



## Workshop on Norwegian Tunnelling Technology and Practice (14 PDU's Approved)

### Workshop Details

**Venue :** MND Auditorium,  
MND Complex Annexe A,  
5 Maxwell Road,  
Singapore

**Date :** 17 – 18 Feb 2009  
**Time :** 0830 - 1700 Day 1  
0900 - 1700 Day 2

### Speakers:

- ★ **FOSSUM, Knut**  
(KF Gruppen AS)
- ★ **GRIMSTAD, Eystein**  
(Norwegian Geotechnical Institute)
- ★ **GRØV, Eivind**  
(SINTEF)
- ★ **HAUG, Ruth Gunlaug**  
(Norwegian Public Road Administration)
- ★ **LU, Ming** (SINTEF)
- ★ **PEDERSEN, Geir**  
(Skanska Norway)
- ★ **WETLESEN, Thorvald**  
(Bever Control AS)
- ★ **WOLDMO, Ola**  
(Woldmo Consulting AS)
- ★ **ZHOU, Yingxin**  
(DSTA Singapore)

### Organised by:



Society for Rock Mechanics &  
Engineering Geology (Singapore)



Norwegian Tunnelling Society

### Supported by:

Innovation Norway  
Building & Construction  
Authority Singapore

**This** workshop aims to present and discuss systematically the Norwegian Tunnelling Technology (NTT) as it is practiced in Norway and increasingly more in other countries. In Singapore, the use of NTT and technology transfer was an essential part of the strategy bringing to the successful development of the Underground Storage Facility. With increasing work and demand for expertise in rock tunnelling and development of underground rock cavern space in Singapore, it is important for regulators, planners, developers, engineers and contractors to have a more comprehensive understanding of what the Norwegian Method of Tunnelling encompasses. This workshop brings together several experts and practitioners from Norway to share their knowledge and experience in the essential aspects of Norwegian tunnelling. Experience and perspectives from Singapore will also be presented and discussed.

**For more details and online registration, please visit :  
[www.srmeg.org.sg](http://www.srmeg.org.sg)**

### Registration Fee

**SRMEG Members:** \$400.00    **Non-SRMEG Members:** \$450.00  
(Registration fee covers workshop handouts, tea breaks and lunches)

Prof / Dr / Mr / Mrs / Ms: Title and Full Name (underline Surname / Family Name):		Member of SRMEG: YES    NO	
Organisation:			
Address:			
Office Phone:	Mobile:	Fax:	
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### Method of Payment

- By bank Draft / Cheque in Singapore Dollars drawn on a bank in Singapore and made payable to: "**Society for Rock Mechanics & Engineering Geology**"

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# Programme

## Norwegian Tunnelling Technology and Practice Workshop 17-18 February 2009, MND Auditorium, MND Complex Annexe A, 5 Maxwell Road

Time	Content	Speaker
<b>17 February 2009, Tuesday</b>		
0830-9000	Opening	<b>Norway and Singapore Reps</b>
0900-0930	Introduction to Norwegian Tunnelling Technology (definition, content, processes, practices, areas of application)	Eivind Grøv
0930-1015	Planning and site investigations for rock tunnelling (processes, cost, engineering geology reporting)	Eivind Grøv
1015-1030	Discussion	
1030-1100	Tea Break	
1100-1145	Rock mass classification and use of the Q-system for rock support design (rock bolting, sprayed concrete, reinforced ribs of sprayed concrete, manual and automatic tunnel mapping, and final support)	Eystein Grimstad
1145-1215	Numerical modelling, instrumentation and construction sequence planning	Ming LU
1215-1230	Discussion	
1230-1330	Lunch	
1330-1440	Norwegian contract system and risk sharing (Cost estimate, unit prices, time units, schedule validation, approval procedures, payment, compensation and variation orders, geological risks, construction risks, types of contracts, basis for risk sharing, tender evaluation)	Eivind Grøv Ruth Gunlaug Haug
1440-1500	Discussion	
1500-1530	Tea Break	
1530-1615	Norwegian standards, guidelines, and technical specifications	Ruth Gunlaug Haug
1615-1645	Vibration from blasting (standards, monitoring and control)	TBA
1645-1700	Discussion	
<b>18 February 2009, Wednesday</b>		
0900-1010	Experience from the Underground Ammunition Facility project (rock engineering, geological risk management, contractual arrangement) Perspectives from the consultant and contractor	ZHOU Yingxin Knut Fossum
1010-1030	Discussion	
1030-1100	Tea Break	
1100-1130	Tender Preparation and construction planning by the contractor (pricing of tenders, time schedule accounting, unit price influence)	Geir Pedersen
1130-1210	Construction (Requirements for organisation set up and project execution, what happens at the tunnel face, participants and co-operation, how decisions are made and why, excavation method and equipment, selection and application of temporary and permanent support)	Knut Fossum
1210-1230	Discussion	
1230-1330	Lunch	
1330-1440	Technology and innovation (Equipment underground, documentation from the drilling jumbo and from computerised pumping, total station survey, Bever control systems, rock bolting and sprayed concrete)	Per Gunner Andersen, Thorvald Wetlesen, and Ola Woldmo
1440-1500	Discussion	
1500-1530	Tea Break	
1530-1600	Handing over and operations and maintenance of underground facilities	TBA
1600-1700	Future opportunities for Singapore-Norway collaboration Discussions	All

# About the Speakers

**FOSSUM, Knut.** Civil Engineer educated at University of Trondheim, Mining Engineering, but has been working in tunnel technology most of his life. Fossum is Chairman and General Manager of the tunnel and civil contractor KF Gruppen AS in Norway.



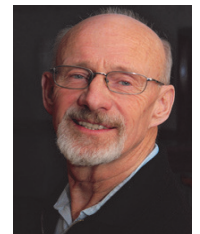
Since educated in 1977, he has worked as a specialist in rock support, rock bolting, sprayed concrete and injection as well as rehabilitation of underground structures. He was in the management team of the contractor for construction of the Fjellinjen tunnel under Oslo City. Fossum has promoted Norwegian Tunnel technology worldwide and especially versus Singapore. He was the Norwegian project manager during construction of Mandai Ammunition Storage. Fossum did promote Norwegian Tunnelling Technology for JTC in the early stage of the Island Oil Storage project. Presently he is developing hydro power in Indonesia. He is a member of NFF International Committee and responsible for the Norwegian delegation in the annual

ITA/WTC exhibition on behalf of NFF -Norwegian Tunnelling Society

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**GRIMSTAD, Eystein.** Technical advisor in engineering geology at Norwegian Geotechnical Institute. Member of Norwegian Tunnelling Society (NFF) International committee. He has been the president of the Norwegian national group of ISRM (Int. Society for Rock Mechanics & Engineering Geology).

He was employed by Norwegian Road Research Laboratory in 14 years and spent some time at tunnel construction sites as advisor. Lecturer at domestic training courses within the field of slope stability, rock mass classification and rock support including Norwegian sprayed concrete supervisor certification.



He has done research work concerning durability of rock bolts, updating the Q-system, and for design of reinforced ribs of sprayed concrete. He has worked as advisor for tunnelling and stability of rock slopes in many countries, and particularly in India, Brazil, China and Chile.

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**GRØV, Eivind** Graduated from the University of Science and Technology in Trondheim (previously NTH) in 1983, with a MSc. degree in Geotechnical Engineering and Rock Mechanics.

Grøv has been working for some 20 years in the consulting business covering a wide range of tunnelling and underground projects including oil and gas storages, hydropower projects, road and railway tunnels also sub sea tunnels in rock etc. His experience cover a wide range expert services provided to projects abroad, like in Saudi Arabia, Singapore, China, Russia, Hong Kong etc. Grøv has been and is involved in the Jurong Rock Caverns as Deputy Project Manager and responsible for the review tasks of the underground works.



Grøv is now Research Manager in SINTEF Rock- and Soil Mechanics, SINTEF being the biggest Scandinavian research institute. Grøv is also lecturing at the University of Science and Technology in Trondheim, both domestic students and foreign students at scholarships to Norway. He has held lectures and key note speeches on several international conferences.

Grøv is also elected Vice President of ITA (the International Tunnelling and Underground Space Association) for a term of 3 years. He is tutoring the Working Group 12 of ITA on Sprayed Concrete Application. Grøv is a member of the board of the Norwegian Tunnelling Society for 6

years now including 4 years as the President of the International Committee.

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**HAUG, Ruth Gunlaug.** Graduated from University of Science and Technology in Trondheim i 1987, MSc Construction Engineering and also holds a Master degree in Construction Management from University of Colorado. Present President, Norwegian Tunnelling Society( NFF )

She has been working with tunnel projects and tunnel related management most of her career. Haug has been working with large urban tunneling projects in and around Oslo, mostly road tunnels employed by the Norwegian Public Road Administration. She also have many years of experience with high speed railroad project to Oslo airport as well as sub-sea tunneling. In her early career, she also worked with underground hydro power projects. Haug has been involved in some of the major reorganizing projects within her company and have gained much experience with public relation work. As a speaker she has been involved in many international seminars and conferences and she is a former Piarc member.



Haug is now Project Manager working for the Norwegian Public Road Authorities with special tasks related to tunnel development and education. She has for 9 years been board member of the Norwegian Tunneling Society ( NFF ) an organization that includes 1000 personal and company members involved in the Norwegian tunnelling industry. Haug was elected as President of NFF in 2008.

**LU, Ming** First and Master degree in Tsinghua University, Beijing, China, and PhD in Imperial College, University of London, UK. He is now working at SINTEF Rock and Soil mechanics as Chief Scientist. He is also adjunct professor at the Norwegian University of Science and Technology.

He has been involved in the following fields of rock engineering:



- Design and construction of underground power houses and tunnels for large hydropower developments
- Design, consultancy and quality assurance of road tunnels
- Underground oil/gas storage of different types
- Planning and implementation of geological investigation of underground works
- Research and development on numerical analysis for rock mechanics
- Rock mechanics research for off-shore oil industry.

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**WETLESEN, Thorvald** Graduated from University of Science and Technology in Trondheim with M.Sc degree in Mechanical engineering (1967), and from Massachusetts Institute of Technology US, with M.Sc degree in Electrical engineering (1974).

He is managing director of Bever Control AS since 1987. This company has a leading international role on design and development of computer controlled drill and blast operation under ground. It includes planning systems, machine controls, excavation scanning, reporting and documentation. He has extended experience in implementation of advanced systems in underground operation in the international market with reference to Singapore, China, Korea, Scandinavia, Germany, Switzerland, Spain etc.



Wetlesen has also 16 years of experience from industrial research and development in SINTEF in electronics and automation as Research Engineer and later as Research Director for Electronics and Automation division. He worked on automation in robotics, construction, process, marine, and offshore oil industries.

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**WOLDMO, Ola** Civil Engineer by education and specialist in the field of equipment and materials for tunnelling and for rock support. Managing Director of Woldmo Consulting AS. Appointed as project coordinator for South East Asia affairs within the Norwegian Tunnelling Society ( NFF) International committee.

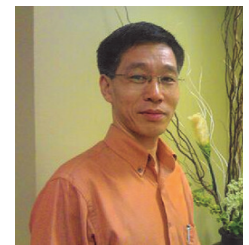


18 years of experience from management positions in the tunnelling division of Veidekke AS, the leading tunnel and civil contractor in Norway. Special knowledge achieved, is typical Norwegian methods like water ingress control by rock mass grouting and pre-injection in tunnels. Lecturer at domestic training courses for sprayed concrete supervisor certification. Deputy project manager at the Norwegian Defence Estates Agency during the construction of the Rena Camp tanks training facility. Five years of international experience in technical sales and implementation of Norwegian Tunnelling Technology in Asia Pacific as Marketing Director for BASF within Asia Pacific region located in Hong Kong and Singapore. Supporting infrastructure projects in Korea, China, Vietnam, Taiwan, Hong Kong, Singapore, Indonesia, Philippines and Australia.

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**ZHOU, Yingxin.** Senior Principal Engineer and Programme Manager for Underground Technology & Rock Engineering Defence Science and Technology Agency, Singapore

Since 1994, Dr. Zhou has been actively involved in the planning and development of Singapore's first underground ammunition facility, being in charge of all rock engineering aspects and a major technology development programme for underground ammunition storage safety. He is currently the programme co-ordinator of a joint DSTA-NTU research programme on Underground Technology & Rock Engineering. He is also a Technical Advisor to JTC on the Jurong Rock Cavern Project for underground hydrocarbon storage.



Dr Zhou is currently President of the Society for Rock Mechanics & Engineering Geology Singapore, and President of the Commission on Rock Dynamics of the International Society for Rock Mechanics (ISRM). He is a member of the Editorial Board of the International Journal on Tunnelling and Underground Space Technology. He is also Congress Co-chair of the ISRM 2011 International Congress on Rock Mechanics in Beijing China, and is serving as member of several International Conference Advisory/Scientific committees.