



Robust and compact I/O components for tunnel construction

Tunneling through mountains using Beckhoff technology

- Ambitious transportation infrastructure projects such as the 24.5 km (15 mile) long “Túnel de Pajares” built for the AVE high-speed train in northern Spain, can be constructed today in a relatively short time due to impressive advances in boring technology. The company responsible for the construction, Acciona S. A. with its headquarters in Alcobendas near Madrid, decided to utilize the Beckhoff I/O system when equipping their tunnel boring machine, because its robust design can address extremely high environmental demands for resistance against dust, humidity and strong vibration and in addition can be installed in a very compact space.



Modern tunnel boring machines are large-scale machines with diameters of 10 meters and above.

Construction of the 24.5 km (15 mile) long "Túnel de Pajares" for the Spanish AVE high-speed train was completed within only two years using the most advanced tunnel boring technology.

Francisco Gorines, maintenance manager at Acciona, explains the decision to use the Beckhoff I/O components: "One of the reasons that we decided to go for the Beckhoff technology was the small dimensions of the system and the large supply of I/Os."



Due to the very limited space available, an I/O system was needed that can be installed in a very compact space.



The tunnel boring machine is only halted for maintenance purposes. It operates round the clock.

One of the decisive reasons that Acciona decided in favor of Beckhoff I/O technology was resistance to the extremely harsh operating conditions such as dust, humidity and strong vibrations.



Whether underground, underwater or deep in a mountain, and whether the tunnel is for a road, rail, metro, supply or waste – advanced boring technologies help create vital connections and essential infrastructure for the economic development of industrialized countries. Tunnel boring machines (TBM) with a diameter of up to 10 meters and above can handle entire sections of tunnel and, if needed, can secure the excavation site with a provisional or final lining at the same time.

Tunnel construction with advanced technology

Working the rock or layers of earth is usually done by a revolving drill head with cutting edges, powered by hydraulic motors which in turn are supplied by electric motors, as the machine is usually powered by electricity. The supply units for the tunnel boring machine are behind the drill head: a row of platforms follow the boring head on metal rails which themselves have been laid down by the machine. On these platforms are the tanks, power supply, ventilation, material silos and the conveyor system for the excavated material. Needless to say on these kinds of large machines, there are hundreds of sensors and detectors which all securely transfer information to the control center, so that the boring machine operator can carry out the various control and monitoring tasks.

Decentralized I/Os save installation time during assembly and disassembly

The tunnel boring machines are set up, disassembled and transported to another site after the work is completed. This is the reason that the use of decentralized I/Os saves a large amount of money in the form of less installation time. It makes a difference whether hundreds of cables have to be con-

nected or disconnected, or if there is only a single communication cable. In addition, mistakes when connecting the equipment are largely avoided, which leads to impressive time savings during commissioning.

For this project, Acciona decided to replace most of the sensor wiring with decentralized bus terminal stations with PROFIBUS networking. These nodes transmit the data from the PT100 temperature sensors as well as the digital and analog I/Os to the control room.

Exceptionally robust and compact design

One of the greatest challenges for Beckhoff technology in this application is the extremely difficult operating conditions for the equipment, such as dust, humidity, strong vibrations, etc. In view of the very limited space available, the I/O system had to have exceedingly compact dimensions – an important criteria for Acciona in deciding in favor of high density KM I/O modules from Beckhoff. These terminal modules complement the Beckhoff I/O system with an extremely compact terminal design and increased packing density. The KM terminal modules combine 16, 32 or 64 digital inputs or outputs on a very compact area.

Francisco Gorines, maintenance manager at Acciona, explains this point: "One of the reasons that we decided to go for the Beckhoff technology was the small dimensions of the system and the large supply of I/Os. There are many different pieces of equipment integrated in our system, such as PT100, 4...20 mA, 0...10 V, etc. and we know that Beckhoff Bus Terminals provide for all these types of devices."

→ Acciona S.A. www.acciona.es

→ Beckhoff Spain www.beckhoff.es