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Volume 32 • Number 3 • September 2014

GEOTECHNICAL news

• A Course in a Castle: Geotechnical and Structural Monitoring Poppi, Italy June 2014

innovation

DIGITAL MEMS INCLINOMETER SYSTEM

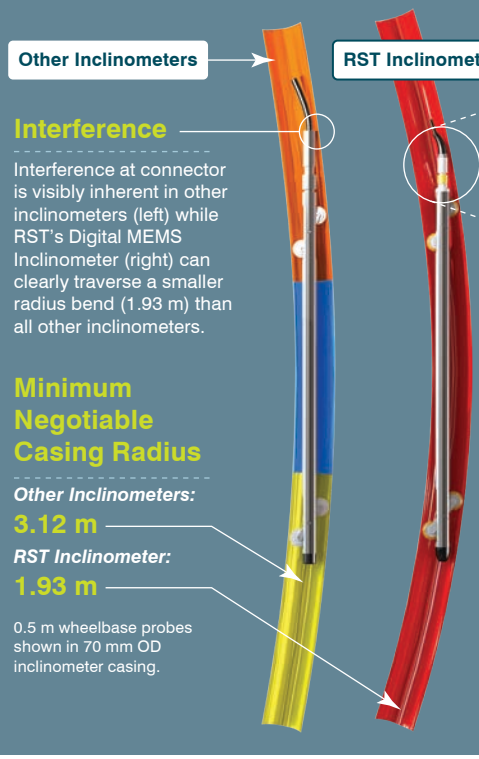
in MEMS Digital Inclinometer Systems

How the best just got better.

For measuring any lateral movement down in the earth, via inclinometer casing, the Digital MEMS Inclinometer System from RST Instruments Ltd. was the first, and is still the best, Digital MEMS Inclinometer System available.

Over the last 10 years, RST's Inclinometer systems have had the shortest overall length available for a given base length compared to competitive inclinometers. Undaunted, we've forged ahead and improved on our very own industry-leading specifications. With a new minimum negotiable casing radius of 1.93 m, RST's Digital MEMS Inclinometer can still traverse a smaller radius bend than all other inclinometers available in the industry.

OTHER INCLINOMETERS VS. RST



Interference

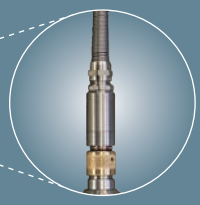
Interference at connector is visibly inherent in other inclinometers (left) while RST's Digital MEMS Inclinometer (right) can clearly traverse a smaller radius bend (1.93 m) than all other inclinometers.

Minimum Negotiable Casing Radius

Other Inclinometers:
3.12 m

RST Inclinometer:
1.93 m

0.5 m wheelbase probes shown in 70 mm OD inclinometer casing.



RST's newly developed connector is by far the industry leader for the least amount of connector interference.

RST also provides the most robust cable on the market with a breaking strength of 5.90 kN (1325 lbs.) Also, our new, non-slip, swaged cable marks are unmatched in grip strength.

The compact reel system with 50 m cable weighs a very manageable 4.7 kg and can be easily held with one hand. A padded carrying case is included.

MEMS TILT & INCLINATION SERIES

Above, the RST Digital MEMS Inclinometer Probe with industry leading system accuracy of ±2 mm per 25 m, is shown connected to the cable.

SYSTEM INCLUDES:

MEMS Digital Inclinometer probe, cable system, reel with battery power, and an Ultra-Rugged Field PC that functions as a wireless readout, analysis, and data storage device. Includes all accessories, as shown at left. Please contact the RST sales team for complete details.

The all new Ultra-Rugged Field PC^2 functions as the data collector which provides a high-level user interface, "at-the-borehole" data analysis and graphical comparison to previous data sets. The new "zoom-in" feature allows you to explore your data in more detail and Bluetooth® and Wi-Fi® connection come standard. Microsoft® Office Mobile is also included.

inclinalysis™
digital inclinometer analysis software

RST Inclinalysis™ Software is a powerful companion to the RST Digital MEMS Inclinometer System. It allows the user to quickly and efficiently reduce large volumes of inclinometer data into a variety of formats suitable for analysis and presentation.

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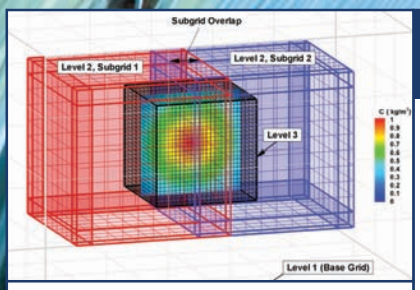

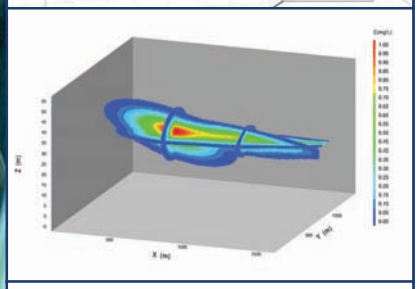

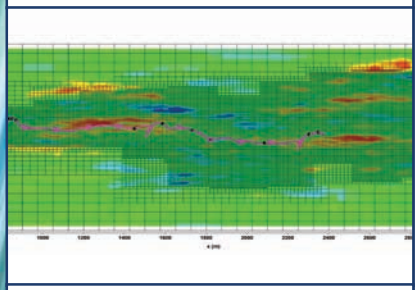

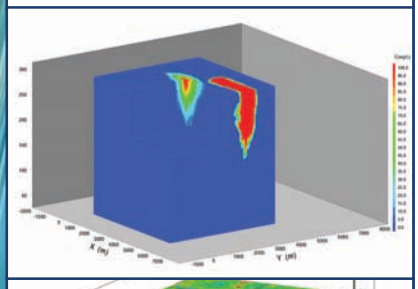

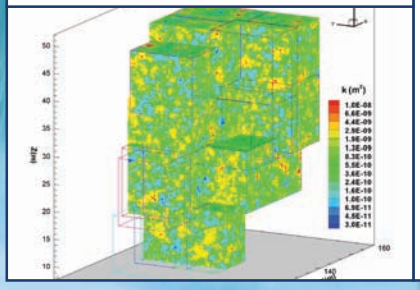

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CONTENTS

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GEOPAC
BUILD ON US

Geopac Provides "Dry Box" Solution to Allow Construction of Underground Parkade in Richmond, BC

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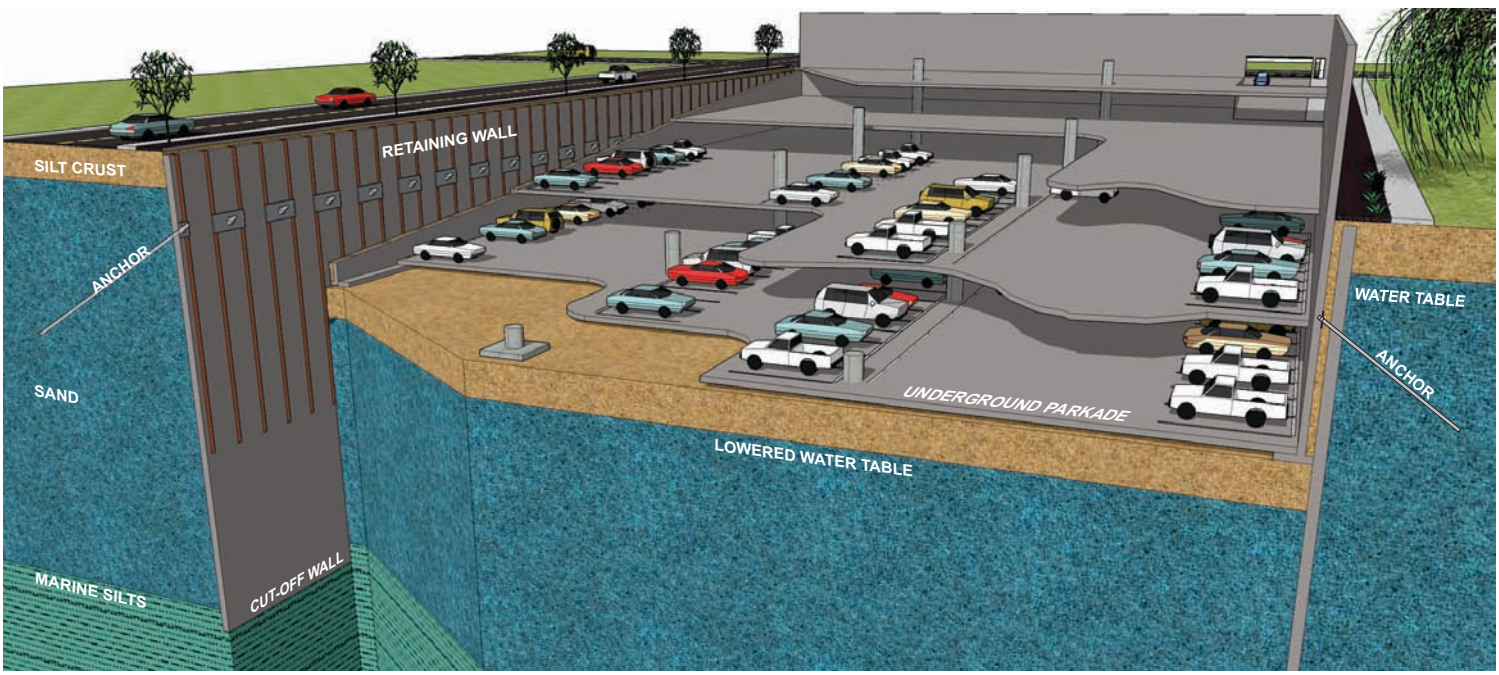

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Message from the President

Richard J. Bathurst, President of Canadian Geotechnical Society

CGS headquarters never sleeps. At least that has been my impression as your executive team moves into the last four months of its mandate. Of course, the efforts of our able Secretary General, **Victor Sowa**, along with **Wayne Gibson** and **Lisa McJunkin**, our CGS administrators, make it all happen. Many activities remain under the radar for CGS members. For example, with the assistance of President-elect **Doug VanDine**, the next Secretary General of the Society has now been selected. We will introduce the new Secretary General at the Business Meeting which is held in conjunction with **GeoRegina 2014**. We will also take the opportunity to recognize the contributions of the current Secretary General, Victor Sowa, who will be stepping down in early 2015. I should also mention that the Executive at our May spring meeting proposed to change the title of Secretary General to that of **Executive Director**. A motion to this effect will be presented to the membership at the CGS Business Meeting which is held at the beginning of **GeoRegina 2014**. We believe that this title better reflects the duties of this position and is consistent with North American practice.

As part of the Executive Director transition, the Executive has initiated a plan towards a virtual CGS document repository. Under this plan, all documentation will be stored in "the cloud" and be available to all Executive members to assist them with the execution of their various duties. Similarly,

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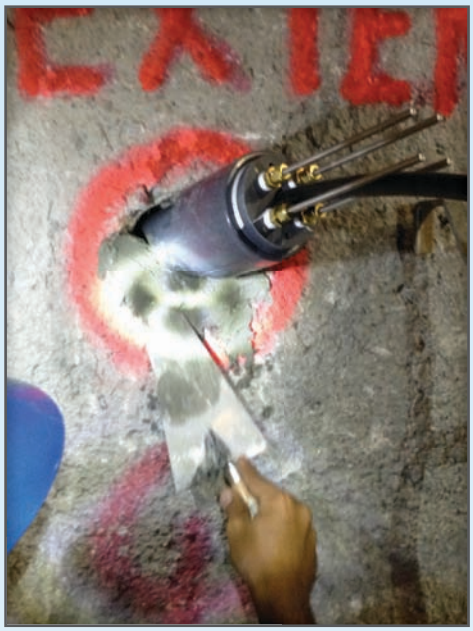
GEOTECHNICAL INSTRUMENTATION

Canada - Pile Test Monitoring



Peru - Hydro Dam Monitoring

Portugal - Bridge Monitoring

Chile - Embankment Monitoring

United States - Pipeline Monitoring

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chairs of Divisions and Committees will have access to document libraries that can be used as templates to assist them with their duties and to provide a useful record of previous activities.

The Executive at its spring meeting also made progress in updating the **Canadian Foundation Engineering Manual** (CFEM) which was last revised in 2006. The Executive is looking at the next CFEM to be delivered in e-book format and to make updates on a chapter by chapter basis. This strategy will reduce costs and ensure that those chapters that most urgently need to be updated to reflect the changing state-of-practice in Canadian geotechnique, are made in a timely fashion. By the time you read this message, you will have received a message from the CGS asking for your input on this very important project.

A major activity of the CGS executive and the chairs of the CGS Divisions during this past summer was the nomination and selection of winners of the various CGS awards. I cannot overstate how important these awards are to our members and our Canadian geotechnical community. With the exception of the R.M. Quigley Award for best paper published in the Canadian Geotechnical Journal, all CGS award winners must be CGS members. There have been a number of disappointments in the nomination process when deserving members have let their membership lapse and therefore removed themselves from consideration. I ask all members to remind deserving individuals that an important benefit of CGS membership is to be recognized by one or more of the prestigious awards of both the CGS and the Engineering Institute of Canada (EIC); but to be recognized, you must be a CGS member!

At the time you read this article you should have made plans to join us at **GeoRegina 2014** to be held **September 28 to October 1**. Please check the conference website at *www.georegina2014.ca* for information regarding other events including the Legget Luncheon, Hardy Address and Best Graduate Student Paper presentation. Among the special presenters will be **Dr. Scott McDougall** of BGC Engineering Inc., who is the **2014 CGS Colloquium speaker.** I am also delighted to report that the CGS Geotechnical Research Board chaired by **Dr. Murray Grabinsky** has selected **Dr. Greg Siemens** of the Royal Military College of Canada to be our 2015 CGS Colloquium speaker. Dr. Siemens will give his talk at **GeoQuebec 2015** in September of next year.

The **CGS Cross Canada Lecture Tour** (CCLT) brings one national and one international expert to selected Sections across the country each year. The Fall 2014 CCLT speaker was not finalized at the time this message was prepared, but I am delighted to report that the **2015 Spring CCLT** speaker will be **Professor Nick Sitar** from the University of California, Berkeley.

Finally, I wish to alert our CGS members to the **4th Climate Change Technology Conference** to be held in May 2015 in Montreal *www.cctc2015.ca*. This conference is organized by the Engineering Institute of Canada (EIC), along with ten of its member societies, including the CGS. This is a Canadian and international forum for the exchange of ideas for dealing with climate change. It is also an opportunity to keep abreast of emerging techniques and technologies for the mitigation and adaptation to the impacts of climate change. We are all stakeholders in this important debate and many of you are engaged in technical activities that are impacted by climate change. The conference organizers would like to hear from you.

I hope to see you all at **GeoRegina 2014.**

Provided by Richard Bathurst – President

Message du président

Le siège de la SCG ne dort jamais. Du moins, c'est l'impression que j'ai eue alors que votre équipe de direction évoluait au cours des quatre derniers mois de son mandat. Naturellement, les efforts déployés par notre compétent secrétaire général, **Victor Sowa**, ainsi que par **Wayne Gibson** et **Lisa McJunkin**, nos administrateurs de

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la SCG, ont permis de concrétiser tout cela. Beaucoup d'activités passent inaperçues pour les membres de la SCG. Par exemple, avec l'aide du président élu **Doug VanDine**, le prochain secrétaire général de la société a maintenant été choisi. Nous présenterons le nouveau secrétaire général lors de la réunion d'affaires qui aura lieu conjointement avec **GéoRegina 2014**. Nous saisirons également l'occasion pour reconnaître la contribution du secrétaire général actuel, Victor Sowa, qui quittera son poste au début de 2015. Et j'ajouterai que le directeur, lors de notre réunion de mai, a proposé de changer le titre de secrétaire général pour celui de **directeur général**. On formulera une proposition en ce sens aux membres lors de la réunion d'affaires de la SCG qui se tiendra au début de **GéoRegina 2014**. Nous croyons que ce titre reflète mieux les fonctions de ce poste et va de pair avec la pratique nord-américaine.

Dans le cadre de la transition du directeur général, le directeur a mis en œuvre un plan pour un répertoire de documents virtuels de la SCG. En vertu de ce plan, toute la documentation sera stockée dans « le nuage » et mise à la disposition de tous les membres de la direction pour les aider à exercer leurs diverses fonctions. De même, les présidents des Divisions et des Comités auront accès à des bibliothèques de documents qui peuvent servir de modèles pour les aider dans leurs fonctions et fournir un rapport utile d'activités précédentes.

Lors de sa réunion du printemps, le directeur a également progressé dans la mise à jour du **Manuel canadien d'ingénierie des fondations** (MCIF) qui a été révisé pour la dernière fois en 2006. Le directeur envisage de distribuer le prochain MCIF sous forme de livre électronique et de faire des mises à jour chapitre par chapitre. Cette stratégie réduira les coûts et garantira que les chapitres qui doivent être mis à jour le plus instamment pour refléter l'état changeant de la pratique dans le domaine de la géotechnique canadienne soient faits en temps opportun. Au moment où vous lisez ce message, vous aurez reçu un message de la SCG vous demandant votre avis sur ce projet très important.

Une activité importante du directeur de la SCG et des présidents des Divisions de la SCG l'été dernier a été la mise en candidature et la sélection des lauréats des divers prix de la SCG. Je ne saurais trop insister sur l'importance de ces prix pour nos membres et notre communauté géotechnique canadienne. À l'exception du prix R.M. Quigley pour le meilleur article publié dans la Revue canadienne de géotechnique, tous les lauréats des prix de la SCG doivent être membres de la SCG. Il y a eu un

certain nombre de déceptions dans le processus de mise en candidature lorsque des membres méritants ont laissé expirer leur adhésion et par conséquent, se sont retirés de la liste. Je demande à tous les membres de rappeler aux personnes méritantes qu'un avantage important de l'adhésion à la SCG est d'être reconnu par un ou plusieurs des prix prestigieux de la SCG et de l'Institut canadien des ingénieurs (ICI); mais pour ce faire, vous devez être membre de la SCG!

Lorsque vous lirez cet article, vous devriez avoir pris des dispositions pour vous joindre à nous à **GéoRegina 2014** qui aura lieu du **28 septembre au 1er octobre**. Veuillez vérifier le site Web de la conférence au *www.georegina2014.ca* pour obtenir des renseignements concernant d'autres événements, y compris le dîner Legget, la Hardy Address et la présentation d'un meilleur article d'un étudiant diplômé. Parmi les participants spéciaux, notons **M. Scott McDougall** de BGC Engineering Inc., qui est le **conférencier du Colloque 2014 de la SCG**. Je me réjouis également de souligner que le Conseil de recherche géotechnique de la SCG présidé par **M. Murray Grabinsky** a choisi **M. Greg Siemens** du Collège militaire royal du Canada pour être notre conférencier du Colloque 2015 de la SCG. M. Siemens fera son exposé à **Géo-Québec 2015** en septembre de l'année prochaine.

La Tournée de conférences pancanadiennes (TCP) de la SCG fait venir un expert national et un expert international à certaines sections de partout au pays chaque année. Le conférencier de la TCP de l'automne 2014 n'était pas définitif au moment où ce message a été préparé, mais je suis ravi de vous informer que le conférencier de la **TCP du printemps 2015** sera le **professeur Nick Sitar** de la University of California, Berkeley.

Enfin, je souhaite informer nos membres de **la SCG de la 4e Conférence sur les technologies du changement climatique** qui aura lieu en mai 2015 à Montréal (*http://www.cctc2015.ca*). Cette conférence est organisée par l'Institut canadien des ingénieurs (ICI) avec le soutien de dix de ses sociétés membres, y compris la SCG. Il s'agit d'un forum canadien et international visant l'échange d'idées pour faire face au changement climatique. C'est aussi l'occasion de demeurer au courant des percées techniques et technologiques pour l'atténuation des effets du changement climatique et l'adaptation à ceux-ci. Nous sommes tous des intervenants dans ce débat important et beaucoup d'entre vous participent à des activités techniques qui sont affectées par le changement climatique. Les organisateurs de la conférence aimeraient avoir de vos nouvelles.

J'espère vous voir tous à **GéoRegina 2014**.

Del la part de Richard Bathurst - président

From the Society

Upcoming Conferences and Seminars

2014 Canadian Geotechnical Conference
September 28 - October 2, 2014
Regina, Saskatchewan

The Canadian Geotechnical Society (CGS) invites you to its 67th annual conference at the Delta Hotel in Regina, Saskatchewan. GeoRegina 2014 will be held from Sunday, September 28 to Wednesday, October 1, 2014.

The theme for **GeoRegina 2014, Engineering for the Extremes**, will highlight current trends in geotechnical engineering by addressing increasingly complex problems under more extreme operating conditions. The organizers intend to bring a focus to local challenges, such as climate, expansive clays, and permafrost, in the face of unprecedented economic and population growth. The technical program will offer opportunities for delegates to explore various examples ranging from environment damage to rehabilitation of failing infrastructure. We hope to present a conference where innovative, multidisciplinary solutions and best practices for dealing with extreme engineering challenges are openly shared and discussed. In keeping with CGS practice, challenging and informative workshops, seminars and tours will be offered in conjunction with the conference, along with a Partners Program that will highlight local and regional activities. The official languages of the conference are English and French.

Known as a city with *Infinite Horizons*, this community slogan reflects both the vastness of space and momentum of our current growth. We welcome you to a city that has gone from prairie field to one of Canada's fastest growing cities.

The Delta Regina hotel is located in the heart of downtown Regina and within walking distance of the city's many landmarks including Wascana Park and the Legislature Building, Victoria Park, Casino Regina housed in the old Union Station, and numerous shops and restaurants. Delegates and their guests may also choose to visit popular tourist attractions such as the RCMP Heritage Centre, Globe Theatre, Royal Saskatchewan Museum, Norman Mackenzie Art Gallery, Saskatchewan Science Centre, Regina Symphony Orchestra, Government House and Saskatchewan Sports Hall of Fame.

For more information on **GeoRegina 2014**, please visit the conference website at *www.georegina2014.ca*.

Seventh International Conference on Deep and High Stress Mining
September 16 - 18, 2014
Sudbury, Ontario

Underground mining continues to progress at deeper levels and industry is now extracting mineral reserves at depths that previously would have been considered "unmineable". Deep mining is a very technical and challenging environment. The geotechnical and logistical issues, including recirculation and refrigeration of fresh air, are often intense and best practices and innovations need to be implemented.

The Australian Centre for Geomechanics, The University of Western Australia looks forward to hosting the Seventh International Conference on Deep and High Stress Mining in Sudbury for the first time. This follows the previous International Deep and High Stress Mining Seminars held in Perth, 2012; Santiago, 2010; Perth, 2007; Quebec City, 2006; Johannesburg, 2004; and Perth, 2002. The series objective is to promote documentation of the latest technologies and practices of mining in deep and high stress mining environment.

For more information, go to the conference website at *www.deepmining2014.com*

First International Conference on Discrete Fracture Network Engineering
October 19 - 22, 2014
Vancouver, B.C.

The Vancouver rock mechanics community is pleased to host **DFNE 2014, the 1st International Conference on Discrete Fracture Network Engineering**, *http://www.dfne2014.ca*. This conference will be the inaugural international meeting of engineers and geoscientists who use discrete fracture network engineering in the characterization of rock masses and solutions of engineering problems. This new and rapidly expanding area of engineering has wide applications, including underground and surface mining, underground nuclear waste disposal, petroleum geomechanics, civil engineering and natural hazards. Most modern geomechanical simulation software packages now include the option to consider discrete fracture networks which are increasingly important to engineers and geoscientist involved in practical rock engineering and fluid flow problems. This conference will include keynote lectures by experts in the areas of Discrete Fracture Networks and their application to mining, civil and petroleum engineering. With almost 170 accepted abstracts and five short course/workshops dealing with a wide range of DFN topics from data collection and structural geology to DFN development and geomechanical modeling, a major focus of the conference is to provide a practical introduction to DFN engineering and its relevance to industry as well as to introduce state-of-art developments.

DFNE 2014 will be held at the Sheraton Wall Centre in scenic downtown Vancouver, British Columbia, Canada from October 19 - 22, 2014. The **DFNE 2014** organizing committee invites you to join us to share your ideas and experiences in the increased development and practical use of this technology under the theme **Engineering Characterization of Fractured Rock Masses: Applications of Discrete Fracture Network Engineering.**

The Conference Co-Chairs are **Doug Stead** of Simon Fraser University and **Bill Dershowitz** of Golder Associates. For more information contact Doug Stead at *dstead@sfu.ca*

68th Canadian Geotechnical Conference and 7th Canadian Permafrost Conference
September 20 - 23, 2015
Québec City, Québec
Call for Abstracts

The Eastern Quebec Section of the Canadian Geotechnical Society and the **Canadian National Committee for the International Permafrost Association (CNC-IPA)**, invite you to **GéoQuébec 2015**, for the joint 68th Canadian Geotechnical and 7th Canadian Permafrost Conference. The conference will be held from September 20 - 23, 2015 in the Convention Center in Québec City, Québec. It will cover a wide range of topics, including speciality sessions that are of local and national relevance to the fields of geo-engineering, permafrost and engineering geology. In addition to the technical program and plenary sessions, the conference will include a complement of workshops, short courses, technical excursions and local tours.

The official languages for the conference will be English and French. The Convention Center is located in the historic downtown area of Québec City, a UNESCO World Heritage Site, facing onto Québec's Parliament Hill. Old Québec City, which is the cradle of French civilization in North America, is best explored on foot and September is the best time of the year with a typically warm, dry weather and the maple trees just beginning to take on their colourful fall foliage.

The conference theme **Challenges from North to South**, reflects the diverse and complex challenges

that the geotechnical, cold regions engineering and permafrost communities will need to address in order to support sustainable economic development. The Local Organizing Committee invites members from the Canadian and international communities to contribute papers on their recent research and advancements in geotechnical, geo-environmental and cold regions engineering, as well as permafrost science.

Authors are invited to submit abstracts of a maximum 400 words through the conference web site, *www.geoquebec2015.ca*, which will be launched in late September just prior GeoRegina 2014. The abstracts should generally fall within the following topics, but sessions will be added for groups of abstracts which share a common theme but are not listed below:

- **Fundamentals**
  Soil and Rock Mechanics, Foundation Engineering, Groundwater Hydraulics, Physical and Numerical Modelling, Geocryology, and Periglacial Processes
- **Soil and Terrain Characterization**
  Laboratory Testing, In Situ Testing, Instrumentation, GIS and Remote Sensing
- **Geohazards**
  Climate Change, Permafrost Degradation, Earthquakes, Landslides
- **Infrastructure Design and Operation**
  Transportation, Pipelines, Embankments and Dams, Harbour and Shoreline Geotechnique, Infrastructure performance in Cold Regions
- **Problematic Soils**
  Permafrost Soils and Ground Ice, Collapsible Soils, Expansive Soils, Ground Improvement
- **Mining Waste Management and Environmental Geotechnology**
  Mine Waste Disposal, Contaminated Soils, Landfills and Barriers, Restoration of Derelict Lands, Mining in Cold Regions
- **Sustainable Development**
  Policy and Regulation, Risk and Reliability, Northern Communities
- **Case Studies and Case Histories**

The deadline for abstract submission is **January 15, 2015**. Authors whose abstracts are accepted by the conference's Technical Committee will be notified by **February 21, 2015** and invited to submit full papers. The submitted papers, which can be in either English or French, will be reviewed prior to final acceptance and inclusion in the conference proceedings. At least one author of an accepted paper must register for the conference for its inclusion in the proceedings.

For more information regarding sessions, topics and the technical program, please contact **Jean Côté** (Conference Co-Chair - geotechnical) at *jean.cote@geoquebec2015.ca* or **Michel Allard** (Conference co-Chair - permafrost) at *michel.allard@geoquebec2015.ca*. For geotechnical contributions, please contact **Didier Perret** (Technical Program co-Chair) at *comtec_geot@geoquebec2015.ca* and for permafrost and cold region engineering contributions, **Richard Fortier** (Technical Program co-Chair) at *comtec_perg@geoquebec2015.ca*.

68e conférence canadienne de géotechnique
7ième conférence canadienne sur le pergélisol
20 - 23 septembre 2015
Québec, Québec, Canada,

Appel à contributions

La Société canadienne de géotechnique (SCG), la Section régionale de l'Est-du-Québec de la Société canadienne de géotechnique et le Comité national canadien de l'Association internationale du pergélisol (CNC-AIP) vous invitent à participer à GéoQuébec 2015; il s'agit de la 68e conférence canadienne de géotechnique et de la 2e conférence conjointe SCG/CNC-AIP sur le pergélisol. Cet événement se déroulera au Centre des congrès à Québec (Québec), Canada, du 20 au 23 septembre 2015. Le thème de GéoQuébec 2015 – Des défis du Nord au Sud - reflète la diversité des défis complexes auxquels font face les spécialistes en géotechnique, en géotechnique des régions froides et en pergélisol pour assurer le développement durable des communautés canadiennes. Les langues officielles de la conférence sont le français et l'anglais. Le Centre des congrès se trouve à quelques pas du quartier historique de la ville de Québec, un joyau du patrimoine mondial de l'UNESCO, et fait face à la colline parlementaire de Québec. Le mois de septembre à Québec est le meilleur moment de l'année, avec une température clémente et des érables qui se parent de leur feuillage coloré.

Le Comité local d'organisation de la conférence invite les membres des communautés canadiennes et internationales en géotechnique, en géotechnique des régions froides et en pergélisol à contribuer à la conférence en soumettant les résultats de leurs travaux et découvertes dans ces domaines. La conférence couvrira un large spectre de thèmes incluant des séances spéciales d'intérêt local et

national dans les domaines de spécialisation de la géo-ingénierie, du pergélisol et du génie géologique. En plus du programme technique et des séances plénières, la conférence comprendra des ateliers, des cours intensifs, des excursions techniques et des visites guidées.

Les auteurs sont invités à soumettre des résumés de 400 mots au plus en utilisant le site internet de la conférence (*www.geoquebec2015.ca*) qui sera disponible à la mi-septembre 2014. Les résumés peuvent être rédigés en français ou en anglais. La date limite pour soumettre un résumé est le 15 janvier 2015. Une invitation pour la soumission d'articles sera envoyée avant le 21 février 2015 aux auteurs dont les résumés auront été acceptés par le Comité du programme technique. Les articles soumis, soit en français, soit en anglais, seront révisés avant leur acceptation pour publication sur clé USB dans les actes de conférence. Au moins un des auteurs d'un article accepté doit s'inscrire à la conférence pour la publication de cet article.

Les résumés devraient normalement se rattacher à l'un des thèmes suivants. Les thèmes des séances techniques pourront cependant être modifiés en fonction des résumés reçus.

- **Aspects fondamentaux**
  Mécanique des roches et des sols, Fondation, Hydraulique des eaux souterraines, Modélisation physique et numérique, Géocryologie, Processus périglaciaires
- **Caractérisation des sols et de sites d'étude**
  Essais en laboratoire, Mesures in situ, Instrumentation, SIG et télédétection
- **Risques naturels**
  Changements climatiques, Dégradation du pergélisol, Séismes, Glissements de terrain
- **Conception et opération d'infrastructures**
  Transports, Gazoducs et oléoducs, Remblais et barrages, Géotechnique marine, Performance des infrastructures en régions froides
- **Sols problématiques**
  Pergélisol et glace de sol, Sols susceptibles aux affaissements, Sols gonflants, Techniques d'amélioration des sols
- **Gestion des résidus miniers et géotechnique environnementales**
  Entreposage des résidus miniers, Sols contaminés, Sites d'enfouissement et barrières imperméables, Restauration de sites contaminés, Exploitation minière en régions froides
- **Développement durable**
  Politique et réglementation, Géorisques et fiabilité, Communautés nordiques

Les études de cas sont sollicitées. Les articles sur de nouvelles techniques d'analyse, des solutions innovantes à des problèmes et des projets de recherche sont aussi encouragés.

Toutes questions relatives aux sessions, aux thèmes et au programme technique peuvent être posées aux membres du comité local d'organisation de la conférence:

Pour information générale, **Jean Côté**, Coprésident de la conférence (géotechnique) *jean.cote@geoquebec2015.ca*, **Michel Allard**, Coprésident de la conférence (pergélisol) *michel.allard@geoquebec2015.ca*. Pour les contributions en géotechnique, **Didier Perret,** Coprésident du programme technique *comtec_geot@geoquebec2015.ca*. Pour les contributions en géotechnique des régions froides et sur le pergélisol, **Richard Fortier**, Coprésident du programme technique *comtec_perg@geoquebec2015.ca*.

Correction

In the June issue Geotechnical News, the caption for the photograph of 2014 GSE Symposium Lecturers incorrectly identified Dr. Richard Goodman as Dr. Richard Fredlund. The caption should have read *"Back Row (left to right) Dr. Nobert Morgenstern, Dr. Scott Anderson, Dr. Doug Stead, Dr. David Cruden, Dr. Serge Leroueil,* **Dr. Richard Goodman**,". Apologizes to Dr. Goodman on the error.

Editor

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International Course on Geotechnical and Structural Monitoring Poppi, Tuscany, Italy – June 2014

John Gadsby

Continuing education courses on Geotechnical Instrumentation for Field Measurements have been held in either Missouri or Florida every second year for the past 40 years, with John Dunnicliff as the course director. That series of courses has now been replaced by an annual course in Tuscany, Italy—the first edition took place in June this year. The theme of 2014 course was changed to Geotechnical and Structural Monitoring (GSM), and billed as an International course. The course was directed by John Dunnicliff and organized by Paolo Mazzanti of NHAZCA (Natural Hazards Control and Assessment) - spin off of "Sapienza" University of Rome.

Poppi is about 40 km east of Florence and about 30 km northwest of Arezzo. Poppi is considered one of the most beautiful towns in Tuscany with the spectacular tenth-century castle of the Guidi Counts situated on the hilltop that dominates the surrounding countryside. The course was held in the castle.

The GSM was truly an international gathering and probably the most international for any engineering short course. The course attracted some 100 participants from 27 countries with 18 different languages. The language of the course was English and yet for 80% of the attendees this was their second language.

Tenth century Poppi Castle.

The three-day course covered three principal topics: basic concepts of monitoring; types of geotechnical and structural instrumentation; case histories and the lessons learned. In contrast to the Florida courses GSM included substantial content on remote monitoring systems such as GPS, Laser and Radar systems, with a look also at satellite monitoring.

The presentations were given by an international group of leaders in the geotechnical and structural monitoring community. All lectures were given using a standard PowerPoint template that gave a uniformity and clarity to the presentations.

The section on case histories covered a wide range of monitoring programs for almost every type of engineering structure. These case histories illustrated the importance and diversity of geotechnical and structural monitoring projects and the advances made in the past 60 years.

The 2014 edition of GSM was a great success. Anyone in the monitoring community should add this course to his/her list of "to dos" for the following reasons:

- It is the only comprehensive course on geotechnical and structural monitoring:
- It is exceptionally well organized;

Course organizers. Left to right: John Dunnicliff, Paolo Mazzanti, Alfredo Rocca, Ambra Argento, and Elisa Brizi.

- It is a great opportunity to network with an enthusiastic group of engineers and scientists;
- Add to this the beauty, culture and warm hospitality of Tuscany; and
- Where else do they close down a town's main street for an engineering banquet and serve gourmet Tuscan food? Wine too!

The good news is that a second edition will be held on June 4, 5 and 6, 2015. I suggest you sign up now (*www.geotechnicalmonitoring.com*). Travelling to Tuscany just for a three-day engineering course may seem onerous, but you can always extend your visit by adding a vacation and joining one of the nearby world famous cooking or wine schools.

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Introduction by John Dunnicliff, Editor

This is the seventy-ninth episode of GIN. One article this time.

The first GIN was in the September 1994 issue of this magazine. If you're wondering why this isn't the 81st episode, keep wondering (I don't know!). In that first GIN, when my introduction was called a 'column', I wrote:

> *This is the first episode of what may become an ongoing saga in Geotechnical News. Its purpose is to share useful information relating to geotechnical instrumentation. Each part will be brief, and I intend to focus on performance of instruments. As a practitioner, I know how difficult it is to be confident that such-and-such an instrument will work well, and it seems to me that if we share performance information with each other, we will make this less difficult.*
>
> *This is therefore not "my column", but "our column" … Whether or not this idea stays alive will depend on you (as Stephen King says: "constant reader") than me.*

Poppi street party.

The content has broadened from the originally intended focus on performance of instruments, and I have no problem with that. But what I DO have a problem with is my regular need to ask, as I did yet again in the previous GIN, **"Is anybody there?"** and **"Do you want GIN to continue?"** If you DO want it to continue, I need articles from **YOU**.

Resolving unexpected monitoring results

The article by Glenn Tofani is just the kind of contribution that I like to have in GIN—clear and useful to others. It presents two case histories with unexpected monitoring results. The focus is on the importance of developing an analytical model, or an understanding of the underlying processes, in order to understand the monitoring data.

International Course on Geotechnical and Structural Monitoring in Italy

Our first international course in Tuscany, Italy in the 10th century Poppi castle is now history. The course attracted some 100 participants from 27 countries with 18 different languages. In general it seems to have been a success, but of course we'll make some changes to improve the next one in June 2105. We intend that this will become an annual event.

My primary memories of the course are:

- The outstanding organization by my Italian colleagues (far better than any other courses that I've been involved in).
- The beauty, culture and warm hospitality of Tuscany.
- The close interactions among us all. The town of Poppi was so small that at the end of every day we sat together at the outdoor bar alongside the castle (recommended wine: Prosecco), and in the same restaurants and, most memorably,

- The unforgettable street party, for which the main street of the little town was blocked for us! See the photo.

You may note that none of these four memories is about technical content – but I was happy with that too! I hope to meet some of you in June next year. For more information, see *www.geotechnicalmonitoring.com.*

Presentation style for technical lectures

For many years I've been trying to find a model of the best style for presenting technical lectures. Eureka, on youtube! ---

- Search for "entabulator by erik fraz".
- Search for "the brain as explained by john cleese".

So now we have our models. Yes, they're funny, but have you had to sit through lectures that are as gobbledy-gooky as these? I have.

Closure

Please send an abstract of an article for GIN to *john@dunnicliff.eclipse.co.uk* —see the guidelines on *www.geotechnicalnews.com/instrumentation_news.php*

Fee sihetak! (Egypt)

Resolving unexpected monitoring results - Two case histories

Glenn Tofani

An important aspect of most monitoring programs is the development of an analytical model, or an understanding of the underlying processes, that produce the responses that were recorded. Monitoring programs occasionally yield results that are either unexpected or not easily explained by conventional models. This article presents short summaries of two projects where unexpected monitoring results were obtained. These summaries describe

the type of monitoring that was performed, how the data that were collected differed from the expected results, and how those discrepancies were ultimately resolved. The type of instrumentation associated with these case histories includes inclinometers and piezometers.

Upslope inclinometer offsets at Big Rock Mesa Landslide

The first case history involves a large (200+ acre) landslide in Malibu, California referred to as the Big Rock Mesa Landslide (see Figure 1). The landslide activated in 1983 after an extended period of heavy rainfall. The basal rupture surface of the landslide was up to approximately 250 feet deep with a series of apparent secondary failures along the steep coastal bluff. The general orientation of the basal rupture surface was defined using a series of inclinometers. A simplified cross section through the landslide is provided as Figure 2. One of the inclinometers was installed along the top of the coastal bluff. That inclinometer indicated progressive shearing in an upslope direction with no offsets in the apparent direction of landslide movement. This data initially confounded a number of investigators and it was speculated that either the orientation of the inclinometer axes had been recorded incorrectly or the inclinometer casing was twisted or rotated above the depth at which the movement was occurring. Both of these potential explanations were evaluated and disproved. A finite element model of the landslide was developed to evaluate stresses and deformation patterns within the mass (see Figure 3). This model indicated the abrupt upward curvature of the basal rupture surface which occurred along a fault that extended along the shoreline would indeed induce a stress pattern consistent with the reverse shearing observed in the inclinometer. To further evaluate the results predicted by the computer model, a 1:50 scale physical model of the landslide was created (Figure 4). The physical model consisted of a ¼" thick piece of aluminum plate that was bent to match the shape of the basal rupture surface. The upper surface of the aluminum plate was then covered with a thin layer of wax. Fine, moist sand was then placed on the aluminum plate and molded to conform to the topography of the landslide. A small amount of powdered bentonite was mixed with the sand to provide a scaled level of apparent cohesion consistent with the formational materials that comprised the landslide. The simulated landslide failure surface was then slowly heated using a series of thermal strips attached to the bottom

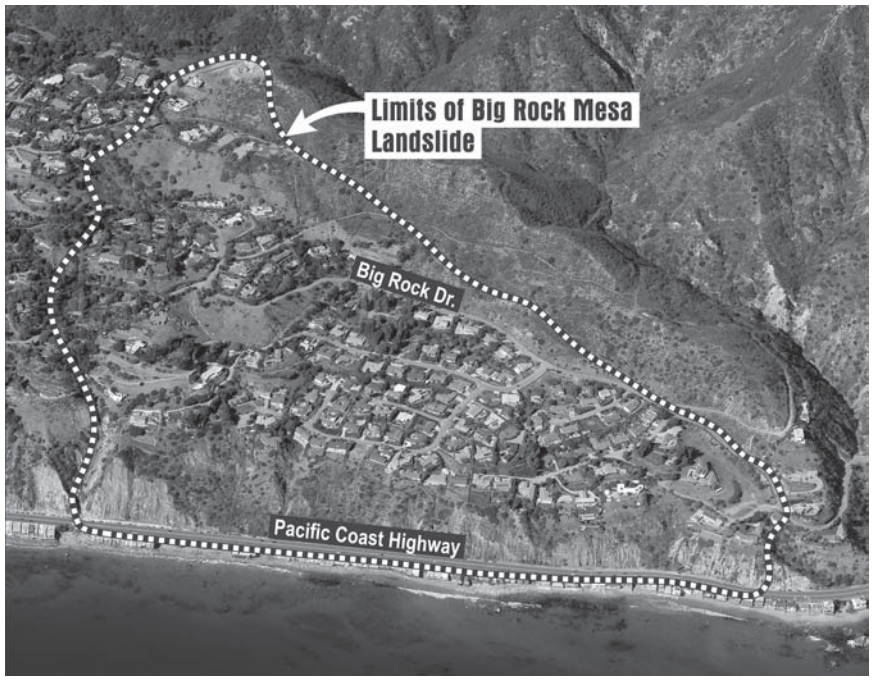

Figure 1. Big Rock Mesa Landslide – Malibu, California.

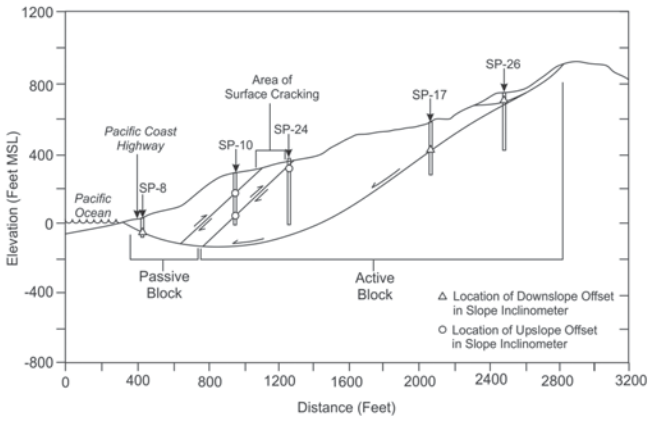

Figure 2. Cross section through Big Rock Mesa Landslide.

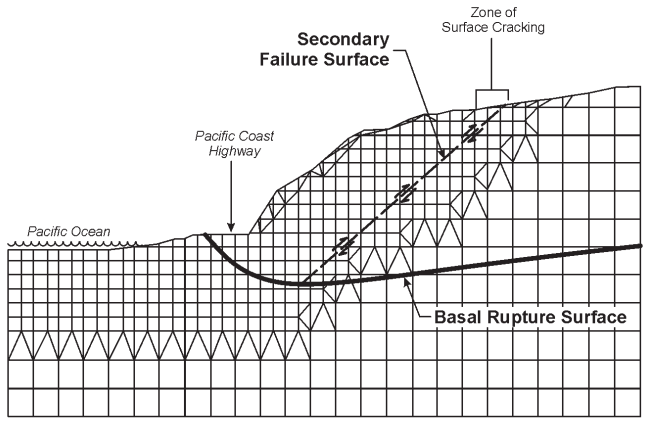

Figure 3. Portion of landslide finite element model.

of the aluminum plate. As the plate was heated, the wax softened, and the simulated landslide displaced along the failure surface. A grid pattern was painted on both sides of the model to allow any internal deformation to be more easily identified. As the landslide moved along the failure surface, a well defined zone of reverse shearing developed through the bluff consistent with the inclinometer results. The combination of the finite element and the physical models confirmed the validity of the inclinometer results and the interpreted configuration of the basal rupture surface. That knowledge facilitated the development of remedial measures to stabilize the landslide. Those measures have been effective to date.

Landslide movement induced by expansive soils

The second case history involves movement of a landslide that occurred after the construction of a large gravity buttress. The presence of the recently active landslide was identified during the pre-grading investigation of a residential development in Clayton, California. The majority of the landslide was removed during grading, however a portion of the slide debris was left in place behind a gravity buttress that was designed to provide a factor of safety in excess of 1.5 with respect to gross stability. An aerial photograph of the landslide area is provided as Figure 5, while a stratigraphic cross section though the site is provided as Figure 6. Up to approximately 100 feet of fill was placed above the landslide debris that remained in place. The fill consisted predominately of moderately to highly expansive clay and clayey silt derived from the Martinez and Domengine Formations. Shortly after the residential development was completed, a series of cracks formed within streets and other improvements parallel to the top of the descending slope. Inclinometers were installed within the development and monitored for several years. Up to approximately three inches of lateral movement was

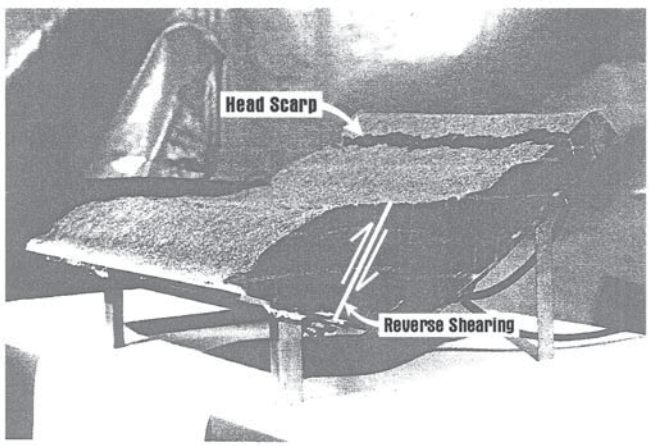

Figure 4. Physical model of landslide.

Figure 5. Aerial photograph of Keller Ridge Landslide area – Clayton, California.

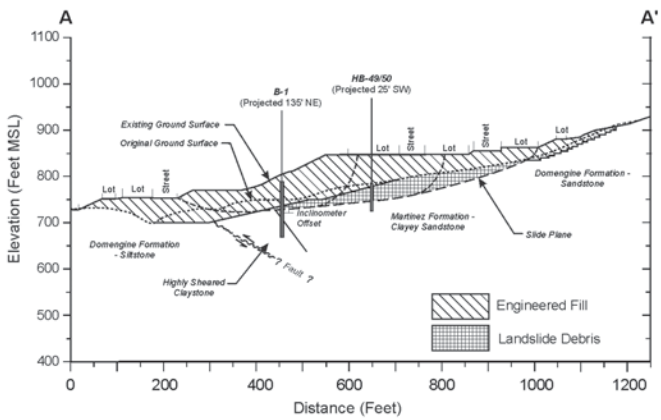

Figure 6. Cross section through Keller Ridge Landslide.

recorded by the inclinometers. Where the ancient landslide debris had been left in place, the movement occurred along the basal rupture surface. Downslope of the slide debris, the movement generally occurred as a dispersed zone of deformation within the fill without any well defined offsets. The monitoring results and crack patterns indicated the amount of movement increased in the downslope direction. Piezometers were also installed within the development to delineate groundwater levels. The effective shear strength parameters for the landslide rupture surface were relatively well defined by back-calculations based upon a factor of safety of unity prior to grading. The shear strength parameters for the fill soils were based upon a large number of tests that had been performed on that material. Slope stability calculations using all of the available data for the post-graded condition yielded factors of safety in excess of 1.5. Those results appeared to be inconsistent with the fact that several inches of movement had occurred along the basal rupture surface. A finite element model of the site was created to more thoroughly evaluate the induced stresses and deformation. This model incorporated the shrink-swell characteristics of the expansive fill soils and simulated the post-grading wetting that had occurred as a result of the residential landscaping and irrigation. As a result of the post-grading soil wetting and expansion in conjunction with the upslope topographic confinement and lack of confinement downslope, the model predicted stress levels and displacement patterns that were consistent with the observed conditions. The model provided a basis for predicting the maximum amount of ground movement that could be anticipated and confirmed the factor of safety against gross instability remained relatively high.

In both of the cases outlined above, analytical and/or physical models were developed and utilized to evaluate monitoring results that could not be readily understood or explained without the use of those models. The use of this type of modeling has proven useful in the evaluation of data from monitoring programs on many occasions.

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New Industrial Research Chair aims to manage tailings from the greatest show unearthed

Vivian Giang

Dr. Ward Wilson is an internationally recognized expert in mine waste management systems, a field that has taken him to numerous mining sites around the world. From Oceania to the Americas, southeast Asia and even Europe, Wilson has dealt with the tailings from various industrial and metallic minerals, including silver, gold, potash and uranium, before delving into fuel minerals such as coal. It was only a matter of time until he would begin working on the tailings from one of the world's biggest mining projects – Alberta's oil sands.

The Alberta oil sands cover an area of about 142,200 km² and contain an estimated 400,000,000 m³ (2.5 trillion barrels) of bitumen. With today's technology, about 27,000,000 m³ of bitumen are considered proven reserves. This volume of oil is the third-largest proven reserve in the world only being exceeded by reserves in Venezuela and Saudi Arabia.

Wilson vividly remembers the first time he came in contact with oil sands, albeit very briefly, in the 1980s. "While working as a consulting engineer with Clifton Associates Ltd. in Saskatchewan, a lab supervisor showed me a jar of oil sands that her grandmother received from a tour of the Great Canadian Oil Sands Ltd. in Alberta. I had never seen anything like it before," he says.

However, with his consulting work at the time and subsequent return to academia, Wilson put aside the jar of oil sands and concentrated on developing extensive research programs in soil cover systems for mine waste management and long-term closure of tailings and waste rock, in addition to research programs to characterize waste rock systems for the control of acid rock drainage (ARD). Wilson's noteworthy contributions include leading the development of the comprehensive numerical model "SoilCover" for the prediction of soil cover performance under the Canadian Mine Environment Neutral Drainage (MEND) Program and being responsible for the benchmark research programs for predicting and monitoring of the performance of the cover systems at the Equity Silver (Canada) and Kidston Gold (Australia) mines. Wilson is currently engaged in large scale-up experiments for waste rock at the Grasberg (Indonesia) and Antamina (Peru) mines to investigate various mitigation techniques as well as a new and innovative research program for the blending of tailings and waste rock (Paste Rock) to produce new high-strength sealing materials for mine waste management systems.

Wilson also served as a specialist consultant to several large international mining companies and collaborated on significant research programs including the well-known ARD Risk Review completed by Rio Tinto in the mid-2000s. In addition, Wilson was the lead author responsible for the chapter on "Prevention and Mitigation" in the Global Acid Rock Drainage (GARD) Guide prepared for International Network for Acid Prevention, which is now becoming recognized as an international industry standard for ARD.

Throughout this time, Wilson taught at several universities, including the University of Manitoba, University of Saskatchewan and University of British Columbia. Again, it was only a matter of time before he would complete his tour of Western Canada and take on full professorship at the University of Alberta in 2010. There, he quickly began transferring his expertise in mine waste management to tackle the unique tailings challenges in the oil sands industry, bringing him back to the jar of oil sands he had seen nearly three decades prior.

"[The Alberta oil sands] is the biggest mining project in the world. The operations and investment that are happening here are bigger than anything I've ever seen," says Wilson.

In Northern Alberta, water-based processes are used to extract bitumen from mined oil sands ore. The oil sands industry has always operated under conditions of zero discharge for process affected water, and tailings impoundments are used almost exclusively for waste management. The combined footprint for these impoundments is currently more than 130 km². Over two years of extensive consultation with industry, academic collaborators and industry regulators, Wilson developed a comprehensive research program aimed to significantly advance the rate at which tailings

ponds can be reclaimed. In 2013, Wilson was awarded the NSERC/COSIA Industrial Research Chair (IRC) in Oil Sands Tailings Geotechnique with additional support from Alberta Innovates – Energy and Environment Solutions. The IRC program focuses on four major areas of innovative research in collaboration with industry and government:

- investigating the unsaturated soil mechanical properties of oil sands tailings;
- investigating consolidation processes for various forms of fluid fine tailings, mature fine tailings (MFT) and amended MFT;
- assessing and improving tailings deposition; and
- understanding the long-term geotechnical behaviour of fine tailings through laboratory testing and simulations.

The IRC program will provide Alberta's oil sands industry, its regulators and consultants with novel technologies to measure the effectiveness of current tailings remediation efforts, new and innovative processes for reducing the amount of post-production tailings, and simulation models to assist industry with tailings planning and management. Further, the collaboration between industry and academia will enable fundamental discoveries for the behaviour and improved management of fluid fine tailings, benefitting the engineering discipline, and bolster Canada's position as an international leader in mining reclamation and oil sands tailings geotechnique. These advances are aligned with the Alberta Energy Regulator's requirements (Directive 074) and commitment to improve tailings management through the reduction of land disturbance by tailings management facilities and earlier restoration of tailings deposits. The IRC program will enable industry to responsibly develop Alberta's oil sands and reduce the impact of its tailings, while training the next generation of experts for the oil sands industry.

"The paramount goal of the IRC is to train highly qualified personnel. A primary function of research at university is to provide opportunities for students to discover and grow. We're helping students to grow and develop as professional engineers and leaders in oil sands tailings geotechnique," says Wilson.

The Alberta Energy Regulator predicts that the oil sands industry will increase production to 3.7 million barrels per day within the next decade, with gross revenues expected to grow to $100 billion per year, making Alberta a major provider of energy for Canada and the world. However, industry's ability to manage its vast amount of tailings will be critical in ensuring the continuity of its operations. Through Wilson's commitment to improving technologies in mine waste management practice, environmental protection and the sustainable use of resources, this new IRC program will help put the people and technologies in place to manage tailings from the greatest show unearthed.

Back row(l to r) Iman Entezari, Bereket Fisseha, Ward Wilson, Neeltje Slingerland, Nicholas Beier, Sally Petaske
Front row (l to r) Vivian Giang, Louis Kabwe, Janeen Ogloza (Photo courtesy of Hope Walls Photography).

Introduction by Jonathan Fannin, Editor

Jonathan Fannin

In my opening remarks for the return of this column on geosynthetics I observed that - notwithstanding the ongoing development of novel materials and innovative products - we can no longer claim geosynthetics are a new material in construction practice. I also noted in those opening remarks that we have an extensive body of information on geosynthetics, published in the form of conference papers and peer-reviewed journal articles, all of which complement the many standards for materials testing and the companion design guidance of regulatory agencies.

This second article now reports on a learned society that has, for more than 30 years, contributed substantially to disseminating the state-of-practice for the use of geosynthetics in geotechnical earthworks – the International Geosynthetics Society (IGS) and one of its chapters, the North American Geosynthetics Society (NAGS). It also reports on two specialist journals that have, likewise, contributed to advancing the state-of-art for use of geosynthetics in engineering design – Geotextiles and Geomembranes (GG) and its companion, Geosynthetics International (GI). The collective effort of the learned society and the journals, to provide a forum for presentation of conference papers and publication of peer-reviewed articles, has contributed significantly to what constitutes the "art and science" of designing with geosynthetics as we know it today.

The International Geosynthetics Society

Jorge Zornberg

Jorge Zornberg, IGS President

It is a privilege for me, in my capacity of current President of the International Geosynthetics Society (IGS), to share my thoughts about the IGS to the readership of Geotechnical News. The International Geosynthetics Society was officially founded on November 10, 1983. The organization of early international conferences on geosynthetics (or "fabrics" as they were called at the time) provided the forum for initial discussions on the formation of an international society. An early international conference on the use of "Fabrics" in geotechnics was held in Paris, France, in 1977. However, the concept of an international society, which will later become the IGS, was only formulated in 1980. Subsequently, during the Second International Conference on Geotextiles held in Las Vegas, USA in 1982, the formation of the IGS was explicitly discussed. Finally, the "International Geotextile Society," as it was named at the time, was officially founded.

Over its 30 years of existence, the IGS has grown remarkably. The IGS currently has over 3,500 members, including some 400 student members and 160 corporate members. The IGS chapters, were initiated with pioneer chapters in western Europe, North America and eastern Asia, but subsequently spread out to the rest of the world, including South America, Africa, and eastern Europe. During this period, the IGS has organized seven international conferences, fourteen regional (continental) conferences, and hundreds of national (chapter) conferences. In addition, current counts show IGS chapters

in 41 countries or group of countries, with several other countries currently in the process of establishing new chapters. The society has established awards programs with emphasis on rewarding technical excellence, it has implemented numerous educational programs, compiled educational material, prepared terminology documents in multiple languages, sponsored student programs, and organized numerous outreach programs, to name a few of its activities and achievements.

Benefits of IGS membership include reduced registration fees when attending any of the IGS international, regional, and national conferences. In addition, the IGS organizes a number of additional programs for its members, including a series of awards program aimed at rewarding technical excellence, service to the IGS and its chapters, and a special program focusing on students. The website of the IGS is being revamped, and you are encouraged to visit us at *www.geosyntheticssociety.org.* It provides access to a significant content of free information, as well as information that is accessible in the 'members only' section. This section includes key benefits to IGS members, in the form of access to the IGS membership directories, proceedings of the previous IGS Conferences, educational presentations, and access to our prestigious journals.

The IGS has been crucial to the advancement of geosynthetics through the numerous activities that it has conducted over the years, which aim to promote education on geosynthetics. Although geosynthetics are now a well-established technology in our portfolio of geotechnical and civil engineering solutions, ingenuity continues to be significant in projects that involve their use. This is likely because of the ability to tailor their mechanical and hydraulic properties in order to satisfy specific needs in the multiple areas of geotechnical engineering. Looking ahead, I anticipate that we will continue to see a significant growth in geosynthetic use because of the ongoing needs and creativity of geotechnical engineers. To this effect, it is particularly relevant that we manage to improve the exposure of geosynthetics to prospective civil engineers (from structural to environmental to hydraulic to geotechnical engineers) and related disciplines while, at the same time, also striving for ingenuity in the development of new products, applications and systems.

The North American Geosynthetics Society

Bob Mackey

Bob Mackey, NAGS President

The North American Geosynthetics Society was established as a Chapter of the IGS in 1986. Since the founding of the Society, the following individuals have served as president: Joseph Fluet (1987-1989), Robert Koerner (1989-1991), Robert Holtz (1991-1993), Jay Beech (1993-1995), Barry Christopher (1995-1997), Richard Bathurst (1997-1999), John Paulson (1999-2001), Karen Henry (2001-2003), David Suits (2003-2005), Grace Hsuan (2005-2008), David Elton (2008-2011), and Dean Sandri (2011-2013). NAGS is an organization in which individual and student members comprise the learned society whose mission, in strong cooperation with IGS, is to provide leadership in advancing education and research on geosynthetics by:

- Organization of and participation in technical conferences, seminars and workshops.
- Development and dissemination of tools for geosynthetics education.
- Recognition of technical contributions and innovations regarding geosynthetics.
- Stimulation of geosynthetics research and their applications through an Awards Program.

In meeting those goals, we organize short courses on a variety of geosynthetic topics, and we organize or participate as co-organizers and sponsors of conferences such as the biannual geosynthetics conference series, the first of which, Geosynthetics '87, was held at New Orleans. Over time, this has involved significant collaboration with the Industrial Fabrics Association International (IFAI), the Geosynthetic Manufacturers Association (GMA), the American Society of Civil Engineers (ASCE) and the Canadian Geotechnical Society (CGS). Traditionally, NAGS provides leadership on developing the technical portion of the conference sessions. Participation by students in the activities of NAGS has been supported in several ways, with free student membership offered to all

students holding an interest in geosynthetics. Our members are eligible to participate in all NAGS and IGS events and receive discounts in accordance with the individual guidelines of each conference – often the discount is sufficient to compensate for the NAGS membership fee with registration at just one event. Programs sponsored by NAGS at our events have grown to include a student paper competition at the biennial conference, with the finalists receiving travel support to the conference, and the top-ranked paper being acknowledged with a cash award for the author. The award winning student also receives financial support for participation at an international conference following the biennial conference at which the paper was first presented.

We are currently in the midst of changes that are intended to enhance our impact within the North American geosynthetics community. Unlike other national IGS-chapters, NAGS is one of several geosynthetic organizations at work within the USA and Canada, all of which share similar objectives and goals, namely continuing professional development, improved communication and the promotion of geosynthetics technology.

Accordingly, NAGS is seeking either to combine with, or coordinate the efforts of, these other organizations in order to minimize unnecessary duplication of effort and improve the future success of our mutual objectives and goals. Given this objective, NAGS is revising its By-Laws to allow for designated Board seats to be filled by representatives of other organizations. Agreements have been reached to allow three organizations each to appoint one member to the NAGS Board: these members will represent the GMA, the ASCE Geo-Institute Geosynthetics Committee, and the CGS Geosynthetics Division.

Returning to the theme of continuing professional development, we have recently developed a NAGS Webinar Series, which is broadcast quarterly. The initiative is being undertaken with leadership from Dr. Richard Brachman, Queens University, Canada. The webinars delivered to-date are:

- 19 March 2014, by Dr. Kerry Rowe, on “Recent insights on the performance of GCLs in bottom liners and covers”.
- 9 July 2014, by Bob Mackey, P.E., on “Composite Drainage Nets.”
- 8 October (upcoming), by Dr. Jonathan Fannin, on “Geofilters – granular and geotextile”.

Other activities of NAGS include:

- assisting with the organization of the Geosynthetics’15 Conference, Portland, Oregon, USA, 15-18 February 2015 (http://geosyntheticsconference.com)
- hosting the GeoAmericas 2016 Conference, Miami South Beach, Florida, USA, 11-14 April 2016
- establishing the NAGS Recognition Awards: Committee Chair, Jay McKelvey, P.E., Earth Engineering, Inc.
- considering the rationale for a name change - in recognition of Mexico now having its own IGS-chapter, and an emerging belief that the “North American” Geosynthetic Society is no longer appropriate – however a suitable alternative has not been found acceptable by the NAGS Board.

For more information regarding the activities and efforts of NAGS or interest in getting involved in the above activities, please feel free to contact Bob Mackey, NAGS President, bmackey@s2li.com or David Suits, NAGS Executive Director, *nagsdirector05@gmail.com*.

Kerry Rowe, Editor of Geotextiles and Geomembranes and Past-President of the IGS

Geotextiles and Geomembranes

Kerry Rowe, Editor

Geotextiles and Geomembranes was launched in 1984, shortly after the founding of the International Geotextile Society in 1983, in response to the rapid development of research and applications for geotextiles, geomembranes and related products (what we now collectively term geosynthetics) under the editorship of Dr. T.S. Ingold and with Dr. J.P. Giroud as the Chair of the Editorial Board. As indicated in the first editorial, it was intended that Geotextiles and Geomembranes would provide a “forum for the dissemination of information amongst research workers, designers, engineers and manufacturers”. Published by Elsevier, it has now been doing so for 30 years! In 1994, Drs. Ingold and Giroud moved on to launch Geosynthetics International and thereby provide a second specialty geosynthetics journal and Dr. N.W.M. John became Editor. No papers were published in 1995.

In 1997 the journal comprised two special issues: one on Geofoam and the other on papers from the 10th GRI conference. In 1998 Dr. R.K. Rowe became Editor and Chair of the Editorial Board, a position that he holds today.

The first volume (1984) of Geotextiles and Geomembranes had six full length original articles (by Giroud; Andrawes, McGown and Kabir; Koerner, Bove and Martin; Gamski; Heerten; and Rowe and Soderman). In 2012 (the most recent year for which full statistics are available), a total of 63 articles were published, the rejection rate was 65%, and it had the highest impact factor of any geotechnical or geosynthetics engineering journal based on citations of its published articles. Thus Geotextiles and Geomembranes provides a leading outlet for geosynthetics related research, and is an essential source of information for those wishing to keep up-to-date. As one of the two IGS sponsored journals, access to Geotextiles and Geomembranes is free to IGS members (and hence CGS members who select the Geosynthetics Division as their first choice option). Knowledge regarding geosynthetics has evolved enormously in the 30 years of Geotextiles and Geomembranes and there is no slowing of the pace as an inspection of recent issues of the journal will show. Each year there are more challenging applications and new products, and each year we learn more about the effects of not using geosynthetics properly. Journals like Geotextiles and Geomembranes help keep the practitioner at the leading edge and are essential to the professional development of those involved in the geosynthetics industry.

Geosynthetics International

Richard Bathurst, Editor

Richard Bathurst, Editor of Geosynthetics International and Past-President of the IGS

Geosynthetics International is received by all members of the IGS as part of their membership (and hence is also received by CGS members who select the Geosynthetics Division as their first choice option). It is published in e-only format six times a year, by Thomas Telford Ltd., the publishing division of the UK Institution of Civil Engineers, having been previously published by the International Fabrics Association International (IFAI) out of St. Paul, Minnesota. The topics covered include the range of geosynthetic materials (including natural fibre products), from a perspective of research, behaviour, performance analysis, testing, design, construction methods, case histories and field experience. The first volume of 1994 contained ten full length articles in two issues, on the cyclic load-extension behaviour of geosynthetics, the effect of solar radiation of geomembranes, carbon black content, installation damage, durability, performance monitoring of reinforced soil structures constructed with poorly-draining backfill soil, deformation mechanisms in reinforced soil, landfill covers, and pavement applications, with authorship from Canada, the USA, Brazil, France and the United Kingdom. By 2013, the last year for which complete data are available, the volume had grown to contain thirty-two full length articles in six issues, with a truly diverse international authorship. The growth in number of published articles, and diversity in contributing authorship, is both a testament to the global use of geosynthetics technology in ground engineering and a strong indicator of the benefit to be gained from knowledge dissemination to the members of the IGS.

A closure to these four contributions

by Jonathan Fannin

It is very clear that we have an extensive body of technical and case-study information on geosynthetics, much of which has been published in the form of conference papers and peer-reviewed journal articles. A significant body of this content (including the proceedings of the IGS conferences, and issues of the journal Geotextiles and Geomembranes, and the journal Geosynthetics International) is readily accessible to members of the International Geosynthetics Society (IGS). In Canada, IGS membership is automatically included with a selection of the CGS Geosynthetics Division as your primary technical Division when joining or renewing membership with the Canadian Geotechnical Society.

Paolo Gazzarrini

Overture

Summertime is quite finished so, perhaps, you will have more time to read this 36th episode of the Grout Line. Two main features:

The first is, as every year at this time, a "classic" and brief report of mine about the Grouting Fundamentals and Current Practice Course (35th edition), held at the Colorado School of Mines in Golden, CO, from June 16 to June 20, 2014.

The second is a very remarkable article about pre-excavation grouting at Lake Mead, Las Vegas, NV, which, not only describes the interesting case-history related to the grouting, but also illustrates an unusual use of TBM as a "packer" (bigger than standard!), to perform permeability tests in rock and evaluate the seepage of the water in the tunnel.

35th edition of the Grouting Fundamentals and Current Practice course

As previously mentioned, the course was held at the Colorado School of Mines, Golden, from June 16 to 20, 2014. An intense week, packed full of presentations, fruitful discussions and with new presenters as, for example Maren Katterbach (Lombardi Engineering), Mike Miluski (Compaction Grouting Services) and Ken Ivanetich (Hayward Baker). See the picture of Scott Kieffer (course leader/organizer), right, Maren Katterbach, center and Trevor Carter (instructor), left.

As in every previous year the participants varied from Agencies to Engineers and Contractors.

As usual the climax of the "grouting week" was the half day field grouting demonstration, held at Baski Inc, where everybody is hands-on, with dirty grouting material, clean grouting equipment and new grouting instrumentation. This year, for the first time, an Optical Televiewer was demonstrated in the field.

As I mentioned earlier, the last, but not least, newcomer Maren, started a new interesting initiative on LinkedIn, a Group called "Grouting Fundamentals and Current Practice". The Group is intended to serve as a platform for follow-up discussions involving participants and instructors, as a general discussion platform for grouting activities, and to promote the course. All participants from the last 10 years will soon be invited to join.

I recommend and encourage everyone interested in grouting to participate!

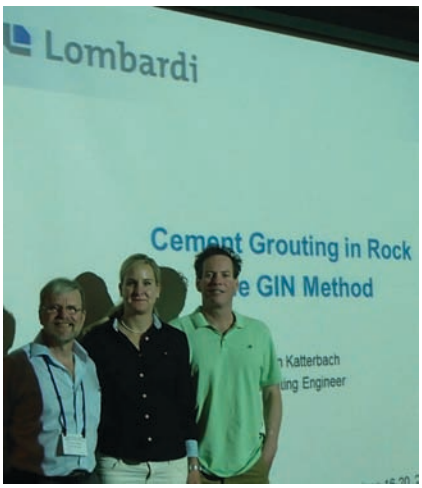
Here's the link:

https://www.linkedin.com/groups/Grouting-Fundamentals-Current-Practice-GFCP-8127869?home=&gid=8127869&trk=anet_ug_hm

For next year, the tentative dates for the Course are June 22-26, 2015. Please mark your calendars, if you are interested!

And, as usual, the same request, asking you to send me your grouting comments or grouting stories or case histories. My coordinates are: Paolo Gazzarrini, *paolo@paologaz.com , paologaz@shaw.ca or paolo@groutline.com.*

Ciao! Cheers!



Trevor Carter, Maren Katterbach, Scott Kieffer.

Lake Mead - Intake Tunnel No. 3 Pre-excavation grouting challenges using a high pressure slurry TBM

Jim Nickerson, Renzo Ceccato, Roberto Bono, Claudio Cimiotti, Pietro Fioravanti

Introduction

The Lake Mead Intake No.3 project is located inside the Lake Mead Recreational Area, approximately 30 km away from the city of Las Vegas in Nevada, USA. The goal of this project is the construction of a third intake

located in the largest reservoir of the United States, that was formed by the Hoover Dam and which extends across the Colorado River between Nevada and Arizona. Due to the constant drawdown of the lake level in the last 15 years, the new intake will lay at a depth greater than the two intakes that are in operation. The water autority forecasted that there is a high risk that Intake No. 1 could be dry by 2020, resulting in the impossibility of the water supply infrastructure to satisfy the overall demand from the Southern Nevada region. This risk can be overcome by the construction and operation of Intake No. 3.

In March of 2008, the Vegas Tunnel Constructors (VTC) joint venture, formed by the Italian company Salini-Impregilo SpA and the American company SA Healy, was awarded by the Owner (Southern Nevada Water Authority - SNWA) the contract for the construction of the Lake Mead Intake No. 3 project. The project includes fabrication and positioning an intake riser, excavation and lining of a 185 m deep shaft and construction of a 4.6 km (Figure 1) tunnel by means of a tunnel boring machine (TBM).

TBM description

The tunnel boring machine designed to excavate the 4.6 km intake tunnel is a Herrenknecht shielded machine. It is a hybrid prototype with the capability of excavating the ground either in open or closed mode, depending on the hydro-geological conditions of the encountered rock masses (Figure 2a and 2b).

The open mode operation consists of excavating the ground without any face support and discharging the excavated material through an 18 m horizontal screw conveyor. This feeds a system of belts which runs along the TBM trailing gear, along the lined tunnel and terminates at the bottom of the shaft, where the muck is discharged into two buckets. Each bucket has a 15 m3 capacity and runs vertically up the 180 m deep shaft, bringing the material to surface. Once at the surface, a 550 m long belt conveyor system is loaded to take the muck to the designated disposal area on site.

In closed mode, the TBM operates like a slurry machine. Mining occurs by applying a support pressure at the face. This mode is used in order to guarantee stability of the ground avoiding any uncontrolled muck handling and to reduce the risk of tunnel flooding in case highly permeable rock masses are encountered or direct connection with Lake Mead is made. The supporting pressure is applied by injecting bentonite drilling mud in the excavation chamber. This is also used as a means to remove the excavated material from the heading. A mix of bentonite and muck, called slurry, is transferred to the surface through a system of pipes and pumps running along the TBM then down the lined tunnel and finally the shaft. On the surface, the slurry is pumped to a separation plant where the excavated solids are removed and the drilling mud is recycled through the slurry circuit.

The machine is designed to withstand a maximum hydraulic head pressure of 17 bar and operate at 15 bar. The cutterhead is equipped with no. 48 cutters, 17" diameter resulting in an excavation tunnel diameter of 7.22 m. The cutterhead and the total installed power required are 2,800 kW and 5,750 kW respectively. The breakout torque is 10 MNm. The nominal and the maximum thrust are 70,000 kN and 100,000 kN respectively.

The shield is composed of 3 main parts characterized by different diameters in order to obtain a conical shape: Front shield (7.18 m), Middle shield (7.16 m) and Tail shield (7.15 m). An articulation joint is located between front and middle shield. The machine including the cutterhead and shields is 15 m long and weighs 900 tons. All the equipment necessary to operate the TBM is installed on 15 gantries, a total length of 175 m and a total weight of 600 tons.

Among many special features, the TBM is equipped to handle high water pressure and inflows. The machine is equipped with no. 3 drill rigs in order to perform either geological investigation (probing and coring) or pre-excavation ground treatment to reduce the permeability and/or increased

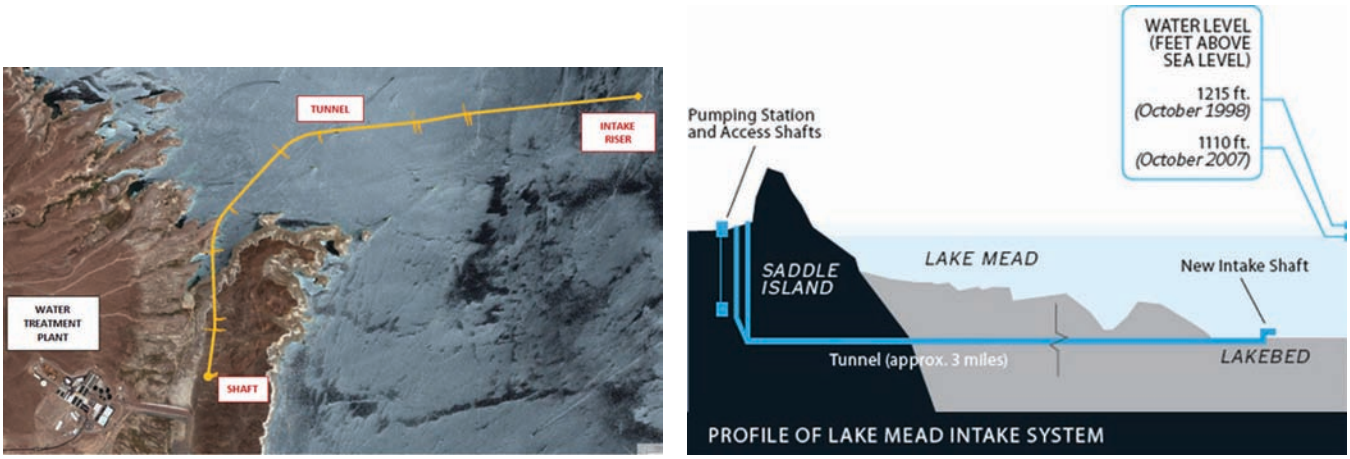


Figure 1. Project plan and profile.

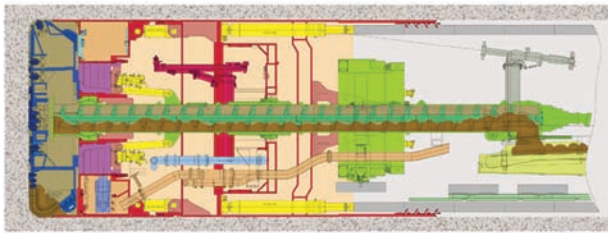


Figure 2a: Open Mode Configuration.

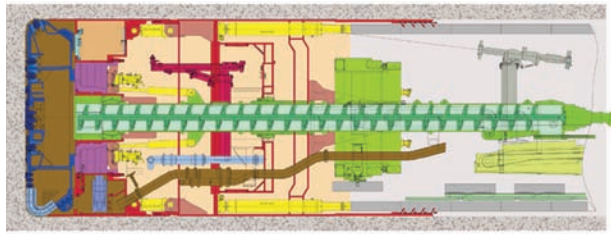


Figure 2b: Closed Mode Configuration.

stability of the rock masses ahead of and around the TBM. Drilling can be carried out through the cutterhead or the shield with a pattern of holes (14 peripheral through the shield; 20 through the cutterhead) characterized by different inclinations (0°, 3.5° and 7°), as illustrated in Figure 3.

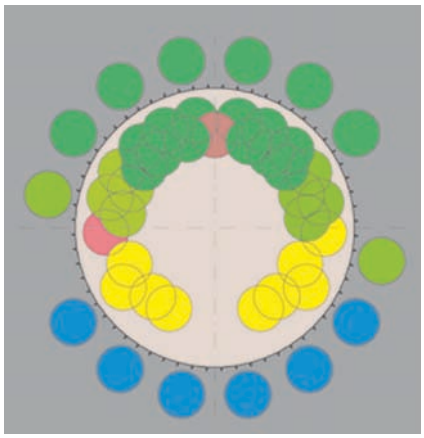


Figure 3: Drilling pattern through the shield (outer holes) and the cutterhead (inner holes).

Face interventions for maintenance are planned to occur, most of the time, in atmospheric conditions. However, in the event maintenance will be required during the closed mode operation, the TBM is equipped and the personnel are trained for hyperbaric interventions.

This means that the pressure in the excavation chamber and in the working chamber will be the same as the face pressure.

In order to reach the excavation chamber and perform maintenance operations under pressure, the TBM is equipped with a series of hyperbaric chambers and access pipe that connects to the excavation chamber, which will be pressurized to the same applied face pressure (Figure 4).

The hyperbaric system also includes a rail transported, portable recompression chamber (Shuttle) that will be located in the tunnel during hyperbaric activities and has the capability of connecting, under treatment pressure, to the Special Decompression Chamber (medical lock) and also to the TBM manlock (prechamber).

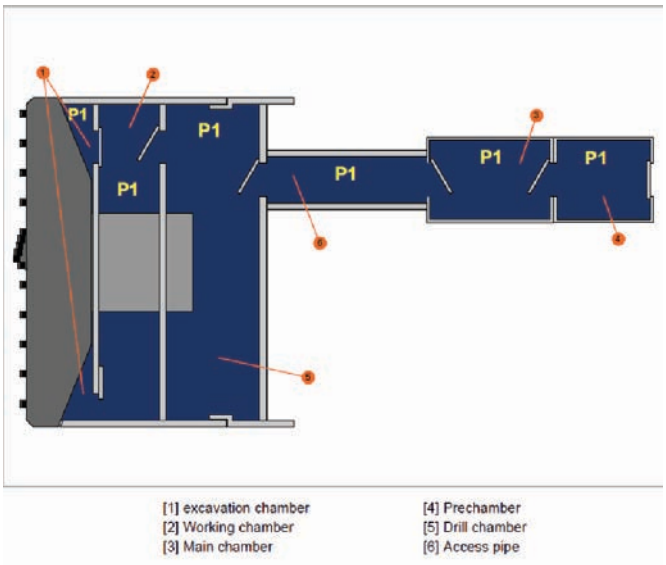


Figure 4: All the environments are pressurized at the same pressure as the face.

Mining Activities

The tunnel boring machine was launched on December 27, 2011. Based on the expected geological conditions of the Saddle Island Lower Plate, the plan was to mine the first 200 m of TBM tunnel in closed mode with face support pressure less than 7 bar. For logistic reasons and due to space limitations the conveyor belt system which was installed after the first 250 m in the starter tunnel; the TBM would then operate in open mode.

After 140 m of excavation at ring N. 77, the air bubble pressure was lowered and maintenance was carried out at atmospheric conditions. At that point, a sub-vertical fault, entering the tunnel section from left to right, was detected and mining resumed with pressure exceeding 12 bar to compensate the hydraulic head and guarantee stability at the face. The TBM progressed very well into the detachment fault and the slurry pressure in the excavation chamber was raised to 13 bar in accordance with the groundwater head and the low cohesive material at the face.

On July 2, 2012, at approximately 280 m of excavation along the first curve of the alignment, the TBM penetration values became lower and lower, until the machine stopped advancing at push 158.

Several attempts to free the machine were unsuccessful. The decision was made to lower the face pressure to 0 bar to inspect the cutterhead.

In order to access the working chamber under atmospheric pressure, it is important to estimate in

advance the quantity of water inflow. For this purpose the TBM can be used as a large-scale constant-head permeameter according to the following procedure. Starting from its initial value, the face support pressure is lowered in steps of 0.5 bar. After each step the increase of water inflow is measured observing the change of water outflow in the slurry line while keeping the slurry level in the bubble chamber constant. The final value of water inflow is recorded after reaching stationary seepage flow conditions. In the present case, this normally took less than 15-20 minutes. After several steps (generally more than 10), the relationship between the quantity of water inflow and face support pressure can be established and subsequently, linearly extrapolated to 0 bar (Fig. 5 shows an example). This approach allows estimating the quantity of water inflow under atmospheric conditions safely, i.e. without the risk of a face instability associated with lowering the support pressure to 0 bar.

During the water tests the force acting on the cutter head, the torque (by rotating the cutter head without TBM advance) and the colour of the drained water are observed in order to timely identify the possible onset of local instabilities and thus interrupt the test by increasing the support pressure immediately to its initial value. By using the TBM as a large constant-head permeameter, the overall permeability of the rock mass (and therefore also the effectiveness of pre-grouting) can be estimated by numerical back-analysis of the measured relationship between face support pressure and water inflow (Figure 5). It should be noted that for high quantities of water inflow, the relationship between face support pressure and quantity of water inflow was not always linear (Figure 6, upper curve). Possible reasons for this non-linearity are turbulent flow or closing of joints due to increasing effective stresses around the tunnel face.

Three large-scale permeability tests were performed but all were aborted at 10 bar with over 200 m3/h water inflow.

At this point the JV opted to drill and grout the ground ahead of the TBM in order to reduce the permeability, increase the overall stability and allow men to enter the cutter head.

On a TBM machine drill and grout operations at such high pressure had never been done before. The ground, mainly composed of sandy, silty and clayey material, made it very difficult to grout.

At this point, an inspection of the cutter head was possible by using a camera installed on a steel pipe and pushing it into the excavation chamber through a drill port equipped with a blow-out preventer. The inspection revealed that the cutter conditions were not that worn, and on August 1, 2012, a further attempt to free the machine was completed. The face pressure was raised to 14 bar, the penetration showed values just above zero, however the machine was advancing. After 12 pushes, a bit over the length of the shield, the TBM parameters were back to regular operation, though showing inconsistencies on penetration and advance speed.

A plan of permeameter tests was discussed as cutterhead inspection and maintenance at atmospheric conditions was a priority. Since restarting the mining activities, during the next 77 pushes, 10 tests were performed and the resulting water inflows reached a maximum of 1,100 m3/h at 8 bar. Accordingly, it was impossible to access the excavation chamber for maintenance. There was one exception where the face pressure was lowered to 0 bar and the excavation chamber was accessed. Unfortunately the geological conditions were not favourable to perform the cutterhead maintenance.

On September 29, 2012, at push 235, the TBM penetration reduced. The camera inspections detected wear on the cutters. The possible scenarios were two: perform a series of pre-excavation grouting campaigns to allow for maintenance or prepare all necessary equipment for hyperbaric intervention in saturation. Both options had never been done before at 14 bar pressure and the hyperbaric work had more inherent risk and cost, so the decision was to start grout-

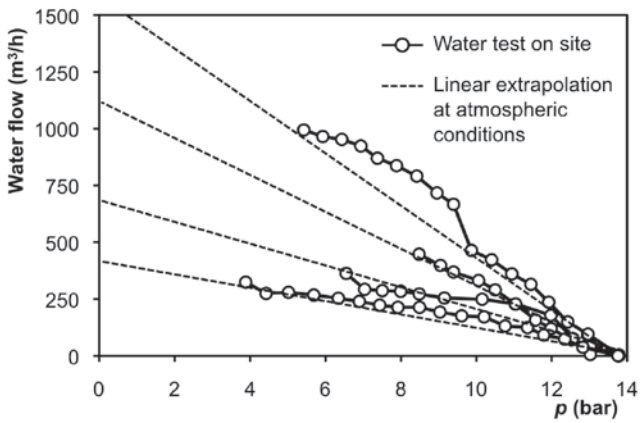


Figure 5: Interpretation of water inflow by means of numerical seepage flow analysis.

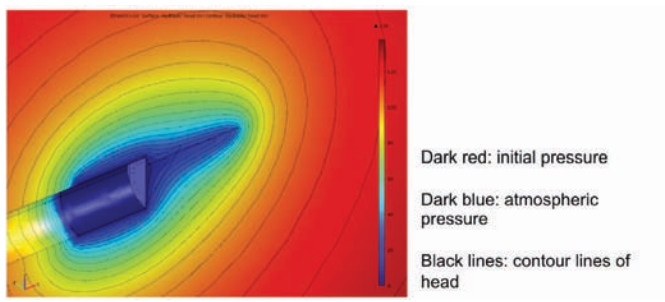


Figure 6: Relationship between face support pressure and quantity of water inflow.

ing the ground ahead and around the TBM.

However, the hyperbaric intervention was still an option and the procurement of the gas and equipment and planning of the logistics was being done concurrently with the grouting program.

Pre-excavation grouting campaigns: means & methods

The ground treatment ahead of the machine was planned and based on the GIN-method [5]. Maximum injection pressure and maximum injection volume were defined in accordance with the fractured ground conditions. A significant difficulty was caused by the fixed pattern of available drilling holes (see green and blue dots on Figure 3). For different stages a methodical injection sequence was followed for the primary and secondary holes.

This was the first intensive grout intervention at 13 bar of face pressure. Normal drilling and grouting procedures were not applicable in our case. It was very difficult managing the water inflow (with pressure) and placing the packer once the hole was drilled. In order to keep up with the challenging geological conditions some modifications and innovations of the equipment were introduced. In particular our focus was on:

- Designing an additional backflow preventer to be installed in front of the original one in order to prevent water and materials coming into the tunnel.
- Changing geometry of the drill steels, from a T38 with round shoulder to a T38 with a square shoulder, in order to reduce the friction point between the steel and the inner rubber of the backflow preventer.
- A packer and the casing had to be designed in-house, to be able to install the packer in highly fractured material. The casing allowed us to install the packer at the correct location and inflate it without damaging the backflow packer.
- Different size and configuration of drilling bits.
- Different mix designs were used depending on the fractured rock mass. Portland and Microfine cement were both used as per the mixes shown in the table below:

A total of three pre-excavation grouting campaigns were performed (Figure 7 and Figure 8).

The first grouting campaign was carried out at ring #235, STA 18+65. The area grouted was planned to extend 11 m, which covered the upper part of the layout shown in Figure 3. The campaign was completed in 1 month then the TBM was advanced 4 m. 1st Campaign - Technical data:

- Number of holes drilled: 22 holes
- Total length drilled: 278 m
- Total quantity injected: 43 m3
- Volume injected: 155 l/m

The second campaign was performed at ring #237, STA 18+79. The grouting was increased to 15 m with an overlap of 4 m of the first campaign. Grout injection was done through the entire pattern of available holes. The campaign was completed in 1.5 months then the TBM was advanced 6 m.

2nd Campaign - Technical data:

- Number of holes drilled: 65 (Including re-drilled holes)
- Total length drilled: 821 m
- Total quantity injected: 223 m3
- Volume injected: 272 l/m

The third campaign was executed at ring #240, STA 18+97. The grouting

MIX 5 bis	PORTLAND CEMENT									
MIX 0,6:1 (W/C)	Weight Cement lb	Weight Water gallons	Weight Rheobuild 1000 lb	Weight mixture lb	Volume mixture gallons	Weight Cement kg.	Weight Water kg.	Weight Rheobuild 1000 kg.	Weight mixture kg.	Tot. Volume mixture Lit.
	329	23.8	3.3	530.7	37.1	149	90	1.49	240.7	140.5
bags	3 1/2		1.2 lt							
W/C	0,6:1									
Rheobuilt 1000	1 % of weight of Cement									
Cement Portland II										
Density MIX	1.647									
Density cement	3.03									
Density Water	1.00									
Density Rheobuild 100(	1.21									

MIX 9 tris	MICROFINE CEMENT									
Microfine cement MIX 0.8 :1 (W/C)	Weight Cement lb	Weight Water gallons	Weight Rheobuild 1000 lb	Weight mixture lb	Volume mixture gallons	Weight Cement kg.	Weight Water kg.	Weight Rheobuild 1000 kg.	Weight mixture kg.	Tot. Volume mixture Lit.
	0	0.0	0.0	0.0	0.0	0	0	0.00	0.0	0.0
bags	6		1.0 lt							
W/C	0.8 :1									
Rheobuilt 1000	1 % of weight of Cement									
Rheocem 650										
Density MIX	0.000									
Density cement	3.03									
Density Water	1.00									
Density Rheobuild 100(	1.21									

was further increased to 17 m, with a 5.5 m overlap of the second campaign. This time both drilling and grouting were performed in two different stages; up to 9 m for the first, and up to 17 m for the second. The campaign was completed in 2 months.

3rd Campaign - Technical data:

- Number of holes drilled: 101 (Including re-drilled + different stages)
- Total length drilled: 1,246 m
- Total quantity injected: 294 m3
- Volume injected: 236 l/m

A summary of the three grouting campaigns is shown in Table 1.

After completion of the third campaign, on February 19, 2013 a permeameter test was performed to reach 0 bar of pressure. This is the first time we were able to lower the face pressure to atmospheric conditions. The overall water inflow was reduced from 1,100 m3/h (290 gal/h) to 220 m3/h (587 gal/h), and a face inspection was accomplished. Even if the total water inflow was reduced however, the overall stability of the tunnel face was not completely safe.

Under such hydro-geological conditions we were able to perform the following maintenance and repairs:

- Full cutter head inspection
- Changed 4 cutters
- Cleaning of the cutter head openings
- Replaced level sensors in the working chamber
- Maintenance on the compressed air line (SAMSON)
- Free the stone crusher and the working chamber from the grouting injected during the three campaigns

The most important activities were the replacement of worn pipelines, valves, pumps and the installation of a new hydraulic valve on the slurry return line just behind the suction pipe in the drilling chamber, which became an additional safety device in case the pipe would burst.

When maintenance was completed, the TBM was able to advance forward through the fault area and reach a zone with better hydro-geological condi-

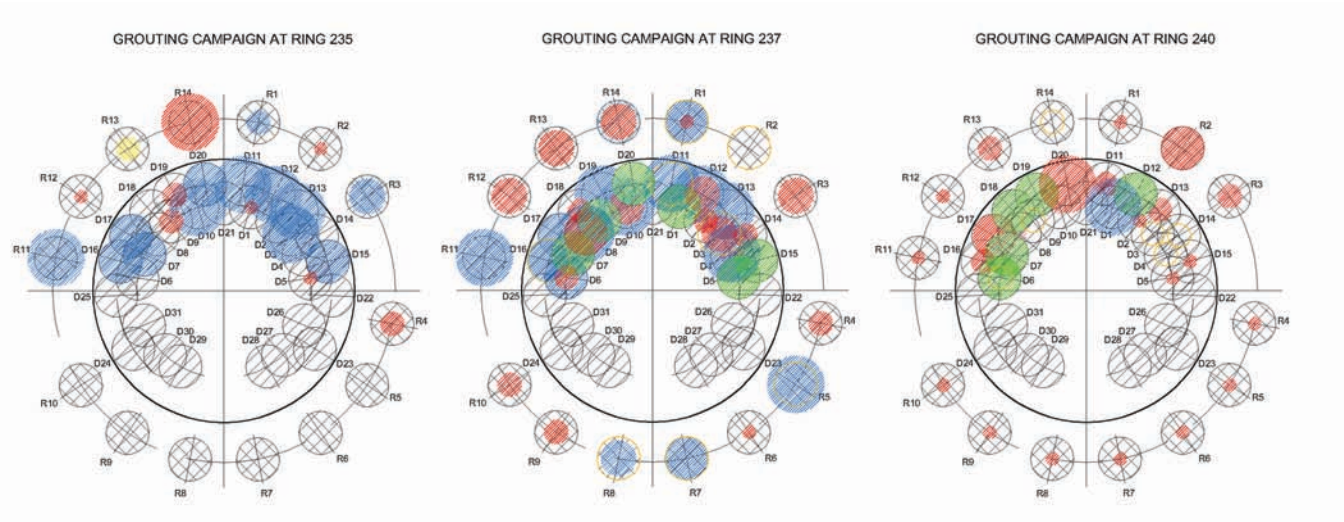


Figure 7: Grouting campaigns.

Table 1 Grouting Campaigns : summary of quantities

Grouting Campaign	Grout Volume (m3)	Portland cement (kg)	Microfine cement (kg)	Start Date	End Date
Ring 235 Sta. 18+64.9	43	5 500	22 924	01-Oct-12	25-Oct-12
Ring 237 Sta. 18+78.9	223	50 350	51 710	29-Oct-12	15-Dec-02
Ring 240 Sta. 18+97	294	193 898	73 237	19-Dec-12	13-Feb-13

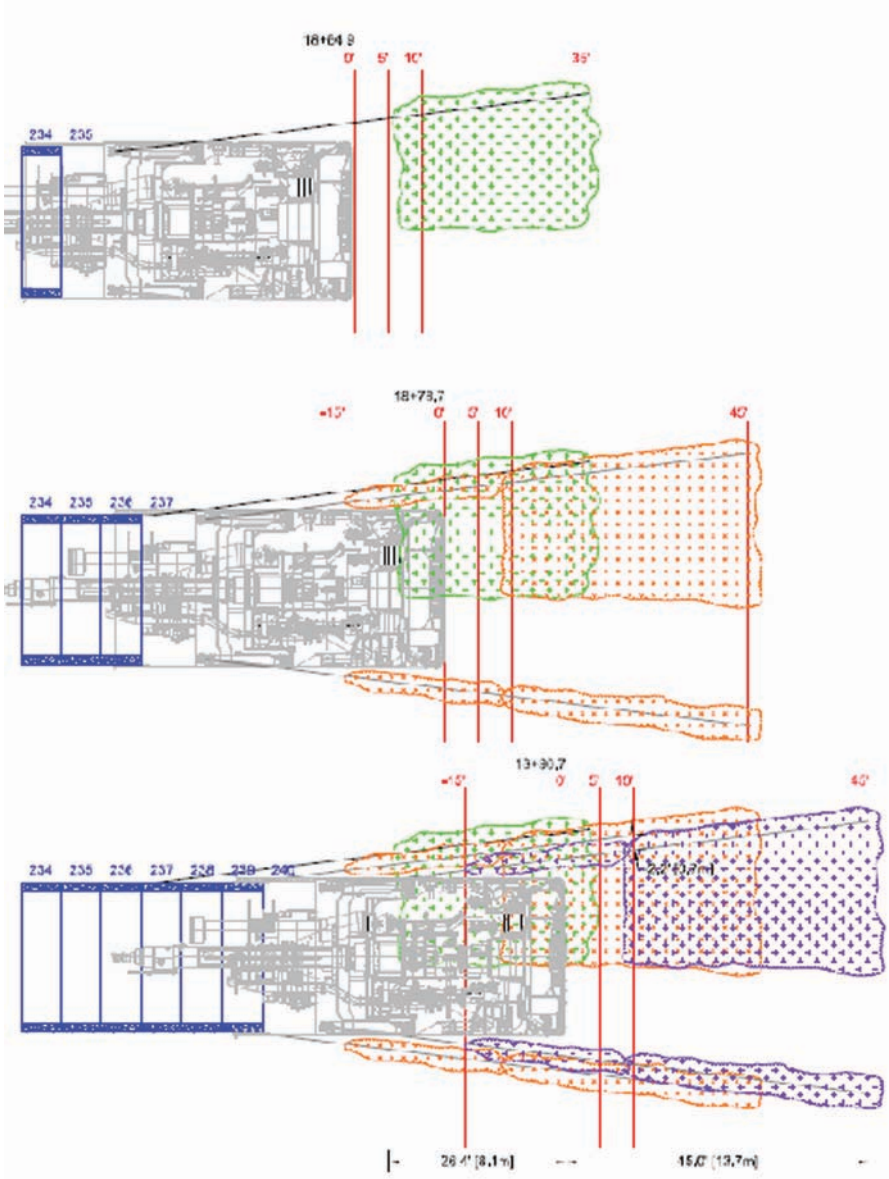


Figure 8: Three grouting campaigns.

tions where a full cutterhead repair was performed.

Conclusions

It is remarkable that for the first time worldwide, a slurry shield TBM advanced in closed mode at 14 bar for hundreds of meters.

Several innovations were developed in this challenging project such as:

- The setup of the procedure for large-scale permeability tests and their numerical interpretation
- Utilization of video cameras for cutterhead inspection at high pressure
- The design of new tools to drill (probe and core) and grout injection under 14 bar of pressure
- Specific grouting procedures and methodology

All efforts were carried out to avoid saturation hyperbaric interventions, which were considered too risky in terms of safety, time and cost.

However we were fully equipped to perform an intervention at 14 bar of compressed air pressure which has never been performed on TBM tunnelling projects.

In conclusion, targeted and sequenced grout campaigns with detailed custom made procedures and methodologies are effective even if conducted under severe hydro-geological and ground conditions.

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