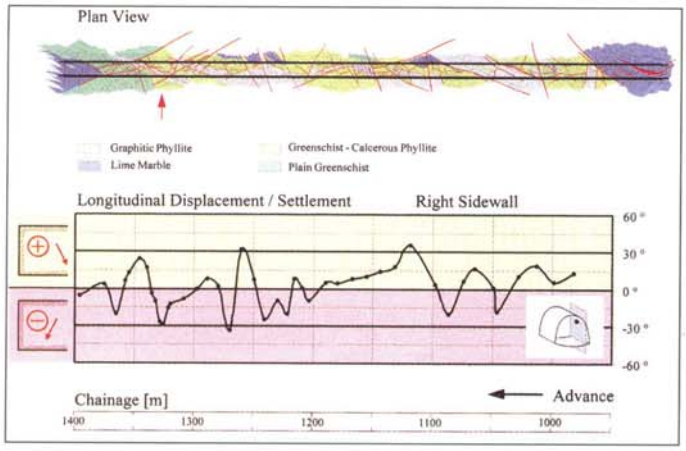
8.3 Advanced monitoring data evaluation for tunnels with high overburden in poor rock

Tunnels with high overburden in poor and strongly heterogeneous rock are an ongoing engineering challenge around the world. Many projects have been delayed considerably when unexpectedly meeting fault zones. Occasionally changes in rock mass behaviour are detected to late due to the lack of information on the parameters of the rock mass outside the visible excavation area. Several attempts are made to improve the prediction of the rock mass structure ahead of the face, most of them without promising results.
Geodetical displacement monitoring in tunnelling allows to determine the displacement vector in space of each measured point. The increase in information has lead to additional possibilities in data visualisation. The objective of new tools for efficient data processing and visualisation is a better understanding of geomechanical processes during tunnel excavation.
Better adjustment of excavation and support to the geotechnical conditions, as well as a certain ability of predicting the ground reaction ahead of the tunnel face is possible with the help of the improved methods of data evaluation.

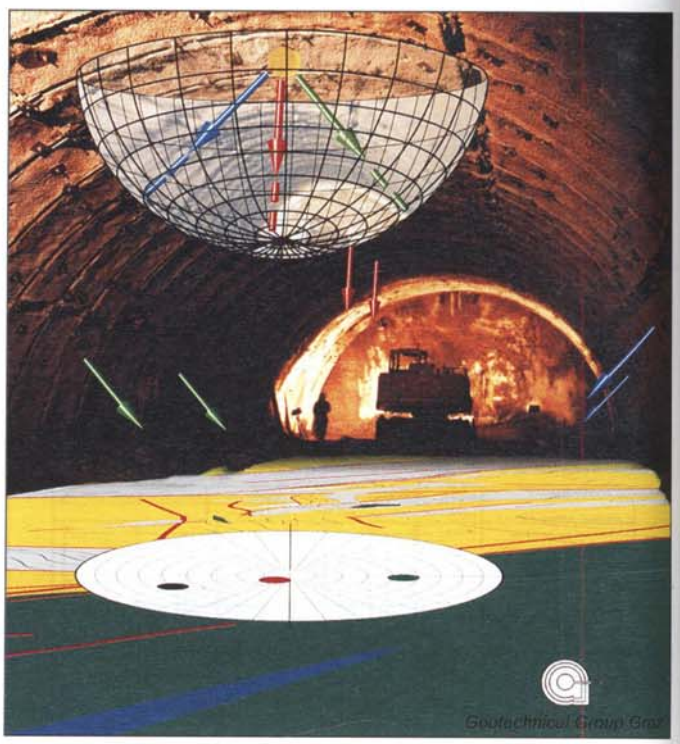
Trends of displacement vector orientation

The vector orientation in a vertical plane along the tunnel axis (settlement and longitudinal displacement component) shows changes in rock mass stiffness. When excavation approaches weaker material, the orientation of the displacement vector shows an increasing tendency against the direction of excavation. In case of stiffer material ahead of the face, the opposite tendency – relatively low value of longitudinal displacement and even displacement in direction of excavation – can be observed.



Vector orientation in space

To make full use of the information available and to avoid the necessity of requiring several diagrams to obtain the displacement vector orientation in space, display of the orientation in stereographic projection similar to the display of discontinuities can be used. Monitoring data evaluation from various alpine tunnels shows an enormous potential in short term prediction of rock mass conditions well ahead of the excavation. This method of display allows an easy correlation of



deformation patterns to the geological structure. The influence of rock mass structure on deformation behaviour is shown. Therefore it's a powerful tool to detect changes in rock mass quality well ahead of the face.

Future aspects

Displacement vector orientation can be automatically compared to allowable limits of deviation from „normal" values. „Normal" displacement vector orientation can be determined during the design, considering influence of the geological structure (for example schistosity, bedding, etc.) and previous experience.
Warning mechanisms can be used to identify situations deviating from „normal" and uncritical deformation processes. In a further step, the warning can be accompanied by indications on the likely mechanisms, causing the deviations. This very much would improve and speed up interpretation on site, thus supporting decisions on excavation and support very efficiently.

Geotechnical Group Graz
Institute for Rockmechanics and Tunnelling, Technical University
D. I. Albert Steindorfer
A-8010 Graz, Austria, Rechbauerstraße 12
Tel.: ++43/316/8738117
Fax: ++43/316/8738618
e-mail: steindorfer@fmt.tu-graz.ac.at
WWW: http://www.cis.tu-graz.ac.at/geotechnical group