



■ At 2m per hour, the box tunnel is jacked into place.

One Hundred and One Hours

by Hugh Anderson

In a world where there is no such thing as absolute stability, movement is an ever present phenomenon. How much something moves and when, is of different importance to different people. One aspect of movement that we take for granted is the adequate, reliable and safe provision of transport infrastructure.

There are over 410,430km of roads and rail track in Great Britain (according to the Department for Transport), a figure that is constantly being extended as population demands increase. This network is linked by over 7,600 railway crossings on both public and private land. Each year 2,000 motorists and pedestrians are reported to have misused these crossings, as we are reminded in the news. Trains can reach speeds of 200km/h and cannot stop quickly enough, making crossings extremely hazardous and constantly exposed to risk.

The risks posed by railway crossings can be eliminated by replacing them with bridges or underpasses. One location where this is currently taking place is

the Owen Street Level Crossing where the B4517, Alexandra Road, crosses the West Coast Mainline near Tipton Station in the West Midlands, UK. The crossing is being replaced by 300m of road, which will pass under the railway line by means of a 55 m by 9m box tunnel. The work is being carried out by the civil engineering contractor, BAM Nuttall Ltd.

The £20 million (EUR 23 mil., US\$ 32 mil.), 18 month project to replace the Owen Street Level Crossing is the first of four major physical regeneration schemes scheduled to take place in Tipton over the next three years. A newly constructed tunnel and high quality road layout aims to improve traffic flow and boost business in the town.

It was in the 1950s that Sandwell Metropolitan Borough Council first started the process of replacing the Owen Street level crossing, which is believed to be the last of its kind on the West Coast Main Line. This is a busy line with many high speed trains, many not stopping at Tipton Station, so the barrier can be down for long periods, sometimes as long as three quarters of an hour at a time, which is not conducive to encouraging business in town.





The contract to design and construct the Owen Street Relief Road, with funding from the Department of Transport, was awarded to BAM Nuttall Ltd in August 2007.

60 Meters in 30 Hours

The two year project commenced in October 2007 and the new relief road is scheduled to be opened soon. The site investigations revealed that the ground presented a major challenge as the area used to be a canal basin, which had been filled in with poor materials, and former industrial workings meant that the site was contaminated. This was further complicated by a geological fault running across the site.

BAM Nuttall has considerable experience in the field of jacked box tunnelling, its most recently completed project being the successful jacking of a box tunnel under the live M1 motorway near Northampton at junction 15A. There is however, one major difference between the project in Tipton and their previous contracts. In the past, the box tunnel was jacked at the rate of two and a half to three metres in a shift, but at Tipton the whole process had to take place during the one possession and the 60 metre move was achieved in 30 hours, an impressive average of two metres per hour!

For most people the Easter break began at midnight on Thursday 9th April 2009, but for the engineers at BAM Nuttall Ltd it was the beginning of a one hundred and one hour possession of a one hundred metre section of the West Coast Main Line.

During the preceding months Jamie Beech, Agent for BAM Nuttall Ltd., and his engineers had constructed a box structure which was to become a road bridge under the railway line to replace the Owen Street level crossing in Tipton. For the next four days, the BAM Nuttall team used the John Ropkins system of jacked boxed tunnelling to jack the concrete structure into place.

Requirements exceeded

The possession began with taking up the existing track. A task that took up the first ten hours of their allocated time. During the sheet piling and construction of the access on either side of the tunnel location this rail track had been continually monitored using two permanently mounted Leica TCA1201+ Total Stations measuring to 300 mini-prisms fixed to the rails, gantries and other relevant structures. The data from these instruments were continually processed using Leica GeoMoS. GeoMos is capable of collecting data from virtually any sensor required for monitoring, and displaying this data in an easily understood, meaningful and user defined manner. A meteo sensor was included to monitor temperature and pressure, which was used to correct the observations so that the accuracy of the results was not affected by the weather. The reliability and repeatability of the system exceeded the requirements of the project, which was for points to be recorded to <5 mm. The repeatability of measurement was an impressive ± 2 mm. Twenty mini prisms were transferred to the ballast shoulder to monitor the coffer dams during the jacking process.

Jacked Box Tunnelling System

The jacked box tunnelling system developed by the Kent based company John Ropkins Ltd UK, an independent civil engineering consultancy specialising in box tunnelling techniques, evolved from the pipe jacking methods of the mid-1960s. It is a non-intrusive method for constructing new structures beneath existing surface infrastructure, such as the

M1 motorway in Northamptonshire and the West Coast Main Line in Tipton. Unlike traditional construction methods, which can severely disrupt traffic flows and greatly inconvenience the locality, this method enables traffic flows, whether road or rail, to be maintained throughout the construction process, minimising the cost of disruption.

Once the track had been lifted and the ballast removed the excavators could take up their positions to dig the material ahead of the box construction. The box is fitted with a cutting head so that it cuts its own path. This minimised the amount of backfill required, with its inherent necessity of compaction and the possibilities of settlement in the future, and eliminated overdig. This process also meant that a full height channel did not need to be excavated, but the excavators were required to remove the material that was excavated by the cutting head as the box edged forward.

The inert excavated spoil from the site was deposited using a temporary haul road to the nearby Tibbington Open Space, which is known locally as "The Cracker". This is a recreational area which will be landscaped to create new sports playing fields for the community. This minimised waste disposal and vehicle movements.

The box tunnel has a plated steel soffit and was constructed on top of 120 steel wire ropes that were laid on top of the jacking slab. The wire ropes were greased to provide lubrication during the sliding action. The box was moved forward using three packs of 6 rams, each capable of 200 tonnes of thrust. As the box moved forward, an additional 512 wire ropes were fed under the box. These greased wire ropes formed a "track" for the steel soffit plate to move on, reducing friction. The progress of the tunnel was monitored by another Leica TPS1200+ Total Station reading to a 360° prism on the structure to ensure

that it was moving in the required direction and that the correct height was maintained.

Using GeoMoS and other equipment from Leica Geosystems to continually monitor the state of the track and other structures as the work progressed, provided cost savings to the project, since work could proceed with the confidence that the system would alert the engineers to potential movement before it became critical.

Jamie Beech, Agent for BAM Nuttall, comments: "We were thoroughly impressed with the automated monitoring solution from Leica Geosystems. The off-the-shelf package not only provided us with the level of precision, detail and accuracy that was demanded of the project. The solution gave us 100% confidence in the project and allowed us to collect valuable information to analyse and submit to Network Rail, giving them evidence that their infrastructure remained unaffected and confidence in our continuing works."

The effectiveness of the solutions employed by BAM Nuttall on this project are well demonstrated by the fact that not only was the box jacking completed and the track restored within the one hundred and one hours, but was actually completed two and a half hours before termination of the possession. ■

About the author:
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