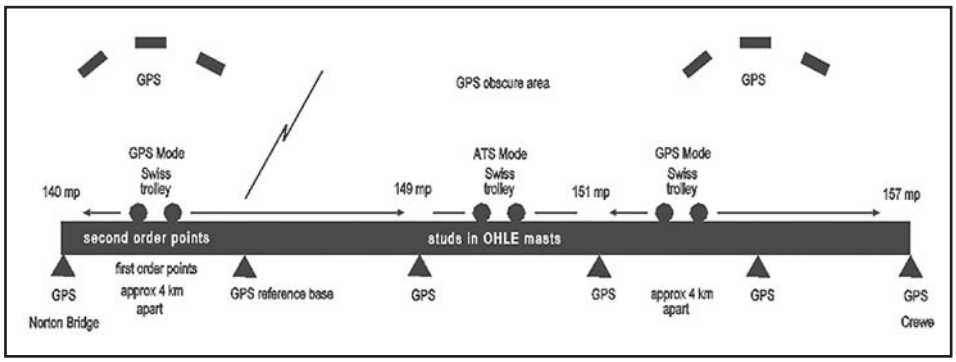
A ‘Simple’ Approach for Track Renewals and Maintenance from a Surveying Point of View?

Gerard Peels (Overseas member, unattached) and Stephanie Dale describe the use of the Swiss Trolley, a multisensor measurement system, on the West Coast Main Line blockade. The authors are employed by terra international surveys ltd of Zurich.

On the West Coast Main Line Section 12 blockade only the Automated Tracking System (ATS) mode of the Swiss Trolley for surveying track could be used. The survey task was executed in conjunction with an already installed fixed point network.

terra international surveys of Zurich, Switzerland, working on the major closure of RS2 between Norton Bridge and Crewe, propagated and implemented another in-house solution which is described here.

The Swiss Trolley in ATS mode on the West Coast Main Line.



As a major Swiss survey company operating in a very demanding international market, *terra international surveys* often have to set up first order networks and coordinate systems on major civil projects, including airports, tunnels, bridges, hydrographical surveys and railways.

Based upon these primary networks, second order networks are implemented. The same first order network (GPS points) are simultaneously used as reference base points while measuring the track using the Swiss Trolley in GPS mode. The sketch *(right)* illustrates the principle applied.

The paramount condition for surveying track in absolutes is the availability of co-ordinate systems that are constraint free and homogeneous. The definitions of the co-ordinate system and the used projection system should be documented extensively, and every surveyor involved in using GPS should know and apply these parameters. The constraint free network and the good quality of the network of fixed points of secondary order then prevents the phenomena of “stepping” or discontinuities.

Meanwhile, in-house software developments have reduced this negative effect considerably. The correcting influence of a local and proper geoid is essential for GPS measurement, but this will not be discussed here. The heights were periodically taken from existing benchmarks along the track to determine the geoid.

On WCRM’s Route Section 2 from Norton Bridge to Crewe, a problem was encountered in accepting the given co-ordinate grid because no uniform transformation parameter set was available.

For a number of technical and economic reasons a new co-ordinate system had to be designed, meeting the required degrees of quality, accuracy and repeatability. The size of a typical stretch of track which could be easily measured kinematically (twice, up and down) in one shift, using GPS, free access permitting (well-organised possession management with limited additional interrupting construction activities) and encountering no GPS obscure areas, was approximately 7 kilometres. After that, the reference base had to be repositioned to another first order GPS point to permit further measuring.

The initial step consisted of the installation of the first order GPS network. This network is connected into the national OS grid for geographical reference only. Typically, the GPS points are installed on structures relatively close to the track at approximately 2 to 4 km intervals. Amongst others, the sequence, method, time and interval of measuring these points are crucial for obtaining quality. The equipment used was *Trimble Rovers* and *Base Stations (5700, 5800 series).*

The second step consisted of the installation of a second order or tacheometrical network. To cover all aspects of construction and subsequent maintenance, studs were installed in every second stanchion along that particular route on both sides. This network contained over 500 such studs, the use of which allowed for swift and accurate measuring, and is in fact a standard in a number of countries. Leica GPH1 prisms mounted onto the studs were measured using the Leica TCRA 1102+ to the limits of acceptance and quality required.

Each stud would have been measured from at least two set-ups. Each first order GPS fixed point was tied into the network by at least two measurements. Free stationing was used in case of obscured lines of sight.

The computation was a combination of the first and second order network. This was achieved by employing a special rigid network adjustment. The calculated three-dimensional results were amalgamated into the first order GPS network and typically showed:

◆ horizontally an accuracy of better than 3mm for 85% of all measured points, the remaining 15% being between 3 and 7mm

◆ vertically all points better than 3mm, 90% of all points being between 1 and 2mm.

Strictly speaking, the studs were not required other than in those areas with a GPS obscure area, such as between mileposts 149 and 151 due to cuttings, and trees on top of these

The Swiss Trolley in GPS mode .

cuttings. However, the anticipated use by Network Rail of Plasser &Theurer's EM-SAT for maintenance purposes demanded a fixed point and co-ordinated network along the track.

The third step comprised intensive work on-site and in the office. Track measurements were performed over a number of weeks during possessions. Terra used both the kinematic modes for their GPS and ATS measurements. The Swiss Trolley feature "stop-n-go" was never used because the amount of required data for tamping operations was vast and it was not economical to obtain in this way. Normally *ad hoc* remaining lifts and slues can be marked up using the "stop-n-go" feature, and this method would be useful if the time for calculations were dramatically reduced, e.g. in a weekend possession.

The captured data was sent to the main office after each measurement for post-processing and returned the following morning. During these post-processing calculations, measured values were compared to the nominal values stemming from the designed alignments. Data was filtered and the intervals from approximately every 0.2m to 1.2m, depending on the walking speed during the measurement (kinematic registration at 6Hz interval), created. The residuals or corrections form the lifts and slues for the tamper operations and were handed back to the Through Alignment Team as WinALC.ver files.

In this way, over 135 km track was measured during the several stages of the track renewal.

This interfacing feature had shown its value right from the beginning.

In a fourth and concluding step, final track measurements were used to determine the as-built documentation. Horizontal and vertical geometry calculations were executed using the regression analysis functionality within the InRail software of Bentley Systems. The cant alignment was copied from the nominal values of the design, as we did not want to divert from the design office values. Known wave patterns were eliminated, as the track in its final position was clearly smooth-tamped (four-point re-aligned). Also, the longitudinal profile could be improved accordingly, which should, once implemented, improve the dynamics of passing trains.

The geometrical results were translated into WINALC geometry files (.geo). Having this information available now meant that the marking up of the track could be carried out. Passing clearances in terms of centreline-to-centreline distances could also be evaluated. Finally a list of tie-in data, calculations of the chainage of individual studs, with horizontal and vertical offsets to the centre line of the particular up or down line, was made for tamper synchronisation purposes.

When placing the tamper perpendicular to the OHLE mast with a stud, checking the listing for that particular stud indicates a chainage that allows the tamper operator to synchronise corrective lifts and slues with the designed geometry on his WinALC interface.

Conclusion

Using the Swiss Trolley, terra has met the required standards of quality and tolerances. Further research and development is enabling new features to be added to this Swiss Trolley base configuration for track measurements, such as multi-point ground penetrating radar and laser scanning.

Other plans contain the migration from trolleys directly onto the tamping plant. An overall accurate and complete three-dimensional capture of the track corridor is just around the corner.

Simple, right?

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