Customer:
Balfour Beatty Rail

Project:
Bathgate - Airdrie Passenger rail link

Solution:
Trimble GCS900, Trimble SPS930 Total Station, Trimble SPS882 Smart GPS Antenna, GEDO CE TMD

Case Study

▲ The 100mm 'step' and cross section can clearly be seen.

The Missing Link

The 15 miles of new line between Bathgate and Airdire is part of a £300 million rail project to re-connect Glasgow and Edinburgh and another example of Balfour Beatty Rail's willingness to tread new ground when it comes to technology.

After 50 years of closure, Network Rail is re-opening the Bathgate – Airdrie passenger rail link and creating a 47 mile direct route between Edinburgh and the East and Glasgow and the west. This £300 million project is a major investment for Scotland's public transport network and Network Rail anticipates an express journey time between Edinburgh and Glasgow of just 64 minutes and a commuter journey time of approximately 74 minutes.

Works also include upgrading the existing lines between Bathgate and Edinburgh and between Airdrie and Drumgelloch. Once completed, the line will be double-tracked and electrified from Edinburgh to Glasgow and passengers will be able to travel continuously through to Helensburgh. The new railway will bring considerable benefits for communities along the route and offer a fast alternative travel option to using the congested M8.

In a contract awarded by Network Rail, Balfour Beatty Rail (BBR) is responsible for £60 million of the work, which includes the reinstatement of the 'missing link' stretch of track between Bathgate and Airdrie. Tasked with taking the 15 mile site from formation to a final ballast trim, BBR knew from the outset that Machine Control would be the most productive groundworks solution for this extensive plain line project. No stranger to innovative engineering approaches in the rail industry*, BBR acknowledged that the magnitude of the site and also its predominantly open location meant that Machine Control using GPS for positioning rather than a Total Station would be a viable option.

BBR Permanent Way Project Manager Mark Wood explains the reasoning behind their decision. "At the start, there is no doubt that we had reservations about using GPS machine control on this project. Although we have seen the technology extensively and very successfully used on road projects, the rail industry generally holds that GPS machine control does not deliver the accuracies required for rail work. However we were convinced through our own experiences that we could achieve the +/- 20mm tolerances that we required for the ballasting and indeed the demonstrations we saw bore this out.

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Bathgate-Airdrie is a 15 mile long site and we wanted to be able to just set up and go and only be using tripods and instruments in areas where the GPS signal might be compromised, for example under bridges.

"In our opinion Trimble is the fore runner in GPS so it made sense to initially hire in two D37 Komatsu dozers from Paul John Plant, each equipped with Trimble's GCS900 machine control system supplied by Trimble's UK distributor, **KOREC**, who would also look after the training and support for all the Trimble technology on

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▲ Complex design data - two yellow lines show the vertical difference on the in cab screen

the project. Balfour Beatty Plant & Fleet Services, an internal plant and fleet provider to Balfour Beatty Group, supplied us with four Trimble SPS930 Total Stations, nine Trimble SPS882 Smart GPS Antennas which are interchangeable as base and rover, and nine TSC2 data loggers which we configured and 'personalised' for each of our foundation and permanent way engineers. The individual data loggers were the perfect solution for ensuring that all our engineers were equipped and ready to work with any instrument on the site."

"Fine tuning the format for easy data transfer was a sharp learning curve for all involved but KOREC's Technical Support were on hand to remedy any problems."

"Of course not everything always runs smoothly" Mark continues. "We always knew that we would need to be able to switch from GPS to Total Stations when using our GCS900 systems in areas where the GPS signal would be compromised and we've now reached the stage where switching from one to the other is a pretty straightforward operation – it's not quite as simple as flicking a switch but not far off! We have been fortunate in that our plant suppliers, Paul John Plant, really bought into what we were doing and fully supported our requirements. Consequently they supplied the dozers with the three masts that we stipulated – one on each end of the blade for GPS and one in the middle to pick up the Total Station signal when we need to switch over."

Organisation is key

On all rail jobs, productivity is of paramount importance, especially for blockades and Mark is keen to stress that there is no room for 'free styling' on a job of this stature where they are dealing with 3,000 tonnes of ballast a day. He also stresses that it is vital to ensure that plant suppliers are fully briefed as to what they need to supply, particularly for a special requirement such as the ability to switch between receiving GPS and Total Station signals. Design data also needs to be correctly prepared so that it can be quickly and easily loaded into the driver's control box in the cab. "Initially we did have problems getting the design data into the cab," says Mark. "Fine tuning the format for easy data transfer was a sharp learning curve for all involved but **KOREC's** Technical Support were on hand to remedy any problems that we had and we can now produce a 3D file in just 5 minutes – a far cry from the early days!"

System Basics

The Trimble GCS900 system is designed to put design surfaces, grades and alignments inside the cab. The design data from Scot Wilson is converted to 3D in Trimble Business Center software and then transferred onto a data card to go in the cab. The same design data can be loaded on to the engineer's individual TSC2 data loggers for checking.

On board the dozer, the positioning sensors are used to compute the exact position of the blade up to 20 times per second and compare it to the design elevation to cut or fill to grade. Additionally, when in GPS mode, cut/fill data is passed to the GCS900 in cab lightbars providing visual guidance for the operator. Although some operators had never used a computer before and were initially daunted, BBR reported that their drivers found it easier to use than they expected and were quickly won over.

Productivity Gains

BBR's Permanent Way Section Manager Gary Brown is fully convinced that they made the right decision. "The productivity gains are there for all to see. In the morning we set up one base station which the foundation engineers can also use, and this gives us the 3km range we require for working that day. If we were using a Total Station, we would have to do at least five set ups to cover the same distance. The ability to view both cross-section and profiles is a definite advantage, we would never have had this functionality in 2D. Undoubtedly the highlight has been the way that the GCS900 system has dealt with some fairly complex design data and watching the dozer form a vertical curve profile basically "at the flick of a button" has been particularly rewarding. Around 30% (8-10km) of the job has this complex design element and as a result we have been able to avoid a deep ballast bed by super elevation co-planing, a difference of around 100mm. We are forming curves rather than cutting them, following the profile, which in turn improves the tamping quality and cuts time. In short, as well as saving massive amounts of ballast the GCS900 has also ensured that we can cut down on the amount of tamping required – these are significant savings. From our experiences with the GCS900 over the past 6months we now appreciate the benefits the system has to offer and in most cases, from a production and management perspective, we have managed to double our output giving us a good cost saving both in time and in plant hire charges. However we are always motivated to break new ground and next time around, I think we can push it even further."

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Using the TMD for Tamping

This project has also seen BBR become the first in the country to use the Network Rail approved GEDO CE Track Measurement Device (TMD) for tamping as well as surveying. Once the new Bathgate-Airdrie track has been laid, the tamping machine runs across the railroad to 'sweeten' it up. By following the tamper with the TMD, the engineer can see the difference between the design and actual alignment on his TSC2 data logger. Back at the office, this information is then downloaded into the GEDO Tamp PC software where the design string and as-built string for the road can be viewed. A WinALC file is created and it is this data which goes into the tamper and dictates how much movement of the track is required. The TMD can then be used in the same way for any additional passes until the track is perfect.

> "If we were processing a 7km file using traditional methods, it would take 6-7 hours - the TMD can do it in 15 minutes."

The Network Rail approved TMD (again supplied by Balfour Beatty Plant & Fleet Services) comprises a multi-function highly accurate track measuring device along with field and office software allowing **KOREC** to offer a highly productive and user friendly solution. A single prism can be mounted on either side of the TMD and then tracked by one of the Trimble SPS or S-Series Robotic Total Stations allowing the geometry of one railroad to be recorded in one pass to the highest accuracy. The system is scalable, offering software for preparing alignment and tamping files as well as real-time comparisons with design geometry in the field.

Tamper time is expensive and therefore it makes sense to get from as-built to design as quickly as possible. Using the TMD for tamping cuts out the time consuming steps of the traditional method for carrying out this work, eg. a trundle wheel to mark chainages as required... measurement of the track geometry... creation of WinALC file... calculation of the differences between this and the design – all repeated until track is perfectly positioned. BBR's Permanent Way Section Manager Gary Brown supports this. "We're the first to use the TMD for tamping in the UK rather than just general surveying. It's hard to put an exact figure on how much time the TMD has saved but undoubtedly the time and cost savings have been immense, for a start, on a 20km site, we would have had to set-out and knock in 2,000 pegs for both roads and this has been avoided completely. Additionally, if we were processing a 7km file using traditional methods, it would take 6-7 hours - the TMD can do it in 15 minutes. Also, by cutting out the need to record measurements manually in a notebook and then do the calculations for the lifts and slews, we're also cutting the possibility of human error. All this adds up to a considerable saving in time and reduction in costs."

▲ The TMD on site between Bathgate and Airdrie

The project is scheduled for completion in October 2010 and open to passenger traffic in December 2010.

* At the annual Rail Industry Innovation Awards Ceremony on 26th June 2009, Balfour Beatty Rail Services received the "Innovation Award for Small Scale Projects" based on its work using Trimble Machine Control for excavation and ballast placement on track renewal jobs in the St Denys and Wimbledon areas.

Contact us:

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