

Automated 3D control for ballasting works



Task

Positioning of track on the Channel Tunnel Rail Link (CTRL) using automated 3D control

Customer

Alstom, Carillion, and Travaux de Sud Ouest (TSO) of France (known collectively as ACT)

at indicating super elevation changes, would involve a phase of setting out, installation and maintenance that would compromise time allowed in the possessions. Leaving setting out until such a point in the works could degrade precision on site and put the integrity of the design at risk through using unchecked 'front end' calculations.

3D automated control using total station guidance appears ideally suited to this work:

- Site control can be installed without interference to the running of the existing railway. All that is required are the 'off-line' control points.
- The complex formation cross-falls can be pre-computed and uploaded as a secure model in the guidance computer by the 'owner' of the information. This removes the risks associated with communicating working information from the owner (the surveyors) to the front end users (the multi tasking site engineer).
- The system can be set up and checked in minutes, freeing the engineer to run the schedule of works and anticipate events for the remainder of the possession.
- Independent formation checks are afforded using a simple DTM stake out/comparison program that replicates the model uploaded to the guidance computer. This traps the remaining potential error in defining dozer blade offset from prism/receiver mast.
- A 'video game' style console showing the dozer in animated form against the wire frame of the Digital Terrain Model communicates lateral controls to the driver. These can be configured to automatically shut down the dozer if it wanders off the area of work. This has major safety benefits when working on a partial blockade (near running lines) or near to valuable infrastructure that could be damaged by stray plant.
- The driver can concentrate on manoeuvring the

Date

Nov 2003 - March 2004

Project Facts

Instruments:

- * Leica TCRA1101+
- * 360° prism
- * Javelin dual grade laser
- * GPS 500 series receivers

Field:

- * 3D automated control using total station guidance

Office:

- * Leica's software package (Site Manager)
- * combinations of MX, InRail and ASCII outputs for design data

The Challenges Faced

Positioning track on the CTRL Section two creates two distinct challenges for the survey team on Contract 576, a £120M joint venture between Alstom, Carillion, and Travaux de Sud Ouest (TSO) of France (known collectively as ACT).

The first challenge is to achieve onerous precisions on the high-speed sections in the 'main trace' enabling track to be positioned to +/-2mm along the entire 40KM length.

The second challenge is to complete the links to the existing national rail network. These connections, at Dagenham, Essex and Northfleet in Kent are for relatively high-speed 'turn-outs' and connecting lines (98KPH) to provide, amongst other things, rapid freight connections between the busy Tilbury and Rochester lines to the Channel Tunnel and a high speed passenger connection from the Rochester line to London.

These connections are constructed during short line blockades when the CTRL project takes line possession on pre-determined dates to carry out the works. To avoid any chance of these activities crossing the critical path of the works it is clear that surveying and positioning methodology should be optimised.

Methodology

Discussing methodologies with Senior Engineer Chris Ottley and Works Package Manager Ben Bolt, both Carillion Rail specialists in this kind of work, revealed joint reservations about using industry standard grade lasers with such complex formations. Profile boards, although more straightforward

James Douglas, Chief Surveyor, ACT



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Chief Surveyor, ACT

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Case Studies: Machine Automation

Benefits

- * Site control can be installed without interference to the running of the existing railway.
- * The complex formation cross-falls can be pre-computed and uploaded
- * The system can be set up and checked in minutes
- * Independent formation checks are afforded using a simple DTM stake out/comparison program that replicates the model uploaded to the guidance computer.
- * A 'video game' style console shows the dozer in animated form
- * The driver can concentrate on manoeuvring the dozer without assistance from a banks man or engineer.

dozer down a narrow corridor and cutting or filling to the required dip without assistance from a banks man or engineer.

Procurement

Given the author's choice to use a Leica system of hardware and software for establishing the high precision control system for the positioning of the main trace track work, synergies were sought in establishing guidance for a 3D automated dozer control system for the Network Rail Interface. The Leica TCRA1101+ had already been selected for both challenges and during the procurement process total stations were assigned all the configurations and software permutations required to handle both the aforementioned phases of C576. A Javelin dual grade laser was included as part of the dozer guidance package and interchange of the total station and 360° prism with GPS 500 series receivers was also presented as a straightforward process if and when required. As vertical precisions were desirable to near sub centimetre level for ballasting works and the working area was relatively small (about one kilometre of five metre corridors for the initial phase at Northfleet) the total station solution was considered ideal.

Data Management

Leica's software package for converting design information to the required Grade Star format (Site Manager) is very flexible and combinations of MX, InRail and ASCII outputs for design data can be used.

In the most complex case at Northfleet, a formation for the two levelled turn-out with rail pads additionally shimmed up on the bearers, as per a Corus Cogifer design, had to be developed for set out. The rake of the bearers on the 'soffit' of the turn-out can be calculated by combining the rail's level and cant with the given shim values on the drawing. For the last few long bearers (where the two tracks are still joined to the same bearer) the rake of the bearer was counter to the super elevation of the chord track. Once the rakes of the bearers were calculated an envelope was 'swept' through the mainline alignment using commercially available alignment software and corrective offsets to the underside of the bearer (top of ballast) were applied. The 'chainage/offsets to co-ordinates' function of the alignment software was then utilised. The output ASCII file was directly transferred to Site Manager for creation of a 'wire frame' and DTM of the shoulders and toes of the ballast.

On site a relatively dense network of control (allow-

ing straightforward free-stations during the block-ade) tied to the Rail Link Engineering grid was established. The prescribed slews and lifts for tie-in to the existing mainlines were verified for fit (or refined in the design) during short 'no train' periods (1am-4am) surveys in the weeks preceding the possessions.

In Action

During each 50-hour possession the existing mainline rails were cut, the formation dug out and re-ballasted and then a turn-out unit and short chord section installed. Positioning quality was required to satisfy a temporary speed restriction beneath the full line speed so as to afford line opening for normal traffic hours and final tamping on a subsequent possession.

For each turn-out the engineers and the dozer guidance system performed admirably. When final checks were made to the rail in the last few hours of the possession, with the total station on-board Leica Road Plus software, the tracks were within millimetres of the required location.

The system's success has encouraged ACT to employ the system on other stages of the works such as the Kent Portal depot at Swanscombe Marshes. Although there is a relatively simple alignment and profile at the portal the challenge here has been keeping up with design changes forced by the complicated interfacing for the CTRL project. As the survey control remains the same the process for the site engineers has remained unchanged. Instrument heights are not even an issue because pillar plates have been installed on a retaining wall overlooking the site. The surveyors have updated the model on the dozer 'in the background' and without 'down-time' and final grade is being reached without rework or alteration of any conventional references such as lasers, profiles or batter rails.

Conclusion

Clearly the application of automated 3D control of machines and positioning systems can extend far beyond 'special' situations where the productivity gains in time pressurised activities (after a short period of off-line preparation) far outweigh start-up costs. With the use of the system on an additional phase of works (Kent Portal) and the deduction of the total station costs, the system has virtually paid for itself in saved site engineer hours already. The 'intangible' benefit of 'seamless' transfer from 'design to machine' needs to be considered in every evaluation: The elimination of costly mistakes caused by interpretation or intermediate calculation being a most desirable condition. Automated 3D guidance of dozers is simple to commission and rewarding to manage for the surveyor whose role as intermediary between designer and site engineer on the CTRL is an accepted fact.

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