Putting power through the tunnel

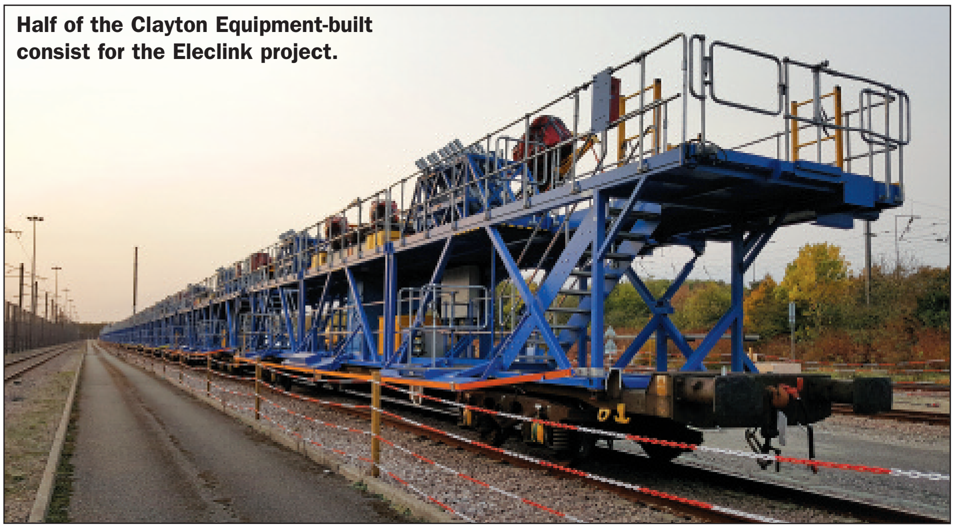
Description of the specialist Modules supplied by Clayton Equipment for use on the Eleclink project.

In 2016, Clayton Equipment was approached by the lead contractor working on the Eleclink interconnector project through the Channel Tunnel. The project brief was to design and deliver special work platforms (Modules). They mounted on standard 60' mainline wagons to facilitate the installation of the interconnector support system, high up the tunnel wall (approximately at the 10 o'clock position, 4.5 metres from the railhead and three metres from the track centre).

The total installation length was approximately 55km, with the possession times limited to 5 hours and a target distance per shift of 2km. Access would be limited to one day each weekend, working around the complex Eurotunnel train movements and other maintenance activities.

The design brief given to Clayton required defined steps for each shift:

- Travel into the tunnel at line speed of 90km/h, hauled by Eurotunnel's own diesel locomotives.
- Once stationary in the possession, over 140 personnel to safely walk onto the Modules from the central access tunnel.
- All personnel to be safely seated, allowing the consist to be hauled at low speed to the working position within the possession.
- The working platforms on the upper deck to then extend out towards the tunnel wall, allowing the work to start.
- Personnel on first half of the Modules to drill a number of 20mm diameter holes in a pre-defined pattern, then mount and secure the supporting brackets.
- Personnel on remaining working Modules to lift, mount and secure 415kg, 7.5 metre long hexagon 'Monorail' beams onto the supporting brackets.
- Once the work at the location was complete, the upper work platform to be partially retracted (still exceeding main line running gauge, but clear of all tunnel infrastructure), to allow the consist to move to the next working position in the possession.


Half of the Clayton Equipment-built consist for the Eleclink project.

- At the end of the shift, all upper platforms to be retracted so within gauge, with all moving parts and machines locked.
- Travel back at line speed.
- During the following week, the consist to be easily replenished with replacement supporting brackets, fasteners and Monorail beams.

Contract award

After the commercial negotiations, the contract award was placed in October 2016, just 24 weeks before the first section was due on-site in February 2017 to enable training of the 144 personnel to begin. The complete delivery was due in December 2017.

This extremely compressed timescale demanded 100% capacity from both the engineering and production departments, leaving no spare time for any other contracts. The time was required to build one of the world's longest construction trains at over 500 metres long and a total mass of 1,350 tonnes when all 24 wagons were coupled together.

As there was twenty-four 60' wagons to fit out, it was decided early in the concept stage that each 60' wagon would comprise of three 20' Modules bolted together to form the required 60' length. The reasoning behind this was that handling the fabrications would be too cumbersome, with each requiring special road haulage from the Clayton Equipment factory in Burton-upon-Trent to the site in Folkestone, and lifting such a long load on-site would be difficult in the busy Eurotunnel terminal.

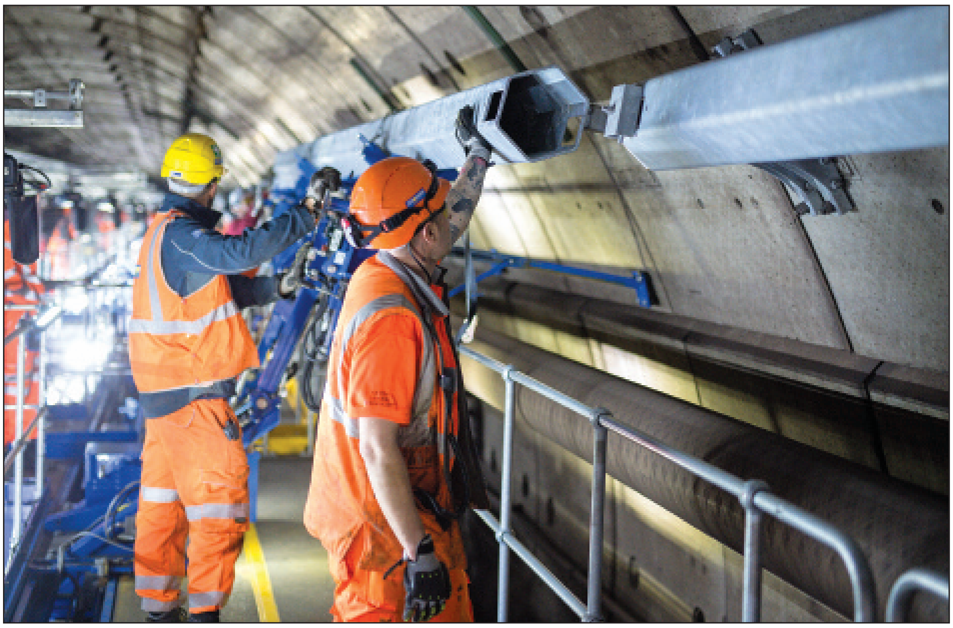
However, this meant that seventy-two 20' sections were now needed! Even so, each Module still had to be designed to be moved using normal road flatbed vehicles and located on the rail wagons using their ISO twist-lock fittings.

The Modules

On the first set of 12 Modules, three drilling machines were located, with each machine drilling four 20mm diameter x 130mm deep holes, totalling 144 drills. Eurotunnel required that no dust was to be imparted into the tunnel during the drilling. Therefore, each drill had its own vacuum unit (144 vacuums). Specially designed and 3D printed vacuum nozzles were located around each drill bit, which collected the initial debris


The other half of the consist.

Right and below: Installation of the Monorail beam in the tunnel from the Modules.



when the drill first touched the concrete segment, continually removed the dust during the drilling cycle, and also 'wiped' the drill flutes free of residual dust as the drill bit was withdrawn from the hole.

Once each pattern of four holes were drilled, one of the sixty-four, 30kg supporting brackets were lifted to align with the drilled holes, allowing the stainless steel expanding anchors to be inserted. Each was then torqued to secure. As such, a total of 768 supporting brackets were available during each shift. In total, approximately 32,000 holes would need to be drilled and 8,000 supporting brackets would need to be installed.

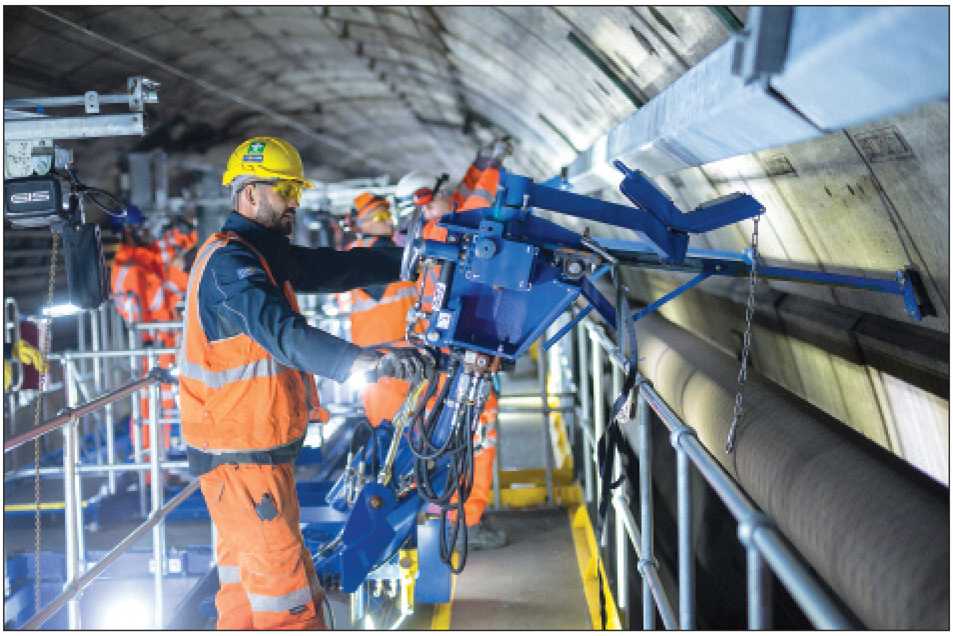
On the second set of 12 Modules, two steel fabricated 'cassettes' were located into two 'pockets' in the Module, each cassette containing 32 Monorail beams. As such, a total of 384 Monorail beams were available during each shift. Above each cassette, two swing jib cranes with electric hoists were located, 48 cranes in total. Each pair of cranes then enabled a Monorail beam to be lifted out of the cassette and into the adjacent hydraulically powered lifting machine. On each Module, each of the two lifting machines then lifted the Monorail beams over and onto the supporting brackets. These machines also had to have the ability to 'hand over' a Monorail beam from one Module to the adjacent Module for locations where the Monorail beam location was between two of the rail wagons (i.e. over the buffers).

Special features

The Clayton design also had to cater for the haulage locomotives not being able to stop the consist exactly in position; where the location and distance between each wagon could not be determined; the UK and French concrete segments that line the Tunnel walls not being the same so require different hole pitches and that holes could only be positioned in rebar-free zones. As such, all of the 36 drilling machines and 24 Monorail lifting machines had to be able to move longitudinally along the upper work platform, so they could be in the right position every time. Therefore, along the 60' length of each Module, a linear slide enabled all machines to move independently.

It was also recognised at the early design stage that the power to supply the drilling and lifting machines, lighting and system controls, would be considerable. The Tunnel's own electrical supply was not sufficient, nor could the Tunnel's electrical outlets always be in the location needed. Diesel generators with their associated exhaust emissions were not suitable, due to the large quantity needed. There would have also been a significant issue with personnel long-term noise exposure caused by 24 generators, plus 144 drills drilling concrete, along with 144 drill vacuums, 12 air compressors and 12 hydraulic pumps! As such, the design relied on Clayton's vast experience on emission-free, battery-powered solutions (their first battery locomotive was in 1940!). In total, the battery capacity available was 1.7 MWh.

Lead acid batteries were chosen as they are proven in rail applications, with high reliability and safety, require no battery management systems, can be fully recycled and the customer could maintain them without external support. As a footnote, lithium ion-based batteries were also considered, but not chosen due to long-term product support issues and difficulty in recycling. Oh, and they would cost £500,000 more! To ensure that a possession was not lost, spare batteries were located on every fifth Module, to provide back-up in the event of power supply failure. The main contractor then recharged the batteries between each weekend shift.



Consideration was also given to the welfare of the large number of personnel. Due to the consist length, a welfare unit located at one end was not feasible, as it would take a person 30 minutes to walk to the end and back! Therefore, every Module had a chemical toilet situated on the lower level.

On a unique design and build contract such as this, lessons were, of course, learned. The major issue was just the total length as it built up during commissioning. Tools located at one end were of little use if you were at the other end, 30 minutes away. Mobile phones proved to be useful!

Successful deployment

The main contractor has successfully completed the Monorail installation, which is currently in the approval process before the cables can be hauled into the tunnel. See *Rail Infrastructure* Issue No: 131 for the article on the GOS Tool & Engineering Services cable hauling machines.

Again, working in partnership with the main contractor, Clayton Equipment was also awarded a contract to design and deliver additional bespoke Modules to the site in Folkestone. These four unique Modules consist of a pair of 'clean rooms' and a pair of power generators. These are to be used to facilitate the final cable joining process within the tunnel later this year. Due to the critical nature of the cable joining process, the clean rooms surround the cable joining area and control the environment in which the cables are joined - humidity must be below 50% Rh, the temperature between 12 and 28°C, and the air filtered using four large HEPA units.

After accepting the brief, it was clear the project was unique and required a number of complex solutions. The project including the design build and delivery of the special work platforms was the result of the collaboration between the company's engineering and production departments. Clayton has always excelled in the design and manufacture of equipment beyond traditional new build locomotives manufacturing to the specific requirements of the project. This was a prime example of an optimum bespoke solution provided to a customer.