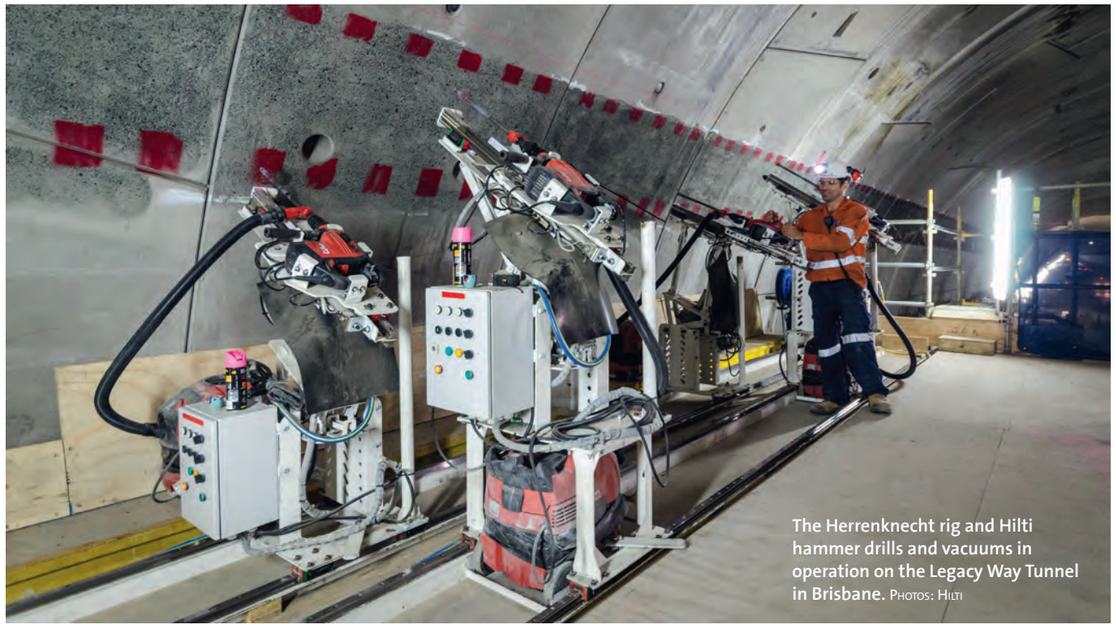


The Herrenknecht rig and Hilti hammer drills and vacuums in operation on the Legacy Way Tunnel in Brisbane. PHOTOS: HILTI

Legacy Way – efficiencies in concrete anchoring

Chemical anchoring has come a long way since polyester-based capsules arrived on the market in the late 1970s, and the technology is now used virtually on all construction projects. However, there have been incidents associated with chemical anchor failures and typically these have been attributed to inappropriate product selection or poor installation quality – specifically borehole cleaning.

According to Martin Cunningham, national project engineer at Hilti Australia, product selection of chemical anchors has improved significantly, a result of designers having an improved understanding of individual product performance combined with advances in international design standards.

"Installation quality, however, still relies heavily on supervision and the competence of the installer," Cunningham said.

Coupled with proactive work from manufacturers and suppliers to the market, advances in the performance of the installed product have been positively influenced by The Australian Engineered Fasteners and Anchor Council (AEFAC) – an industry association formed in 2012 seeking to enhance the specification, selection, design and installation of structural anchors and fasteners in the Australian construction industry.

Cunningham said there had also been innovation in installation, including the company's own SAFEset System, which includes a hollow drill bit.

"This drill bit removes concrete dust by a connected vacuum as the borehole is drilled resulting in no need for further cleaning before the resin adhesive is dispensed. An added benefit is a significant reduction of dust in the working environment," Cunningham said.

In mid-2011, Transcity Joint Venture (Transcity JV – Acciona Infrastructures, Ghella and BMD Constructions), responsible for the construction of Brisbane City Council's Legacy Way tunnel, investigated anchoring in critical applications on the project.

The 4.6 km segment-lined road tunnel incorporates a smoke duct above the tunnel roadway for smoke extraction in the event of a fire. This is formed by precast panels primarily supported by a continuous corbel. The construction of the smoke duct and corbel was the largest single anchoring application in the tunnels' fit-out and the first step in its construction was the installation of anchors. These consisted of 103,200 N20 reinforcing bars bonded 270 mm into the segment lining with Hilti HIT-HY 200-R adhesive resin. Reinforcement was tied to these anchors and subsequently the corbel was cast.

In the absence of an Australian Standard for anchors, Transcity JV designers (GHD, Cardno and URS) nominated ETAG 001 'Guideline for European Technical Approval of Metal Anchors for Use in Concrete' and EOTA TR20 'Evaluation of Anchorages in Concrete concerning Resistance to Fire' as the standard for anchoring on the project. In addition to product testing completed in attaining an ETA (European Technical Approval), application-specific sustained load 'creep' testing was required and was carried out by Swinburne University in Victoria from March 2013. Cunningham said the analysis following this 92-day test corroborated the ETA data for the Hilti HIT-HY 200-R resin and confirmed that the extrapolated displacement fulfilled the performance requirements for the application.

"In addition to ensuring the ability of the anchors to withstand long term loading, designers needed to

assess deflection as this influenced long term durability," principal engineer GHD Materials Technology Group, Paul Sandeford said.

"Any opening between the segmental lining and the corbel might allow leaking groundwater to penetrate to the anchors, however satisfactory deflection was confirmed by the application specific load testing."

Drill speed appraisals in January 2013 confirmed that there were significant and tangible productivity benefits to be gained from utilising the SAFEset system.

"Borehole drilling at 77 seconds per hole was experienced, compared to traditional drilling which was 10-20% slower. This represented a time saving of up to 90 seconds per hole when adding the time for the traditional cleaning regime," Hilti Australia's Cunningham said.

The traditional regime uses a traditional helix drill bit which requires the use of wire brushes and compressed air – "a time consuming process with the quality dependent on labour practices", according to Cunningham.

Following this evaluation, Ignacio Sanz, then of Transcity JV (now construction manager, Salini Impregilo) noted that "one of the most important factors that was tested in January 2013 was the drilling time and the elimination of cleaning means another 60 seconds less per hole".

Transcity JV elected to undertake anchor drilling from self-propelled gantries. On each drilling gantry eight Herrenknecht-designed and built pneumatic drilling rigs held the Hilti TE 70 hammer drills and vacuums.

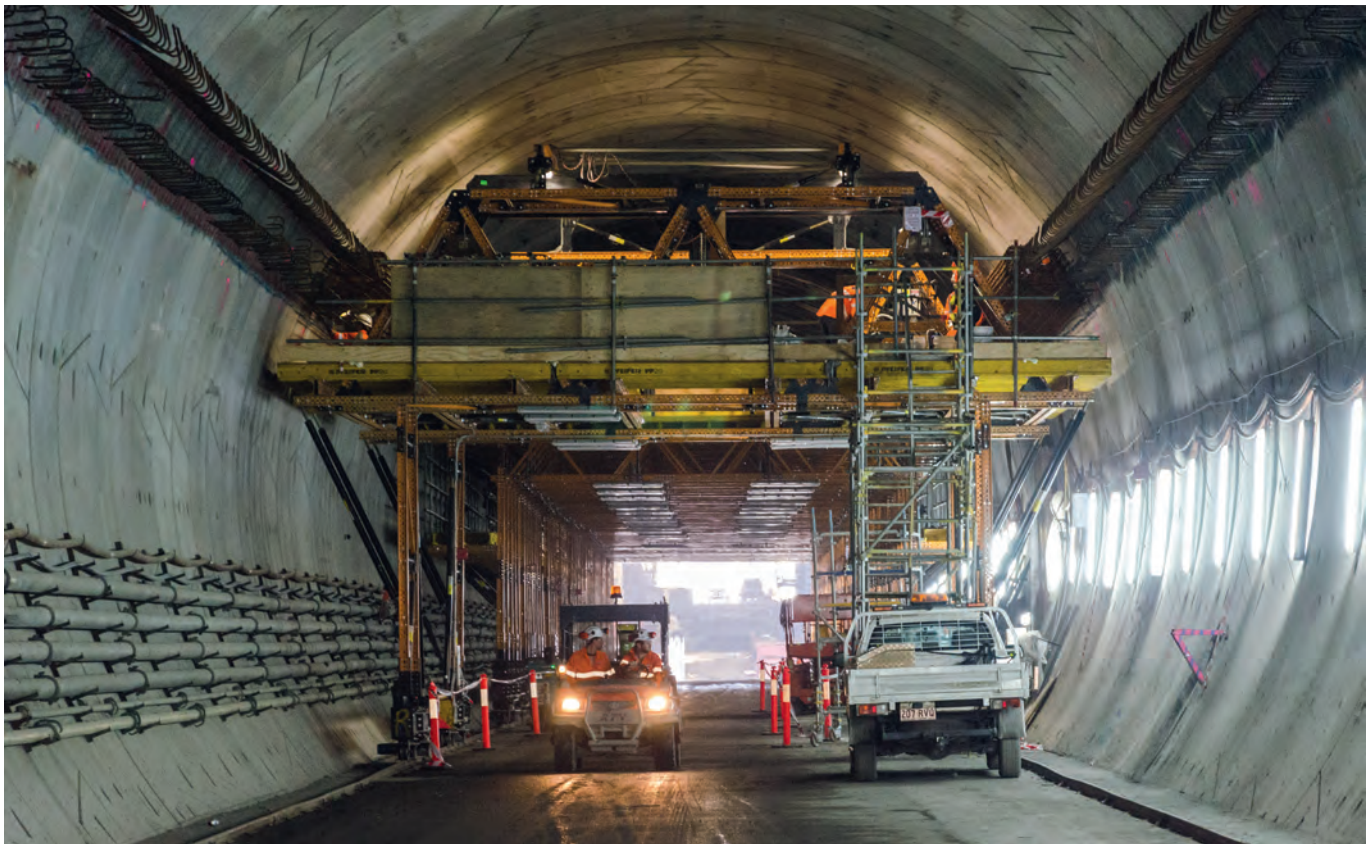
The programmable logic control (PLC) on these linear rail-mounted rigs provided the operator with an efficient semi-automated drilling process. Throughout the operation, approximately 33 t of concrete dust was safely collected by the vacuum cleaners, and the resulting dust-free environment reduced the amount of drilling rig maintenance required, another time and cost saving.

"The dustless system was crucial in the successful design of our automated mechanical drilling rigs. These rigs require many moving parts and precision elements which are vulnerable to damage from concrete dust," Herrenknecht mechanical project engineer, Simon Strong said.

Each drilling gantry was typically manned by four operators, with each operator running two drilling rigs simultaneously. Due to the automatic cleaning of the bore hole, minimal additional quality control measures were required to ensure correct borehole preparation and ultimately the performance of the anchor.

According to Cunningham, the success of this critical application is an example of good design practice and successful integration of new technologies.

"The resin anchor performance criteria set by the designers in their strong and carefully considered specification ensured that only anchor systems with existing international approvals and established known performance in areas such as displacement under sustained tensile load were assessed for potential use." ■



The self-propelled gantry built to support the drilling rig and workers on the Legacy Way Tunnel. PHOTO: HILTI