



ROADPAC'14

RP80
Pavement renew

User guide

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Program features

Program RP80 is part of ROADPAC system. The program uses archive files of vertical and horizontal road alignment and cross sections file of RoadPAC type, thus it uses results of programs RP12, RP31, RP43 a RP51. Archive files of vertical and horizontal road alignment can be alternatively created by use of corresponding programs of system (VIAAXI, VIANIV). The program has several stages and levels of calculation, which are selected automatically based on the fact, which of the archive files are available in given moment.

1.1 Individual program stages:

- 1) **Preparation / modification of input data.** Program RP80 reads input data of current pavement field survey, sorts them in horizontal direction along chainage of a newly designed project centreline of reconstructed road and then sorts them according to specified rules to cross sections. If there is no project centreline yet, the program will perform only transformation of VST file (field survey) to input .SOU file format of DTM for drawing as a supporting sheet for interactive design of project centreline by program VIAAXI in AutoCAD, and into .AC1 format file for checking drawing in AutoCAD. Data can be then interactively edited in AutoCAD environment and saved back in new VST file. (See chapter “*Drawing in AutoCAD*”.)
- 2) **Design of new pavement surface.** For this purpose user can exploit all features of RoadPAC system. He can successively design horizontal alignment of a road (VIAAXI), vertical alignment (VIANIV) and grading details (RP43, RP51) of a new surface.
- 3) **Evaluation of newly designed pavement surface.** If in given design stage there is only horizontal alignment available, the program will just sort input data, i.e. field survey of current pavement according to Fig no. 1 on page 5 and see table on page 3 stage 1). If the data is already sorted, the program performs only checking. The program will then read already sorted data and depending on whether user has designed a new grading details available or if user only has vertical alignment available, it will perform evaluation of base course milling and a new wearing course cut-fills or just review of vertical alignment in detail. User will then return to Stage 2) and back to Stage 3) several times until designed solution meets all conditions of given order, which can extensively vary.

1.2 Processed data files

Input files:

- .V80 - input data
- .VST - input field measurements file (survey)
- .SHB - main points of horizontal alignment
- .SPR - cross sections file
- .SNI - vertical alignment file

Output files:

- .L80 - program output listing and computed results
- .V27 - input data for RP27
- .SOU - input data for DTM
- .ACI - input data for ACAD

Temporary files

- .OFF - sorted file of offsets collecting input cross section
- .ALL - work file, includes all used points

Table of basic program features with regard to existence of input files:

	VST file	SHB file	SNI file	SPR file	Result in files
1	no	no	no	no	L80, no results
2	no	YES	no	no	L80, no results
3	YES	no	no	no	L80, SOU, AC1 unsorted listing
4	YES	YES	no	no	L80, V27, OFF, SOU, AC1+ sorting
5	YES	YES	YES	no	row 4 + evaluation of vertical alignment
6	YES	YES	YES	YES	row 5 + full evaluation

2. Input data**2.1 VST file - file of input field measurement**

Is prepared from output of automated measurement system or by table processing of other systems of surveying.(from existing DTM)

The program assumes field survey, for which a surveyor does not need to maintain progress by profiles. He can even survey pavement with its surroundings without any limits as for ordinary survey, which is not intended for pavement reconstruction. The result file program reads in free format. Individual figures are separated by single or multiple spaces. One line contains 4 figures for one surveyed point: Sequential number, Y coordinate, X coordinate and Z elevation.

Any further values on a line are ignored. Sequential number of a point is not considered, the program will internally renumber them for further processing. User can assign any name to this file with extension .VST. The system uses DOS convention, i.e. length of name may not exceed 8 characters.

2.2 V80 file - control data

Input data are collected by direct completing table in a form or by clicking on individual controls of a form. Forms handling is described in detail in chapter "Introduction". Data is collected in one form with no tabs. It will be displayed after selection "INPUT DATA" in the main program menu: Following illustration depicts program control data:

The screenshot shows the 'Pavement renew' software window. It contains several input fields and controls:

- Date: 23.4.2014
- Input data: 101
- .SHB: 101
- .SNI: 101
- .SPR: (empty)
- Surveyed Points input file: (empty)
- .VST: (empty)
- Project title: aaaaaaa
- Road title: bbbbbbb
- Output file: 101
- .V27: (empty)
- Output file: 101
- .SOU+: (empty)
- .AC1: (empty)
- Output file of calculated offsets: 101
- Active road is: 101
- Removing of surveyed points with offset > (m)L: 10.00
- Removing of surveyed points with offset > (m)R: 10.00
- Longitudinal amplitude of surveyed points at cross-section(m): 2.00
- Vertical amplitude of surveyed points at cross-section(m): 1.00
- About processing: (button)

Date information that will be used in listing

Project title information that will be used in listing

Road title information that will be used in listing

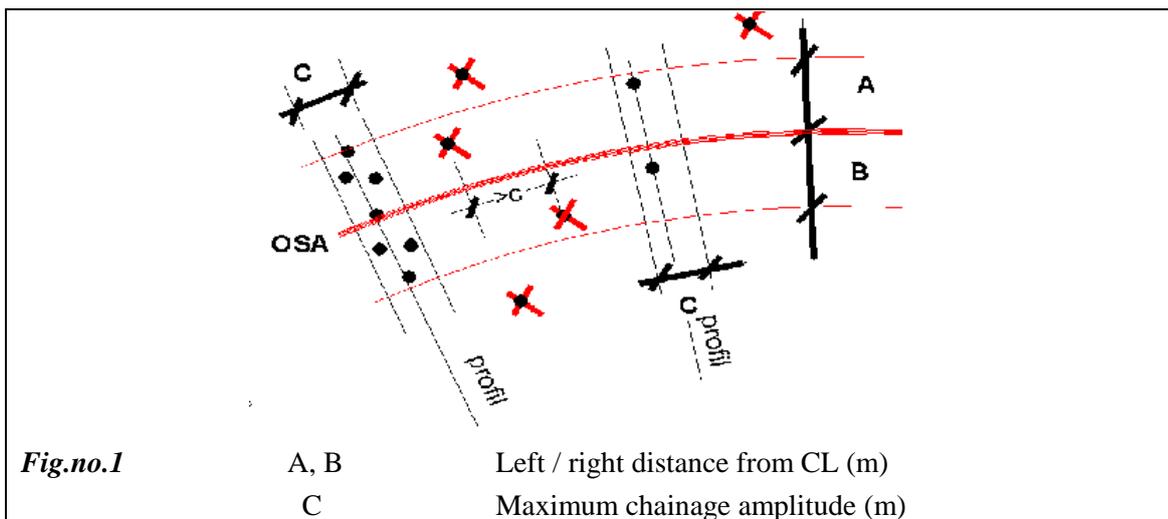
Input File names are not required. If they are omitted, the program will select the active road name from main menu.

2.3 V80 file - testing parameters

Description of individual items:

Remove points with offset on the left from CL greater than (m) all points left from Centreline with distance greater than specified value will be removed from measurement.

Remove points with offset on the right from CL greater than (m) all points right from Centreline with distance greater than specified value will be removed from measurement.



- From chainage** specifies section, for which are specified parameters valid (beginning).
- To chainage** specifies section, for which are specified parameters valid (end).
- Thickness of milling** Thickness of milling as depicted in illustration, in the 1st section from left.
- 1. Boundary** The program will double points in points of boundary of different thickness of milling to ensure that calculation of cut-fills, base course and a new surfacing would be as accurate as possible. The program will not double such points, if a specified boundary will be out of the survey extent, e.g. if interface would be specified in a section of cross section, which will be created only by extrapolation.
- Thickness of milling** Thickness of milling as depicted in illustration, in the 2nd section from left.
- 2. Boundary** Boundary between 2nd and 3rd section
- Thickness of milling** Thickness of milling as depicted in illustration, in the 3rd section from left.
- Thickness of surfacing** this value specifies minimum thickness of wearing course of surfacing that must be maintained everywhere. The program will mark cases, where it is not maintained, by asterisk ** in corresponding column of result list.
- Left trim** specifies position of cross section end at the left side. Narrower cross section will be completed by extrapolation by another point in given distance from CL. Wide cross section will be shortened by interpolated point.
- Right trim** ditto, right from CL
- Recommendation** Before the calculation is recommended to users should check, whether specified sections will cover entire extent of reconstruction. Therefore it is convenient to specify processed sections at the beginning and at the end of expected reconstruction of pavement with sufficient overlap. If user would specify beginning and end of section beyond extent of surveyed points, the program will perform just a listing without calculation of cut-fills and areas.

2.5 Testing values for measurement

Two testing values are submitted below the above stated table:

- X min, X max** two values (cm), which specify upper and lower limit of difference between newly designed surface and original milled surface in every point, which you consider acceptable. It is recommended to have upper limit identical to specified thickness

of a wearing course of surfacing. The program then saves all points with difference less than X min in file Vmin.AC1 for drawing in AutoCAD. Points with difference from the new surface are within extent of X min to X max will be saved in Vok.AC1 file and points with difference greater than X max to Vmax.AC1 file. Testing values are only passive.

3. Processing steps of program RP80

Input file (VST) checking

In a stage, when no designed centreline is available at the beginning of design process, the program can generate data file in road .SOU and road.AC1 formats. The files are used as a basis for design of horizontal alignment of a road centreline of a new pavement surface by program VIAAXI. File road.AC1 can be drawn in AutoCAD environment. All graphical parts of the program are displayed in AutoCAD and described in chapter 4 Plotting in AutoCAD. User can also design a road centreline of a pavement reconstruction by programs of RoadPAC system (i.e. RP12, RP15 and RP14). Main points of horizontal alignment are then saved in SHB file.

Sorting of input data

In a stage, when SHB and VST files already exists the program is already functional and program will sort input file VST according ascending chainage of centreline, according to rules specified in testing parameters of program and finally the profiles will be sorted by distance from centreline from left to right. Number of points in VST file is not limited, number of points in a single profile must not exceed 100 points, minimum is 2 points. The program will again create road.AC1 file, which can be modified in AutoCAD and returned back as new input data. Then the program will save sorted data in .OFF, .V27, .SOU files with names specified in control data.

Road .OFF file is an archive file of the program; the program uses it in the third stage of calculation. **V27** file includes input data of program **RP27** of **RoadPAC** system. With use of program RP27 user can generate from this file (V27) new STR file, i.e. cross sections of original surface of old pavement, and a longitudinal section of an old pavement along centreline by program RPPP. Such files will be used for drawing of vertical alignment and cross sections of pavement reconstruction.

Road .SOU file includes input data of program **DTM**. With use of above mentioned program can user generate SPR file, i.e. cross sections of original surface of an current pavement.

User thus can proceed in the second stage in interactive mode via DTM (digital terrain model) or traditionally with use of computational features of RoadPAC system. As in this design stage the V27 file includes directly surveyed points of cross sections, it is recommended to proceed in traditional way by use of RoadPAC system. Going the DTM way means complex interpolation of cross sections over triangle network in specified chainage, which results in increased number of points in one profile.

Design of vertical alignment

In a moment, when user has longitudinal section of a surface of old pavement along designed road centreline available, he can proceed with design of vertical alignment of a new arrangement. For this purpose you can use either VIANIV or traditional program RP31 of RoadPAC system. For reconstruction of pavement is most convenient interactive program VIANIV, which includes (will include) selection of automated first design of vertical alignment according to longitudinal section of an old pavement above designed road centreline. Once the vertical alignment is designed, user can run the program to evaluate it.

The program first checks, whether road .OFF file exists. If this is the case, input data will be sorted and the program will not work with VST file any further.

The program will issue following message in program journal:

***** File of points is already sorted by chainage.**

Then the program check sequencing in all profiles and issues following message in program journal:

***** File of points was also sorted transversally.**

If designed altitudinal solution of a vertical alignment is shorter than extent of horizontal alignment of an centreline, the extent of calculation will be shortened to an extent of vertical alignment and the program will issue following message to program journal:

***** Attention, section of solution was shortened to extent of existing vertical alignment.**

It is logical, because the program does not have in this section level of a new pavement surface available. The program always creates a temporary file with extension ALL, where it saves all recognised points of survey measurement. Sections of solution and detail description of ALL file are listed below (description of milling).

If road .SPR file does not exist yet, which is the case, the program will inform user about it in following manner:

***** Input file path\name .SPR does not exist, the program will perform only partial calculation.**

Such partially auxiliary solution includes just evaluation of a vertical alignment design. Journal of this calculation is saved in L80 file and user can view it or print by selection **Display and print results** from the main program menu.

New road surface is not designed yet.

If the program does not have **new pavement surface** available, which is designed by programs RP43 and RP51, values of input data **CODE, sections of milling, thickness of a new surfacing, trim** and **testing values** will be ignored. Nevertheless, partial - auxiliary calculation will be performed as already mentioned. Program report will have following results for each profile:

Point	Chainage	Offset	Surveyed	V.A	Crossfall	Crossfall	Delta		
8									

c.	km	from CL	level	level	to left	to right	of elev	?	
+-----+	+-----+	+---m---	+m/nm---	+m/nm---	+-----%	+-----%	+---in CL---	+-----+	
1.	28.2423195	-.0849	218.329	218.350					
2.	28.2423196	.3148	218.328	218.350					
3.	28.2423206	.7149	218.328	218.350					
4.	28.2423217	1.5147	218.328	218.350					
5.	28.2423237	2.3150	218.330	218.350					
6.	28.2423243	3.1156	218.333	218.350					
7.	28.2423254	3.9154	218.339	218.350					
8.	28.2423266	4.4150	218.344	218.350					
9.	28.2423276	4.8152	218.348	218.350					
10.	28.2423277	5.2148	218.358	218.350					
11.	28.2423287	5.6150	218.368	218.350					
12.	28.2423288	6.0146	218.377	218.350					
13.	28.2423298	6.4148	218.383	218.350					
14.	28.2423308	6.8149	218.389	218.350					
*Average chainage.=		28.2423268	CL=	218.329	218.350	-.25	-1.33	.021	---

Our profile has 14 points up to now (trim and boundary of milling was not completed yet). Almost entire profile is situated right of the axis. The program sorted points from left to right by distance from axis. Calculated average chainage of profile at km 28.242268. Calculation of cut-fills will be related to this chainage. The program also specified elevation of vertical alignment in axis, cross fall left of axis -0.25% and right of axis -1.33%. Vertical alignment is 0.021 m over pavement surface. Three minus characters (---) identify that user could lower vertical alignment but just in case of non-zero milling of old pavement surface.

New surface is already designed.

New surface is designed and calculated by programs RP43 and RP51 of RoadPAC system. The program performs, like for design of a new road, suggestion and calculation of surfacing with lateral constraint in distances identical to values **left and right trim** and thickness of structure of the pavement equal to **thickness of surfacing** in program RP80 specification.

The program registers existence of a new pavement surface and performs full calculation of volumes of new wearing course and milling. The program will use all data for specified section of solution. The program also creates a temporary file (with extension .ALL), where it completes cross sections by trim points and will double points at boundaries of different milling thickness. This file is renewed in every run of the program.

The program works so that it performs a separate calculation of milled area in each cross profile. Then it calculates total area between new surface and surface modified by milling. Additional calculation of base course will be result of subtraction of surfacing wearing course layer area from this total area. User of the program then has to make sure that vertical distance between new surface and milled surface is greater or equal to thickness of a new wearing course in every point of cross section. The program will perform calculation even if this assumption was not fulfilled. In result list is every such point marked **. It is at user's sole discretion to decide, whether it is just a casual point, incorrectly surveyed point, etc. or whether he should modify program parameters and repeat calculation.

Fig. no.4

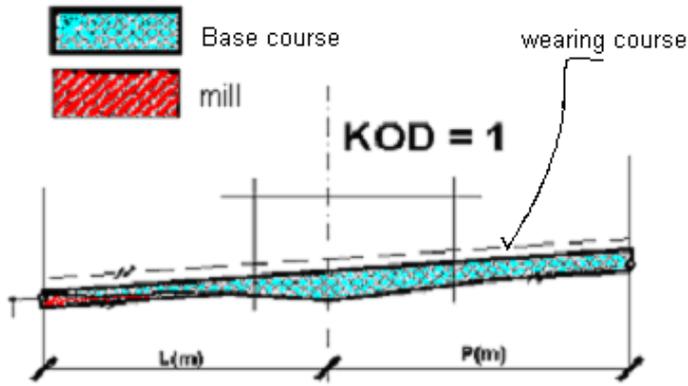
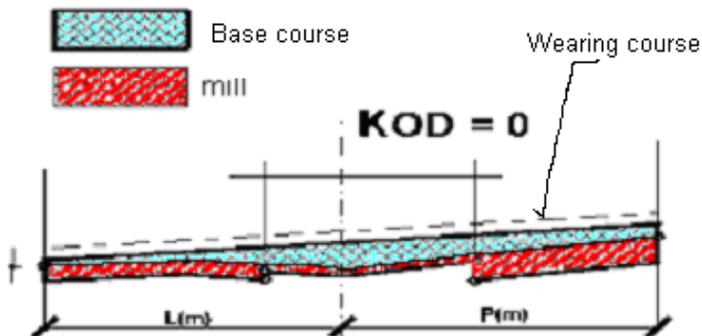


Fig. no.5



If you specify **CODE = 1**, the program calculates milling only in places, where it is necessary. With **CODE = 0** the programs calculates milling everywhere, where specified. Therefore with **CODE = 1**, i.e. with use of mills, which can perform milling according string, there are always savings of construction costs. **CODE = 0** is used in all cases, where survey of composition of old pavement surfacing will request removal of old surfacing layers. Results of the calculations are saved in L80 file by profiles with calculation of surfaces and volumes and with final recapitulation.

In example of part of result list there is a profile with average chainage 28.022500. The profile has 24 points. The profile is trimmed to 2.5 m distance left of axis and at 10.0 m right of axis are completed points in distance 0.5 m to the right and 5.0 m right of axis at a boundary of milling. Specified milling: 7 cm, 0 cm and 7 cm from left.

Type of milling is specified by **CODE 1** (milling from a new pavement surface), therefore doubling points at a boundary is not necessary. Table heading clearly indicates meaning of individual items in columns.

Points where the milling is necessary are marked by one asterisk *.

Points, where error was identified, are marked by two asterisks **.

Point no	Chainage km	Offset m	Surveyed level	How much where(*)	Elevation from	Delta of	Delta (+)OK	New elev.
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+-----+-----+-----+point--+mills---+project--+elev.-+-----+-----+
Average chainage profile *** 28.022526 Milled under previous pavement,
Thickness of new surface == .040m Wearing course
  1 28.022500 -2.500 222.050 .000 222.411 .361 .361 222.050
  2 28.022505 .060 222.415 * .023 222.462 .047 .070 222.392
  3 28.022507 .460 222.472 * .072 222.470 -.002 .070 222.400
  4 28.022509 .500 222.472 * .071 222.471 -.001 .070 222.401
  5 28.022509 .501 222.472 * .001 222.471 -.001** .000 222.471
  6 28.022509 .860 222.470 .000 222.478 .008** .008 222.470
  7 28.022513 1.660 222.477 .000 222.494 .017** .017 222.477
  8 28.022517 2.460 222.487 .000 222.509 .022** .022 222.487
  9 28.022521 3.260 222.487 .000 222.525 .038** .038 222.487
 10 28.022525 4.060 222.498 .000 222.541 .043 .043 222.498
 11 28.022527 4.560 222.504 .000 222.551 .047 .047 222.504
 12 28.022529 4.960 222.507 .000 222.559 .052 .052 222.507
 13 28.022531 4.999 222.507 .000 222.560 .053 .053 222.507
 14 28.022531 5.000 222.507 * .017 222.560 .053 .070 222.490
 15 28.022531 5.360 222.511 * .014 222.567 .056 .070 222.497
 16 28.022533 5.760 222.526 * .021 222.575 .049 .070 222.505
 17 28.022536 6.160 222.533 * .020 222.583 .050 .070 222.513
 18 28.022537 6.560 222.542 * .021 222.591 .049 .070 222.521
 19 28.022539 6.959 222.551 * .022 222.599 .048 .070 222.529
 20 28.022540 7.360 222.558 * .021 222.607 .049 .070 222.537
 21 28.022542 7.759 222.583 * .038 222.615 .032 .070 222.545
 22 28.022545 8.259 222.592 * .037 222.625 .033 .070 222.555
 23 28.022548 8.959 222.614 * .045 222.639 .025 .070 222.569
 24 28.022550 10.000 222.559 .000 222.660 .101 .101 222.559
ABX= 4.995m3 BASEC. (+)=3.407m3 MILL= 3.029m3 Full ares.= 1.074m2 Mill area.= .179m2

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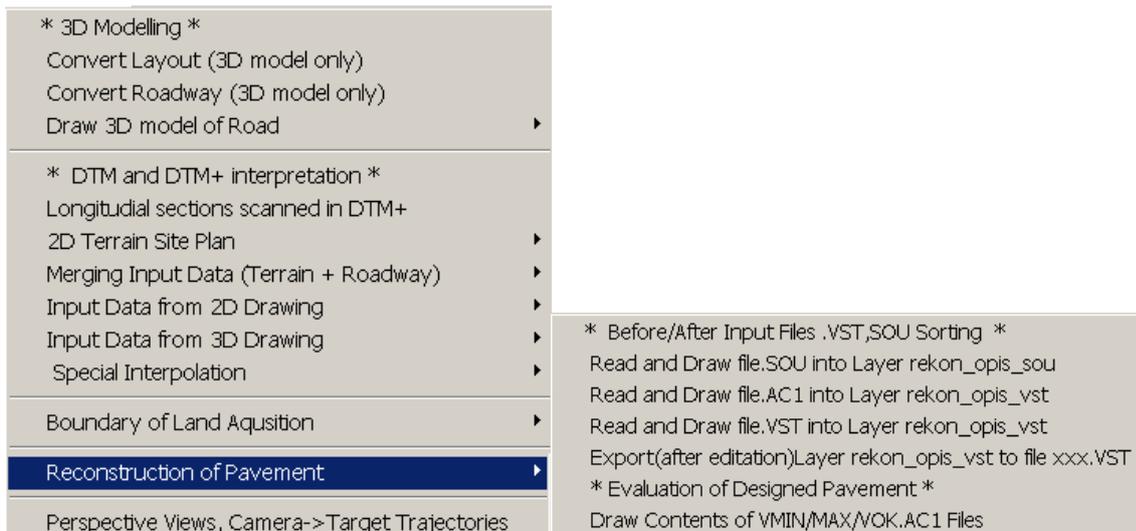
=====
Total cut-fill *ABX= 1280.795 m3 *Base course = 1827.225m3 *Milling = 1336.779 m3
=====

```

4. Plotting by AutoCAD system

AutoCAD includes extensions of RoadCAD7 with features for plotting.

If there is full exploitation of the extensions of RoadPAC system, the features work with AC1, SOU, SHB, SPR and SNI file types. The mentioned extension will plot **layout of pavement reconstruction** from the named files. Individual functions, which are available for point array drawing, can be launched from the main pull-down menu see next picture.



Pavement reconstruction

Clicking on this item of pull-down menu will open new pull-down submenu.

This submenu is divided in two parts:

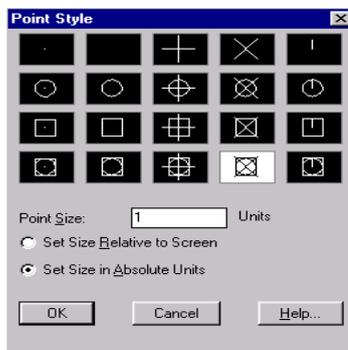
Before/After Input Files.VST,SOU Sorting

- ***Read and Draw file.SOU into layer rekon_opis_sou.*** Clicking on this item of submenu will start function that will draw on screen contents of SOU file, created by running program RP80 (table in chapter 1), even though there is no horizontal alignment of project centreline available yet. Points are stored in DWG drawing in layer **REKON_OPIS_SOU**.
- ***Read and Draw file.AC1 into layer rekon_opis_sou.*** Clicking on this item of submenu will start function that will draw on screen contents of AC1 file, which is created at every run of program RP80 (table in chapter 1). If there is no horizontal alignment of project centreline available yet, it will plot all points of VST file. If the centreline already exists, the program will plot just points that meet input data criteria. Points are stored in DWG drawing in level **REKON_OPIS_VST**. Individual points can be accompanied by description of altitudes and sequential numbers of a point. Purpose of both functions is to enable visual check of input data before use of program VIAAXI and to perform modifications of input data. 3D points can be arbitrarily deleted or completed at **REKON_OPIS_VST** layer. This option is recommendable, if input measurement includes many points that have nothing to do with current pavement or are surveyed incorrectly but meet criteria of input data. (Culverts, poles, trees, fences, etc.)
- ***Read and Draw file.AC1 into layer rekon_opis_sou.*** ditto for file .VST
- ***Export (after editation) layer rekon_opis_vst to .VST file.*** Clicking on this item of submenu will start function that saves current content of **REKON_OPIS_VST** level after possible modifications (otherwise the function is meaningless) to file xxxx.VST with arbitrary name. So created file can be then used as a new input for program RP80.

Evaluation of designed pavement

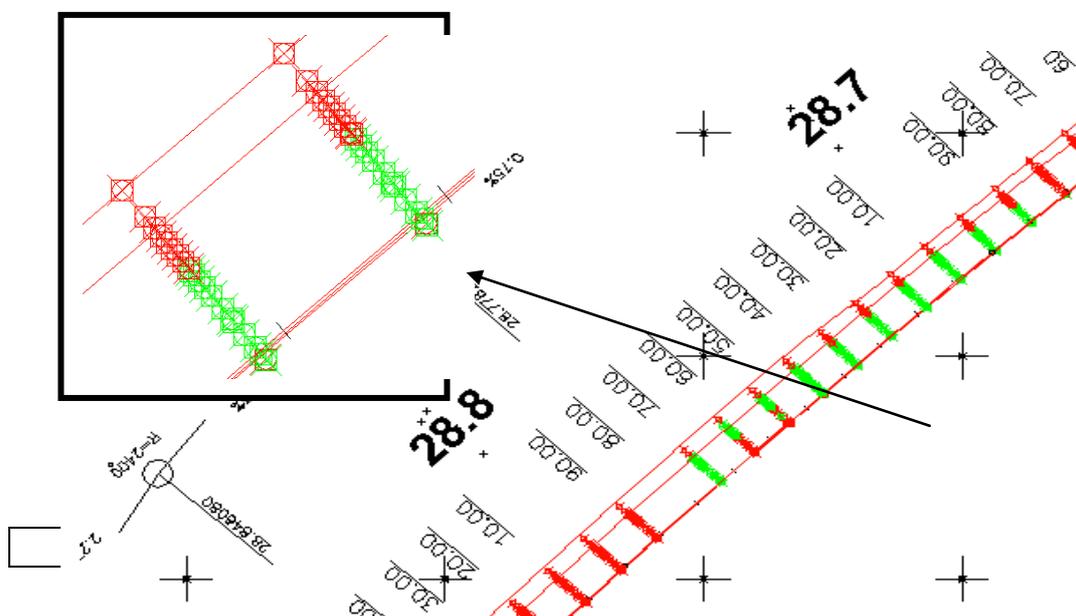
- Draw contents of VMIN/V max/Vok.AC1 files.** Clicking on this item of submenu will start function that will draw contents of VMIN/VMAX/VOK.AC1 files on screen; these files are created during each run of program RP80, if there are **horizontal alignment, vertical alignment and new pavement surface** available. Then the program sort points according of different milling thicknesses. File **VMAX and VMIN** contains points **which do not conform to newly designed conditions**. File **VOK** then **contains points which meet specified condition**. Points are stored in DWG drawing in levels **REKON_VMIN /REKON_VMAX/ REKON_VOK**.

All drawing functions use for points drawing a point type element (_Point). To emphasise drawing with utilisation AutoCAD system features, you can plot points with use of various symbols according to following scheme:



Thus created DWG drawing can be with use of features of RoadCAD7 extension completed by drawing of centreline, chainage of cross sections, hectometres, description of set-off elements. For plotting points of individual AC1 files you can use different colours and special symbols. Thus you can get quite meaningful layout of a reconstructed section.

Fig.no. 6 Example of evaluation of pavement reconstruction layout + detail of plotting of points



For plotting of **longitudinal profile and cross sections** of pavement reconstruction we will use standard programs RP34 and RP 53 of RoadPAC system. Cross sections can be plotted with original surface of old pavement or with milled surface. Longitudinal sections are completely standard.

Run of program RP80 always creates new V27 file, input file for cross sections calculations in terrain, which includes files for trimming and boundary of milling with altitudes of points modified by milling. Name of the file is created automatically on a basis of name submitted by user in control program data with suffix _1.

4. Drawing by RoadPAC system

Example:

There is name PH1 specified for V27 file in control data; the program will store milled surface in PH1_1.V27 file and not milled in PH1.V27. User can then decide between plotting cross sections with milled or not milled pavement surface. Program RP27 will save points of pavement surface in file PH1.STR, than it calculates cross sections by program RP51 and stores results in PH1.SPR. Eventually the user will run program RP53 for plotting of thus created cross sections. The same procedure can be performed with data saved in PH1_1.V27

Fig. no.7 Sample of plotted cross section with milled terrain + detail

