Geological investigation and documentation during construction

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Purpose

- documentation of encountered geological and geotechnical conditions
- comparison of predicted and encountered conditions
- provision of geological information for the evaluation of geotechnical monitoring results
- evaluation of documentation data for short-term prediction ahead of the tunnel face
- provision of geological information concerning classification of overbreak, behaviour of unsupported rock mass, excavation method, etc.
- investigation of the rock mass in the surrounding of the excavation for detection and characterisation of geological hazards, e.g. fault zones, cavities, water inflow, collapse areas
Basics

- basic content of documentation shall always be in accordance with the tender
  - for comparability of the documentation data with the geological and geotechnical data of the tender, the same features, using the same classification systems shall be recorded
  - documentation systems shall be flexible to allow for the implementation of features, which have not been included in the tender, but are of importance for the construction
Documentation

- constrains
  - physical access
  - safety
  - time constraints
  - number of measurements
content of documentation

- the content of documentation has to be adjusted according to the type of excavation (e.g. drill & blast, hydraulic excavator, road header, TMB), because excavation methods limit the accessibility and influence the appearance of geological and geotechnical features.
Documentation

- drill & blast excavation
Documentation

- mechanical excavation with hydraulic excavator
Documentation

**mechanical excavation with TBM**
Documentation

- improvement of photo documentation and discontinuity mapping by processing of oriented 3D-images from freehand photos
Documentation

- improvement of photo documentation and discontinuity mapping by processing of oriented 3D-images from freehand photos
  - combines geometry and visual information
  - provides an objective documentation of a rock surface
  - enables geologic mapping (among others)
  - increases working safety
### Documentation

- discontinuity measurements
  - interactive joint set generation (automatic pending)
  - automatic joint set clustering
Documentation

- quantification of overbreak

110 dm³
Documentation

- subsequent acquisition and assessment of the tunnel face
  - objective, reproducible data
  - improved use of support
  - claim management
**Documentation**

- cutter head of TBM is used as moving platform for video camera (rugged compact camera, LED lights, laser pointers)
Investigation

- investigation of collaps area for design of remedial actions
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Investigation

- geophysical investigation in combination with rotary drilling
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There is no data acquisition system existing, which has the versatile capabilities of a human being. The ability to view and move simultaneously to survey a rock mass in three dimensions from a range of distances and angles, to touch and probe the rock exposure, to make comparisons with features observed elsewhere simultaneously, are not achievable by an automatic data collection system. But it has also to be considered that humans are susceptible to subjectivity and personal bias. Humans may have different education, degrees of experience and motivation, they work relatively slowly and can get bored or tired, particularly when working under adverse environmental conditions. (after Priest, 1993)

Therefore the combination of both systems, human and computerised technology is a good solution.