



Geotechnical Division Case Study Llys Faen Tunnel Rockfall Protection

Rockfall protection system installation above and adjacent to the railway and tunnel portal

The site is located along the Chester to Holyhead railway line (CNH3), specifically adjacent to the eastern Penmaenrhos tunnel portal.

The line is the main North Wales railway artery linking Holyhead to London. Adjacent to the tunnel is a significant 50m high natural slope with a limestone quarry behind. This has resulted in a significant slope with a large arete of limestone towering above the railway. British Geological Society (BGS) modelling of landslide risk / rockfall posed by natural slopes to infrastructure identified this site as being at high risk.

Griffiths were involved with this site from 2016, undertaking devegetation and drainage works to undertake inspection and investigation works to facilitate the design for main rockfall protection works completed in 2019. The works included the installation of 300No. rock bolts, active netting to the tunnel portal area, the installation of 5 debris fences and an area of passive netting at the very crest of the rock arete.

Possessions and line blockages on this line are particularly limited, constraining potential programme outputs. To make construction more efficient Griffiths installed a temporary road rail access point (RRAP) approximately 200m from the working area. The benefit of this approach allowed Griffiths to fully utilise the possessions required for on track plant – saving 2 hours per shift of transit time from the closest permanent access point located several miles away, resulting in circa 25% greater productivity.

Owing to the very difficult terrain, it was not possible to access plant on the high and steep rock slope. To overcome this, Griffiths devegetated a corridor along the boundary fence to install an access road to the tunnel portal. This allowed Griffiths rope access operatives to access the slope above the railway directly on foot during the daytime whilst trains were running, working in a safeguarded fenced environment.

Griffiths utilised a 50T road rail crane during possession to lift critical materials and manoeuvrable plant to strategic positions on the rockface to reduce manual handling requirements.



Pictured above: view of rockfaces adjacent and above Penmaenrhos Tunnel after devegetation

Griffiths provided support to the design process to ensure buildability was considered. Limited access for plant to the majority of the working area places practical limits on drill hole diameter for example. As a result, the design opted for more smaller diameter shorter bolts which could be installed with lightweight drilling equipment for the areas which were inaccessible to plant and a more material economic design where plant access was possible with larger diameter, longer bolts spaced further apart.

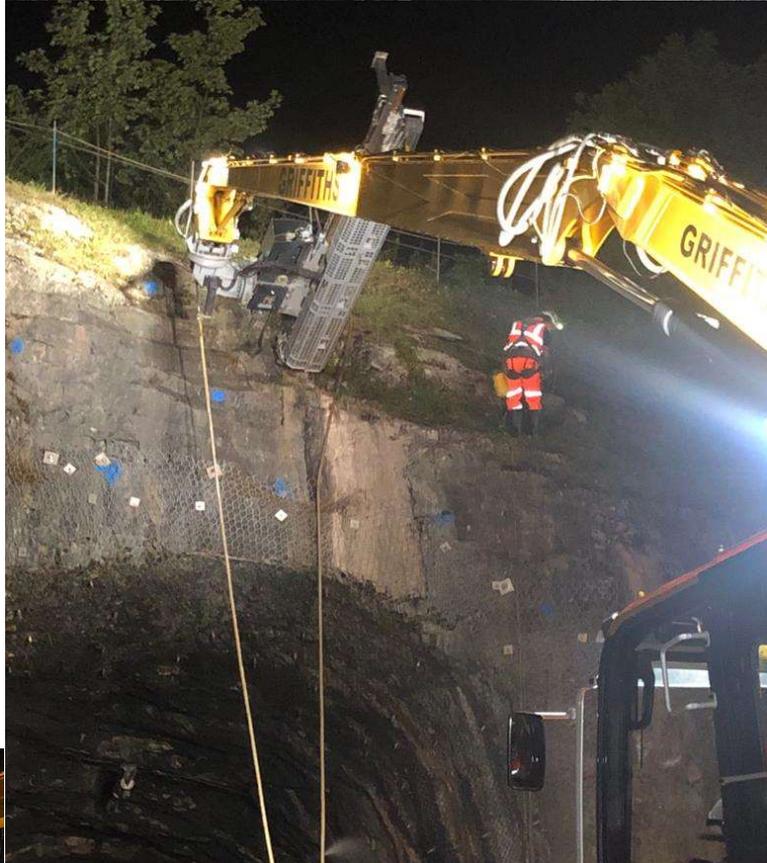
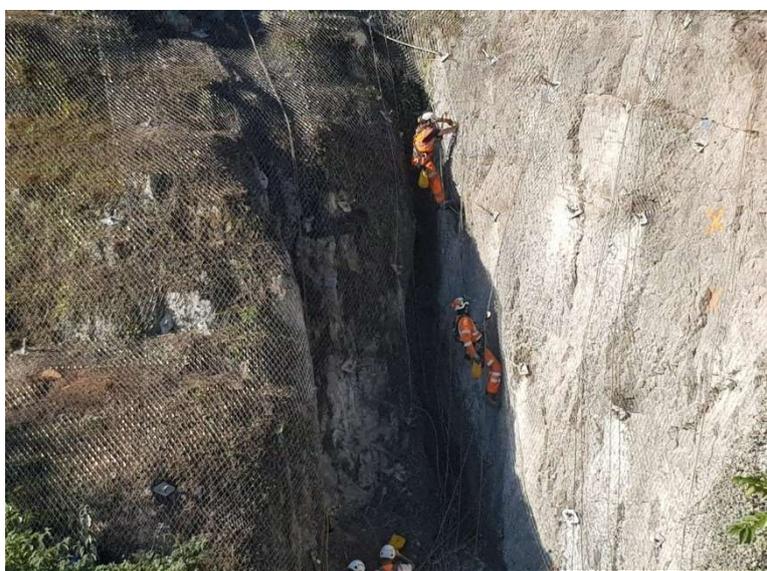
Owing to the coastal environment the debris fences and active netting were installed using marine grade stainless steel. The use of stainless-steel components to form the debris fences was a first. As there is not a design manual for the debris fences made of stainless steel, Griffiths engineers and construction managers had to establish the most effective way to link the components and ensure sufficient tension in the wire ropes was achieved. To achieve this Griffiths had to fabricate eye nuts, which were factory welded to hex nuts. Griffiths also had to install additional anchors outside of the footprint of the fences to allow the last post at each end of a fence to be tensioned independently to the rest of that fence.

The rock bolts immediately around the tunnel were installed during a possession using a hydraulic excavator mounted drill attachment mounted on an RRV. Ancillary equipment such as the compressor and water supplies were sited on the access route outside of the Network Rail boundary minimising time lost to setting up, therefore maximising outputs. The larger diameter rock bolts drilled by the RRV were secured using grout.

The rock bolts above and adjacent to the tunnel were installed using a lightweight acrobatic skid rig which can be manoeuvred by rope access haulage techniques. Griffiths also utilised portable winches secured to temporary anchors to assist in moving materials around the slopes. The rock bolts were secured using resin grout, being spun in with a Turmag.

The use of the portable winch and acrobatic skid rig greatly reduced the manual handling requirements and exposure to vibration of the workforce.

The works were staged in a sequence working bottom up, the reason for this was to provide progressive protection to the railway, with each fence constructed in turn preventing the potential for ravelled or dislodged rock reaching the tracks.



Pictured above:
Drilling rock bolts around the Penmaenrhos railway tunnel.

Pictured above:
Fig 1) Installation high tensile mesh around tunnel portal.
Fig 2) Drilling rock bolts above tunnel portal crown.
Fig 3) Stainless steel debris fence No 1. and apron above tunnel portal.

Project at a glance

Client: Network Rail
Location: Llys Faen, North Wales
Completed: September 2019
Value: £700k