The SURPAC ENGINEERING Module Applications

Horizontal Curve and Straight Alignment

- Given a set of user defined parameters for a road or railway route containing a series of horizontal curves, this application will compute the [Y, X] (or [E, N]) co-ordinates and Chainages of positions along the centre line of a route, or along a defined Offset Line.
- The required input parameters are :-
  - The [Y, X] (or [E, N]) co-ordinates for the Start and End points of the section of the route to be computed, plus the chainage of the Start point. These Start and End poin represent the total length of the centre line, or offset line, to be computed.
  - The [Y, X] (or [E, N]) co-ordinates for the Points of Intersection for all curves lying alon the defined route (up to 100 curves).
  - The circular Radii for all curves lying along the route.
  - The lengths of all Transition curves, if any, for all the curves along the route.
  - The Chainage Interval required between Centre Line points.
  - Selection of Centre line or Offset calculations.
- The route section can also be as long, or as short, as required. It may consist of a single curve (where the start and end values may be coincident with the BC and EC points), or a single straight. The maximum number of points on any Centre Line file is unlimited.
- Once a route, or section of a route, has been computed, this application may be used at a later date, for the editing of any of the curve parameters, if required. Curves may be Added, Inserted, Modified or Deleted from the original scheme. Any number of updates may be made and the Centre Line co-ordinates re-computed and re-stored.
- As the Centre line values (Co-ordinates and Chainages) are computed they are stored on a user defined Horizontal Alignment File. Simultaneously, the centre line point values are displayed on the SURPAC printer emulation screen. From this screen, the output may be sent to the current Printer, to an ASCII file, or to the Clipboard.
- Setting out data for Centre Line points may be computed and printed via the Setting Out Data Sheets.
- The user may select to determine centre line values, or offset values on either side of the centre line. Offset lines are useful when curvilinear boundaries are required along an existing, or proposed road/rail route.
- Computed Points may be :-
  - Converted to a User defined SURPAC Co-ordinate File,
  - Plotted on a User defined SURPAC CAD Plot Sheet,
  - Combined with SURPAC Vertical Curve Data for determining Section profiles,
  - Used to generate Centre Line Setting Out Field Sheets.

Vertical Curve Alignment and Section Formation Creation

- This programme provides for the generation of the Design Cross-section formation d along a road, or a railway route. This data generation is wholly dependent upon the e

design criteria.

- After entry of the required criteria, the Design Cross-section formation data are computed for each section and stored in a User defined Vertical Curve Alignment File. This information may be used by :-
  - The Cross Section Creation and Plotting,
  - The programme for the plotting of Cross sections,
  - The Longitudinal Section Creation and Plotting for plotting Longitudinal sections,
  - and the Sectional Volumes and Toe-Peg Calculation programme for calculating sectional volumes, Mass-Haul volumes and Toe-Peg distances for batter board placement.
- The initial design criteria required by the programme are the design data for the vertical curves along the proposed route. For each Vertical Curve, the required input data are :-
  - The Intersection Point Chainage
  - The Intersection Point Elevation
  - the Length of the Vertical Curve.
- From this information, the programme will compute the parabolic vertical curve parameters, the Start and End chainages of the curves and the gradients of the straights connecting the curves.
- Any vertical curve may be defined as having a Curve Length = 0. This is interpreted as being a "kink", or bend point along the centre line, and no parabolic curve is computed. The two line gradients will intersect at the defined Chainage and at the defined Elevation.
- The defined point may merely be a chosen point along a gradient, i.e. the incoming and outgoing gradients may be the same. This is useful for including "odd" chainage points that may be required for Cross Section and/or Long Section plotting.
- All vertical curve data should be entered to cover the total length of the route under consideration. The design Centre Line elevations, at the designated chainage interval, are then computed.
- After the Centre Line elevations have been computed, design data for the Section Formations are entered, if these are required. If the formation design criteria are constant along the entire route, then a single set of input data will be sufficient. If there are variations, such as the super-elevation changing from curve to curve, then separate design data must be entered section by section.
  - The elements required for the calculation of the design formations are :-
  - The start and end chainages of the section, or route,
  - The median width and slopes,
  - The straight to curve development lengths and ratios,
  - The curve widening within the curve, if required,
  - The Carriage Way cross-falls and super-elevations,
  - The Carriage Way widths,
  - The kerb heights and slopes
  - The pavement (shoulder) widths and slopes,
  - Any auxiliary Carriage Way widening along the straights.
  - The programme makes allowance for the above mentioned design elements for the formation Cross sections. These exclude the batter slopes and side drains, which are

defined at the Cross-section plotting stage, when using the Cross Section Creation and Plotting programme, or the volume calculation stage when using the Sectional Volumes and Toe-Peg Calculation programme.

- Once all section design data have been entered, the design formations for each section are also stored on the current Vertical Alignment File .

Cross Section Creation/Editing/Plotting

- Cross Sectional data may be generated through a variety of different methods, namely :-
- By Manual (keyboard) entry,
- By Interpolation when combining a Horizontal Alignment (Centre Line) File and a Tacheometric File.
  - *The use of a Horizontal Alignment File infers that the centre line points are at regular intervals, and will lie along mathematically correct geometric entities such as straight lines, circular curves and transition (clothoid) curves.*
  - *The two defined files must have a common area of overlap. Further information such as the required Section chainage range, the Section widths and interpolation distances along the Sections may be entered.*
  - *This method provides a technique of creating Cross Sections without having to stake the Centre Line, or physically measuring the Sectional data. This method is not suitable, however, for terrain that contains man made features such as drains, existing roads etc.*
- By Interpolation when combining a Co-ordinate File and a Tacheometric File.
  - *The use of a Co-ordinate File makes allowance for "centre line points" that need not be a regular intervals, and may not necessarily lie along mathematically correct geometric entities.*
  - *The two defined files must have a common area of overlap. Further information such as the required Section chainage range, the Section widths and interpolation distances along the Sections may be entered. Interpolation is carried out via a least squares plane fitting technique.*
  - *As for the previous method, this method also provides a technique of creating Cross Sections without having to stake the Centre Line, or physically measuring the Sectional data. This method is not suitable, however, for terrain that contains man made features such as drains, existing roads etc.*
- By using a a Horizontal Alignment (Centre Line) File plus extraction of BreakLine Data from a Tacheometric File.
  - *This option searches through a user defined Tacheometric File for all BreakLine information, and then combines this information with centre line information taken from a user defined Horizontal Alignment File .*
  - *The two defined files must have a common area of overlap.*

- *Only those points that represent intersections between a BreakLine and defined cross sections will be added to the cross section file. Hence, by manipulating BreakLines in a Tacheometric File it is possible to pre-select features that will be reflected on the cross sections. No interpolation will take place using this Option.*
- *This method provides a technique of creating Cross Section information on discreet topographical features without having to stake the Centre Line, or physically measuring the Sectional data, and is suitable for both natural terrain and terrain that contains man made features such as drains, existing roads etc.*

- **Generate Cross Sections using both Interpolation and BreakLine Data from a Tacheometric File**
  - *This option uses the Centre Line data taken from a user defined Horizontal Alignment Fil to position and orientate the cross sections. It then searches the defined Tacheometric File for all BreakLine Information, and combines this information with least squares interpolated heights to supply the most complete cross section information of all the options.*
  - *The resulting Sections are more comprehensive than those of the previous options, and hence take somewhat longer to generate.*
  - *This method provides a technique of creating Cross Section information on discreet topographical features, plus interpolated heights, without having to stake the Centre Lin or physically measuring the Sectional data, and is suitable for both natural terrain and terrain that contains man made features such as drains, existing roads etc.*
- **Load Cross Section Information held in a Tacheometric File.**
  - *This option combines information held in a user defined Horizontal Alignment File and surveyed Sectional information held in a user defined Tacheometric File . The two files must have a common area of overlap.*
  - *Further information such as required section widths and acceptable Off-line tolerances along the sections must be entered.*
  - *This method provides a technique for generating Cross Sections that have been Surveye using polar techniques and stored in, and then transferred from, an electronic logger or Total Station. This method requires that the centre line is staked and the Sections are measured in the field and is, therefore, suitable for terrain that contains man made features.*
  - *Load Cross Section Data from a Handi-Data "LEVELS" format ASCII File .*
  - *Using this option the Cross Section data are read from an ASCII File, set in the "Handi-Data Systems SURPAC" format. This method provides direct reading and loading of data as measured in the field. For further information on the ASCII file format, refer to the "LEVELS" User's Guide for the PSION Organiser, or for the PSION Workabout "DISK Transfer".*
- **The total number of points per cross section is 51 . The centre line point plus 25 points left and right from the centre line.**
- **Cross Sections may be Displayed on the Screen, Plotted directly to a Printer/Plotter, or stored in an HPGL file format.**
- **Cross Sections may be combined with a Vertical Curve Alignment File data created through the Vertical Curve Alignment programme. If Design File information is included, then the programme allows for the inclusion of user information related to the construction of batter**

slopes, drainage channels etc. This combination is used both for the plotting of Cross Sections, and the generation of Sectional Volumes.

Longitudinal Section Creation/Editing/Plotting

- The data used for display, or plotting, may be any of the following :-
- Section Plotting Using both Design and Cross Section Files
  - *Combines the centre line of a Vertical Curve Alignment File and User designated elemen of a Cross Section File. The selected element may be any of the available 51 elements (2 points left of the centre line, the centre line and 25 points right of the centre line) of a Cross Section.*
- Section Plotting Using a Cross Section File only.
  - *Uses any User designated element of the available 51 elements of a Cross Section File.*
- Section Plotting Using both Design and Long-Section Files
  - *Combines the centre line of a Vertical Curve Alignment File and a Longitudinal Section File (created through this application - see further on).*
- Section Plotting Using a Long-Section File only.
  - *Uses a Longitudinal Section File, as created and/or edited through this application.*
- Section Plotting Using a Design File only.
  - *Uses a centre line of a Vertical Curve Alignment File.*
- Section Plotting of Random Grouped Section Files.
  - *This option displays, or plots, a series of Long-Section Files (known as Random Groupe Files), which have been generated from data in a Tacheometric File , and in which the Points follow a specific numbering coding system used by SURPAC.*
- The Options for Creating a Longitudinal Section File are :-
  - Generate Sections from a Tacheometric File plus defined Bend Points.
    - *This method locates and sorts Long-section data along defined section line, or serie of consecutive section lines within a Tacheometric File. The section line positions ar defined by identifying consecutive Bend Points held in the Co-ordinate File. The two defined files must have a common area of overlap. This is not an interpolation technique, and only surveyed data will be used. This method is best suited for measurements downloaded from a total station, or logger. Side Slope Points may als be included.*
  - Interpolate Sections from a Tacheometric File plus defined Bend Points.
    - *This method uses a system of Least Squares plane fitting along the user defined section line(s) and at a defined interval. The section line positions are defined by identifying consecutive Bend Points held in the Co-ordinate File . The surveyed data Tacheometric data, plus BreakLines where necessary, held in a user defined Tacheometric File. This method is best suited for determining random sections over surveyed area where no direct long-section information has been surveyed. It provid a technique of creating long-section information on discreet topographical features, plus interpolated heights, without having to measure directly along the section line,*

is suitable for both natural terrain and terrain that contains man made features such as drains, existing roads etc.

- Create Sections from a Contour Triangulation File plus defined Bend Points.
  - *This method searches for all possible intersections between the Longitudinal Section Lines (defined by the Bend Points) and the sides of Triangles created in a User defined Contour Triangulation File . The Section Line positions are defined by consecutive Bend Points held in the Co-ordinate File . This method is best suited for determining random sections over a surveyed area where no direct long-section information has been surveyed. It provides Long-Section data based on Contour Triangulation, without having to measure directly along the Section Lines, and is suitable for both natural terrain and terrain that contains man made features such as drains, existing roads etc.*
- Load Section Information from a Handi-Data "LEVELS Lng-Sect" File.
  - *This method will load Long-Section data from a Handi-Data Systems PSION Organiser, or PSION Workabout, "LEVELS" Lng-Sect File [as long as the data are captured in SURPAC Format]. For further information, refer to the "LEVELS" User's Guide for the PSION Organiser, or the PSION Workabout, DISK Transfer.*
- Load Long Section Information from an ASCII File.
  - *Data are imported from a Fixed Column ASCII File.*
- Create a series of Grouped Random Section Files from a Tacheometric File.
  - *Using this function, it is possible to rapidly create a series of long-section Files from data held in a Tacheometric File . The Points for each Section created are identified by means of the Point numbers of the Data in the Tacheometric File using a number coding system. Each Section created will be in its own, separate Longitudinal Section File , which will be given the Name of the Tacheometric File plus the Section Number.*

Sectional Volumes

- This application combines a Vertical Curve Alignment File and a Cross Section File to determine sectional volume information.
- The following pre-conditions must exist :-
  - *The two files selected must have an overlapping strip that contains sections with common chainages.*
  - *The Vertical Curve Alignment File must contain the Design formation Cross sections, and not just the Vertical Curve information.*
  - *The Cross Section File must contain ground, or surveyed, sections wide enough to cover the Design formation Cross sections, plus the Batter slopes and side drains.*
  - *If the extent of a ground, or surveyed, section is not wide enough to accommodate the design criteria mentioned above, the programme will connect the last Design formation Cross section element (such as the end of pavement) with the last surveyed section point. This function can be put to a good use when a section of road has a retaining wall, for example, and does not follow the normally defined Batter requirements. In this case, limit the relevant survey cross sections to the wall position.*
- Before computing any volumes, the application will prompt for information related to the method of connection between the Design Cross sections and the Surveyed Cross section.

This information consists of :-

- *The Start and End Chainages of the required strip.*
- *The angles for Cut and Fill Batters.*
- *The Drainage Channel information. This only applicable to sections in Cut.*
- *The Depth of Top Soil Stripping. This value, if required, will be applied to all surveyed section heights.*
- *The Depth for Special Grade Material. If a value is given, the amount will be subtracted from the Design section Carriage Way heights. This is to compensate for the "boxed out" volume reserved for the Special Grade Material.*
- *The Bulking/Formation Factor. This figure is used to compensate for the difference in compaction between natural, Cut material and Filled material. If you define a factor greater than 100% then this implies that the Cut material will occupy a larger volume when used for Fill.*
- *Finally, you have the choice of computing and displaying the Accumulated Cut and Fill Volumes for the strip defined, or of computing and displaying the Cross sectional Cut an Fill Areas for each Cross section.*

- Once all the required parameters have been set, click the Compute Button . The programme will compute the volumes and display the output in the SURPAC Printer emulation Screen. The application output data consists of :-
  - T*he Section Chainages,*
  - *The Cut and Fill Volumes between two consecutive Cross section,*
  - *The Mass Haul, or Net Cut and Fill Volumes, up to the current Cross section,*
  - *The Accumulated Cut and Fill Volumes up to the current Cross section,* or
  - *The Cross Section Cut and Fill Areas for the current Cross section,*
  - *The left and right Toe Peg distances for the current Cross section.*