



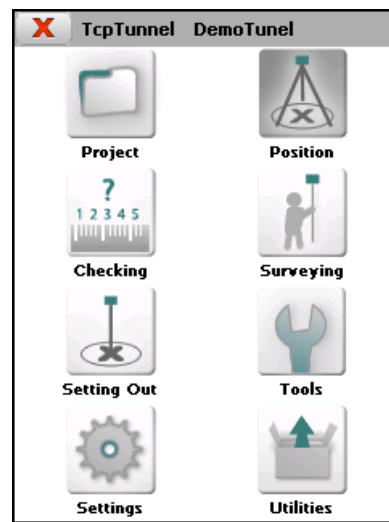
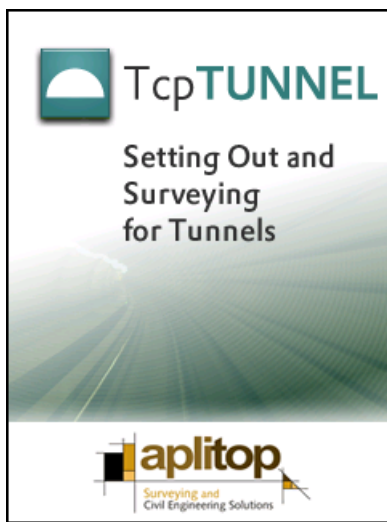
TcpTunnel

Setting Out and Surveying for Tunnels

Introduction

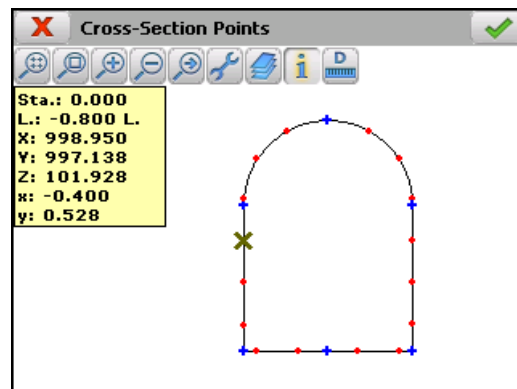
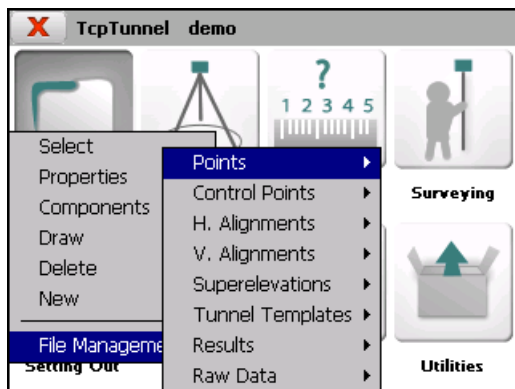
This application, installed in a mobile device, provides users with the most common options for setting out tunnels and gathering data from them with either motorized or conventional total stations.

The program has complete control over the total station, including the compensator, the laser pointer, measurements with or without prism and battery status, which are constantly monitored.



Project Definition

Each project is defined through the tunnel's vertical and horizontal alignments, superelevations and cross-sections tunnel templates. The program supports spiral horizontal alignments or horizontal alignments with crossed sections which have different heights.



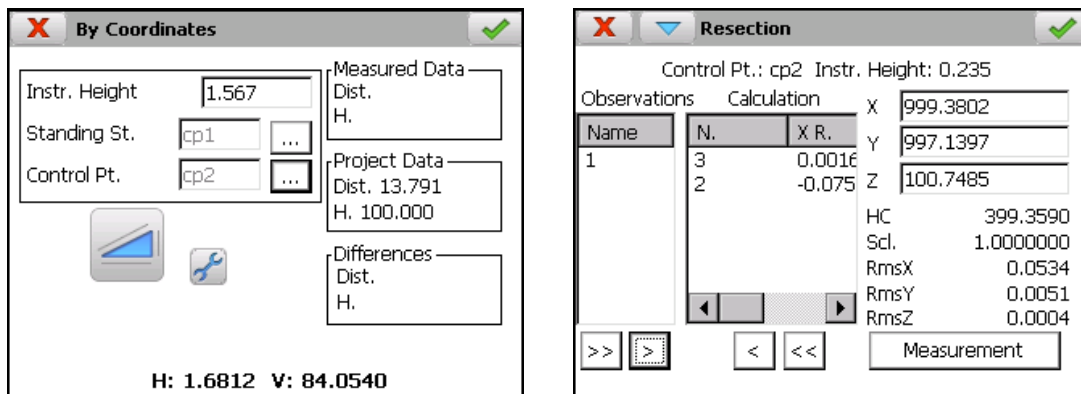
Tunnel templates can be simple or complex, and they can define by parameters, coordinates or points measured with total station. The tunnel template can be defined graphically by designating a polyline in **TcpTunnel CAD**.

Independently of the kind selected, the vertical distance from the keystone to the vertical alignment, the horizontal distance from the horizontal alignment to the center of the tunnel template and the horizontal distance from the vertical alignment to the horizontal alignment

will have to be entered. The thickness of the roadbed may optionally be entered.

Positioning and Orientation

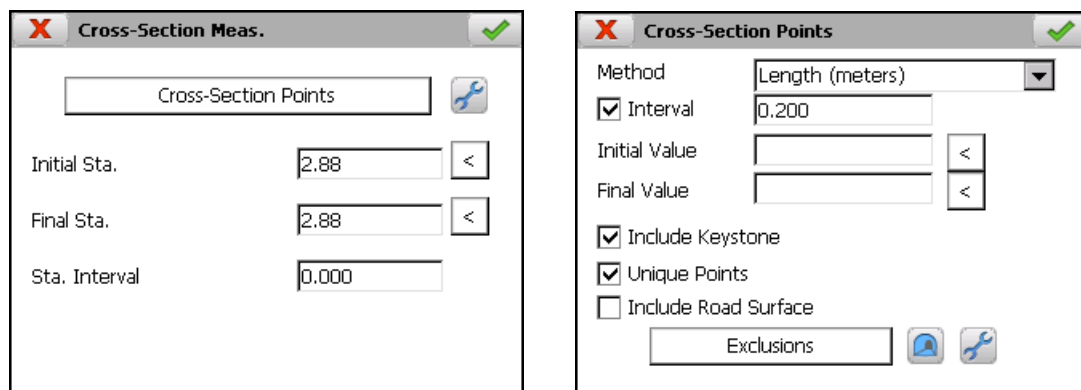
As a prior step to surveying and setting out, the station should be oriented by one of the methods available: angular, coordinate or resection. This one is calculated by the least square method with reports generation. In this case, the user can select between local and UTM projected coordinates. Also, the program saves the data of the last positioning.



Surveying

Surveying measurements in the tunnel are stored as point files in the mobile device's memory. They can subsequently be sent to a PC and processed by any program as a conventional points file.

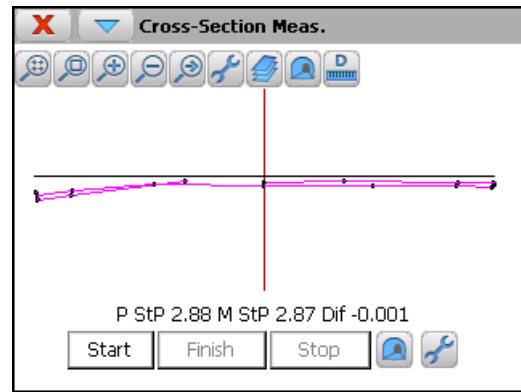
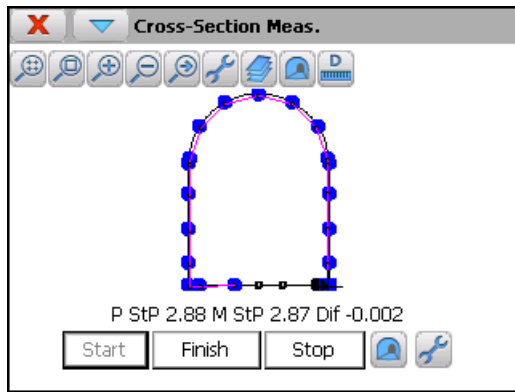
The **automatic cross-section measurement** is made on each theoretical station along the horizontal alignment, with the interval entered by the user.



When defining a theoretical point of the tunnel cross-section, one of the following methods should be selected:

- Level, defined as the elevation difference with regard to the keystone.
- Angle, taking the keystone as 0, the cross section right-hand side as between 0 and 200 and its left-hand side as between 0 and -200.
- Length of the arc starting from the keystone.

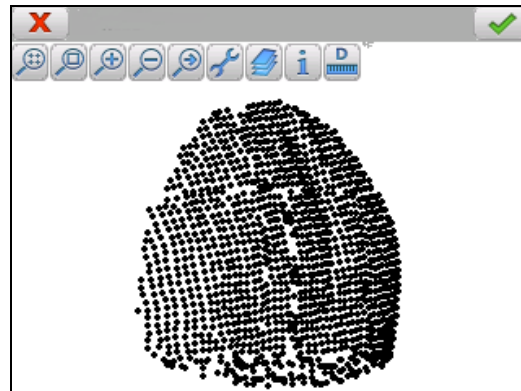
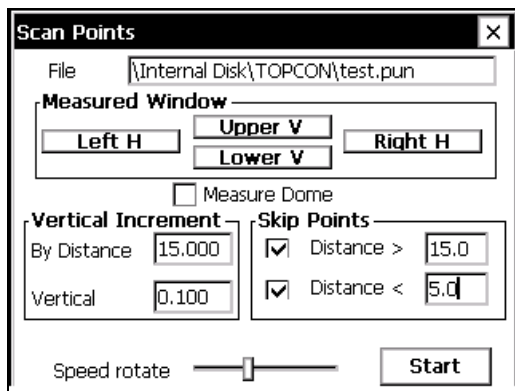
Also, the keystone, singular points and roadbed can be measured and it allows to define zones to ignore ventilation pipes and other areas that are not of interest for measurement.



The station measured and the difference compared to the tunnel template are shown for each point read.

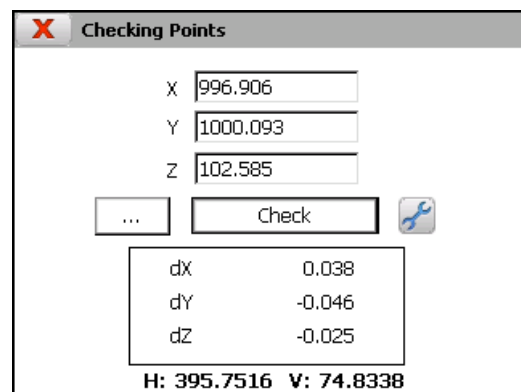
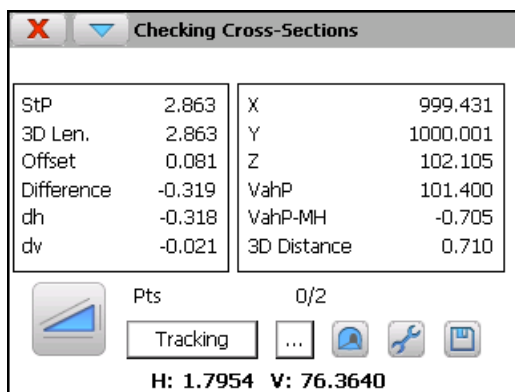
The option for **measuring point** allows measuring and saving coordinates of individual points which can be compared later.

Another important feature of TcpTunnel is the possibility of **scanning points** of a tunnel segment (only for total stations with ultrafast measure mode). Defining a scanning window, the program can measure thousands of points automatically, which are used later in the calculation and drawing of cross-sections.



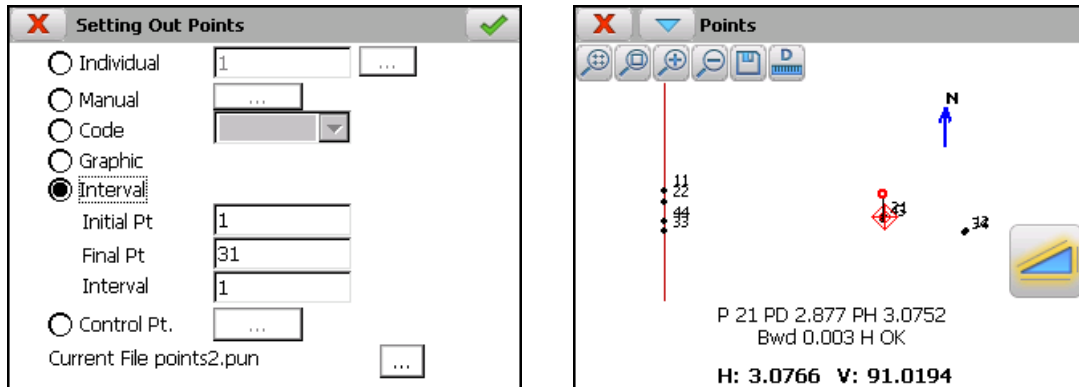
The program allows to measure and save points of the tunnel cross-section. Then, the program can **check control points**, orienting the total station automatically, getting the analysis with respect to the reference system and reporting the deviation from the theoretical point.

You can also check specific points in a cross-section on a specific station. If the total station supports the tracking mode, the program allows continuous analysis of the points measured.

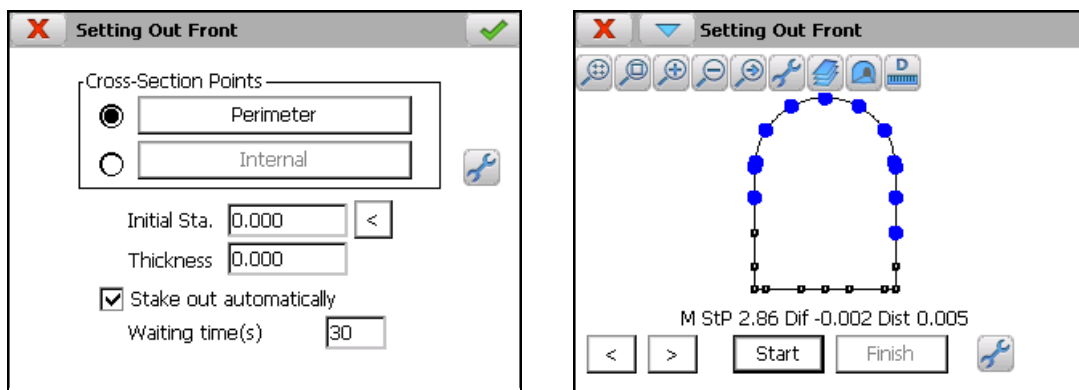


Setting Out

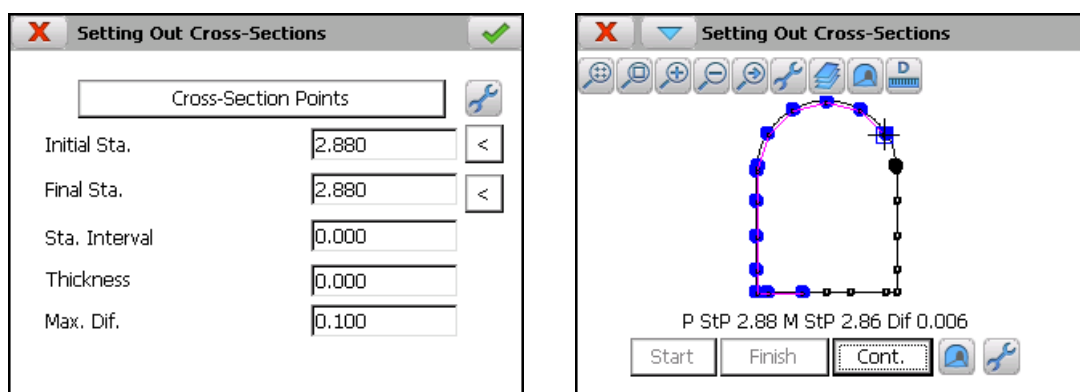
Setting Out Points. The program allows to set out one or more points of the project file, by selecting the number, the coordinates or from the drawing.



Setting Out the Front. The total station reads a point situated at the tunnel's excavation front, indicating the side and level desired. It analyzes the coordinates to subtract the station and searches the level's projection at the front through an iterative process until the 3D distance between the theoretical and measured points is less than the tolerance defined and provides information on the result obtained.

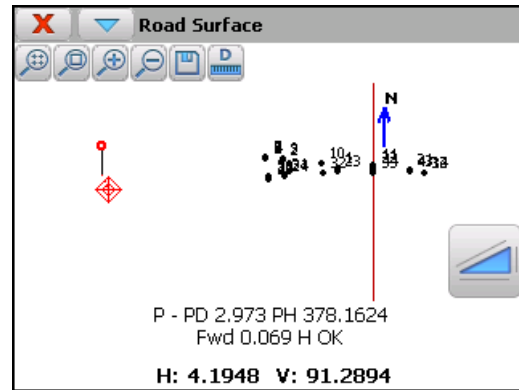
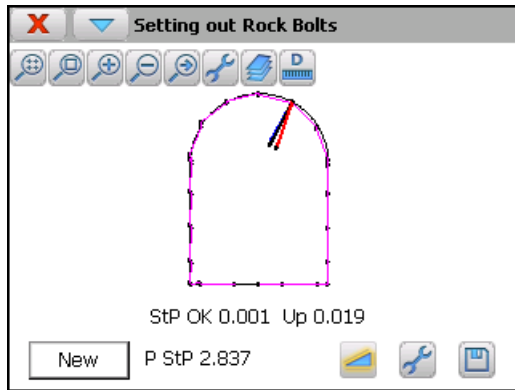


Setting Out Cross-Sections. Setting an interval and a tolerance of stations allows one to set out points of the tunnel's cross-section in each profile depending on the kind of increment indicated.



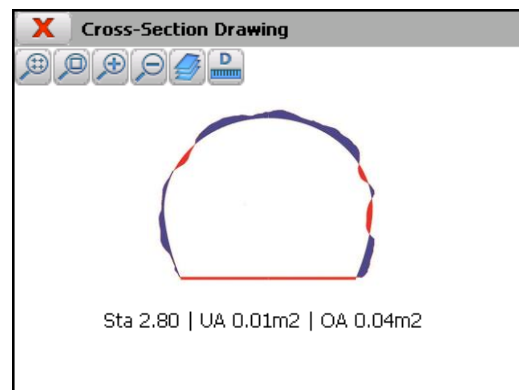
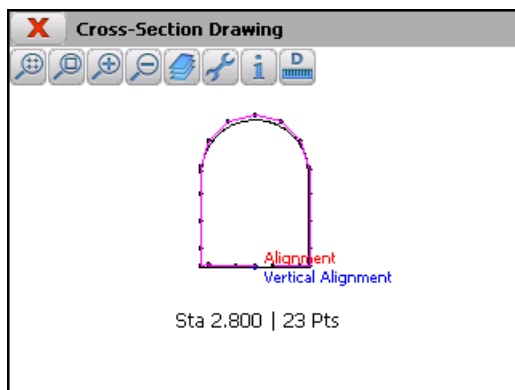
Setting Out Rock Bolts. This feature makes easy the positioning of bolts for supporting rock or concrete, giving instructions to operator for the right placement on the desired station besides being perpendicular to template

Setting Out Road Surface. The program requests the station, the offset from the horizontal alignment and the thickness for vertical alignment. It then situates the exact station through an iterative process and provides information on the elevation difference compared to the theoretical point.



Areas Calculation

The application allows user compare graphically theoretical and measured cross-sections along the horizontal alignment. To do this you must specify the point files recorded on surveying and set the values of initial and final station, station interval and station tolerance.



On screen are shown, in different colors, the under-excavation and over-excavation surfaces along with their numerical values calculated for each cross-section. Also, with motorized total stations, the program allows to rotate the instrument automatically to every point of the cross-section.

Utilities

Among others, the application is equipped with the following additional tools:

Points on Alignment. By entering a station and an offset, the program shows the X,Y, and Z coordinates, the radius and azimuth at that point and the height and slope of the vertical alignment.

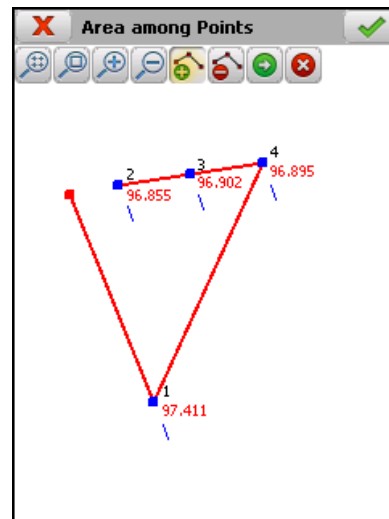
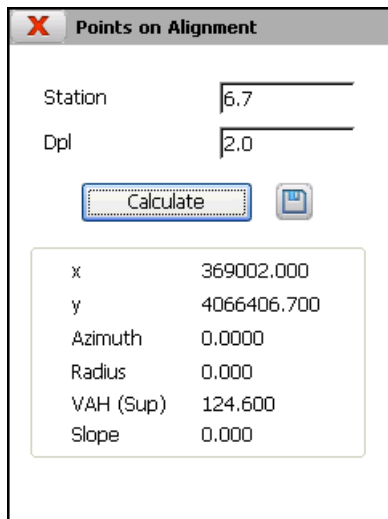
Points Analysis. By entering some coordinates, the program provides information about the station and the offset corresponding to this point. A point can also be read with the total station to obtain the same result.

Distance between Points. By entering 2 points, the program shows the distance, the azimuth and the elevation difference existing between the points.

Area among Points. Starting off from a sequence of points, the surface and perimeter they

delimit is shown, as is a diagram of the latter.

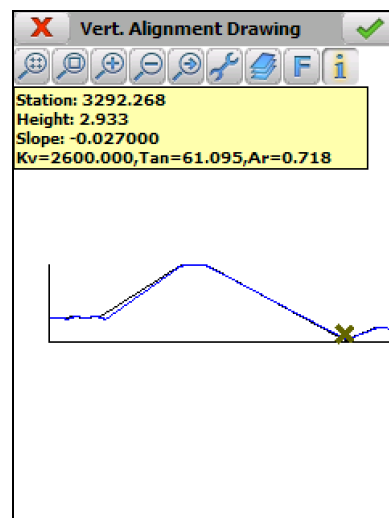
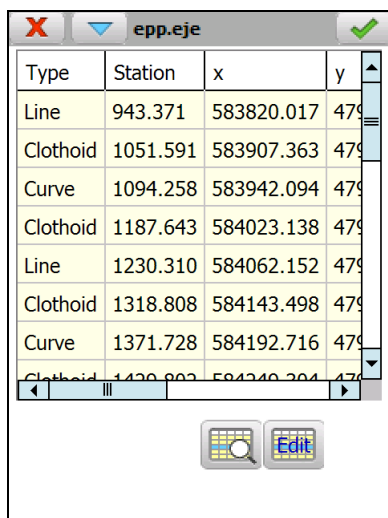
Settings. This menu allows user to set the units of measurement for angles, the communication parameters and the working mode of the total station, the tolerances for setting out, etc.



File Management

The application works with **TCP-Digital Terrain Model** compatible ASCII files although it also includes a PC program that facilitates the conversion of files into the most common files available in the market. All the data transferred between the PC and the mobile device is transmitted in a very simple way using Microsoft ActiveSync/Windows Mobile Device Center.

Each project may contain station files, points, horizontal and vertical alignments, superelevations and cross-sections tunnel templates, thereby allowing users to edit and add new information, in addition to drawing it on screen.



System Requirements

Supported Devices

Mobile devices with ARM processor and Microsoft Windows CE 4+, Windows Mobile 4.2+, Windows Embedded Handheld 6.5 or Windows Embedded Compact 7 operating systems.

Supported Total Stations

Brand	Model
Geodimeter	400, 412, 600, Constructor
Geomax	Zoom80 ¹
Leica	T1000, TC303, TC700, TC800, TC1000, TC1100, TM30 ¹ , TPS1200 ¹ , TS11 ¹ , TS15 ¹ , TS30 ¹ , MS50 ¹
Nikon	DTM
Pentax	PTSII, R300, R400, V300
Sokkia	1130R, 3000, 3100, 3110, 3130R, 3230RM, Set3B2, SRX, FX, DX, SX
Spectra	Focus10
Topcon	200, 600, 750, 800, 3000, 7500, 8000, 9000, DS, IS, MS, OS, PS, QS, GT
Trimble	3300, 5000

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