ZED Tunnel Guidance Ltd

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Low-cost PC-compatible Tunnel Guidance

ZED-20 is a low-cost TBM guidance system which uses a PC-compatible intelligent laser target. The technology used is the same as previous ZED guidance systems, proven in practice on hundreds of tunnelling projects world-wide.

The ZED-20 unit consists of an intelligent laser target and a dual-axis inclinometer all in one compact enclosure. The target measures the position of the laser spot, together with its angle of incidence. The inclinometer measures machine roll and look-up. Measured parameters are transmitted every five seconds to a PC which, in the basic version, calculates machine position and orientation and displays them graphically. The connection between target and PC can be either a single-pair cable up to 1km long or, optionally, a radio link. A typical system interconnection is shown on page 3.

Ideal for pipe-jacking

This simple configuration – just one compact unit and a PC – makes the ZED-20 system ideal for applications such as pipe-jacking on straight drives. The operator can now benefit from the real-time guidance information and steer to the prediction position as previously available on large-bore TBMs.

OEM integration

The Target Unit is also available for OEM integration to meet more complex guidance requirements. The format of the data stream is simple to interpret and fully documented. Technical support is available to assist in the integration process, giving machine builders the ability to incorporate low-cost “own label” guidance based on well-proven principles.

Rugged and reliable

Like all ZED guidance equipment, the ZED-20 Target Unit has been designed to withstand the rigours of the tunnelling environment. The unit’s steel case completely protects the optical and electronic components. High-quality connectors maintain reliability despite harsh environments or rough handling. The unit requires minimal power and is very tolerant to variations in the supply: -25/+50% of nominal.

The sensitive detectors will operate with laser powers below 0.5mW, giving excellent range and the ability to cope with difficult atmospheric conditions. A built-in laser power sensor constantly monitors the beam. Comprehensive diagnostic and error information is reported along with the positional data.

Upgraded for use with a TCA / TRCA Total Station

The system described above can be upgraded to operate with Leica’s TPS 1100 Series TCA or TCRA Total Stations, please refer to the diagram on page 4.

System operation is based on newly developed theodolite technology, using self-centring and locking EDM’s (electronic distance measurement) called Automatic Target Recognition or ATR and a target unit that is sensitive to the infra-red laser emitted from the instrument that it uses to home-in and then lock onto a reflector.

Apart from this change in the measurement to a reference, the principle of operation of the system is similar to the Basic or ZED 26 System, where the designed tunnel axis is assumed straight. The total stations position will be entered as an offset in the X & Y plane perpendicular the designed axis. Initially, the Bearing or Azimuth of the total station is set to be parallel to the designed axis and equal to zero. The Elevation will be entered as either as a grade, mm / 10m, or directly as an angle.

As the TBM excavates, with the instrument locked onto the target unit, the changing angular data as the instrument tracks the machine, together with the inclinometer (TBM ROLL and LOOKUP or pitch) and the

LEAD (the horizontal angle between the TBM axis and the infra red laser used for the ATR) from the target, permits the TBMs position to be determined.

All data processing and entry is made on the PC where it also displays the relevant information to the machine operator. Logging of all guidance data can included and controlled by the PC.

The main advantage of using this configuration is the greatly extended range, or separation distance between the target unit on the TBM and the theodolite, when compared to using a conventional laser based system. Typically, lasers are limited to approximately 200m, due to a breakdown of the beams quality with diffraction and absorption, but with this method the distance may lie between 400m and 600m.

Successful above ground testing at our factory has been made to approximately 650m. The method has been tested on a 9m hard rock Herrenknecht, with the contractor Prader AG at a site in Fluelen, Switzerland, although here the maximum separation achieved was only ~170m.