



ROADPAC'14

PROGRAM RP12

Horizontal Alignment

User guide

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1. INTRODUCTION

The program "HORIZONTAL ALIGNMENT" forms part of the ROADPAC program system. In the computer aided design of the highway road it is one of the first programs to be used for the design of horizontal alignment of a road. It is conventional style for horizontal alignment design. In recent years users prefer interactive horizontal alignment design style, using program VIAAXI directly in opened DWG file. See special manual.

The program SI12 computes in the coordinate system the data on the individual sections of the road centreline which consists of straights, circles and transition curves (spirals). The computation is determined by the sequence of elements, each of which is formed by a circle with spirals or by a straight with spirals. The individual element can be defined as fixed, rotary, displaceable (free) or connected. Each element is defined maximally by two points through which the road centreline may or need not pass, depending on the type of element.

1.1 Program Functions

1. Computation of the horizontal alignment of road from defined elements and parameters of spirals. This function can be replaced with the data reading of previously computed alignment from the archive file. (File extension "road" SHB.)
2. Check of centreline continuity in all main points.
3. Print-out of resulting data on main points of the road and storage of these data in the SHB data file, if no fatal error has taken place.
4. Computation of coordinates, bearings and radii of curvature in the points determined by chainage, storage of the chainage table in the file with the SSS extension i.e. the CHAINAGE file. The chainage table can be read also from the SSS file.
5. Perpendicular side distances at defined points. Computation of foot coordinates of this perpendicular and its chainage.
6. Computation of offset points coordinates on the perpendicular to the centreline at the defined distance in the detailed points. By means of the connection of these offset points the length of the equidistant (equidistant and offset points).
7. Saving of the computation protocol and the computation results in the text file .L12.

1.2 Processed files

Input files:

- .V12 - Input data
- .SHB - Main points of horizontal alignment file
- .SSS – Chainage file

Output files:

- .L12 - Output listing
- .SHB - Main points of horizontal alignment file
- .SSS - Chainage file

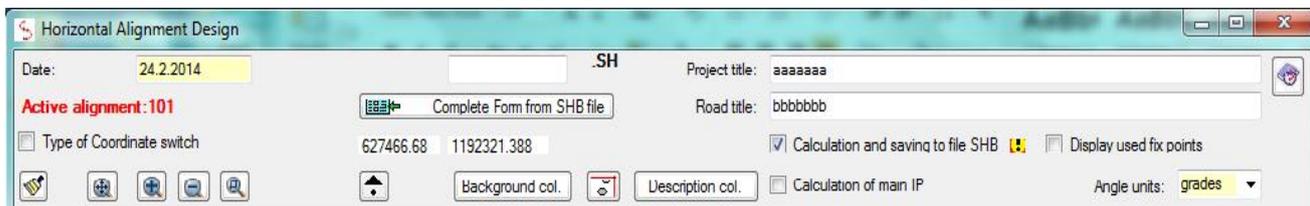
2. INPUT DATA

The input data are provided by filling and editing of tables or to click on controls placed on forms appearing on the computer display. Display operation is described in the user guide. See chapter Introduction. Forms usually incorporate common control part, graphical part if it is useful and input data part. A Picture box, if placed on form, serve to display immediate results.

The input data of the program HORIZONTAL ALIGNMENT are prepared by means of a 5 tabs placed on form, which appears successively on the display. According to job type some blocks or tables may be omitted.

2.1. Control Data Block

It appears after the selection of "INPUT DATA" in the preceding menu. On the next picture is control data part of form.



The meaning of the individual items:

Date - is the date of input data entry.

Project title and Road title - is an arbitrary text printed in the headings of output listings and in the files of the .SHB and .SSS extension.

Input/output files and Name of chainage file (see tab Chainage) need not be defined. If the files are processed in accordance with the requirements given below and the name of the file has not been defined, the program takes automatically the standard name of the file "Active alignment" from the main menu. If the name is defined in proper textbox, then this name has preference to the standard name of active alignment.

Note: In further text the files are named as "road". The name of road meaning either the name defined in the textbox or the name of road defined in the main menu.

Save horizontal alignment to file: (/1 see page 5)

- means not to write the main points in the file of the .SHB extension.

- ✓ means to write the main points of the road in the file with the SHB extension. Should the file already exist, it will be overwritten by the newly computed road. The name of the file is "road" SHB.

To read chainage from file: (/1 see page 9)

- means that the chainage table will not be read from the file with SSS extension. Should it be needed in the framework of the program. It will be defined on form data table CHAINAGE.

- ✓ means that the chainage table will be read from the file with the SSS extension.
See page 9.

To save Chainage to file: (/1 see page 9)

- means that the chainage table (supplemented with the chainage of the main points of the road after the computation) will not be written.

- ✓ means that the chainage table will be written in the file with SSS extension. The name of the file is "road" .SSS.
See page 9.

Use big IP : (/1 see page 5)

- means that the computation and print of major tangential polygon IP is not required.

- ✓ means that the computation and print of the major IP polyline. IP shall be carried out.

Code of angle unit in outputs (0/1/2 see combobox page 5)

- 0 means that the angles in output listings will be given in grades.
- 1 ditto, but in degrees (three figures, meaning degrees, minutes, seconds)
- 2 ditto, but in decimal degrees (one figure only).

2.2 Road Definition Block

It comprises three tables which appear successively on the display if user click on upper bar of a tab to choose Fixed points or Parameters. Second table Fixed points and first table Origin of chainage are placed on the tab fixed points. Third table of road elements, type of parameters is placed on the tab Parameters. For first and second table see next picture.

2.2.1 Fixed points

Fixed points Parameters Chainage Offset points Offset lines

Origin of chainage point specification (If it's not at first fixed point)

RP	Point number	1. coordinate (m)	2.coordinate (m)	Chainage at point (km)	Approx. dist. from beginning (m)
	1	0,000	0,000	0,000000	0,000

Fixed points of alignment design (Free format)

RP	Point number	1.coordinate Y(m)	2.coordinate X(m)
	1	631 262,291000	1 193 289,779000
	2	631 216,075708	1 193 286,232636
	3	631 032,369166	1 193 276,661432
	4	630 557,813143	1 193 368,715971
	5	630 201,496864	1 193 534,280551
	6	629 436,676814	1 193 614,367320
	7	629 247,100427	1 193 565,436412
	8	628 612,594617	1 192 992,152088
	9	628 482,593294	1 192 665,164155
	10	627 782,174845	1 192 137,019795
	11	627 514,153395	1 192 105,698060
	12	627 425,884985	1 192 077,045371

About fixed points

In the Fix points table one row defines one fixed point. Each fixed point is described with three items. The table may contain the definitions of maximum 100 fixed points. Point number must be higher than zero. Two points must not have the same number.

1. Coordinate Y and 2.Coordinate X are the coordinates of a positively oriented coordinate system. (Axis +Y derived from axis +X by clockwise rotation by 90 degrees.)

The table BEGINNING OF CHAINAGE contains only one row. The data define reference point on the road with fixed chainage, to which the chainage system on the road under computation is referred. The table need not be defined. In such a case the program assigns the first point of the first element the chainage km = 0.000000.

Should it be required to define the chainage of the road in some other way, the reference point must be defined in table by five items. The first three items define the point with coordinates 1.Y and 2.X. From this point a perpendicular is dropped to the road centerline. The foot of this perpendicular is assigned the chainage (km) given in the fourth item. With regard to the non-uniqueness of the problem the fifth item defines the

approximate distance of the foot of the perpendicular from the beginning of the first element of the road in meters. In case of existence of several foots of perpendiculars, the program selects that one, which is nearest the defined distance from the beginning of the road.

Note: The point may be defined by the reference to the preceding table. In such a case its No. is given and its coordinates Y and X too.

2.2.2 Road parameters

Tab ROAD PARAMETERS

RP	Element type	Length of element (m)	Radius R <0;>(m)	1. Spiral A'-L(m)	2. Spiral A'-L(m)	First Point Number	Second Point Number
	fixed	0,000	0,000	-184,0000	0,0000	1	2
	rotary	0,000	1 250,000	-184,0000	-209,0000	3	4
	rotary	0,000	-1 390,000	-196,0000	0,0000	5	6
	rotary	0,000	-1 100,000	-192,0000	-160,0000	7	8
	rotary	0,000	933,000	-140,0000	-130,0000	9	10
	rotary	0,000	-480,000	-30,0000	0,0000	11	12
	rotary	0,000	0,000	0,0000	0,0000	13	14

The tab ROAD PARAMETERS contains the table No.3 of parameters types. One row defines one element. The maximum number of elements defined, must not lead to a higher number of main points of the road than 100. The element of the road may consist either of a circle (circular curve) or a straight line. The element may be followed by one or two spirals, if it is required. The spirals need not be defined at all.

Element types:

- 1 Fixed element is an element whose position remains unchanged during the computation.
- 2 Rotary element is an element whose position changes in the course of computation by its rotation around its 2nd point until it joins smoothly the preceding element or the last clothoide of the preceding element.
- 3 Displaceable (free) element is the element, whose position results from its displacement between adjoining elements while have become fixed elements in

the course of computation.

- 4 Connected element is an element which is defined by its length. This element is firmly connected to the end point of the preceding element in the direction of computation. The end point of the preceding element must be defined. The length of the element is maintained only, if the element is the last element or if another connected element follows (chain connection of elements). If a rotary or displaceable element follows, the program computes the point of connection from defined parameters and the defined length is not maintained.

Rules for Element Sequence in the Road

1. The elements and the spirals are defined in the direction of increasing chainage. For the connection of two curves of the same hand only one spiral may be defined. For the connection of two curves of opposite hand maximally two spirals may be defined.
2. The first element of the road must be a fixed element (type 1) and must be determined by two points. The first point of this element represents the beginning of the road.
3. The last element of the road must be a fixed element (type 1) or a rotary element (type 2) or a connected element (type 4). The last point of such element represents the end of the road.
4. It is not recommended to define several fixed (type 1) elements in succession. The problem is then over determinate.
5. The sequence of elements comprising a displaceable (free) element may comprise maximally 11 elements with fixed elements at the beginning and the end of the sequence. There may be maximum 8 rotary elements between a fixed element and a displaceable element or between a displaceable element and a fixed element. The rotary elements may be absent.
6. After the solution of the connection of the current element to the preceding element the current element becomes a fixed element. If the program processes a displaceable element it will compute its connection to adjoining elements which have become fixed elements previously. The program enables also the computation of elements against the direction of defined elements. This case occurs when the displaceable element is followed by rotary element is terminating with a fixed element.

The meaning of the individual data in the table ELEMENTS OF ROAD, TYPE OF PARAMETRES:

Element type can be defined by the figures 1-4 as follows:

1 - fixed element, 2 - rotary element, 3 - displaceable(free) element, 4 - connected element.

Element length for type 4 elements means the length of the element. Radius of the element is positive, if it is a right-hand circular curve, and negative, if it is a left-hand circular curve. Zero value means a straight. The radius is always defined in meters.

1st and 2nd spirals are the data which can acquire various values. Positive value means that the spiral is defined by a parameter. Negative value means that the spiral is defined by its length. Zero means that the spiral will be computed; however only in the case when the type 1,2 or 3 element is defined by two points. In such a case the element is considered as a fixed element and the spirals will be computed. This method of definition is highly sensitive to the accuracy of coordinates of fixed points; therefore, it is not recommended for standard practice. If we want to suppress the construction of spirals, the item is defined as 0.0001. The item for the second spiral is defined only, if the second spiral is justified (curvatures of opposite hands); otherwise the value is zero.

Point No. of the 1st and 2nd points are the numbers of points defining the position of the elements. The numbers may have the value zero or the values of point number specified in table FIXED POINTS with the following meaning:

Both numbers are positive. The element is defined by two points. Be able to use for types 1, 2 or 3 elements.

The 1st No. is positive, the other is zero. The only defined point is the center of the circle. Can be used for type 1 element (which must not be the first element of the road) and for type 3 element.

The first No. is zero, the second No. is positive. Only the second point of the element is defined, around which the element rotates. Be able to use as element type 2.

Both Nos. are zeros. The position of the element is not defined and must be determined by computation. Be able to use as types 3 and 4 elements.

1st and 2nd offset from centerline. Define the distances of the points from the road centreline in meters. Be able to use for both the points of type 1 element or for the second point of element type 2. Positive sign means that the point is to the right from the road centerline. Negative sign means that the point is to the left from the road CL. If the point is situated on the road centerline the value is zero.

Note : FIXED POINTS table and ELEMENTS OF ROAD, TYPE OF PARAMETRES table and other proper tables can be fill automatic from existing file „road“ .SHB using function „**Read data from SHB file**“ placed in lower part on form .

2.3 Block of Chainage Definition

It enables the definition of the chainage by two tables which appear on display if the tab CHAINAGE is pressed. The first table enables the definition of CHAINAGE GIVEN BY STEP the second table enables the definition of INDIVIDUAL CHAINAGE.

The table CHAINAGE GIVEN BY STEP may have any number of rows. One row defines one section with a regular step. The first item means the beginning of chainage in km the second the end of chainage in km, the third the chainage step in meters which the individual chainage between the beginning and end will be generated with.

The end of the section is written to chainage file if it is a multiple of the step only. For details see page 4. Chapter 2.1

RP	From (km)	To (km)	Step(m)
	0,000000	4,695650	20,000

RP	Individual Chainages (km)
	4,695650

Chainage File:

Chainage file saving ?

Merge content of labels plus content of file.SSS

Save chainage .SSS Chainage is not required

The table INDIVIDUAL CHAINAGE may have any number of rows. Each row defines one chainage in km x.xxxxx. The computer generates a chainage file which unifies both above mentioned tables. Duplicity of chainage is eliminated. With reference to Chapter 2.1 of this manual (Work with the chainage File) the reading and the writing in the CHAINAGE file can be defined together with the definition of the two tables described above. The work with the chainage file will proceed as follows:

The computer will read the chainage file, the values from tables, and after the unification of all chainage data it will eliminate all duplicities. After the computation of the road the chainage of the main points of the road will be added and the table will be stored in the chainage file. The maximum number of chainage data thus processed is 8000.

2.4 Side distance block

It ensures the definition of the data for perpendicular side distances from the defined point to the computed road centreline. The input data are defined in the tab SIDE DISTANCE tab. One row defines one job. The number of jobs is not limited. Picture of display see next page.

Point No. must be a positive integer. Coordinates of the point need not be defined, if

SIGMAM bearing in a main point (grades, or degrees)
 R(m) radius of curvature in a main point
 YC(m),XC(m) coordinates of the center of the osculating circle
 in a main point.

The meaning of data on the second line:

VN number of vertex
 TP type of curve in the given section
 DIF(m) length of element
 YI(m) coordinate Y of spiral inflexion point
 XI(m) coordinate X of spiral inflexion point
 SIGI bearing of spiral inflexion point (grades, degrees)
 A spiral parameter
 YT(m), XT(m) coordinates Y and X of the intersection points
 of section tangents
 T1(m) length of tangent, in case of a circle,
 length of the first tangent in case of a spiral
 T2(m),RISE(m) length of rise in case of a circle,
 length of the 2nd tangent in case of a spiral
 ALFAT angle of tangents

4. Protocol on vertices of the tangential polygon of the road. For each vertex the following information is printed:

VERTEX No vertex No
 YT(m),XT(m) coordinates of the vertex of tangential polygon
 T1(m),T2(m) lengths of major tangents (before and beyond
 vertex)
 ALFAT oriented angle of tangents

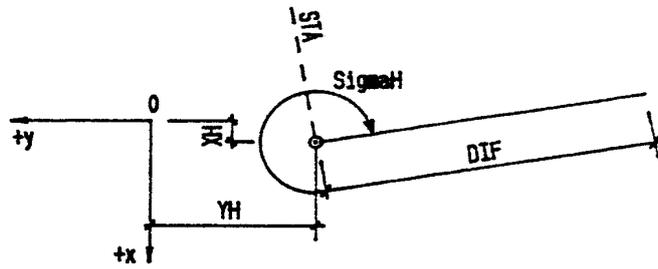
5. Protocol on perpendiculars dropped from defined points (offsets)

6. Protocol on detailed road points. For every detailed point the following information is printed:

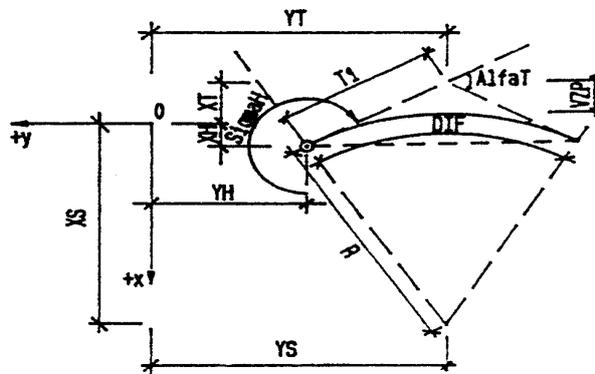
TYPE type of point; detailed point is marked with two
 asterisks (* *), the main point of the road with
 one the following combinations: BT, BS, BC, TE, TS,
 TC, SE, ST, SS, SC, CE, CT, CS, CC, where the
 letter T denotes the tangent, C the circle, S the
 spirale, B beginning, E end, for instance, the
 combination SC means the main point between the
 spiral and the circle.
 STA(km) chainage of detailed point
 Y(m), X(m) coordinates of detailed point
 SIG bearing in detailed point (grades, degrees)
 R(m) radius of curvature in detailed point

7. Protocol on the length of the equidistant and protocol of computed points
 perpendicular to the road

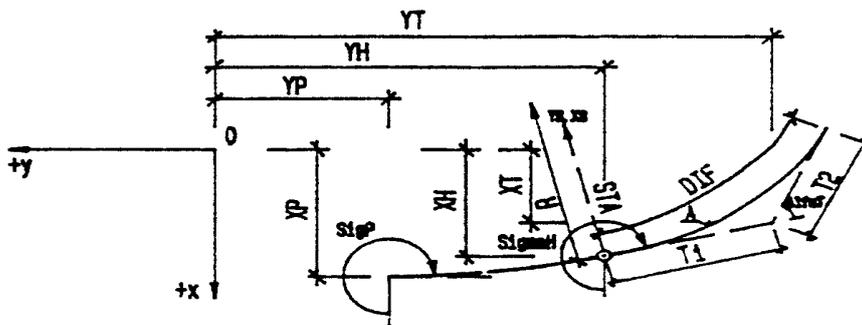
1. STRAIGHT



2. CIRCLE



3. SPIRAL



4. *Warning 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 by *** in reports and formal errors are marked by **.

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

Text of message	Temporary solution
*** Leading line * 12 is missing *	
*** Inaccessible type of leading line: nnn	
*** Inaccessible function code number x= nn	
** First line ignored	
*** Between leading data read no marked line *	
*** Premature end of data	
** End line 999 is missing	
** Inaccessible type of line nnn ignored	
*** Inaccessible type of line (description of line)	
*** Line read with error, ignored (description of line)	
** Line ignored (description of line)	
** More than nnn detailed points, ignored.	
** Formal error, line ignored: (description of line)	
** More than nnn detailed points, ignored from km n.nnnnnn	
** While merging chainage and main points of v. ', alignment nnn main points of v. alignment exceeded	
*** For one clothoide is two length specified	
*** One clothoide is specified by length next by parameter	
*** For one clothoide is two parameters specified	
*** Impossible to determinate position of circle nnn.nnn	
*** Impossible to determinate position of tangent(line)	
*** More than 100 fixed points required	
*** Descending chainage on line nnn is ignored: (description of line)	
*** More than nnn segments, line is ignored	
*** More than nnn segments. ignored km n.nnnnnn from SHB	
*** Incorrectly specified clothoide in segment no: nnnn	
*** Not 1 segment of alignment written	
** In range S1-S2 no detailed point is given, ignored	
** Iteration is not exact D= nn.nnn	Left last value
** Fixed point should not have number 0, ignored (Line description)	
*** Same number of two points nn	

*** First given point is not fixed	
*** Fixed point number nnn not found in the list	
** More than nnn fixed points, other nnn ignored (line description)	
*** More than 1 line type 103, ignored	
*** Impossible to determinate position of circle	
** Second point out of centreline incorrect	Substituted by point on centreline
*** At first element must be given two points	
*** To many floating elements	will be Substituted by rotary
*** After floating element there are more than 8 rotary or connecting elements	
** Elements sequence is not partially determined	
*** At first element there cannot be shift of centreline	
*** Input data of centreline is missing	
*** Main point No nnn chainage is greater as chainage of main point No nnn	
** Discontinuous - offset in main point No nn	
** Discontinuous in direction in main point No nnn DW= n.nnnn (in radians)	
*** Less than 2 road segments	
*** Last point of road has smaller chainage than n.nnnnn previous, cancelled, number of MP is smaller for 1	
*** Point for offset calculation is not given in (line description)	
** Point for offset calculation out of road (line description)	
*** Point, given by chainage in km nnn is out of range.	
*** Connection of branch out of road area n	
*** Iterative calculation of clothoide parameters not exact	Left last value

Next warning messages see USER GUIDE RP15 respectively