curve, average gradient -2.29%,
 specified enlargement of sight width   .0m
Dz = 160.0m,    deltaR = 6.75 Nx = 5.00 Rx =       642.50
 *   Curve R=      900.00m acceptable
 Drive in opposit directi: left turn curve, average grade  2.29%,
safety fence in central reserve
 Dz = 140.0m,    deltaR =-3.75 Nx = 2.75 Rx =       892.28
 *   Curve R=      900.00m acceptable due to safety fence along both
sides of central reserve
```

For left-hand curve the program will sequentially assess 3 types of locations of safety fences in central reserve:

1) Two safety barriers, 0.5m distance from margin of central reserve

2) Two-sided safety barrier in the middle of central reserve

3) Two-sided safety barrier along remote side of central reserve

For right-hand curve the program will assess safety barrier located on road unpaved shoulder.

If neither of above mentioned options serves, the program issues following message:
```
1. Curve in km   .046145 up to   .900816  R=      1250.00m  spare
curve length   670.51m

 Drive in direction of ch: right turn curve, average gradient -2.18%,
 specified enlargement of sight width   .0m
 Dp = 550.0m,    deltaR = 1.75 Nx = 4.00 Rx =       9455.13
```

```
  *** Curve R=      1250.00m UNACCEPTABLE.
     Necessary  enlargement  of  sight  width  on      26.67m  or  no
overtaking !
```

Results of assessments for overtaking are archived within the program and are then used for calculation of percent share of road length, in which no overtaking is allowed.

H   Capacity calculations

In the first part of this chapter the program generates tables of speed of slow vehicle for all road categories. Division by sections is in this diagram independent on traffic direction. It is based on requirement that difference of adjacent ascending gradients may not exceed 1%. The table is also graphically represented in xxx. O44 file.

In the next step is the whole road divided to partial sections according to conditions described in Articles A-2.2.3, A-3.2.3 and A-4.2.3. Following tables include individual partial sections of capacity assessment for individual partial sections.

For single carriageway roads with unlimited access (Section A.2 of Standard) the program prints two tables valid for both traffic directions:

The first table includes supporting figures for capacity calculations: chainage of a section, its length, critical direction (forward and back) for capacity determination, angle alteration and curvature in section, percentage of prohibited overtaking and total sinuosity in a section, steady (or lowest) and average speed of slow vehicle in a section for both directions and categorization of a section in ascending gradient class.


```
Subtotals of S2 category road capacity calculations:

     No      chainage      length  TB  angle  curvature %prohib.
tot.curv.  min.speed    ever.speed  class of

T      B      T       B ascending
     1     .000000     615.584    B     25.04     40.67     77.53
258.57   50.0   64.0    65.7   67.1    2
     2     .615584     919.715    B     34.70     37.73    100.00
287.73   70.0   69.9    70.0   70.0    1
     3    1.535299    1522.130    T     82.14     53.96    100.00
303.96   39.5   63.3    51.1   69.8    1
     4    3.057429    1126.653    B     67.55     59.95    100.00
309.95   48.8   55.9    67.2   62.2    2
     5    4.184082     515.790    B     30.71     59.54     86.24
289.88   70.0   50.0    70.0   62.4    2

 Totals of S2 category capacity calculations:

   No     chainage     length   Prospect  slow vehcl.  Level intensity
classif.    H         vc
            km         m      intensity    %      C        D        E
of segnent  veh./km   km/h
   1      .000000     615.584    7000      1.0    1140     1587
1974    F       169.9     41.2
   2      .615584     919.715    7000      1.0    1141     1589
1977    F       169.5     41.3
   3     1.535299    1522.130    7000      1.0    1141     1589
1977    F       169.5     41.3
```

```
   4    3.057429    1126.653     7000        1.0     1140     1587
1974    F       169.9    41.2
   5    4.184082     515.790     7000        1.0     1140     1587
1974    F       169.9    41.2
        4.699872

 Width coefficient  for category S 11.50              1.00
 Everage  curvature along road                       51.09
 Cogitate value of traffic density                  169.66 veh./km
 Cogitate value of actual speed                      41.26 km/h
```

The second table contains results of capacity calculation: prospective intensity of traffic (specified), percentage of slow vehicles, intensity levels for traffic levels C, D and E, classification of a section by level of traffic quality and finally traffic volume and average travel speed. In conclusion the program prints used width coefficient for appropriate road category and weighted averages of traffic volumes and average speed.

Establishment of additional traffic lane is manifested in corresponding section by transfer to class 1 ascending gradient, which also effect values of intensity levels.

For dual carriageway roads with unlimited access (Section A.3 of the Standard) the program prints separate tables for direction FORWARD and BACK.

```
Results of capacity calculations for category S 24.50 direction:THERE
   No       chainage      length  prospect. slow veh. gradient AL
producing stupen  Classif.of
           km         m      intensity   %          %             LI E
vytizeni  segment
   1     .000000     615.584   12000      1.0      -2.79    2     2700
4.44    F
   2     .615584     919.715   12000      1.0       -.94    2     2700
4.44    F
   3    1.535299    1522.130   12000      1.0       4.47    2     2520
4.76     F
   4    3.057429    1126.653   12000      1.0      -2.93    2     2700
4.44     F
   5    4.184082     515.790   12000      1.0       -.01    2     2700
4.44     F
        4.699872
```

The table contains results of capacity calculation: chainage of a section, its length, prospective traffic volume (specified), percentage of slow vehicles, average grade in a section, total number of traffic lanes, intensity level for traffic level E (= capacity), level of load and classification of a section according to level of traffic quality.

Important notice: If specification requires the third traffic lane for Forwards direction or Backward, the program does not have any ground in the Standard to reflect this fact in capacity calculation. It is possible that this case will be later handled by some coefficient; currently in negotiation process. In the meantime the program generates following message: 0

**　　　In backwards direction was for count of traffic lanes equal 3 used tables A.3-2 and A.3-4 relevant for two traffic lanes road, in standard is not usable data for exact calculation.

For the same reason the program does not also perform repeated capacity calculation for such road categories in case of establishing additional traffic lane in ascending gradient.

For motorways and expressways (Section A.4 of the Standard) the program prints separate tables for direction TORWARDS increasing chainage and BACKWARDS.

```
 Results of capacity calculations for category S 24.50 direction:BACK
   No       chainage      length  prospect. slow veh. gradient AL
producing stupen  Classif.of
             km         m    intensity    %          %        LI E
vytizeni  segment
    1     .000000     615.584    12000      1.0       2.79   2   2669
4.50       F
    2     .615584     919.715    12000      1.0        .94   2   2700
4.44       F
    3    1.535299    1522.130    12000      1.0      -4.47   2   2700
4.44        F
    4    3.057429    1126.653    12000      1.0       2.93   2   2644
4.54        F
    5    4.184082     515.790    12000      1.0        .01   2   2700
4.44        F
          4.699872
```

Contents of tables are the same. If there are additional traffic lanes established in ascending gradient, the program will perform repeated calculation, total number of traffic lanes in CPJP column will be increased by 1. If there was third traffic lane specified for Forward direction or Backward, the program will perform capacity calculations according to Tables A.4-5 to A.4-7. If number of traffic lanes would be increased to 4, it would create similar situation: ground for such event is missing in the Standard. The program would issue following message:

** In segment XX for total number of lanes nn were tables valid for 4 lanes (A.4-5 to A.4-7) used for 3 lanes. Standards does not contain sources for exact capacity calculation

Resulting capacities listed in Table are then underestimated.

If coefficient according to Article A.4.3.3 is submitted, the program will generate similar message:

*   In segment nn   coefficient of city/town influence xxx was consider

Then following assessment of critical localities in ascending gradient of road with regard to necessity to establish additional traffic lane x. The program uses criteria described in detail in Chapter 3.7. For each critical spot (i.e. local minimum in diagram of traffic) the program prints brief assessment and conclusion. Some samples of such assessment:

```
Rewiew of  1. critical location in direction THERE  : km   .000000
speed of slow vehicle =   50.0 km/h
 In critical place is not ascending gradient, not avaluated

Rewiew of  2. critical location in direction THERE  : km  2.865746
speed of slow vehicle =   39.5 km/h
 Article 8.17.3.1a CSN: Prospective intensity exceeds 100% of required
LI
 next additional lane is designed
 Designed additional lane range is from km  2.053442 to km  3.130352

Rewiew of  3. critical location in direction BACK   : km  4.699872
speed of slow vehicle =   50.0 km/h
 In critical place is not ascending gradient, not avaluated

Rewiew of  4. critical location in direction BACK   : km  3.249112
speed of slow vehicle =   55.9 km/h
 Article 8.17.3.1 CSN: Speed of slow vehicle does not fall under 55
km/h

Rewiew of  5. critical location in direction BACK   : km   .000000
speed of slow vehicle =   64.0 km/h
 Article 8.17.3.1 CSN: Speed of slow vehicle does not fall under 55
km/h

 List of designed additional lanes

  direction  begining      end        length      notice
   THERE      2.053442    3.130352   1076.91      stand-alone
```

All additional registered traffic lanes are then assessed in table and classified as: separate, connected to following one or connected to previous one.

If additional traffic lanes were designed and generated in V43 file than the capacity calculation (tables) repeats for categories S2 and D or R with inclusion of additional traffic lanes.

6. Error messages

The program differentiates between fatal errors, which usually cause program termination with unusable results and formal errors that are handled by alternate solution. Fatal errors are marked in reports by *** and formal errors **.

The following table contains list of error messages and comments to alternate solution:

Error message text	Alternate solution
*** Leading line is missing * 44	
*** Inaccessible type of leading line: aaa	
** First line is ignored	
*** Between leading data read no marked line *	
*** Early data end	
** Line 411 is several times repeated in data	

** More than nnn lines 412, other ignored	
** Line 413 is several times repeated in data	
** More than nnn lines 414, other ignored	
** Inacceptable line code: aaa	
*** Formal error in line: (description of line)	
*** Specified category xxx is not mentioned in standard	
*** Specified width nnn is not mentioned in standard	
*** Specified design speed vvv is not mentioned in standard	
*** Combination of entered category xxx and entered width xxx is not allowed in CSN standard	
*** Combination of entered category xxx , entered width xxx and design speed xxx is not allowed in CSN standard	
*** Next traffic lane cannot be specified in for two lane road	
*** In CSN standard are not mentioned conditions for roads with more than xxx lanes in one direction	
** Incorrect code of area type xxx. Slightly wavy area is consider	
** Specified crossfall xxx contradict to xxx article 8.8 of standard xxx crossfall 2% will be used	
** Specified crossfall of formation xxx is smaller than pavement crossfall xxx identical crossfall xxx will be used	
** Specified crossfall of formation xxx contradict to technical conditions, crossfall xxx will be used	
** Specified thickness of pavement xxx m contradict to nnn technical conditions xxx thickness will be used. XXX m, correct it in next run.	
** Specified camber method x is not allowed for single carriageways. NNN will be used method 9 (camber according to centreline)	
** Specified camber method x is not allowed for dual lane carriageways . NNN will be used method 9 (camber according to centreline)	
*** Specified curve position in km xxx is located in straight segment of road	
*** For curve between km n.nnnnnn and km n.nnnnnn are specified more individual parameters	
** For curve in km n.nnnnn is entered dcp smaller than dcz xxx program will use identical value xxx.	
** Code of runoff checking > x corrected on 1	
** Code of' runoff checking corrected on 0, control was not specified.	

** Control of climbing lanes at two lane roads nnn XXX can only be performed after sight distance control. XXX Sight distance control will be performed.	
** Control of climbing lanes can only be performed xxx after control of summits and sags.	
** Min. specified Speed limit in xxx table row is 30 km/h, corrected by program	
** Speed limit of slow vehicle on xxx table row may not exceeds speed xxx km/hour corrected by program	
* % of length with prohibit overtaking specified in nnn table row will be taken from sight distance calculation	
* % of length with prohibit overtaking specified in nnn table row must be specified in range from 1 to 100%	
* Coefficient of city/town influence will be under consideration for R and D categories only	
*** In curve No n.nnnn with radius nnn m is impossible to specify crossfall acc. table 12 and 13 of standard	
*** Creation of additional lane according reconstruction rule cannot be specified for single carriageway road	
*** Road classification must be 1, 2 or 3	
*** Direction code in nnn table row xxx can be only T or B	
*** Direction codes do not keep order T before B	
*** In 1. table row are not data for direction There	
** No segment for capacity calculation is specified. Whole capacity calculation part is omitted	
** No segment for capacity calculation in direction THERE (BACK) Whole capacity calculation part is omitted.	
*** Chainage of segment beginning in nnn. table row is not ascending	
*** *** Chainage of segment beginning nnn. table row is not descending	
*** Chainage of segment beginning n.nnnn is out of road range, shifted to km n.nnnnn	
*** Design traffic volume in xxx table row must be specified	
*** Share of slow vehicles in nnn table row must be specified between 1% and 100%	
** Entry speed of slow vehicle in xxx table row can be specified min. 10 km/h, corrected	
** Entry speed of slow vehicle in xxx table row cannot sustained speed xxx km/hour corrected	

** For single carriageway road, prospective intensity nnn for direction THERE is specified only, it is valid xxx for both directions. Specified value xxx vehcl/hour in direction BACK will be ignored.	
** In segment from km n.nnn to km n.nnnnn the specified percentage of prohibit overtaking: xxxwill be used	
** In segment xxx for total number of lanes nnn were tables valid for 3 lanes (A.4-5 to A.4-7) used nnnnn rd does not contain sources for exact capacity calculation	
** In THERE direction were for total number of lanes nnn used tables valid for 2 lanes (A.3-2 to A.3-4 Standard xxx does not contain sources for exact capacity calculation	
*** Error in RINTR - interpolation between nnn.nn a nnn.nn	