

Ulf Lindfors

Principal Engineer

Expertise

Rock Mechanics, Rock Engineering

Education

Licentiate in Engineering (Rock Mechanics), 1996
Luleå University of Technology, Luleå, Sweden

Master of Science in Geotechnology Degree, 1992
Luleå University of Technology, Luleå, Sweden

Professional Experience

2022 – present

Itasca Consultants AB, Luleå, Sweden
Principal Rock Mechanics Engineer

2018 – 2021

AFRY, Sweden
National Specialist Rock Engineering

2014 – 2018

Itasca Consultants AB, Luleå, Sweden
Principal Rock Mechanics Engineer

2011 – 2014

Senior Rock Mechanics Engineer

2006 – 2011

Vattenfall Power Consultant AB, Luleå, Sweden
Rock Mechanics Consultant

2000 – 2006

SwedPower AB, Luleå, Sweden
Rock Mechanics Consultant

1996 – 2000

Boliden Mineral AB, Boliden, Sweden
Rock Mechanics Engineer

1992 – 1996

Luleå University of Technology, Luleå, Sweden
Doctoral Student, Division of Rock Mechanics

1990 – 1992

Skanska, Division of Underground Construction, Stockholm, Sweden
Foreman underground construction work

Project Experience

Infrastructure (Tunneling):

Lead and manage design work, responsible for rock mechanics work during construction of road tunnels and shafts at two contracts (FSE308 Lovön and FSE403 North) at the large infrastructure By-pass Stockholm (FSK02). Work as functional manager, technical expert support to technical manager and assistant technical manager with responsibility for design work including empirical, analytical, and numerical (2D and 3D) analysis of rock mass stability and support design. Rock mechanics support to mapping assignments. The work includes leading and managing design work for:

- Tunnels from low depth 2 m below surface down to 100 m below surface. The size of the tunnels varies from 40 m² to 390 m².

Page 2 of 6

- Passage below two sea bays (Lambarfjärden and Fiskarfjärden).
- Air exchange shafts, in total 8 shafts with diameter 10.5 m (area 88 m²), height 100 m.
- Air exchange chambers at depth 100 m below surface, section areas up to 375 m².
- Tunnel crossings between tunnels with distances less than 5 m. Design work includes rock reinforcement, excavation sequences, etc.
- Reinforcement at wide tunnel section with low rock quality exposed to large external loads.

Rock mass quality in above mentioned facilities has Q-values normally between 0.1 to 10, but rock mass with lower Q-value exists. The client was Swedish rail and road administration.

Independent reviewer at TSK20 Tvärförbindelse Södertörn regarding chosen methods for rock support analysis, results, work descriptions, and control program.

Part of expert panel for description design and dimensioning rock slopes. The project delivered a general description on how to design and dimension rock cuttings for roads and railways, including design and architecture, geotechnics, and rock mechanics engineering. Wrote the report and was responsible for content regarding rock engineering. The client was Swedish rail and road administration.

Rock mechanics expert support to technical manager of rock engineering at Ostlänken. The client was Swedish rail and road administration.

Independent reviewer (GK3) of rock engineering work for Ersmarkstunneln, Norrbottniabanan.

Technical manager for rock mechanics analysis for the crossing between Kvarnberget and existing Götatunneln (Västlänken). Manage 3D analysis using *FLAC3D* and reporting. Excavation sequencing and reinforcement. Complicated passage with low rock cover and take down/replacing of existing reinforcement as the tunnel cross-section is expanded. Client was Norconsult/Swedish rail and road administration.

Leading the rock mechanics design work, including numerical stress and deformation analysis on existing underground facilities (subway station). The project is part of the design work of excavating bedrock above the underground station and replacing it with constructions (buildings). The construction is Stadshagen Västra, Kv Stugan 5, and client was Primula Bygg AB/SL.

Rock mechanics engineer and quality controller, rock engineering issues for pre-investigations in design-build contracts for the projects Trysfjord brua, Rv5 Kjösnäsfjorda, UDK01 Drammen- Kobbervikdal. All done for the Norwegian road administration.

Quality controller, rock mass stability analysis for Pir G, as part of the extension at Arlanda Airport, and client was Swedavia AB.

Rock mechanics technical support for finding solutions for excavating tunnels 0-3 m above existing tunnels at Västlänken, client Ramböll.

Responsible for the design work of single track tunnels, Akalla, Barkabystaden and Barkaby station, parts of the extension of the Stockholm metro. The work includes leading the design work for reinforcements, blasting, etc., for the underground part of the station for delivery of construction documents including a 3D construction model.

Page 3 of 6

Design work for the extension of the Stockholm metro involving new underground stations and deep tunnels. The work includes scientific rock mechanics support, rock stress measurements, numerical analysis of regional stresses of the Stockholm area, and stress and deformation of underground stations.

Project leader and rock mechanics support for several projects including analysis of rock mass stability at foundation of larger constructions on shallow rock in central Stockholm and Gothenburg.

Detailed design work for the Citybanan (City Link) commuter-train tunnel project in Stockholm, project leader and scientific rock mechanics support for the crossing between an existing subway station and the Citybanan link.

Responsible for designing standard reinforcement classes for the complete Citybanan project, including analytical and numerical analysis. Analysis of tunnel intersections between the Citybanan commuter train tunnel and energy tunnels. The project included three-dimensional rock mechanics analysis.

Developed design guidelines of rock excavations for road and rail infrastructure for the Swedish Transport administration.

Senior inspector, rock mass and rock support at tunnels and rock slopes (cuttings), development of standards for inspections for mines as well as for the Swedish Transport administration.

Participated as an independent adviser for the E6-Dovrebanan project regarding rock reinforcement, lining, grouting, and drainage of tunnels.

Nuclear Waste Disposal:

Developed guidelines for tunnel mapping and core logging for the construction of the final repository for spent nuclear fuel at Forsmark (SKB), Sweden.

Technical expert for reinforcement and stability design of the final repository for spent nuclear fuel at Forsmark (SKB), Sweden. Scientific rock mechanics support for Posiva Oy regarding use of mapping systems and mapping data.

Hydropower:

Rock mechanics support at start of rock mass stability investigation at Grytfors power plant station, owned by Skellefteå Kraft AB.

Rock mechanics expert, study of rock mass stability below dam foundation at Hissmofors Power plant station, owned by Jämtkraft AB. The work included project management support.

Rock mechanics expert regarding stability of outlet construction at Messaure power plant station, Vattenfall Vattenkraft AB.

Study of rock foundation issues for the Suorva hydropower dam. Start up and installation of rock deformations measuring system at hydropower dams. Stability assessment of the rock abutment at the Vargfors hydropower dam. The work included borehole logging, assessment of rock and joint shear-strength properties, and review and update of stability calculations for the rock abutment.

Rock mechanics scientific support, design of tunnel reinforcement and grouting, and reviewer for the Rio Esti Hydropower Project. Part of pool of engineers and rock experts for geotechnical design, as well as planning and performing geotechnical investigations and site supervision.

Scientific rock mechanics support to site investigation for Changuinola 1 Hydroelectric Power Project, feasibility studies for Ruhudji Hydroelectric Power Project.

Page 4 of 6

Scientific rock mechanics support to feasibility studies, new construction, rehabilitation, redevelopment, and risk inventory regarding blasting and rock support design for hydroelectric power projects at several locations in Sweden and Norway. The work included risk inventory of rock block and slope stability at outlet channel, stability analysis for in- and outlet channels, technical advisor/expert in rock mechanics in terms of blasting for intake and outlet canals. Scientific rock mechanics support for rock excavation at several hydropower plants stations in Sweden.

Stress Measurements:

Project manager and field engineer for rock stress measurements using both overcoring and hydraulic fracturing methods in various projects (Sweden and international), including both shallow and deep boreholes. Stress measurements were performed for design of new mine areas, hydroelectric plants, infrastructure projects, and final nuclear waste deposits. Investigation of core diking and overcoring rock stress measurements in high-stress environments through field testing (drilling and overcoring) and analyses.

Analysis and interpretation of rock stress data for the Forsmark site, including regional stress data, to assess the confidence of measured stresses with different methods and to provide input to stress modeling and detailed site characterization.

Responsible field engineer for rock stress measurements in the Stockholm area. The work is done as sub-consultant for Geosigma AB.

Mining:

Rock mechanics expert support for choosing location of three new shafts from surface to 1900 m below surface at Malmberget Mine, LKAB.

Rock mechanic inspections of existing underground facilities (conveyor belt tunnels, large underground stations) at Aitik open pit (Boliden Minerals).

Part of a review team of the rock mechanics work done in Tara mine (Ireland), the mine is owned by Boliden Minerals. Rock mechanics pre-feasibility studies for several deep orebodies within the Skellefteå mining district (Boliden Minerals).

Rock mechanics support and design work for the expansion of an open pit mine, including design of transport tunnels, conveyer belt tunnels, large pits for ore storage, integration with conveyor belt tunnels and large pits for ore storage (Aitik, Boliden Minerals). Rock mechanics support for design of new open pit mine.

Rock mechanics support for LKAB open pit mines, including support in rock mechanical issues such as bench and overall slope stability. Analysis of mining-induced ground deformations for the LKAB Malmberget mine.

Responsible for analysis with numerical and analytical methods for Crown Pillar mining, Crusher Area (underground), Shaft Stability, and Ramp Portal Design (open pit) of the Kittilä mine. Responsible for study of possible ramp repair actions and pit bottom access. Responsible for study of crown pillar repair including rock mass stability and concrete design work.

Several assignments for Björkdal mine, including investigation of slope stability in the open pit as well as drift and mining room (open stope) stability. Also teaching technical and mining staff rock mechanics and reinforcement.

Page 5 of 6

Bulkhead design for a near-surface mine drift to prevent flooding of the mine. Scientific rock mechanics support at pre-feasibility studies at the re-opening of mines in Sweden. Scientific rock mechanics support and design of rock support at the re-opening of mines in Sweden and Finland.

Responsible for numerical study of ore pass, literature study of "Control programs for rock reinforcement", project for narrow mining test.

Rock mechanics work related to mining at several open pit and underground mines in Sweden. The work included rock mechanics operation issues, planning and design of reinforcement for shafts, drifts and mining rooms, and open pits. Mapping and establishing the condition of reinforcement. Monitoring, mapping, and establishing the stability status of shafts, drifts, and mining rooms. Supporting the mine in planning mining sequences, layouts, etc., with respect to rock mechanics. Also supported mines in emergency rock mechanics issues (rock support, mining sequences) both for underground and open pit mines. Supervisor for rock mechanics engineers at site.

Technical expert in rock mechanic issues in the pre-investigation study of reopening the Grängesberg mine.

Miscellaneous:

Senior consultant and mentor for managers and colleagues at ÅF/Afry regarding marketing, tender work, recruitment, and in rock engineering projects.

Eurocode Implementation, TC250/SC7, Expert Rock Mechanics. The work is part of the implementation of the Eurocodes for rock engineering.

Technical expert in rock engineering issues for Trygg Hansa.

Teaching and Academic Experience:

Course in rock stress measurements for LKAB, manager and teacher in the seminar for rock mechanic measurements.

Industrial supervisor Master Thesis Rock Mechanics analysis Krångede, Industrial supervisor Master Thesis.

Teaching open pit rock mechanics for LKAB staff and underground rock mechanics for several mining companies, both engineers and shift crews.

Teaching design work, stress, and stress measurements for PhD and undergraduate student at KTH.

Instructor of undergraduate students in rock mechanics at Luleå University of Technology, Div of Mining and Geotechnical Engineering (1992-1995, 2005-2018). Instructor of Atlas Copco personnel in rock mechanics (2005). Instructor of mining engineers from developing countries in the annual course MINING-TECH, held at CENTEK, Luleå University of Technology (1992-1995). Classes included fundamentals of rock mechanics, stresses and deformations in rock masses, stability and design of rock pillars and stope roofs, general rock mechanics for underground mining, numerical tools and their application in rock mechanics, rock mass classification, monitoring of rock mass response, rock support and reinforcement, stability and design of rock slopes and the design process for tunneling.

Supervision of undergraduate thesis project regarding rock erosion in spillwater channels.

Discussion leader (informal opponent) at Mr. David Saiang's licentiate seminar at the Luleå University of Technology (2004): "Damaged Rock Zone Around Excavation Boundaries and its Interaction with Shotcrete".

Member of the program committee of the Rock Engineering Research Foundation (BeFo). Former Swedish Rock Engineering Research Foundation (SveBeFo). Member of the council for research applications to the BEFO-Formas research foundation.