

# breakthrough

Issue 2 2016



**Engineering  
Gender Equality**



Lessons Learned  
in Latin America

Opportunities in  
Australia

**Olympic Endeavour in  
Rio de Janeiro**

# Ultimate

The Eurasia Tunnel – an unparalleled milestone in tunnelling: 13.7m TBM diameter, enormous 11 bar water pressure, **connecting Asia with Europe** in up to 106m depth, through a highly variable and abrasive geology.

# Pioneer

Final breakthrough on August 22, 2015 – **after 16 months of extreme tunnelling**, a dream came true.

# Success

A cooperation that led to success: Yapı Merkezi, SK E&C and Herrenknecht mastered the Bosphorus crossing with an **unshakeable will and team spirit**.

#### Contractors:

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- › SK Engineering & Construction Co., Ltd.

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## Welcome to 'Breakthrough'

A year has passed and we are excited to bring you the second edition of Breakthrough. It has been a busy year for the International Tunnelling and Underground Space Association's Young Members group (ITAYM). Some of our achievements include: A proposed change to the ITA by-laws, which means in the future the ITAYM Chair and Vice-Chair will be eligible for nomination through their Member Nation societies to the ITA's Executive Council (ExCo); ITAYM integration into the ITACUS and ISOCARP committees (see p16); and new YM Member Nation representatives from Austria, Mexico, Slovenia and Switzerland.

ITAYM has been working hard to truly integrate with, and become the next voice of, ITA. The time is right and industry has also shown a readiness to support this momentum. We are seeking great-minded people from around the globe to participate in the new upcoming ITAYM Steering Board 2016-2018; individuals who will represent their country at an international networking and technical platform. The baseline has been successfully implemented by ITA, but it is now up to Young Members around the globe to take it to the next level and continue the work that has already been achieved.

ITAYM objectives and key activities are set out to create an international professional networking platform and support other Member Nations in establishing their own national Young Member organisations. The ITAYM Steering Board 2014-2016 has created a professional and competent platform for the upcoming Steering Board 2016-2018, which is due to be elected at the World Tunnel Congress ITAYM General Meeting, in San Francisco, this April.

As Chair, I have had the privilege to work with incredible people, that have become good friends. Now, it is time for me to move on to the role of immediate Past Chair. I welcome the opportunity to support the new Board and to continue to encourage young professionals around the globe to take part in representing their country.

In this edition of the magazine, we have focussed on job opportunities around the world, gender equality and education in tunnelling and underground space. I hope that our readers enjoy the content of this second edition and find inspiration in this magazine and in what the ITAYM stands for. I echo my sentiments from the first edition; there are significant opportunities available to young tunnelling professionals and I invite you all to take up the opportunity and get involved!

Dr Jurij Karlovšek  
ITAYM Chair 2014-2016

### Front Cover

*Female engineers working for the Dragados Sisk Joint Venture (DSJV) on Crossrail's C305 eastern running tunnels – including Charlotte Franklin (second from left) who is featured in our 5 from Five article (p43) – gather in front of Herrenknecht TBM 'Ellie' following her breakthrough at the Stepney Green Cavern, for the UK's National Women in Engineering Day.*



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Breakthrough is endorsed by the ITA



## Contributing to Breakthrough

If you would like to get involved in Breakthrough magazine by contributing an article, or suggesting potential content for future editions, we would be delighted to hear from you! Please feel free to contact Breakthrough's editorial team or the ITAYM Young Members Committee (details below).

## Note to YM Member Nations

All national Young Member (YM) groups are encouraged to get involved in Breakthrough magazine – we rely on your input. Please remember to document your country's YM activities and take plenty of good quality photos at any YM events throughout the year so we can make the most of your reports in the next edition!



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Brought to you by the publishers of

# Tunnelling

Journal

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Dudley Road, Tunbridge Wells, Kent, TN11LE United Kingdom  
Tel: +44 (0) 1892 522585 www.tunnellingjournal.com



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# Meet the ITAYM Board

The governing structure of the International Tunnelling and Underground Space Association's (ITA) Young Members Group (ITAYM) is a Steering Board made up of Chair, Vice-Chair, and a number of representatives selected by members of the Group. The Chair and the Vice-Chair are subject to the approval of the ITA General Assembly. Steering Board members are elected for alternating periods to ensure continuity of the group. The mandate is for two years.



**Jurij Karlovšek**  
Chair

Jurij is an Engineers Australia registered Civil Engineer, specialising in geotechnical engineering and tunnelling. He works as a Postdoctoral Research Fellow at The University of Queensland, Australia, where he recently obtained his PhD in the field of TBM segmental lining integrity detection. Jurij's professional career to date spans three continents, with experience in both industry and academia. His broad area of expertise is in Geotechnical Engineering: Conventional and Mechanised Tunnelling, Construction Information Technology, Non-Destructive Testing, and Fire & Life Safety in tunnels. As a Lecturer at the University of Queensland, Jurij actively engages in the mentorship of undergraduate students, supporting their industry activities, and in general helping to make their experience as students a more enriched and profitable one.



**Petr Salak**  
Vice Chair

Petr obtained his Masters in Civil Engineering at the Czech Technical University in Prague and is currently a Senior Tunnel Engineer with Dr. Sauer & Partners, in the UK. He has extensive experience in tunnel and shaft design, site supervision, design management, and his speciality is Sprayed Concrete Linings (SCL). He is a past Chair of the British Tunnelling Society's Young Members Committee, and was awarded 'Young Tunneller of the Year' by the ITA in 2014.

Petr champions student events to promote tunnelling as a career, and the creation of domestic YM Groups, based on the uniqueness of each nation. He enjoys spending time with his young family, travelling, scuba diving, and skiing.



**Lasse Vester**

Lasse graduated with a Masters in Building Technology from the Technical University of Denmark, in 2012. Since then he has worked as a Design Engineer on the Fehmarnbelt Fixed Link project. Before his Masters degree, Lasse worked for Danish contractor E Pihl & Søn AS on construction projects in the Copenhagen area.

Lasse is currently Chair of the Danish Tunnelling Society's Young Members Committee and is heavily involved in his national tunnelling organisation. Outside of work he is a bit of a foodie, and enjoys cooking for family and friends. He also plays football for a local Copenhagen team, and spends as much time outdoors hiking or trekking as he can.



**Nichole Boulton**

Nichole Boulton completed her Bachelors and Masters degrees in the Earth Sciences department at Simon Fraser University, in BC, Canada, in 2005, and has been working for Golder Associates ever since. She has experience in engineering investigation, design and construction for projects in Canada, Australia, and Chile.

She is registered as a professional geoscientist (P.Geo) with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), and is on the Board of Directors of the Tunnelling Association of Canada (TAC) as a representative for Young Members. She loves her dog, Kevin – who grew up in her office and now spends most of his time waiting for her to come home and chill out with him.



**Sindre Log**

Sindre gained his Masters in Civil and Environmental Engineering at the Norwegian University of Natural Science and Technology (NTNU), in 2010. After completing his thesis on hard rock TBMs, Sindre joined specialist tunnel boring machine manufacturer The Robbins Company, one of a few specialist tunnel boring machine manufacturers in the industry. He is now General Manager of Robbins' Norwegian subsidiary. He has been involved in the Norwegian tunnelling society (INFF) for some time, and was one of the founders of the Norwegian Young Members group.

Sindre is a dedicated fly-fisher, football fan, and the father of the youngest TBM enthusiast in the world.



**Senthil Nath**

Senthil gained his Bachelors degree in Civil Engineering and Masters degree in Geotechnical engineering from the Indian Institute of Technology, India and TU Dresden, Germany in 2009. He was awarded with the ITA's ITACET Scholarship to pursue a Masters in "Tunnelling and TBMs" at Politecnico di Torino, Italy and is currently a Sr. Tunnel Engineer at Geoconsult ZT GmbH, in Singapore.

Senthil's career is divided between India, Singapore and Indonesia. He is an active member of local tunnelling society (TUCSS) and a young committee member of the Geotechnical Society of Singapore (GeoSS). Senthil is a passionate photographer, blogger and loves to travel. He recently picked up mountain biking and is currently dealing with the after effects!



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- Project
- Rock Mechanics
- Tunnel Design
- Underground Construction Methods



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Images courtesy of UnPS

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# Passing the torch

In the space of a couple of years, the ITA Young Members group has grown from a few willing young engineers to a burgeoning international network of young professionals that reaches around the globe. Amanda Foley spoke to outgoing ITAYM Chair Jurij Karlovšek, and Chair and Vice Chair nominees Sindre Log and Lasse Vester, about this years' activities and where the organisation is headed



Jurij Karlovšek



Sindre Log



Lasse Vester

When the idea of a Young Members group was first put to the International Tunnelling and Underground Space Association (ITA) by Petr Salak (see Breakthrough's 2015 edition, p8) at the Geneva World Tunnel Congress (WTC), back in 2013, no one could have guessed how quickly the organisation would grow. Since it's official establishment at the Brazilian WTC, in 2014, the ITA Young Members (ITAYM) has recruited more than 30 Young Member Nations into its ranks, with 18 of those represented in person at the first ITAYM General Meeting, in Dubrovnik, Croatia, last summer. What's more – in contrast to previous years – the number of young professionals that attended the Dubrovnik WTC was encouraging, with more than 70 individuals coming together for the ITAYM networking event, sponsored by Normet.

With young professionals continuing to receive reduced registration rates, the hope is these numbers will double for the San Francisco WTC, this April. A very generous \$50,000 contribution by the host nation's tunnelling association, the UCA of SME, will also see conference scholarships awarded to 43 civil engineering students. The recipients of these were selected from over 120 applicants, from 60 different US universities, resulting in a great response to the UCA Young Members initiative.

San Francisco's WTC event also sees the increased involvement of the ITAYM in the ITA's groups and committees, with ITAYM Chair Jurij Karlovšek chairing a dedicated Building Information Modeling (BIM) in Tunnelling Workshop; and Vice Chair Petr Salak taking part in the ITA's Committee on Underground Space (ITACUS) Open Session, where he will introduce the new ITACUS-ISOCARP Young Professionals

Think Deep Programme (see page 16).

With all this activity, the last two years have flown by for the ITAYM Steering Board members and – with their terms of office as Chair and Vice Chair now coming to an end – Karlovšek and Salak can look back upon their achievement to date with pride.

"It has been a huge wheel to turn," says Karlovšek. "But it's spinning fast now. It's great that the ITA has embraced us and been so open-minded to our ideas. I'm very happy for example that the young members have been able to prompt a change in the ITA bylaws, which will be voted on in San Francisco." This change will allow the Chair and Vice Chair of any ITA committee – including the Young Members Steering Board – to be eligible for nomination to join the ITA's Executive Committee (ExCo). "This is a huge development for us, because it gives the green light for the younger generation to step up and continue its involvement within the ITA going forward," explains Karlovšek.

## Second term

Subject to ExCo approval, the new ITAYM Chair and Vice Chair for 2016-18 will be Sindre Log and Lasse Vester, respectively. Three new Steering Board members will also be elected in San Francisco, with a number of nominations having been received for these positions from YM Member Nations. "We have some great candidates for the three roles on the Steering Board that are opening up," says Karlovšek. "They have written great reports on why they would like to be on the Board and how they would like to see things moving forward, so it is great to see that they are already thinking about the future of the organisation."

Karlovšek, who will now take on the role of immediate Past Chair for a year to assist in the transition period, says he is ready to pass on the torch: "Sindre and Lasse are stepping up and they have some fantastic ideas for the development of the Young Members group. We have reached out to a lot of young professionals. But, if we want to take it to the next level, we need to find more individuals who are passionate about the tunnelling industry and are willing to

**“We want to find more young individuals who are passionate about the tunnelling industry and who are willing to step up and get involved.”**

*Jurij Karlovšek, the ITAYM's inaugural chair*

step up and get involved.”

This sentiment is echoed by Sindre and Lasse. “When you start an organisation like the ITA Young Members, there is a lot of momentum at the beginning, getting everything set up, getting all the approvals, and getting people involved,” says Sindre. “But now we are coming to the stage where we need to move forward and define what it is that we are going to deliver on as an organisation.”

“There are a lot of great initiatives being undertaken by the Young Member Nations and a lot of experience that needs to be exchanged via the ITAYM network,” says Lasse. “We now have a lot of people that are aware of our existence, but we need to consolidate our network and allow it to work for the people that are in it. Basically, we need to work on how we work together, but also get more people involved.”

Sindre and Lasse feel that much of this comes down to communication, particularly in terms of reaching out to people that are already active within their own national societies. With this in mind they will be looking to develop the ITAYM's online and social media presence, and also to implement a 'Breakthrough' e-newsletter to keep people informed of activities and events on a more regular basis. Of course, Breakthrough magazine will continue to reach out to young people as well and, as usual, we encourage you to keep in touch with any ideas for articles or content for future editions. 

**“There are a lot of great initiatives being undertaken by Young Member Nations and a lot of experience that needs to be exchanged via the ITAYM network.”**

*Lasse Vester, ITAYM Vice Chair Nominee*



# ITA TUNNELLING AWARDS 2016

November 10-11, 2016 | Singapore



The International Tunnelling and Underground Space Association is now inviting nominations for the 2016 ITA Tunnelling Awards, which will take place during a two-day event in Singapore this November:

- On November 10th there will be a one-day Technical Conference with eight high-profile keynote lectures
- On November 11th will be the one-day Awards Conference and Banquet Dinner, during which the awards will be presented

The awards are designed to identify and celebrate outstanding achievement in tunnelling and underground space development, and promote recognition of the industry's remarkable contributions to engineering and society.

Judged by a panel of eminent industry experts, the ITA Tunnelling Awards shine a spotlight on the individuals, companies, and project owners behind the very best projects and innovations. Entries from every corner of the world are welcome in the following categories:

Major Project of the Year - more than €500 million

Tunnelling Project of the Year - between €50 million and €500 million

Outstanding Project of the Year - up to €50 million

Technical Innovation of the Year

Safety Initiative of the Year

Environmental Initiative of the Year

Innovative Use of Underground Space

Young Tunneller of the Year

Renovation/Upgrading project of the Year

Nominations should be submitted by May 30th, 2016, through the ITA's dedicated Awards website: <https://awards.ita-aites.org>  
Follow the ITA Awards on twitter: @itaAward

## WTC twitter event



At the ITA World Tunnel Congress, in San Francisco, this April 22-28, the ITA Young Members (@ITAYM\_Media) and the UCA of SME Young Members (@WeBuildBeneath) will join forces to hold a social media event using the hashtag #TunnelsRock.

Starting Friday, April 22, we will be posting pictures and tweets from the various courses, workshops, functions, sessions and events, to promote the best of what the WTC has to offer and share the experience with everyone who isn't able to attend in person (and have a little fun in the process). Everyone attending the conference and exhibition is invited to take part, please help us out and post your tweets using:

**#TunnelsRock**  
**#WorldTunnelCongress**

Don't forget to visit the ITAYM and UCAYM at booth 1214!



### ITA Young Members & UCA Young Members WTC 2016 NETWORKING EVENT

WHERE: Americano, 8 Mission Street, San Francisco, CA  
WHEN: Monday, April 25th, 8-11pm  
WHO: Event is open to all those under the age of 35 in the underground construction and tunnelling industry

# EURASIA TUNNEL

## MILESTONE IN TUNNELLING

EURASIA TUNNEL PROJECT RECEIVES  
"MAJOR TUNNELLING PROJECT OF THE YEAR"  
AWARD AT ITA TUNNELLING AWARDS 2015



# CONNECTING CONTINENTS

The Eurasia Tunnel Project (Istanbul Strait Road Tube Crossing Project) connected the Asian and European sides via a 5 km highway tunnel going underneath the seabed. The Eurasia Tunnel will serve the Kazlıçeşme-Göztepe route where vehicle traffic is most intense in Istanbul and will cover a total of 14.6 kilometers. Tunnel pass and road improvement-expansion works will cause holistic relief on vehicle traffic. Not only will the travel duration on the route with its highly intensive Istanbul traffic decline from 100 minutes to 15 minutes, but also the privilege of safe and comfortable travel will be experienced. It will also contribute to the reduction of environmental and noise pollution.

### TBM

The most advanced Tunnel Boring Machine (TBM) technology of the world was used for the Strait Crossing Tunnel. The TBM employed for this project ranks first in the world with its 33.3 kW/m<sup>2</sup> cutting head, second worldwide with its operating pressure of 12 bars and sixth in world with its 13.7 m excavation diameter. The tunnel consists of 1,672 rings in total and two seismic rings were constructed at two different points to increase the resistance of the tunnel against a possible major earthquake. Specially designed and tested by labs for assuring its success, the seismic rings are a first in the world in the TBM tunneling sector, considering the current diameter and seismic activity level.



TBM diameter **13,7 m**

TBM pressure **12 Bar**

Tunnel Depth **106,4 m**



# Olympic Endeavour in Rio

Rio de Janeiro's highly anticipated new Metro Line 4 is set to open for testing this summer, in preparation for the Olympic Games, which will be hosted by the city this August. Eloi Angelo Palma Filho, a Civil Engineer at DNIT (Brazil's National Department of Infrastructure Transportation), and Executive Secretary of the Brazilian Tunnelling Committee (CBT), takes a look at some of the highlights of the project.

When it opens this summer, more than 300,000 people are expected to use Rio de Janeiro's new Metro Line 4 each day, removing over 2,000 vehicles per hour from the city's busy streets during peak hours. The new 16km long underground link will connect Ipanema in the east with the Olympic Park and Olympic Village sites in the Barra da Tijuca suburbs west of the Pedra Branca mountains. The Project is considered vital by the International Olympic Committee as most of the events of the 2016 Games will take place in Barra, which is currently not connected to Rio's two-line metro system.

There are six new stations on the line: Nossa Senhora da Paz (Ipanema), Jardim de Alah (in between Ipanema and Leblon), Antero de Quental (Leblon), Gávea, São Conrado and Jardim Oceânico (Barra). Passengers will be able to travel between Barra and Ipanema in just 15 minutes and between Barra and the city centre in 34 minutes.

The construction of the project was divided into two sections, with an 11.46m diameter Herrenknecht Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM) used to

excavate the 5.7km long coastal section of the project, and the remaining 5km of twin tube tunnels being excavated by drill and blast tunnelling.

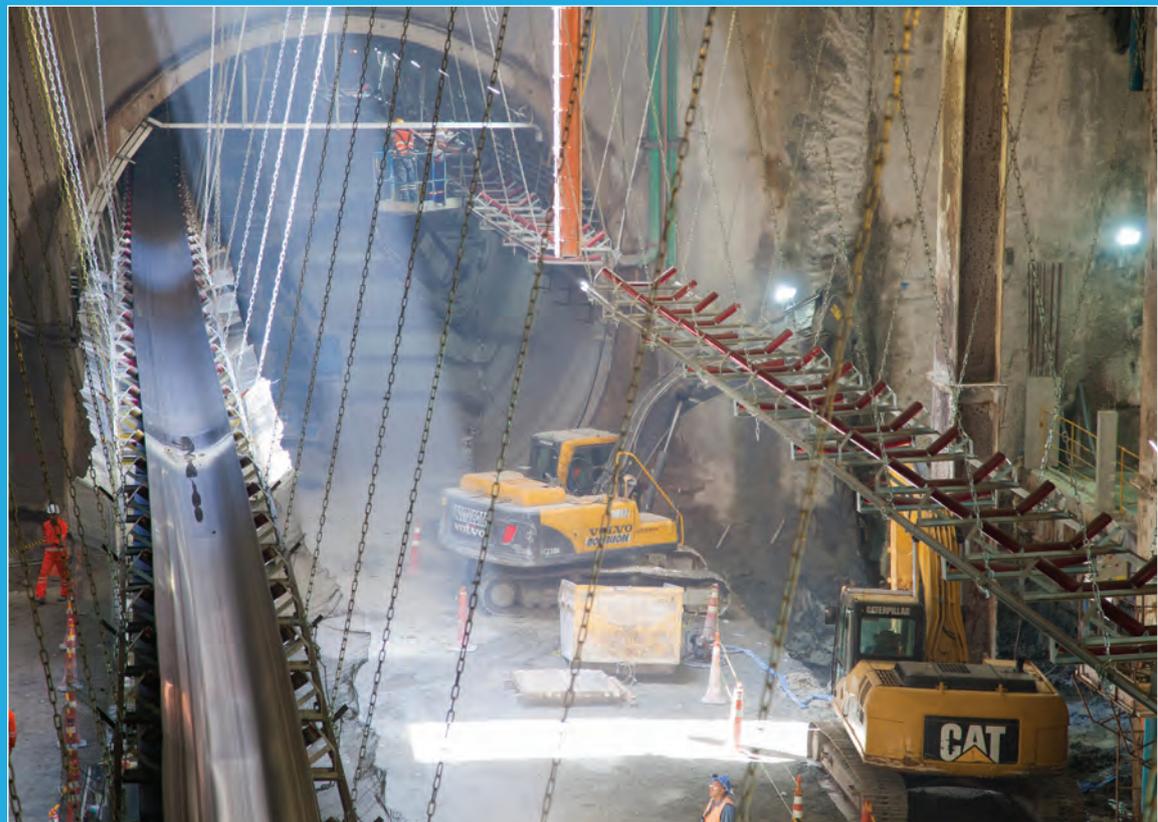
Construction of the drill and blast tunnels through the mountains and the Tijuca Forest Park (Lot 1), between new Cut and Cover stations in

Barra (Jardim Oceânico) and Gávea, was carried out by the Construction Consortium Rio Barra (CCRB), a joint venture led by Queiroz Galvão with partner companies Odebrecht Infraestrutura, Carioca Engenharia, Cowan and Servix.

The EPB machine was selected for the 5.7km

alignment between General Osório and Gávea as the coastal location meant that ground conditions would be a mix of sand, silt, clay and rock. Additional restrictions on blasting in the highly built up areas of Ipanema and Leblon would have made drill and blast excavation very difficult.

This is the first time a TBM has been used in Rio de Janeiro. The TBM tunnel alignment (Lot 2), between Gávea and the junction with General Osório Station, was completed by the Consortium Line 4 South, a joint venture led by Odebrecht Infraestrutura with partner companies Carioca Engenharia and Queiroz Galvão.



## TBM excavation

The TBM, nicknamed 'Tatuzão' in Brazil, was launched from a site just outside General Osório Station, at the easternmost end of the project, where the new line links with Rio's other two metro lines. The machine began its journey in rock, going on to excavate coarse (and small portions of fine) sand, explains Alexandre Mahfuz, an engineer with Consortium Line 4 South, and Young Member of Brazilian Tunnelling Committee. The depth of the tunnel ranges from 12 to 18 metres below the water table, which lies about 3 to 4 metres beneath the surface.

The tunnel is lined with pre-cast concrete segments, which form 'rings' when they are pieced together by the TBM as it progresses. The average time of each TBM advance (the distance the TBM mines before stopping to install a new lining ring) was 55 minutes and the average time of the ring assembly was about 25 minutes. The TBM excavation progressed on a daily average



of about 10 rings, but at its peak reached 19 rings, the equivalent of about 35 metres of tunnel excavated in one day.

On a project of this size, conducting monitoring and surveys of the buildings surrounding the excavation of the tunnels and stations is routine. The surveys are carried out to check the condition of the buildings and their foundations before excavation of the tunnels and stations begins. The buildings receive reference pins and inclinometers, which



enables monitoring of how the buildings behave before and during construction. At the start of the project these analyses were weekly, but as the work progressed they were performed several times a day.

All measurements were within expected limits: "The surface monitoring was carried out in real time and we achieved very low settlement results of 6 to 8mm during TBM excavation in the sand," recalls Alexander.

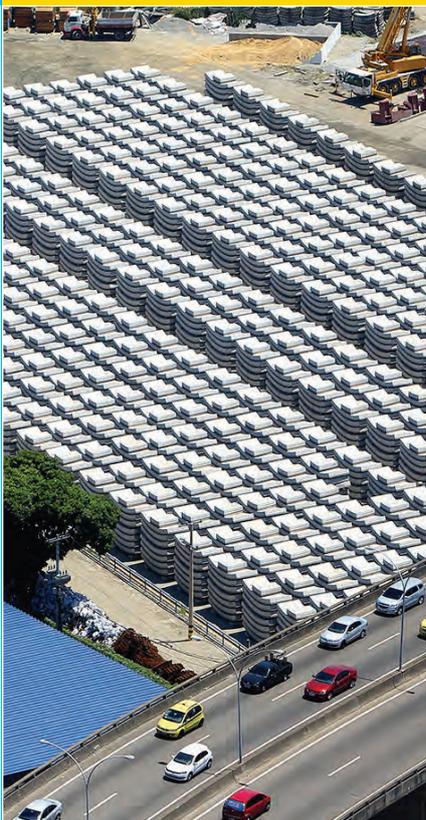
## Precast segment manufacturing

The equipment for the production of the 22,000 concrete segments that line the 10.33m internal diameter tunnel was custom fabricated in Germany by Herrenknecht Formwork, a subsidiary of the same company that supplied the TBM. The project's segment manufacturing facility had five full sets of segment moulds, each with eight forms (seven segments plus a key segment). The production of the segments was carried out using a "carousel system", similar to that of an automobile assembly line.

The first step in the carousel production system is to clean each of the moulds and prepare them for receiving new concrete by applying a releasing agent. The next step is the placement of a steel reinforcement cage into the mould. On Line 4, the contractor aimed to reduce the total amount of steel used in the segments by adding fibres to the concrete mix design. "We used macro-synthetic fibres, which are designed to provide high-performance secondary concrete reinforcement and

polypropylene fibres, which are used to inhibit explosive spalling in the event of a fire in the tunnel," explains Alexander. The next stage in the process is to install inserts in the mould (which form recesses in the finished segments to accommodate fixtures and fittings); and then quality control checks are carried out on the armature release mechanism. Having closed the lid of the form, concrete is poured.

After demoulding, segments are measured to ensure they meet the tight tolerances specified. Then they go into a curing tunnel, which is heated to a temperature between 40 and 50 degrees. They remain there for six hours to accelerate the setting of the concrete. Upon exiting the curing tunnel, each ring of segments is stacked and taken to the storage yard. They stay there for approximately 28 days to complete the cure cycle, gaining additional strength before they are ready to be used. Of the 22,000 segments produced, only 23 had some type of imperfection and were rejected.



## Record excavation rates at Jardim de Alah

Jardim de Garden of Alah, in Leblon, is one of the six new stations on Line 4. When it opens later this summer, the station will benefit about 20,000 passengers a day. During construction, at the end of March 2015, contractors broke their own production record with about 1,700 cubic metres of earth excavated in a single day. This amount was almost double that achieved on a typical day at the station. The previous record belonged to the Antero de Quental Station, also in Leblon, which managed to reach 1,000 cubic meters in a single day.

Passenger access at Jardim de Alah is now open at Ataulfo de Paiva Avenue, on the corner of Admiral Pereira Guimarães Street. The station's other access will be on the corner with Borges de Medeiros Avenue, opposite the Jardim de Alah channel, which was treated with Jet grouting (grout injections) to facilitate the machine breaking through into the station (see below).



## Immersed breakthrough

Jardim de Alah was the second station to receive the TBM 'Tatuzão'. In the Line 4 design, the typical safety measures that were put in place for the TBM's arrival at the stations were: Treatment of the ground using jet grout injection; and lowering of the watertable if inflows were detected. However, in the case of Jardim de Alah, the presence of a river

(the Jardim de Alah channel) in close proximity to the station complicated matters. Even with jet grouting, the risk of the river inundating the station as the TBM broke through into free air was too high. Therefore, a technique that has never been used in Brazil before was adopted.

Prior to the TBM reaching Jardim de Alah, from beneath

the channel, a bulkhead was created within the station structure to form a submersion chamber that the TBM would drive into. The chamber was flooded with more than 8,000 cubic meters of water to counteract the high groundwater pressures found under the channel.

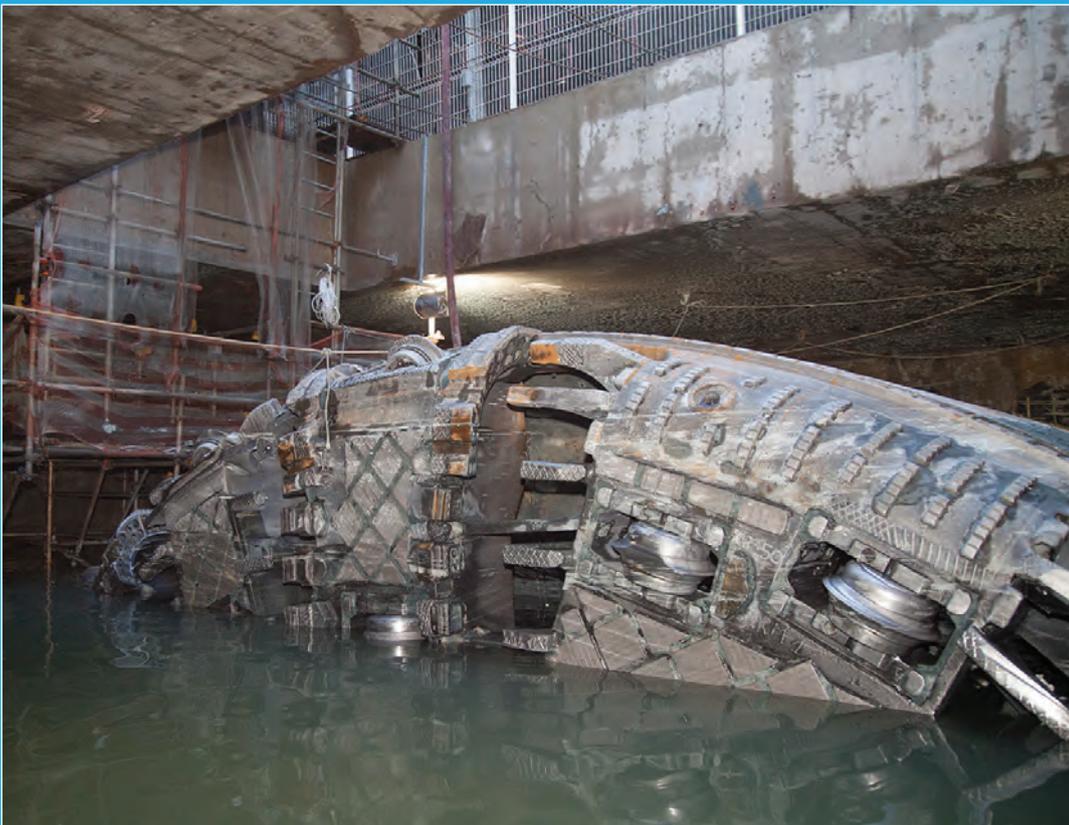
Despite this decision, a massive ground consolidation

programme was also conducted around the station with jet grouting, including the bed of the channel, which was isolated through the construction of a cofferdam wall.

With all these preparations in place, the TBM finally broke through into the station in an underwater environment. The chamber was subsequently sealed and the water pumped out, before removing the chamber's bulkhead and continuing the work of bringing the machine forward into the station.

### Excavation was also made with conventional excavation

Aside from the portion of the project that was excavated by TBM, was a stretch that was constructed in hard rock using conventional drill and blast excavation. This 5km segment of twin tube tunnels runs between Barra and São Conrado stations. The tunnels were excavated in gneiss, known Pedra da Gávea (Gavea Stone), with a maximum overburden 840 meters. To blast these tunnels, 3,865 tons of explosives were used, the equivalent of the fireworks needed for 161 New Year's Eve celebrations in Copacabana.





## Leaving a legacy

While the construction of Rio's Metro Line 4 is a key infrastructure project for the upcoming Olympic games, the new subway line will have a lasting impact on the city. The line will not only link the Olympic Park with Ipanema in the south, but also provide Rio's residents with connections to Copacabana, the city centre and the north.

The new line will start service with controlled operations in July, only functioning outside rush hours. Larger gaps between the trains will allow for adjustments and testing. It is hoped that by early August, when the Games start, the line will be operating normally. 

# Exploring the Underground

Antonia Cornaro, Business Development Manager for Amberg Engineering and Vice Chair of the ITA Committee on Underground Space (ITACUS), and Petr Salak, Design Manager for Dr. Sauer & Partners and Vice Chair of the ITAYM, report on a promising new cooperation.

Efficient and sustainable infrastructure is vital for economic development, which is why virtually every major urban metropolis is building or extending rapid underground transport and utility tunnel systems to cope with growing populations and the corresponding demand for mobility. But a city's underground space can be used to much greater advantage if it is considered for a whole range of other functions too, freeing up valuable ground-level space for other uses including green areas.

The ITA Committee on Underground Space (ITACUS) was established to promote a diverse use of underground space for sustainable urban development, as well as maintaining and improving liveability, and preparing cities for the impacts of climate change by increasing their resilience.

The ITAYM recognises the importance of this objective and has begun to work alongside ITACUS.

01  
ITACUS Steering Board Meeting in Hagerbach, Switzerland

02  
ITACUS and ITAYM meeting in Rotterdam, Netherlands



To develop the relationship between the two groups members of both organisations met in Rotterdam, in the Netherlands, in July 2015. The meeting was attended by Han Admiraal (ITACUS Chair), Antonia Cornaro (ITACUS Vice Chair), Jurij Karlovsek (ITAYM Chair) and Petr Salak (ITAYM Vice Chair). It was agreed that the ITA Young Members should participate in ITACUS' activities and that both organisations will keep in regular contact to foster further collaboration.

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New ITACUS initiatives were discussed, such as joint activity groups on 'Resilient Urban Underground Space', 'Urban Underground Freight' and ICARUS – the International Centre for Applied Research in Underground Space, an underground innovation laboratory. Last, but not least, a joint activity group between the ITA Young Members and ITACUS' strategic partner ISOCARP's (International Society of City and Regional Planners) Young Planners was also launched, with Petr Salak agreeing to head up the initiative.

The fruitful meeting in Rotterdam was followed by successful meetings in London, UK, in September, and at the Hagerbach Test Gallery, in Switzerland, during the ITA Awards in November 2015.

During the ITAYM's recent discussions with the ISOCARP Young Planners group, at a meeting in Amsterdam, this January, plans were focused on setting up a multi-disciplinary collaborative workshop in a city that has specific urban planning issues that need to be explored. The ITAYM believes that this is a great initiative that can be repeated at least once a year in different cities and could have a real impact on the development of underground space use. Several cities are currently being targeted for this purpose. Together, the aim is to promote the benefits of underground space, three-dimensional urban planning and safeguarding underground space for future infrastructure.

For further information go to [www.ita-aites.org](http://www.ita-aites.org) or the ITACUS LinkedIn group.

# 2016

# Dates & Events

**23-25 May**

**13th International Conference Underground Construction & 3rd Eastern European Tunnelling Conference**

Prague, Czech Republic

Event website: [www.ucprague.com](http://www.ucprague.com)

*This is the largest Czech tunnelling conference, which is held every three years.*

**26-28 May**

**1st National Congress on Tunnelling and Underground Space & Roads, Bridges and Tunnels Fair 2016**

Ankara, Turkey

Event website: [www.utyayk.org/](http://www.utyayk.org/)

*The Turkish Road Association will organize its 1st National Congress on Tunnelling and Underground Space alongside the 2016 Roads, Bridges and Tunnels Fair.*

**6-7 June**

**TBM Applications II**

Bergen, Norway

Event website: [www.tekna.no/](http://www.tekna.no/)

*This seminar, organized by the Norwegian Tunnelling Society (NFF), will highlight developments in TBM tunnelling over the past 20 years.*

**15-17 June**

**Swiss Tunnel Congress 2016**

Lucerne, Switzerland

Event website: [www.swisstunnel.ch](http://www.swisstunnel.ch)

*The Swiss Tunnelling Society organises this conference annually at the KKL Lucerne. During the last few years, it has become the main congress for tunnelling experts in Switzerland.*

**20-23 June**

**Tunneling Fundamentals, Practice, and Innovations Short Course**

Colorado School of Mines, Denver, USA

Event website: <http://csmspace.com/events/tunneling/>

*CSM's annual short course for industry professionals provides a comprehensive overview of tunnel planning, design and construction across all applications and all geologies.*

**26-27 September**

**8th Nordic Grouting Symposium**

Oslo, Norway

Event website: <http://nordicgrouting.com/>

*The Norwegian Group of Rock Mechanics (NBG) and the Norwegian Tunnelling Society (NFF) will hold this event at Radisson Blu Scandinavia Hotel in Oslo.*

**11-12 October**

**The British Tunnelling Society Conference and Exhibition**

London, UK

Event website: [www.btsconference.com/](http://www.btsconference.com/)

*The BTS 2016 conference and exhibition is the largest gathering of tunnelling and excavation professionals in the UK. Takes place over two days at the QE11 Conference Centre, in Westminster, London.*

**11-12 October**

**14th Australian Tunnelling Conference**

Sydney, Australia

Event website: [www.informa.com.au/conferences/](http://www.informa.com.au/conferences/)

*This well respected industry gathering, supported by the Australasian Tunnelling Society, brings you the best opportunity to hear from Australasia's current and future tunnelling projects with a content-rich, two-day agenda.*

**19-21 October**

**Expotunnel: Third Edition**

Bologna, Italy

Event website: [www.expotunnel.it/](http://www.expotunnel.it/)

*ExpoTunnel is the exhibition dedicated to the world of tunnelling, drilling, mining, underground construction and research.*

**6-9 November**

**2016 Cutting Edge Conference**

Los Angeles, USA

Event website: <http://ucaofsmecuttingedge.com/>

*Organised by the UCA of SME and Tunnelling Journal, Cutting Edge is an annual conference that hand picks speakers to discuss the latest trends and developments in tunnelling technology.*

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The International Tunnelling and Underground Space Association (ITA) is a technical organisation committed to developing economical, sustainable and safe solutions that promote the increased and optimised use of underground space. The ITA unites 20,000 experts from 73 Member Nations, representing all areas of the industry and academia. The ITA has 300 corporate members including 17 Prime Sponsors and 60 supporters.



## Inaugural ITA Tunnelling Awards

Thursday, November 19, 2015, was 'D-Day' for the 24 projects, eight young tunnellers, five engineering companies and five contractors that were shortlisted for the 2015 ITA Tunnelling Awards. Held in the caverns of the Hagerbach Test Gallery underground training and research facility, in Switzerland, the event included a one-day Awards Conference where the finalists presented their projects and innovations, followed by a Banquet Dinner where eleven separate awards were presented in the following categories:

Award Category	Winner
Major Project (€500m+)	Eurasia Tunnel Project (Turkey)
Project of the Year (€50-500m)	LILW Radioactive Disposal Facility (Korea)
Outstanding Project (up to €50m)	Norsborg Metro Depot (Sweden)
Technical Innovation	System for Monitoring tunnel lining
Environmental Initiative	Corrib Tunnel Project (Ireland)
Safety Initiative	MineArc compressed air refuge chamber
Innovative Use of Underground Space	Toledo Metro Station, Line 1, Naples (Italy)
Young Tunneller of the Year	Jurij Karlovsek
Contractor of the Year	Salini-Impregilo (Italy)
Engineering of the Year	Parsons Brinckerhoff/WSP
Lifetime Achievement	Prof Dr Sebastiano Pelizza

The 2015 finalists for the Young Tunneller of the Year award were (pictured left to right) Philip Duarte, Sindre Log, Petros Fortsakis, Ryan McCarron, Jurij Karlovsek, Eloi Angelo Palma Filho, Hao Liu and Ponciano Pérez Lupi, all of whom received commendations by the ITA.



## New ITA Publications

At the WTC, in San Francisco, this April, several new ITA Working Group (WG) and Committee publications will be presented during a dedicated conference session:

- WG2: 20 years of FRC Tunnel Segments: Lessons Learned & Proposed Design Principles
- WG11: Owners Guide to Immersed Tunnels
- WG14/19: Recommendations on the Development of Underground Projects
- ITAtech: Guidance for Precast FRC Segments – Volume 1: Design Aspects
- ITAtech: Vibration Control in Urban Drill & Blast Tunnelling



They will then be available to view online at the ITA web site: <http://www.ita-aites.org>

## The 2015 World Tunnel Congress in Dubrovnik

On the 22nd to the 28th May, 2015, the ITA held its 41st General Assembly and the 2015 World Tunnel Congress (WTC), in Dubrovnik, Croatia, which was co-organised with the Croatian Association for Tunnels and Underground Structures. More than 1,550 tunnelling professionals and experts participated in the international event.

The focus of the 2015 Congress was to promote tunnelling in the South-East of Europe, with these countries represented by 13 emissaries. Many topics were addressed during the week, with 390 technical presentations and posters, sessions on technical innovations conducted by the ITAtech Activity Groups, and a workshop on 'Ageing Tunnels – Safety in Operation During Refurbishment' to mark the 10th anniversary of the ITA's Committee on Operational Safety of Underground Facilities (ITA-COSUF).

The 2015 WTC also aimed to illustrate the important role of tunnels in solving problems caused by traffic congestion, flooding, and transportation issues. These issues were addressed during the Opening Ceremony on Monday, May 25th, during which the ITA's President Søren Degn Eskesen, along with eminent technical experts and Croatian politicians such as Andro Vlahusic, the Mayor of Dubrovnik, and Nikola Dobroslavic, Head of Dubrovnik – Neretva County, expressed the importance of tunnels in urban development planning.



# Engineering Gender Equality

Tunnelling is waking up to the fact that it needs a more balanced mix of people in order to build the highest-performing teams. We asked women from the industry about the challenges this involves and spoke to one client that has set an ambitious target for gender parity. Kristina Smith reports.

The challenge of how to bring more women into tunnelling, and engineering in general, is the subject of much debate and report writing around the world. There's a looming skills crisis: as populations migrate to cities, utilities and transport have to move underground – and we have to find more people to build tunnels.

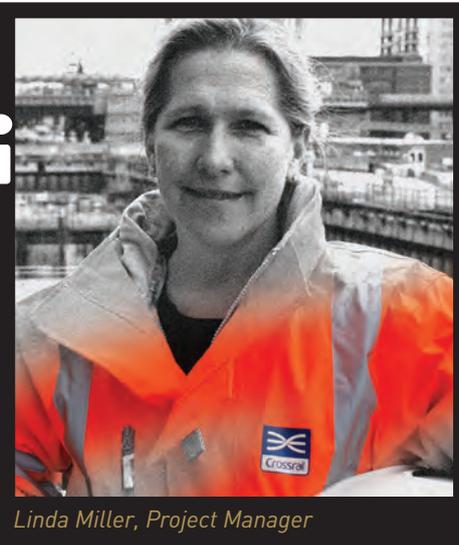
A rising number of contractors, consultants and clients in the underground construction sector are looking to reap the benefits of more gender-balanced teams. Put simply, tunnelling is all about problem solving and if you keep putting the same sort of people together, you'll keep getting the same sort of answers. Broaden the scope of the people you recruit from and your potential solutions broaden too.

"There's a great energy and great collaboration when you have a mixed team," says Crossrail Project Manager Linda Miller. "Having women and men in the room gives you far more possibilities."

## A great career choice

It's difficult to understand why engineering is seen as a good career choice for women in some cultures, and a poor one in others. All sorts of factors come into play – economics, status, tradition – but the influences are multiple and sometimes subtle. A recent OECD (Organisation for Economic Co-operation and Development) barchart<sup>[1]</sup>, shows the percentage of female students in its 55 member nations planning a career in the engineering and computing professions. Jordan, Thailand and Bulgaria are at the top of the list. The UK is 53rd, just above Azerbaijan and China, and the US is only a little higher at 48th.

Eneritz Ochoa, a Shift Engineer working for the BAM Ferrovial Kier Joint Venture



Linda Miller, Project Manager

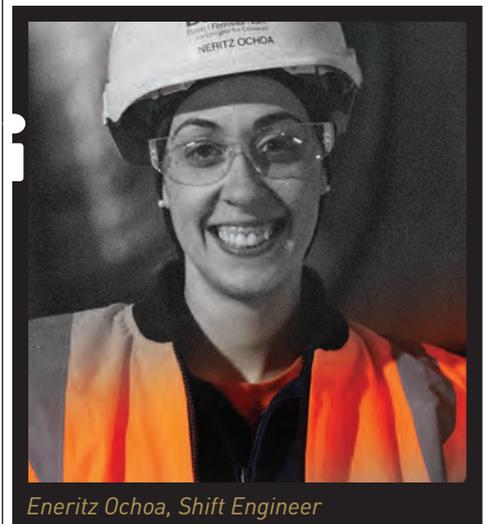
on Crossrail, has noticed the difference in attitude between her home country of Spain and the UK. "At home, if I say I studied engineering, no one is surprised. Here, people say 'Wow'. At first, I found that shocking because I thought England was a progressive country." Ochoa now thinks that the difference in attitude could be down to economics. A boom in Spain several years ago created a high demand for engineers that convinced girls, and their parents, it was a good career choice.

In Turkey, the challenge is not persuading girls to study engineering, it is persuading companies to employ them. Bahriye Yaman, TBM Methods Chief for the YMSK Joint Venture building the Eurasia Tunnel, which crosses beneath the Bosphorus Strait, in Istanbul, says: "In Turkey, we have a lot of female engineering graduates. But many don't stay in engineering because it is very difficult to find a job. Most end up leaving the profession because they can't get equal opportunities."

Like in UK, the attitude that engineering isn't really for women also prevails in the US. Erin Keogh, a Field Engineer at Kiewit remembers negativity from some of her peers at Colorado School of Mines: "I had some strong-minded male peers who wanted to share their views on why I should not be there," she says. "But my family, my professors and everyone else at Mines were very encouraging."

Retaining female engineers in the US is a challenge too. A research study carried out at the University of Wisconsin-Milwaukee<sup>[2]</sup> between 2009 and 2012 found that 40% of female engineering graduates who entered the field had subsequently left. And that wasn't all down to motherhood.

Olga Konopka, who is an Assistant Engineering Manager for Crossrail, thinks that the widespread use of the word 'engineer' in the UK to mean anyone who fixes something, deters people from considering engineering as a career. "I believe that there should be a clearer distinction between engineers and



Eneritz Ochoa, Shift Engineer



■ ■ Crossrail has achieved a proportion of 29% women in its integrated team on the client side. Among its contractors and subcontractors, though, the proportion is lower at just 8%. ■ ■

*Julie Thornton, Head of HR - Thames Tideway*

*Heather Ho, Sub Agent, Thames Tideway*

technicians," she says. "We call out an engineer to fix our boiler. This association doesn't make engineering an attractive career option to a 15-year-old girl."

However, even in Germany where engineers do enjoy a good status, women are under-represented in engineering subjects. An EU labour force survey conducted in 2012 showed that 14% of engineering professionals in Germany were female, the second lowest in the EU: Only the UK, with 6%, was lower<sup>[3]</sup>.

### Clients drive change

The good news is things are changing, driven by project owners like the UK's Crossrail and Thames Tideway. "We are hoping to attract a broad population, which reflects general society, to apply for roles," says Thames Tideway's Head of Human Resources Julie Thornton. "We want to be

seen as a family-friendly organisation that is good for both men and women."

Crossrail achieved a proportion of 29% women in its integrated owner team. Among its contractors and subcontractors, though, the proportion is lower at just 8%. Crossrail has just teamed up with UK organisation Women in Construction, which aims to encourage trades as well as professionals into the industry.

Dr Karin Böppler, Head of Presales, Geotechnics and Consulting at one of the world's leading Tunnel Boring Machine manufacturers, Herrenknecht, has 20 years' experience in tunnelling to draw on. She sees multiple reasons for changing owner attitudes: political pressure, changing attitudes in society, and also changing work styles: "Our techniques, skills and styles of work have evolved in terms of the way individuals interact and

communicate, whether men or women," she says. "Owners are now more aware that they will benefit from a good mix of people when managing projects."

This isn't just a hunch. A 2015 report Diversity Matters<sup>[4]</sup> by management consultants McKinsey found companies in the top quartile for gender parity are 15% more likely to perform better than their peers. And, if owners are drawing their employees from a broader base, suppliers will be pressured to follow that lead, points out Eve Herrington, a Senior Tunnel Engineer at Atkins. "Companies tend to hire in their own image," she says. "And if you have a client that places a high value on diversity, you won't want an all-male board, as that doesn't mirror the client's wishes."

But how does it feel to be in a team that is dominated by one sex compared to one that has gender parity? That's a difficult

question for most women in the tunnelling industry to answer, because they are very often in the minority, especially out on site.

"Working with people is working with people," says Herrington. "There are attitudes that can build if there is only one type of person, so it is always good to have a mixed team working on any project."

Ochoa has noticed a difference. "When I was working as a surveyor for a Spanish company, the balance was better. There was a feeling that we were a team. Here in the UK, out on site the foremen, the miners, are normally older. They do treat me as though I am different. I ask why we are doing something, they reply 'Because I said so.'"

Keogh, though she is one of only six



*Erin Keogh, Field Engineer*

women in a team of 200, feels there is good camaraderie at Kiewit, although out on site, attitudes can be a little different. "One of the subcontractors might say something like "Oh, you picked an interesting career." To which I reply: "So did you!" But I have a very strong team behind me who support me if people question why I am there."

Both Böppler and Yaman note a difference in team culture when more women are present. Böppler says: "The atmosphere and how people work together is better if there is a good mix of gender, especially when you are in negotiations."

"Having women on a team softens the culture," agrees Yaman. "With women around, the men tend to be less aggressive."

Like the industry itself, the women we spoke to are divided on whether setting targets for male-to-female ratios, as the Thames Tideway project has done, is helpful. Herrington voices a common concern: "I would worry people may think I only got the job because I am a woman."

Miller and Yaman, however are both strongly in favour. "I am a staunch believer



*Olga Konopka, Assistant Engineering Manager*

in setting high targets," says Miller. "Experiences in other sectors have demonstrated that this is the only real way to drive change."

### The flexibility question

There is one very specific challenge that a career in tunnelling – especially in the field of contracting – poses for women. And that is the challenge of raising a family when your job requires long days on site and a career path that often takes you from continent to continent.

"It's a difficult subject," says Miller, who has moved around the world with her job – with her husband, and her two sons. "In our industry a lot of people work away from home. That is often more difficult for women... and when it's time for promotion, people who have had more powerful and broad experience presumably get better consideration for promotion."

Heather Ho, a Sub Agent for the BAM Morgan Sindall Balfour Beatty Joint Venture on the Tideway project, works 40-to-50 hour weeks: "It would be nice to have the option to work flexi-time or part-time if I were to have a family, but I cannot see how that would work with my current job. I



*Bahriye Yaman, TBM Methods Chief*

feel that it would be impossible to continue down the route I am currently on. If a company said that I could continue with this career path and have a day off a week, say, that would be very attractive."

It's clear that tunnelling companies will have to address the thorny question of how to become more flexible and family-friendly if they are to achieve more gender balance in their teams. When asked what traits they would look for in an ideal employer, flexibility was high on women's agendas.

"A company that could offer new learning opportunities would certainly be top of my list. Also, being married and wanting a family, flexible working hours can make all the difference between a woman choosing to commit her talent to further the success of a company," says Konopka.

But it's not just women who need flexibility. As Tideway's Thornton points out, if you think about what might attract more women to your organisation, you will attract a far broader range of talent. "If you create a family-friendly, supportive organisation, you make an environment where people want to work, irrespective of their gender." 



*Eve Herrington, Lead Asset Protection Engineer*

### References:

- 1 <http://www.oecd.org/gender/data/wherearetomorrowsfemalescientists.htm>
- 2 <http://www.studyofwork.com/2012/10/another-look-at-stemming-the-tide-why-women-leave-engineering/>
- 3 [http://www.ippr.org/files/publications/pdf/women-in-engineering\\_Sept2014.pdf](http://www.ippr.org/files/publications/pdf/women-in-engineering_Sept2014.pdf)
- 4 <http://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters>
- 5 <http://www.crossrail.co.uk/sustainability/social-sustainability/committed-to-promoting-diversity-valuing-talent-and-respecting-each-other> [graphs showing % of women]

# 10 IDEAS from Tideway

The Thames Tideway Tunnel is a huge new sewer, aimed at solving the problems of London's current system, built by Victorian engineers over 100 years ago for a far smaller population. Currently, just small volumes of rainfall cause the system to fill up and overflow into the River Thames.

The new 7m-diameter sewer tunnel, 25km long and up to 65m deep, will store sewage and transfer it to a waste water treatment plant. Tideway has divided the tunnel into three sections – West, Central and East – which have been let out to joint ventures of BAM Nuttal-Morgan Sindall-Balfour Beatty, Ferrovial Agroman UK-Laing O'Rourke and Costain-Vinci Grand Projets- Bachy Soletanche respectively.

When Tideway's CEO Andy Mitchell announced in 2014 that the project would be aiming for gender parity, it caused a lot of debate. For Tideway's HR team the challenge has been to translate that ambition into systems that meet the goal.

The target applies to the 450 people in the owner's team and their delivery partner team. As tender notices for the main works contracts had already gone out when the decision on gender parity was made, Tideway hopes the contractors will follow its lead and increase diversity.



**The proportion of women on the client team is 36%. Here are some of the lessons that other organisations could learn from Tideway:**

1. Get leadership from the top: easy here as gender parity was CEO Andy Mitchell's idea.
2. Set the culture. Tideway signed up to a flexible working charter which lays down the spirit and the parameters, such as what can be an informal agreement and what must be formal.
3. Set year-on-year targets. And measure against them.
4. Train people. Tideway provides unconscious bias training for everyone and drop in sessions for managers and employees.
5. Look at how you describe yourself. The description of 'a major civils project, building a sewage tunnel' was attracting a limited range of people. By talking about its lasting legacies, the project's appeal broadened.
6. Advertise somewhere else. Tideway uses the [timewise.co.uk](http://timewise.co.uk) website for people who are looking for more flexible work opportunities and searches extensively on LinkedIn.
7. Rewrite the job description. Just a few words can make a big difference. Apps help Tideway analyse whether their adverts' words are male- or female-friendly.
8. Set up a job returner programme. Tideway already has six women, including two engineers, returning to work through its returners programme, a 12-week internship. It is open to both men and women, although statistically more women take career breaks.
9. Involve the supply chain. Ferrovial Agroman, Laing O'Rourke and Costain are joining in on the second returners programme.
10. Analyse. Look for patterns of behaviour that give opportunities to improve. Who's being shortlisted, interviewed and employed?

## We talked to:

### Linda Miller, Project Manager, Crossrail (Bechtel)

With over 20 years of experience, Miller is an enthusiastic advocate for the tunnelling industry and encouraging more people to join it. "There are so many people from the baby boomer generation leaving our industry in the next ten years – and we're not talking to half of our species!"

### Dr. Karin Böppler, Herrenknecht

With 20 years of experience in tunnelling, Böppler fell in love with the industry during an internship and has worked for tunnel boring machine (TBM) manufacturer Herrenknecht since graduating.

### Erin Keogh, Field Engineer, Kiewit

Started working for Kiewit on graduating in 2014, following an internship with the contractor whilst studying at Colorado School of Mines.

### Bahriye Yaman, TBM Methods Chief, YMSK JV (Yapi Merkezi)

With eight years in the industry, Yaman worked for Costain and London Bridge Associates in the UK, before moving back to her home country of Turkey to work on the Eurasia tunnel project. "As a woman on site, you need to build a network to share your difficulties and your experiences with. That's important. It doesn't have to be on the same project, or even in the same country."

### Olga Konopka, Assistant Engineering Manager, Crossrail

Completed an arts degree, and then a civil engineering one. Joined Crossrail as a graduate trainee.

### Eve Herrington, Senior Tunnel Engineer, Atkins

Has worked for Atkins for nine years, specialising in tunnelling for the last three. "If you look at a company's representation, salaries, whether they have women on the board, that says a lot about a company. Look at a company's maternity rights and their reintegration plans because that's a reflection of how much they value women."

### Eneritz Ochoa, Sprayed Concrete Lining Shift Engineer, BAM Ferrovial Kier

Graduating in 2012, Ochoa worked first as a monitoring surveyor on Crossrail before moving to her current position.

### Heather Ho, Sub Agent, BAM Morgan Sindall Balfour Beatty JV

With six years in the industry, Ho started on highway construction before moving underground; currently working on the Thames Tideway Tunnel.

### Julie Thornton, Head of Human Resources, Tideway

With experience that encompasses construction companies and other sectors, Thornton joined the Tideway team in 2013.

# Book Club

Breakthrough takes a look at some books that have recently been published by the UK's ICE and a new series of practical rock engineering videos that are available for free download



## Core Concepts of Geotechnical Engineering

Sanjay Kumar Shukla

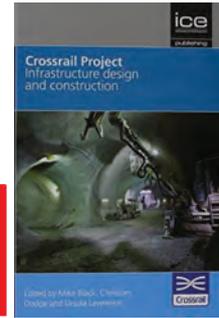
This book is tailored for a one-semester course in a civil engineering programme. It provides a practical introduction for students to the analysis, design, construction, maintenance and renovation of geotechnical structures. It is well organised, full of simplified practical examples and we particularly enjoyed the chapter Machine Foundations as this subject is not commonly discussed.



## Core Principles of Soil Mechanics

Sanjay Kumar Shukla

This one-semester soil mechanics textbook is aimed more at assisting individual learning, both for students or engineers. It covers a wide range of topics including complicated principles (e.g. consolidation, dissipation theory, etc.) with a balanced amount of text and figures and adequate but straightforward examples. We found the code references and the suggestions for further reading highly useful.



## Crossrail Project: Infrastructure Design and Construction - Volume 1

Edited by Mike Black, Christian Dodge and Ursula Lawrence

This book contains a collection of 36 papers about London's Crossrail project – the largest single infrastructure investment ever undertaken in the UK – written by different authors and covering numerous topics such as Ground Engineering, Sprayed Concrete Lining, TBM Tunnelling, Engineering Geology, Geotechnical Monitoring and Mitigation, Architectural Design, Operations and Logistics tunnelling, monitoring, dewatering, etc. Design and Construction provides a valuable source of reference for current practices in the design and construction of large-scale underground projects. Highly recommended to young and experienced professionals alike.



## Crossrail Project: Infrastructure Design and Construction - Volume 2

Edited by Mike Black, Christian Dodge and Jessica Yu

This is the second volume of papers that document the progress of London's Crossrail project, in the UK. This book records the technical challenges and achievements of the contract teams during and prior to 2014. In total, 24 papers by consultants, contractors, suppliers and third-party stakeholders involved in the project are gathered in this publication. A particularly valuable resource as you can read papers one at a time at your convenience.

## HOEK'S CORNER

### Practical Rock Engineering Videos

If you are a young engineering graduate working for a consulting or contracting company on a tunnel project, your civil engineering degree may have included a few courses in soil mechanics and engineering geology and an introductory course in rock mechanics. But these courses may not be sufficient to provide the background you need to understand the complexities of tunnel design and construction. Typically, these skills are learned "on the job" but there is now a little help available from a series of videos on the practical aspects of rock engineering.

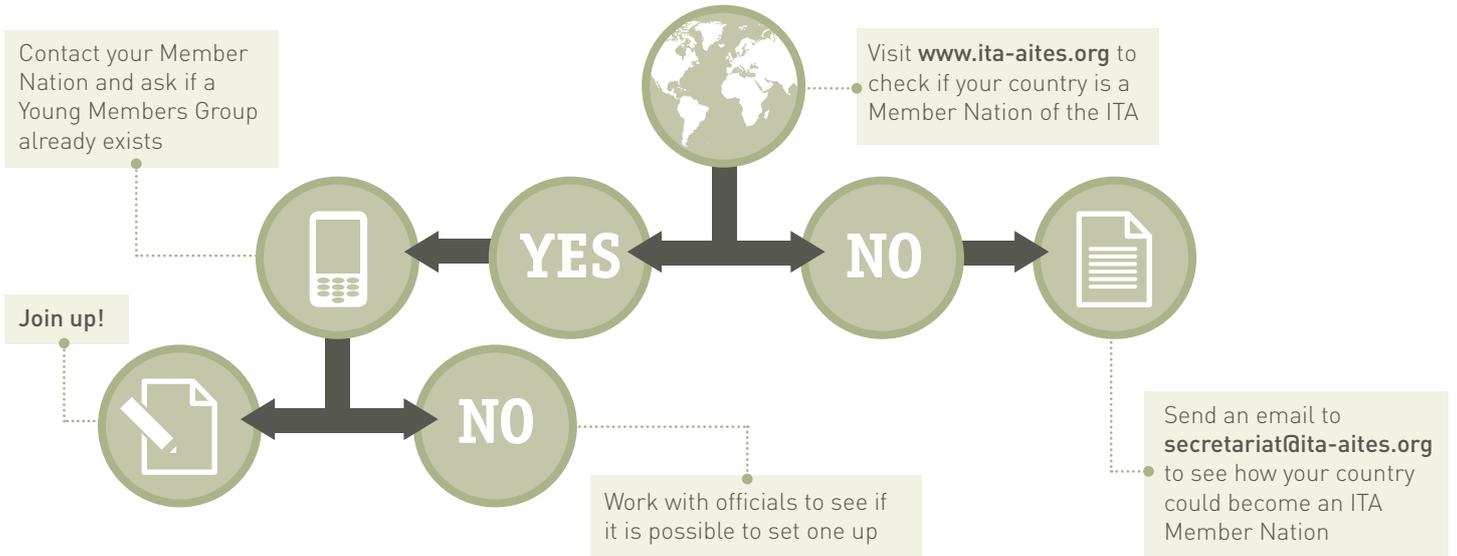
Dr Evert Hoek, a retired geotechnical engineer who has worked as a professor and consulting engineer for the past 50 years, has prepared a number of 30-minute videos that are available for free download on the Internet. These videos include:

**The Development of Rock Engineering | The Art of Tunnelling in Rock | Intact Rock Sampling and Testing | Rock Mass Properties | Rock Slope Engineering | Large Underground Caverns**

The first of these videos are already available while more are in the final stages of editing and will be on line within a few months at the RocScience web site:  
<https://www.rocscience.com/learning/hoek-s-corner/lecture-series>



# How to set-up a Young Members group



## SETTING UP A YM GROUP

1.



Contact your national tunnelling association about the idea of establishing a Young Members group.

2.



Use your own network! Invite your friends and colleagues to help establish the group, spread the word, and get publicity.

3.



Arrange a gathering for those that are interested in contributing. Discuss what people would like to get out of the Young Members group, how to organise yourselves, etc. There are no requirements for form or content – it is up to yourselves and your Member Nation officials to decide what you want.

6.



The ITAYM Group can assist with by-laws or give examples from other countries. Cooperate with the ITAYM Group to get contacts internationally.

Contact Breakthrough magazine to spread the word about your new group and to promote your activities!

5.



Work with your Member Nation on how to organize the board and the aims and objectives of your group, prepare a simple set of by-laws and start working to organize events and bring young members together.

4.



Set up a kick-off event where you invite as many people as possible. Invite an interesting speaker or give a presentation on a high profile project to attract people. Encourage participants to get involved. Organise a social function afterwards to encourage networking within the group.

**YOU NOW HAVE YOURSELF A YOUNG MEMBERS GROUP – ENJOY!**

# #Tunnel Day

Thursday 3rd December, 2015, was the inaugural National Tunnelling Day in the UK. The initiative was conceived by the British Tunnelling Society Young Members (BTSYM) to publicise the work and projects going on in the industry while highlighting the opportunities available for future generations. The day was a great success with more than 700 tweets using the hashtag #TunnelDayUK reaching over 1.5 million online users.

Many companies and major projects across the UK's industry participated either via social media or by holding events on the day. The public were given behind the scenes access to some of the exciting projects beneath our feet, with the Costain Skanska Joint Venture following a shift engineer for the day on the Bakerloo Line Link, and Transport for London releasing unseen photographs from the Bond Street Station Upgrade. Engineering firm Mott MacDonald also got involved by running an online question and answer session with past BTSYM committee member Jessica Serrano.

Early afternoon came and the immediate past Chair of the BTSYM, Eoin Ó Murchú (Senior Consultant, IBM), continued the day presenting at an industry event in London attended by over 400 people, outlining the objectives and motivations of the campaign. It was greatly received by all in attendance, with the crowd taking particular delight in the social media cut-outs the BTSYM had provided. Late afternoon rolled on and the Brunel Museum followed on the success of the day by holding a presentation on the History of Tunnelling in London. The BTSYM then closed the momentous day by running a workshop followed by a social for all the society to enjoy and celebrate the success of the day.

Clients, consultants, contractors and suppliers all got involved to showcase their projects, skills and capabilities and prove how vital development underground is for our future sustainable development. The sector is busier than ever with projects including Crossrail, London Power Tunnels and Northern Line Extension all currently on-site. With Crossrail 2, High Speed 2 and Thames Tideway among many other projects in the pipeline for future years it is vital we maintain the skills within the UK and encourage many more into the industry. Thanks go out to all the companies, groups and individuals who supported the day and showed the nation what great feats of engineering we carry out on a daily basis. We hope next year will be even better and bigger! Save the date, 1st December 2016. 

Emma Hale - BTSYM Media Group Chair

Eoin Ó Murchú - BTSYM Immediate Past Chair



The British Tunnelling Society Young Member organisation aims to further the knowledge and professional development of members, raise awareness of the tunnelling industry, encourage the choice of tunnelling as a career opportunity and develop future leaders in the tunnelling industry. The BTSYM offers excellent networking opportunities for young tunnelling professionals, while raising profiles within the tunnelling industry. For more information on the BTSYM please visit the website [www.britishtunnelling.org.uk/BTSYM](http://www.britishtunnelling.org.uk/BTSYM), like them on facebook [www.facebook.com/BTSYoungMembers](http://www.facebook.com/BTSYoungMembers) or follow them on twitter [www.twitter.com/BTSYM](http://www.twitter.com/BTSYM).





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# Building Tomorrow's Down Under

Joe del Rio is a Project Engineer currently working for CPB Contractors, on the NWRL Project, in Sydney. Having completed his civil engineering studies back in 2003 in his hometown of Bogota, Colombia, he never imagined his career path would end up heading underground and that just a few years later he would be working for one of Australia's leading tunnelling contractors.

When Joe del Rio arrived in Australia in 2006, to undertake post graduate studies, he found himself in one of the southern hemisphere's strongest economies. With a dramatically increasing population, the country urgently requires a raft of infrastructure projects to support its rapid expansion.

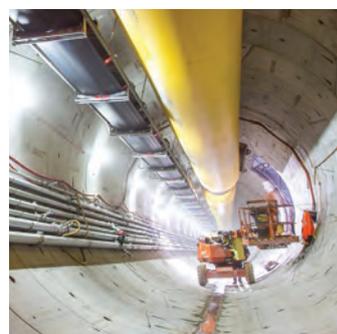
In 2010, Joe began his career underground when he joined CPB Contractors' tunnelling business unit [formerly Leighton Contractors and Thiess], a company that has been a key player in Australia's infrastructure development. Specialising in innovative tunnel solutions and underground structures, and with experience on some of the country's most iconic projects, CPB offers career opportunities to young tunnelling professionals from all over the globe.

Among the major projects Joe has been involved in so far, there is the Brisbane Airport Link, where he was actively involved in the final concrete lining of the mined tunnels using multiple hydraulic driven slip-form moulds; the Narrows Marine Crossing, under the Great Barrier Reef, in Queensland, where he controlled the Tunnel Boring Machine (TBM) production rates and the machine's supply chain in a challenging remote area on



Australia's east coast; and most recently he has worked on the excavation stage of Australia's longest railway tunnel, part of the Sydney Metro scheme.

The AU\$8.3 billion North West Rail Link (NWRL) is Australia's largest public transport project, currently



under construction in Sydney's metropolitan area. The AU\$1.15 billion tunnelling contract included the construction of 15 kilometres of TBM driven twin tube running tunnels between the suburbs of Bella Vista and Epping, and the excavation of five underground

railway stations along its route. Joe's role was TBM Project Engineer, looking after one of the four double shielded boring machines used to cut through Sydney's sandstone.

The NWRL presented various challenges to the engineering and planning teams during its design; one of the biggest hurdles was scheduling the construction of the cross passages that connect the twin tunnels into the project's target programme. With more than 50 cross passages outlined in the design at specific locations along the tunnel alignment, it was necessary to carry out the cross passage activities alongside the TBM advance without affecting programme deadlines.

Joe actively participated in a multi-disciplinary tunnel construction team that was put together to address the challenge and deliver excavation, waterproofing membrane and concrete lining installation activities simultaneously with the TBM's advance. The team came together in a 'clockwork' effort to coordinate activities inside the tunnels and minimize disruptions, not only to the TBM supply chain, but also the cross passage works.

Moving forward in his career, Joe has multiple options to



### KEY FACTS ABOUT THE NWRL PROJECT

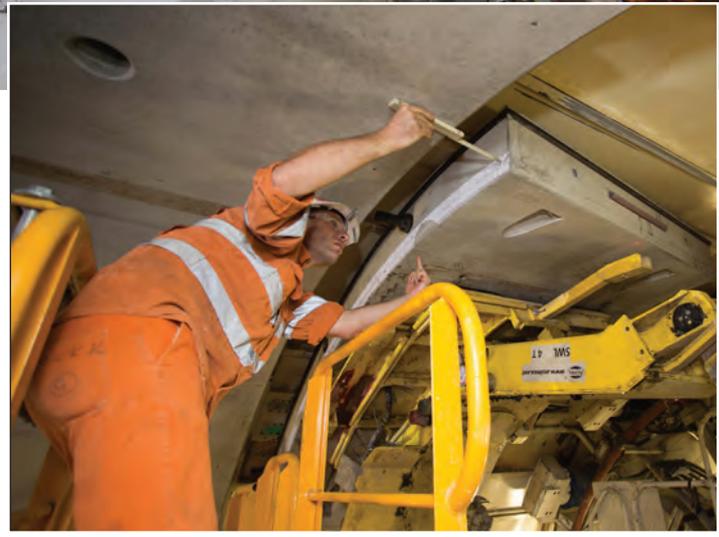
- NWRL is the first transportation infrastructure project in Australian history to use four Double Shield Tunnel Boring Machines (TBMs).
- 16 months were required to complete the 30 kilometres of TBM tunnels, with an average advance rate of 173 metres of tunnel built a week.
- More than 2.8 million tonnes of Sydney sandstone and shale were excavated to complete tunnels and stations.
- More than 4,600 people worked on the tunnelling stage of the project.
- A total of 98,184 concrete segments were required to make up the 16,290 concrete rings built by the TBM crews to line the twin tunnels.

choose from, thanks to a number of projects recently announced and awarded to CPB Contractors in Sydney. For a start, there are the first two stages of the next largest transport and urban renewal project in Australia.

The WestConnex highway project is set to transform the M4 and M5 corridors linking the Global Economic Corridor, in Sydney's east, with the growing population and new development areas across western and south western Sydney. Stage 1 of the project will commence construction in early 2016 and is due to open to traffic in 2019. It will extend the existing M4 Motorway from Homebush to Haberfield and is predicted to accommodate an estimated 67,700 vehicles each

day through 5.5 kilometres of tunnels with three lanes in each direction. CPB Contractors in joint venture with Samsung and John Holland are delivering the design and construction. A total of 16 roadheader excavators have been procured to cut through Sydney's sandstone at an average depth of 35 metres under the major Western Sydney corridor.

Stage 2, known as the 'New M5', will run from the existing M5 east corridor at Beverly Hills via tunnel to St Peters, around 9 kilometres with two traffic lanes in each direction, and will be capable of accommodating up to three lanes in the future if required. CPB Contractors in joint venture with Samsung and Dragados are up for the challenge to deliver stage 2



concurrently with stage 1, using a similar number of road headers, commencing excavation in late 2016 and due to open to traffic in 2019.

Australia's booming infrastructure industry has many new opportunities to offer young tunnelling professionals seeking career challenges while enjoying the advantage of living in one of the best countries in the world.

#### Projects further down the track

Perth FAL, the 8 kilometre Forrestfield-Airport Link with twin tunnels running underneath the Swan River and Perth Airport. The twin-bored tunnels will become the longest underground rail line in Perth. With announcement expected in early 2016, the contract is likely to be awarded in mid-2016 and the project is scheduled for completion in 2020.

Stage 3 of the WestConnex

project includes the construction of 9.2 kilometres of tunnel under the heart of the Central Business District (CBD), linking the previous stages, and is due to open to traffic in 2023.

Sydney Metro will announce the next stage of its network from Sydney's North West to South West, with the construction of 14.8 kilometres of TBM driven twin tube running tunnels, including the harbour crossing, 52 cross passages and several underground stations to be built under Sydney's CBD, iconic landmarks and buildings.

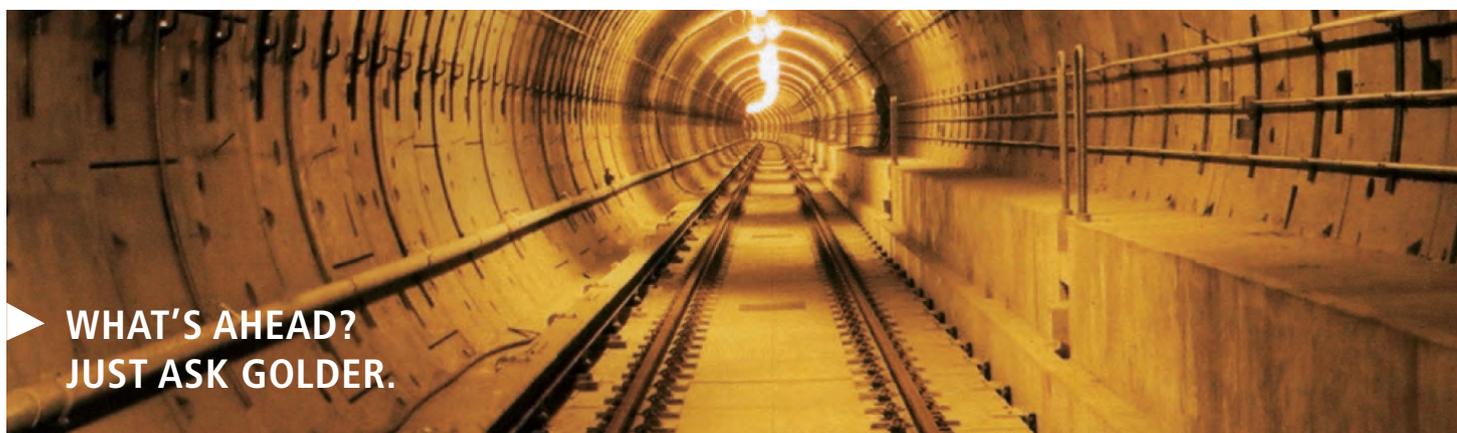
Melbourne has two major upcoming projects out for tender in 2016. The Metro Rail Project is a 9 kilometre twin rail tunnel, from South Kensington in the west to South Yarra in the south east, with five new underground stations. The Western Distributor consists of twin 2.5 kilometre road tunnels under Yarraville. 

# WE CHALLENGE

ITA young members to send  
us papers for the wtc2017



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# Something for the Weekend

Breakthrough's editor tapped some LinkedIn tunnelling groups to find out what the industry's top tunnel movies were and why. Here are five of them!

## The Great Escape

### All-time action classic

This 1963 World War II epic tells the true story of a group of Allied prisoners who plot to break out of a detention camp in Nazi Germany. The movie stars a raft of Hollywood screen legends, three tunnels named 'Tom', 'Dick', and 'Harry', an innovative spoil removal method and not so clever surveying. This all-time action classic also has one of cinema's most famous chase scenes, featuring Steve McQueen jumping this bike over a barbed wire fence.



## Daylight

### Will the dog get out alive?

'Daylight' is a disaster film that assembles the Holland Tunnel (implosion), unlucky travellers (assorted), Sylvester Stallone (very brave) and a dog, all united by cruel fate for a stressful two-hour adventure beneath the Hudson River. The rubble-strewn setting looks cold and dank, and the characters fight unappetising perils like hypothermia. One attractive, unattached young woman (Amy Brenneman) has no choice but to hug Stallone to keep warm. It's certainly not a classic and fits very much into the mould of 'check your brain in at the entrance', but it's still a worthwhile Sunday evening candidate.



## Reign of Fire

### Tunnel safety at its best

When twelve-year-old Quinn visits his mom (a tunnelling engineer) at work, a fire-breathing dragon is woken from its slumber. Fast forward 20 years, and the country has been turned to ash. Quinn (Christian Bale) is responsible for keeping his small community alive. Then a cocky, cigar-chomping American with a Captain Ahab complex and lots of heavy artillery rolls into the compound (Matthew McConaughey) looking for recruits to hunt down the lone bull male. Genius!



## The 33

### Chile's trapped miners 5-years on

In 2010, 33 Chilean miners found themselves trapped for 69 days in a collapsed gold and copper mine while the world bit its collective nails watching rescue attempts on the TV. Antonio Banderas stars as Mario Sepulveda, known as 'Super Mario' for his skill at uniting men faced with starvation. Lou Diamond Phillips excels as Luis Urzua, aka Don Lucho, the browbeaten mine safety manager. Then there's Dario Segovia (Juan Pablo Raba), a junkie who has alienated his empanada-selling sister, Maria (Juliette Binoche). Too big a story to really fit into a two hour film, but a movie with its heart in the right place.



## The Core

### Nonsense but good fun

The Earth's rotating core has stalled. As a result, electromagnetic fields are out of whack, violent storms are tearing through cities, and intense microwaves threaten to cook the planet... Unless the world's best scientists can bore to the centre of the globe in a laser-driven tunnelling machine made of 'unobtainium' and unleash bombs that will act as a nuclear defibrillator. Enough said.





# A Week in my Life

Giacomo Pini is a Civil Engineer working for Salini Impregilo-Healy Joint Venture on the Dugway Storage Tunnel, in Cleveland, Ohio, in the USA. He is one of 100 young engineers recruited last year by Salini Impregilo for its "Tomorrow's Builders" programme for potential future managers. Giacomo specialises in tunnel design, construction supervision and management. He has a year's experience as a Site Engineer on a combined sewer overflow (CSO) system extension involving a 4.5-kilometre TBM driven tunnel and six shafts (see box p36) and he is completing a Master's in Construction Management at Oxford Brookes University, in the UK.

## Monday

The week starts at 6:30am with the weekly safety meeting. As the last topic of discussion ends, the geotechnical engineer and I jump in the car and drive to the Dugway Storage Tunnel (DST) shaft 2 site to perform 'pull out' tests on the rock bolts installed there the previous week. All the rock bolts take 7,000psi loading with minimum displacement: TEST PASSED! We load up our equipment and head back to the office.

Some snow on the roads makes the journey a bit longer than usual, but by 9:00am I'm seated at my desk (luckily we have

treated ourselves to a Nespresso machine) crunching numbers to get all the reports ready for our client.

In front of me, three computer screens are waiting to be switched on. I open my site progress monitoring Excel sheet on the right screen, outlook in the middle and all the subcontractor reports on the left. I try to be as efficient as possible and the daily, weekly and monitoring reports are updated and ready to be sent

out at 11am. Time to run to the other office, a new supplier is seated in the conference room ready to spread

his business cards like a croupier from Las Vegas. The meeting runs smoothly and some new ideas and methods are pulled out of the hat. GREAT RESULT.

I give myself 30 minutes to gobble up some pasta for lunch and I'm out to the DST shaft 8 site to monitor progress.

We still need to obtain a permit for the diversion structure to be built and I want to check if the new layers of sprayed concrete (shotcrete) have been completed following some water infiltration over the previous months. Driving to DST-8 takes about fifteen minutes and I pass by DST shafts 2, 4, 5 and 7 along the way. These shaft sites all need to be visited periodically to monitor progress; discuss new activities with subcontractors and check that all the materials used meet specifications.

Later, I'm back in the office to figure out the correct amount of acid to dump into a shaft that was previously flooded, so we can lower the pH level and pump the water out into the sewer. As the clock shows 7pm, my gallons amount of acid are displayed on the calculator.

## Tuesday

It's 7:05am and I need to hurry up! After moving to Cleveland from Italy, I realised that the majority of Americans have a great ability to be on time. It's a quality I highly value and I feel bad for being even a few minutes late. Today is supposed to be a practical day as we



move from spreadsheets to pumps and gauges on site. At 8.00am, the first acid tote is set up over the shaft and ready to release  $H_2SO_4$  (sulphuric acid) in a 50% solution. The mixing procedures give great results, but four hours of my day are already gone and it's time to eat something! I eat my Parmesan rice while re-reading the set-up parameters and mix design for the shotcrete test that is due to be performed in the afternoon.

As I finish my last grain of rice, the superintendent calls everyone on site for the test. The new site technician follows me to help set up the equipment. The test goes great. Lab tests will tell us if the necessary 4,000psi strength has been reached in 28 days. We get some readings as we pump the water from the shaft and everything seems to hold up pretty well.

### Wednesday

Today I start my day with an objective: LEAVE WORK BY 6.30PM. Balancing the



demands of the job with a healthy sporting life is not always an easy task. But I try my best to do both. The shaft

is de-watered, the six-and-eight-foot diameter jet-grout columns are seven days old and ready to hold the water pressure 80 feet deep. We send a drilling rig down the shaft to install a two-inch pipe with a 10-foot screen at the location of the pressurised water.

I follow every single foot of the drilling closely, looking for ground reactions, checking measurements and monitoring the water flow out of the pipe. I collect as much data as possible, as I know my project manager will question me about everything, right down to the brand of the driller's wife's shoes. Operations run smoothly, pipe is installed and we get a good flow of warm water running out. THE INJECTED CEMENT REACHED THE



The men behind the masks!  
My 'Tunnel Rescue' colleagues

SHAFT. On the way back to the office I check the progress of the work on the conveyor belt foundations and I'm happy to see the rebar is assembled properly, positioned in the hole laid out by the surveyor. Tomorrow, 80 cubic yards of concrete are expected on site for the first pour. Just a few hours of reports, emails and spreadsheets and at 6.30pm I'm on my way to the gym.

### Thursday

Alternative day today. I have agreed to be part of the Tunnel Rescue Team. This is a great experience and a good chance to give my contribution to the project and its players on a more practical level. We have been trained on the equipment, respirators, oxygen bottle installation and refill. Today is about gas detection, operations and rescue management. We are a team of five, including engineers, labourers, surveyors and safety managers. It is good to have a different mix of expertise so we can cover as much as possible during an operation.

The training runs until 4.00pm with some coffee and pizza bagel breaks. As the training day ends, I quickly run to the weekly staff meeting. Everything seems to be going well, even if we need to push a bit on the schedule and fix some minor issues. This gets me thinking during the evening about how we could improve project performance.



Tuesday  
08.00 - Preparing  
the acid for the  
shaft 😊

Friday

It's 7.00am. I'm in my boots, looking at the a.m. reading on my clock, as it feels like it should read p.m. because it's still dark outside (or maybe I just wish it was the end of the day). I have two things that I want to complete before the weekend: the annular grout final mix design and the traffic obstruction permit for the diversion structure. But first I need to check out water levels and ground intrusions in the shaft at DST-1. All values are stable, so we can remove most of the material that penetrated the shaft during the jet-grouting operation. It's time to get back to some paperwork for a few hours.

When you work in a site office, your door is always open so it can be hard to focus on a topic for more than 30 minutes without someone popping in to ask a question or comment. For this reason, I have started to enjoy working on Saturdays: not only because we usually eat a lot of croissants, but also because we can pull out all the numbers that we need for the week without any interruptions. The rest of the day runs smoothly and after many calls, emails, and discussions with my boss and the purchase manager, I feel I have found the right mix design for the grout and the supplier who can provide the materials we need at the cheapest price possible. A few minutes are left before the day ends and even the permit materials, traffic plan, and layout of operations are



Checking the grout flowmeter pressure gauge



Mapping and support inspection at shaft #2



The TBM Shield assembly

finished and submitted to the Department of Transportation. It's time to go for a pizza with some friends.

Saturday

The day starts more slowly than usual. It's 8.00am. With the quiet atmosphere of a Saturday, there is no rush, no stress, and no chaos in the office corridor. It's going to be a productive day. As I was hoping, my boss walks in with lots of freshly

baked croissants, which helps bring the energy for the next few hours. The day is dedicated to plans for the following week, design work that wasn't completed during the previous week and a schedule update for the monthly submission to the client. Saturday is also when I spend some time on my own training. In the last few weeks, I've been taking advantage of the e-learning platform that forms part of our "Build Up" training programme. Today, I get useful some insight on problem-solving. Now that everything is done, it's time to relax and enjoy the weekend. ☺

It's Friday so it's got to be pizza!



The Dugway Storage Tunnel project (DST) is a component of a programme being implemented by the Northeast Ohio Regional Sewer District (NEORS) to improve the control of combined sewer overflows (CSOs) on the east side of the Greater Cleveland service area. The project area is mainly residential, interspersed with commercial properties and parks. The tunnel alignment is approximately 4.5 kilometres long, excavated with an 8.2 metre diameter single shield hard rock Tunnel Boring Machine (TBM). The finished internal tunnel diameter will be 7.3 metres. The depth of the tunnel ranges from 55 metres to 70 metres below ground surface. The project will have a total of six shafts (DST 1-6) with internal lined diameters ranging from 5 metres to 15 metres and adit connections between the shafts and tunnel. The project sees the use of jet-grouting, secant piles, liner plates and ribs, blasting and the use of a Vertical Boring Machine (VBM) to excavate the six shafts on the project.

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# Educating the Industry

Back in 2000, the ITA identified education and training as one of the most important requirements of the association. As a result, the ITA Committee on Education & Training (ITA-CET) was officially established in 2007. The Committee's role is to promote education and training throughout the international tunnelling community, and more specifically, to:

- Coordinate interaction and exchanges among member universities
- Plan, coordinate and prepare the contents of training courses organized and promoted by the ITA
- Establish the content, scope, structure and requirements of professional Masters courses endorsed by the ITA and analyse requests for endorsement
- Share training and educational material

The ITA's Strategic Plan for 2014-2016 reaffirmed this priority, citing knowledge sharing through education and training as one of its strategic goals and charging the Committee with seven specific actions:

- Support Member Nations through training and workshops
- Organize and develop a regional ITA-CET correspondent network
- Implement training for professionals and the industry
- Implement online-learning events
- Create and develop a university network
- Increase the number of ITA-CET lecturers and training topics
- Communicate ITA-CET activities within and outside the ITA community

The ITA-CET Committee consists of 41 members from both the public and private sector and with both academic and industry backgrounds. The Committee is chaired by Robert Galler with the help of Michel Deffayet (Vice Chair) and a Steering Board that includes representatives from the other ITA Committees and the leaders of the four Activity Groups (AG) set up to help the Committee achieve its goals.

## AG 1: Training and education for ITA Member Nations

Activity Group 1, led by Michel Deffayet, is responsible for what is currently the most visible part of the Committee's activities: The preparation of training courses for

Knowledge sharing through education and training is a fundamental goal of the ITA. Professor Robert Galler, Head of Subsurface Engineering at the University of Leoben and Chair of the ITA's Committee on Education & Training (ITA-CET), explains how the ITA-CET Committee and the ITA-CET Foundation are working together to train students and young professionals.



students and young professionals. In this respect, AG1 works in close collaboration with the ITACET Foundation (see below).

In addition to preparing content for the annual ITA-CET training course, which is held during the World Tunnel Congress, AG1 organises the programmes of short courses that are held at the request of ITA Member Nations. The ITA-CET Committee strives to guarantee high-quality courses, both in terms of programme content and choice of lecturers, who are either academic experts in their field or leading industry professionals. The database of lecturers currently includes about 130 professionals around the world.

AG 1 has also set up a "correspondent network" to better identify the training requirements of specific regions and to establish long-term training strategies.

## AG 2: Training and education for professionals and industry

There have been significant developments in equipment and materials over recent years. Activity Group 2, led by Volker Wetzig, aims to identify industry

requirements and promote training and education accordingly. The group has focused on the endorsement of certain in-industry training courses in order to guarantee the level of content. The first ITA-CET endorsement of this type was granted to the EFNARC sprayed concrete (shotcrete) nozzle-man certification scheme (see: [www.efnarc.org](http://www.efnarc.org)). This certification scheme has been running for several years and is highly acknowledged in the underground construction industry.

Discussions between the ITA-CET Committee and the ITAtech Committee (the ITA's committee on technologies) have also highlighted the growing need for training events that provide practical demonstrations of technologies and materials available to the industry.

"Deminars" were therefore developed, mixing traditional classroom presentations with practical demonstrations, in order to illustrate the latest industry developments. The first Deminar, on "Waterproofing and Drainage", was held at the Hagerbach Test Gallery, in Switzerland, in September 2015. A second is planned for September 2016.

### AG 3: University network

The aim of Activity Group 3, led by Georg Anagnostou, is to establish a network of active university professors and lecturers offering courses in underground construction. This network provides information on courses, exchanges ideas on course content and organises student exchanges. The Committee's university network currently has 28 members from universities and higher education establishments around the globe.

AG 3 is also involved in examining requests for the ITA's endorsement of Masters courses. This endorsement is a guarantee of the quality of course content,



and high-level teaching. At present, five such courses have received endorsement (see below for more information).

### AG 4: Development of online-learning

One of the tasks of Activity Group 4, led by Fulvio Tonon, is to develop online or distance learning courses in order to enable a wider audience to benefit from ITA training events. An initial one-hour video-conference training session on Resource-Efficient Tunnelling was recently organised by the ENTPE in Lyon, France, in collaboration with the Politecnico di Torino, in Italy, and a group of engineers at the CETU, in Lyon. The feedback from this initial training session was positive and has shown that simple video-conference equipment can offer a practical means of providing distance learning. The Committee therefore envisages organising similar courses by video-conference in the future and may also develop webinars.

### The ITA-CET Foundation

In order to organise and finance ITA-CET's training activities, the ITA decided to create

the ITACET Foundation, in 2009. Based in Lausanne, Switzerland, the Foundation aims to encourage the education and professional training of specialists in underground space in emerging countries.

This non-profit organisation is financially independent from the ITA and is governed by a Council presided by Abdullah Al-Mogbel, assisted by an Executive Board; funding is received through donors and industry representatives, and volunteer lecturers help the Foundation to organise training courses in countries with limited financial means.

To date, the Foundation has organised 47 training courses around the world,

enable course participants to maintain contact after an event.

### Scholarships for Master Course students

Since 2011, the ITACET Foundation has granted student scholarships to young engineers from emerging countries who have been accepted on an ITA-endorsed Masters course. At present, there are five ITA endorsed courses:

- MSc in Tunnelling and Tunnel Boring Machines, Politecnico di Torino, Italy
- MSc in Tunnelling and Underground Space, University of Warwick, UK
- MSc in Tunnelling and Underground Space, ENTPE/INSA, Lyon, France



gathering over 5,300 participants. In addition to the host countries of the WTC, nations which have benefited from these training courses include: China, Argentina, United Arab Emirates, Brazil, Mexico, Singapore, Saudi Arabia, Thailand, Cambodia, India, Bhutan, Vietnam, Myanmar, Nepal, Malaysia, Finland and Azerbaijan. Many other courses are currently being prepared.

The Foundation has also set up an alumni group on LinkedIn in order to

- MSc in Tunnels and Underground Works, AETOS, Madrid, Spain
- On-line Certificate in Tunneling, University of Colorado, Boulder, USA

Since the Foundation's creation, it has worked hand in hand with the ITA-CET Committee. On a daily basis, the two organisations have quite complementary roles. The ITA-CET Committee is responsible for establishing training course programmes and choosing lecturers who are experts on the topic in question. These course programmes are tailor-made to meet the specific needs of the nation requesting the event. The ITACET Foundation is responsible for handling all financial and organisational aspects of the training course in partnership with the requesting nation. 

For more information on the ITA-CET Committee, please visit: <http://www.ita-aites.org/en/wg-committees/committees/ita-cet> For more information on the ITACET Foundation, please visit: <https://www.itacet.org/>

# Forming a Legacy in Mexico

The AMITOS Young Members Group, one of the newest member nations of the ITAYM, recently held its first meeting

01

Roberto Gonzalez Sr. (pictured left) has led the charge to usher in a new generation of Mexican tunnelling engineers

02

The preliminary meeting of the AMITOS Young Members Group on March 5, 2016

03

Large TBM projects for wastewater, such as the Túnel Emisor Poniente II (TEP II) pictured here, are attracting a new generation of Mexican engineers interested in underground construction

“The number of young engineers in Mexico is growing. There was a big gap in the tunnelling industry for many years here, between the wastewater tunnels built in the 1970’s and the latest raft of tunnels that began construction in 2000. There are a lot of new engineers, but most are dedicated to civil construction on roads, highways or dams. Our job is to get them interested in the underground,” explains Roberto Gonzalez, General Manager of Tunnel Boring Machine (TBM) manufacturer Robbins Mexico.

He says this knowing that multiple projects, including Mexico’s largest tunnel – the 62 kilometre long Emisor Oriente Wastewater tunnel, are currently underway and only represent the beginning of a wave of much needed infrastructure improvements. “It is so important for us to form this group of young people who are really interested in underground construction, and have an outlook on tunnels from a national perspective. Many contractors for large tunnel projects are currently

targeting the much larger school of engineering within the university,” he explains.

Alfredo Galicia is one of those students taking the Masters courses. Galicia earned his Bachelor’s in engineering and is currently working on a Masters degree focused on tunnelling through the National University’s post-graduate programme. “It’s important to me that I have experience in soil mechanics, and that’s what persuaded me to look into the tunnelling programme. I believe that with this support from the AMITOS association, they are creating human resources that will be a big part of the tunnelling industry in Mexico in the future.” Galicia has found the Masters courses to be a big help and is accepting the challenge. “I’m motivated to accomplish this challenge; it hasn’t been easy but the courses are fascinating. I feel lucky to be a part of this generation of future tunnel engineers.”

The Masters courses are only one step in the process, but their success has served as a stepping stone to more opportunities. Gonzalez Sr. is now



01



02

coming in from outside countries, like Spain, to construct tunnels in Mexico. The market here in Mexico needs to be prepared in order to better compete and have a good knowledge base.”

The charge is being led by his father, Roberto Gonzalez Sr., who chairs the Mexican Tunnelling Society, known as AMITOS. Gonzalez Sr. began targeting young engineers with Masters degree classes organised through the National University. “We are on our third generation of students now, and there is more interest each year. We started out looking for geology students, but we are now also

working with professors at the university to establish the AMITOS Young Members Group, which will also serve as the ITA-YM Mexico: “Our goal is for students to be able to attend international conferences, and to have the same knowledge as international members of the ITA so that they can compete on the world stage.” To that end, Gonzalez Sr. appointed Fermín Sanchez to form the AMITOS Young Members Group.

Sanchez studied at the National University himself and now teaches classes there while working on his PhD in geotechnical engineering. “I have worked almost all of my life in tunnelling, whether

it's project management, studies, or calculations," says Sanchez. He also owns a company called Consultec México that provides geotechnical services for Mexican tunnel projects. The company was originally founded by his father in the 1970's. "When I was a student at university, I wasn't sure if I wanted to be an engineer. Then one day my father asked me to help him with a complicated tunnel, and I fell in love with it. It's an important part of my life." Sanchez brought that passion to the Masters tunnelling courses and his work with students. "The engineers that created the Masters courses are very enthusiastic and we give scholarships to students, arrange visits to construction sites, and invite them to congresses. I work directly with the students and that's why I am starting up the young members group."

Currently Sanchez is working to register the group and make everything official, but he's not wasting any time. He has a list of all interested students, which he concedes is basically everyone working towards a Masters thesis in tunnelling at the university. And, on March 5th, he held a preliminary meeting of the Young Members Group. "We sent emails to students and put up posters. We gave a short presentation to them about the tunnelling industry, and our next steps for the organization." A total of 60 students attended the talk. Sanchez is looking forward to planning future events, and has an idea to create a congress for the students to showcase their research and allow them to meet with industry professionals in Mexico.

Sanchez sees this as just the beginning, and not only a needed impetus for more Mexican engineers but also as a cultural shift. "There is a long way to go in terms of tunnel engineering in Mexico. We don't really have an engineering culture in this country, especially for tunnels. For example, many companies just dig the tunnel without doing studies – they don't put much emphasis on monitoring, behaviour of the tunnel, the soils, etc. They just want to come out the other side as soon as possible."

Changing that viewpoint may take some time, but Sanchez is willing to put in the effort. "There are opportunities out there for young tunnelling engineers, but it is not easy. For that reason every time a student graduates we try to provide placement for them into the industry. We are educating the students to have a clear thought process, high-tech engineering skills and a real understanding of the principles of tunnelling." 

 Our goal is for students to be able to attend international conferences, and to have the same knowledge as international members of the ITA so that they can compete on the world stage. 

Robert Gonzalez Sr.



# from Five

Aspiring tunnellers can get a head start on their peers by studying one of the specialist undergraduate or postgraduate tunnelling degrees around the world. We spoke to five graduates to ask them why they chose the course they did and where it has taken them. **Kristina Smith reports...**

## From Lithuania to London, pursuing an engineering dream

**Karolis Gvildys, Engineer,  
OTB Engineering**

*Master of Science, Tunnelling and  
Underground Space, Warwick University*

Karolis Gvildys was on a work placement on the UK's M25 motorway with Balfour Beatty, when the contractor offered to sponsor him to do a Masters in Tunnelling and Underground Space at Warwick University. "I knew that I didn't want to be a general civil engineer, I wanted to specialise in one field, and Balfour Beatty was offering me the chance to do it," says Gvildys who came to the UK from Lithuania to study a Bachelors degree in Civil Engineering at the University of Surrey, having known since 15 that he wanted to be an engineer.

He enjoyed the course at Warwick, it was well-structured, friendly, and had a lot of support from the tunnelling industry. Having been sponsored by Balfour Beatty, Gvildys was committed to working for the contractor for two years after gaining his Masters. But even for those who weren't sponsored, there were no shortage of job offers, says Gvildys: "One of the presenters, who came from the industry to give us a lecture handed out his business cards at the end of the presentation and said 'If you finish this course, we will give you a job'. That instilled confidence in me that I had made the right choice in taking this course."

Having completed his course at Warwick in 2012, Gvildys found himself working on Liverpool Street Station, part of London's Crossrail project for BBMV, a joint venture involving Balfour Beatty. "I enjoyed the whole experience and I learnt a lot whilst working on such



a grand project, but I also found it quite challenging," says Gvildys. "Working on site 12 to 13 hours, seven days straight, and switching between day shifts and night shifts takes its toll."

After a year, Gvildys knew that the life of a shift engineer was not for him. Refunding what he owed to Balfour Beatty, he left to try designing – rather than constructing – tunnels, working for Donaldson Associates. "At first office life seemed a little quiet in comparison to site, but once I settled in I realised that there are different challenges to be overcome." One of the highlights of his time at Donaldson was being given

responsibility for a sewage diversion project involving a 650 metre pipe jacked tunnel and seven shafts.

"I was effectively put in charge of managing the project, from the design to communicating with the client," says Gvildys. "This provided me with numerous challenges and responsibilities, giving me a great opportunity to prove myself."

After two-and-a-half years with Donaldson, Gvildys moved on to work for another designer, OTB Engineering. "Each company has its own work philosophy that affects all aspects of company life, from what software they use, to how they file documents and conduct business. In my opinion, it is best to get a range of experience, to find what works best for you," says Gvildys.

The course at Warwick was good preparation for what he is doing now, says Gvildys. "The modules on underground construction methods and tunnel design proved very useful," he says. "Even though you may not know all the procedures and formulas, you know where to start and you have an idea of what you are looking at. Most civil engineering degrees do not cover any aspects of tunnelling – apart from to say they exist."

## Variety is the spice of life on German railway tunnel project

**Mario Galli, 32, Technical Assistant of Construction Supervision, Dipl.-Ing. H. Vössing GmbH**

*PhD Tunnelling, Ruhr-Universität Bochum*

Mario Galli admits that when he started his civil engineering studies at Ruhr-Universität Bochum, in Germany, he didn't have a clear idea what his future job would be. Like many young people, he was working on instinct, without knowing too much about what a job in the sector would involve. It wasn't until the end of his six-year diploma that he found out. "Tunnelling was the last subject in the last semester – and that was the subject that really got me," he says.

Having gained his diploma, Galli stayed on at the university for a further five years, working as a research assistant and gaining a PhD in tunnelling, under the guidance of Professor Markus Thewes. Along with Thewes, and several other research students, Galli was investigating the use of foams for soil conditioning while using Earth Pressure Balance Tunnel Boring Machines (EPB TBMs).

"It's a big research topic for Markus Thewes' department," says Galli. "We were working with companies, on job sites, contributing our expertise. And we were also carrying out fundamental research, looking at the micro-level interaction between the tunnelling process, the soil and the foam. It was fun!"

Galli also spent time setting up a construction management course for the civil and environmental engineering faculty at the university and helped Thewes establish a two-year Mastercourse, 'Geotechnics and Tunnelling', which is delivered in German.

Feeling ready to leave the world of academia, Galli secured his current job with German engineering firm Vössing last summer before he finished his PhD. He is working for a team overseeing the construction of a 15 kilometre section of railway line on behalf of client Deutsche



Self-discipline, self-management, time management, understanding how to prioritise things, these are just as important as technical knowledge. And you need the courage to make decisions.



Bahn, the German rail authority. With two tunnels, the section "Alb Ascent" is part of the S21 Stuttgart to Ulm rail programme, and will form part of the trans-European rail network.

"I always look forward to coming back to site on a Sunday night," he says. "I can put on my boots and go into the tunnel, look at what I want to, ask questions. I get involved in discussions and decision-making, which is a real privilege. I

organise meetings, write protocols and contractual letters, the diversity is probably the best thing about the job."

Moving from a PhD where a focus on detail is vital, to a construction site, where a global perspective is needed, could have been a tricky move. But Galli realised that he had gained the management and life skills he needed during his time at the University under Thewes, who has an industry background.

"Self-discipline, self-management, time management, understanding how to prioritise things, these are just as important as technical knowledge," he says. "And you need the courage to make decisions. If you don't do that, you will be swamped, as new issues hit you every day."

Though his journey towards a tunnelling career started off rather vaguely, Galli is very much an advocate for the industry now: "If you want to do something special, something fantastic, that gives something back to the world, then you should definitely try tunnelling."

## Thirst for education leads to 'global village' of tunnelling

**Federico Amadini, 30, Junior Engineer, Geodata Engineering**

*Masters Degree, Tunnelling and Tunnel Boring Machines, Politecnico di Torino*

Federico Amadini was drawn to a Masters Degree in tunnelling by his thirst for knowledge. "I still wanted to study. I needed to know more," he says.

Having gained both a Bachelor of Engineering Degree and a Master's Degree in territorial and environmental engineering at the University of Pavia, in Italy, Amadini found the ITA-AITES endorsed Master's Degree in Tunnelling and Tunnel Boring Machines (TBMs) at the Polytechnic University of Turin, which is taught in English. "I wanted something with a practical application. I looked around Italy and around Europe and found this course in Turin. My girlfriend was living there and it was just 300km from my hometown. It was fate – and the best decision I ever made."

The best thing about the course was the breadth of information delivered by tunnelling experts from around the world, brought in by course leader Professor Daniele Peila. "We had many workshops on real case histories. That's very important for tunnel designers, more important than books. It's useful to have a very wide view of tunnel excavation and tunnel methodology as well as the contractual aspects of a job site," says Amadini.

The Masters students also enjoyed a number of site visits: to the Rome Metro, to the Ceneri Tunnel, in Switzerland, and the Herrenknecht tunnel boring machine factory, in Germany.

Having carried out an internship with Italian consultancy firm Geodata, Amadini was employed by them at the end of his course. And over the past five years, he has been designing a whole range of structures connected with tunnelling projects including geotechnics, soil stability, road design,



■ ■ The thing I love about my job is facing problems and being able to come up with new solutions. I really enjoy that, especially looking at the constructed work at the end. ■ ■

retaining walls, buildings, drill and blast tunnels, and TBM bored tunnels.

"It's been a 360 degree experience in design," says Amadini. "The thing I love most about my job is facing problems and being able to come up with new solutions. I really enjoy that, especially looking at the work that has been constructed at the end."

In July 2011, Geodata sent Amadini to India to work on the Chenani-Nashri tunnel, a 9.2 kilometre road tunnel in the Jammu and Kashmir region. "India was incredible," says Amadini. "It's impossible to describe it. And that was my first time out of Europe." Following India, Amadini has worked on the construction of a metro line in Saint Petersburg, Russia, and recently the Alto Maipo Hydroelectric Project, in Chile.

Being out on site really brought to life the information that had been presented

to him on the course. "When you are listening to your professor, it's hard to recognise how important what they are explaining is until later, maybe once you are looking at the screw conveyor of an EPB (Earth Pressure Balance) TBM, with mud in your face," says Amadini. "Some of the other students on the Masters had left their jobs to study, so they had a better appreciation of these things."

Amadini urges anyone considering a career in tunnelling to go for it. "Around the world, there will always be a need for tunnels because populations are growing, and we need to go underground," he says. "And although it looks like a very big world, the world of tunnelling is like a small village. You can travel 20,000km and meet the same people that you saw at a previous job site or conference. I like that, because I come from a small village myself."

## Family's move to Australia sparks interest in the underground

**Charlotte Franklin, 25, SCL Sub-agent, Dragados-Sisk Joint venture, Crossrail**  
*Bachelor of Engineering in Mining Engineering, Camborne School of Mines*

If Charlotte Franklin hadn't spent a year in Australia with her family in 2006, she might be an architect or a graphic designer now. "In Brisbane, my teachers asked me 'Why are you not considering civil engineering or mining engineering?'" she says. The mining sector in Australia is hugely important, with many people aspiring to work in it, and the tunnelling industry is booming at present.

Back in the UK, Franklin studied maths and science subjects and discovered that the Camborne School of Mines, in Cornwall, was really the only place she could study mining. In contrast to their Australian counterparts, Franklin's UK teachers were confused by her choice. "One asked me 'Why are you doing this? Why don't you become a teacher?'"

Undaunted, Franklin got her place at Camborne. "It's such a unique course," she says. "You get the right balance of hands-on, lectures and placements and there's a support network there so that if you do need extra help with anything, there's always someone to talk to."

Franklin's first experience underground came in her first Easter break when she worked in the School's small test mine. "The degree at Camborne, right from the start, makes you think you are a hands-on person," says Franklin. "That's very important when you are on site." She also learnt to pursue the college motto 'Laboris Gloria Ludi' – work hard, play hard – a mentality she says she has preserved once working.

One of the highlights of Franklin's studies was a one-year placement with Sandvik at its research facility in Tampere, Finland. Camborne students are expected to do a placement of at least six weeks in their second year and, with little tunnelling around in the



■ ■ The degree at Camborne, right from the start, makes you think you are a hands-on person. That's very important when you are on site. ■ ■



UK at that time, Franklin took the bold move of emailing the Sandvik president directly – and was rewarded with a place. "It was a fascinating year, being able to work underground, and to experience the culture in Finland, which is completely different to the UK," she says. "I learnt so much and it gave me a better focus, my

grades shot up in the third year."

With tunnelling work on London's Crossrail project kicking off, Franklin found a job and was on site before her actual graduation ceremony. Her first role was as a Tunnelling Boring Machine (TBM) engineer. "It's challenging," she admits. "The people, the work itself, every day is so different. You can have a breakdown on the TBM, be down the tunnel trying to work out what's wrong while your manager is on the phone demanding to know what's going on. You have to keep calm, find a solution and make sure it's done safely."

Major projects such as Crossrail are definitely where Franklin wants to be: "I like going into work every day and it being different. I've been lucky in my short career to have had a variety of roles, on the TBMs, a dip into consultancy and now on the secondary lining works. I am now working on 18 metre diameter caverns, some of the largest in Europe, which is brilliant."

## Internships helped find the ideal tunnelling role

**John Kuyt, 23, Graduate Tunnel Engineer, Arup**

*Master's Degree, Underground Construction and Tunneling, Colorado School of Mines*

John Kuyt is one of those lucky people who always knew what they wanted to do. "I haven't ever really thought about doing anything else," he says. "I've wanted to be a civil engineer my whole life." With family members already working in the civil engineering profession, it was an idea he just grew up with.

The Colorado School of Mines (known as CSM or 'Mines' by its students and faculty), in the USA, was a natural choice for Kuyt. It was close to home, which meant he could pay in-state fees, rather than out-of-state fees, which tend to be higher. And the location, just on the edge of Denver, was a big bonus: "I really enjoyed the skiing," says Kuyt. "Mines is just 45 minutes away from some of the world's best resorts, and I had a Norwegian roommate whose enthusiasm helped out a lot."

Kuyt studied a Bachelor of Science in Civil Engineering at CSM before going on to complete a Master's Degree in Underground Construction and Tunneling. And every summer he worked for a different company as an intern. "I am a little more enthusiastic than most," he admits, with a laugh.

It was his third internship, with Barnard Construction Company, on the San Francisco Central Subway project, that opened his eyes to the world of underground construction. "It was unlike anything I had seen before," he says.

His current role with Arup came through the work he did on his research thesis, collaborating with Arup's London office to look at field data collected on the Brisbane Airport Link tunnels, in Australia. The research looked at the stresses and strains created in the linings of two parallel main tunnels when



There are lots of opportunities to travel. The other great thing is that the projects themselves are interesting and challenging. I never feel my job is mundane.

smaller tunnels – or cross-passages – are dug between them.

Now a Graduate Tunnel Engineer at Arup, Kuyt loves the variety of his job. "There are lots of opportunities to travel," he says. "And the other great thing is that the projects themselves are interesting and challenging. I never feel my job is mundane."

Projects Kuyt has worked on include a new sewer tunnel near South Beach, in Miami, Florida, where he spent a month on site, and a new underground research facility, the Long Baseline Neutrino Facility, at the Lead test mine, in South Dakota, which will see huge rock caverns created 1.5 kilometres below the surface.

Now in the real world, he appreciates the combination of theoretical coursework and practical case histories that his Masters course at Colorado

School of Mines provided. One course has come in particularly useful for the South Dakota job.

"We had a fantastic rock mechanics professor who had 20 years' experience in South Africa designing mines," says Kuyt. "Although I didn't learn everything I needed to know, I got the basics which meant I could pick up two or three papers, understand the context and feel reasonably equipped."

Kuyt's advice to other undergraduates who are considering tunnelling as a career is to get out on site. "If you can get an internship, try and start with a contractor so you can see the work first hand," he says. "And don't assume all jobs in tunnelling are the same. Each side of the industry has different challenges and a different lifestyle – for me, I found out that consulting was best for me." 

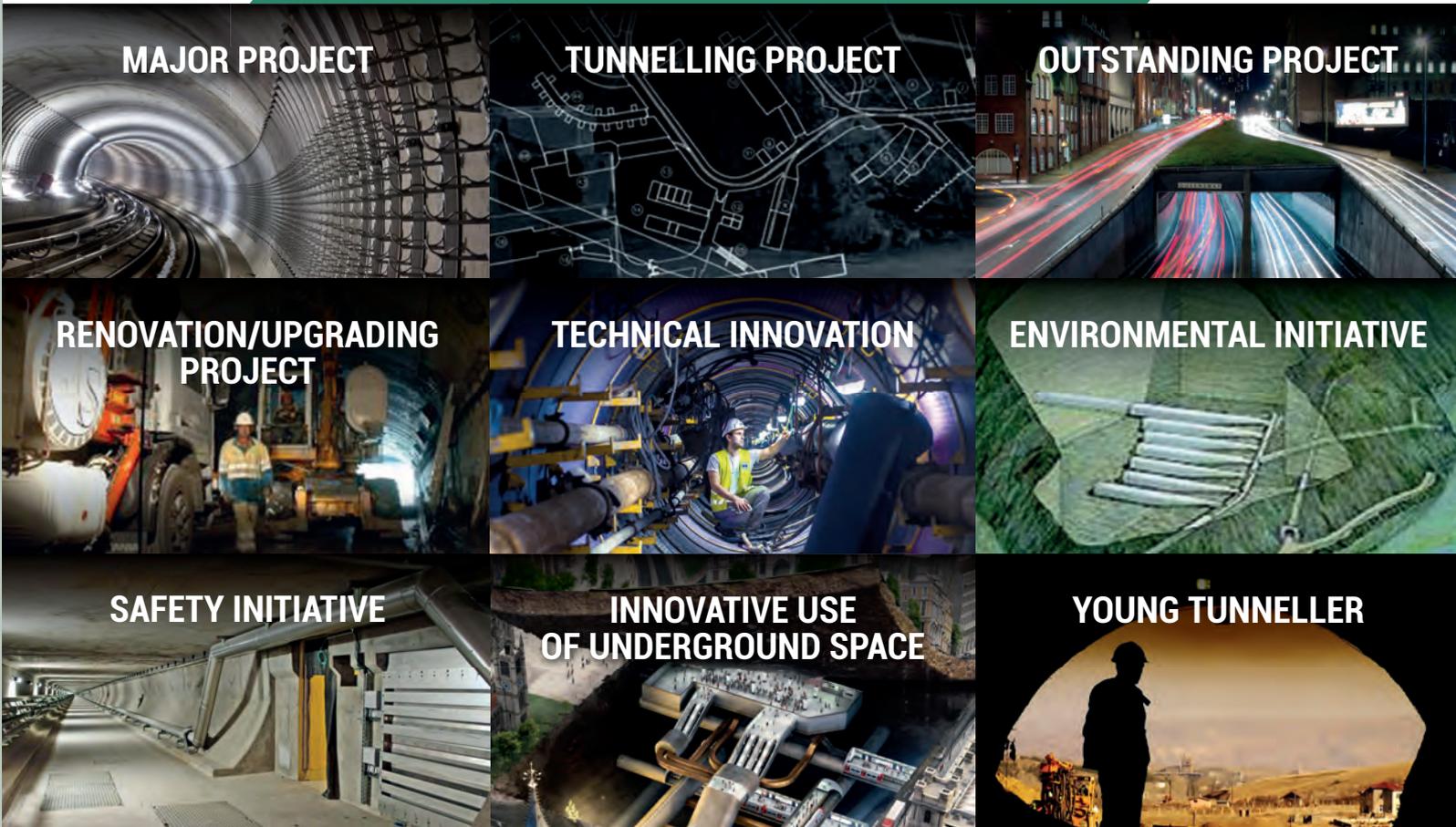


# ITA TUNNELLING AWARDS 2016

10 & 11 November 2016 - Singapore



## Participate in the 2016 Awards



## A 2 DAYS EVENT TO MEET, LEARN AND CELEBRATE

The ITA Tunnelling Awards organized by the International Tunnelling and Underground Space Association (ITA-AITES) will identify and celebrate outstanding achievements in tunnelling and underground space development and promote international recognition of the industry's remarkable contributions to engineering and to society.

- A contest for 9 categories
- A 2 days conference
- An award ceremony banquet

### > ENTRIES

Entries from every corner of the world are welcome in **9 CATEGORIES**. Submissions are to be received by Monday May 30, 2016 through our dedicated website: [awards.ita-aites.org](http://awards.ita-aites.org) - Contact: [awards@ita-aites.org](mailto:awards@ita-aites.org)

### > ATTEND THE 2 CONFERENCES AND BANQUET

The **2016 ITA Awards Conference and Banquet** will be held on November 11 at the Marina Bay Sands in Singapore. On November 10, will take place a **Symposium on Underground Development and Technology** organized by TUCSS. Book conference and banquet from the dedicated website: [awards.ita-aites.org](http://awards.ita-aites.org)



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**AITES** INTERNATIONAL TUNNELLING AND UNDERGROUND SPACE ASSOCIATION

# Bergen welcomes you to WTC 2017



The Norwegian tunnelling market is as active as ever with several high profile projects underway. This includes the world's longest and deepest subsea tunnel, Rogfast, and the 19km twin tube Follo line railway tunnel. In addition, high speed rail tunnels and new rail and metro extensions in Oslo are planned. This, combined with a unique history in tunnelling and underground solutions, makes Norway the perfect host for the 2017 World Tunnel Congress (WTC). Here we give an overview of why Bergen makes such a great venue and why you should start planning your trip to Norway for the WTC in June 2017.

## Why should you go to the WTC?

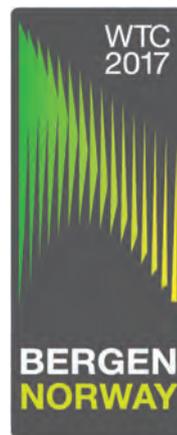
The Norwegian tunnelling society (INFF) and the organising committee for WTC 2017 have made it a priority to encourage young professionals to attend, actively participate in and influence WTC 2017. Incentives for young professionals include carefully selected topics for the ITA-CET training courses, awards for the

best papers submitted and presented by young professionals, discounted conference rates for students and young professionals, social networking events and post conference tours in Norway. The WTC 2017 organising committee has also dedicated a position on its committee to future ITAYM Chair, Sindre Log, to ensure the needs and wishes of young professionals are properly addressed during the event.

The Norwegian Young members group and ITA young members will be active at the conference with a dedicated exhibition stand, which will be a natural gathering point for young professionals during the conference. The young members groups will also have the pleasure of inviting young participants at the conference to one of the most interesting venues in the city, The Nygaten Gallery. The Gallery opened in 1983 and has since gained the reputation of being one of the most spectacular galleries in Norway, as well as a superior event venue with an interesting interior and vibe.

As there is still over a year until the conference, there are several other initiatives being considered, but not

yet confirmed. Among these are daily morning runs, poster sessions from Masters students, a young members lunch and arranging tickets to concerts in the city. More information about these initiatives will be announced as the conference get closer.



## So, why should you go to Norway?

While in Bergen, it is likely you will have the opportunity to run, walk or take the tram up to the top of the city's mountain, Fløyen, one of the most iconic tourist attractions in Norway. However, you shouldn't limit your mountaineering activities to this small trip. Bergen is an ideal starting point to visit some of the most scenic parts of Norway.

Just a few hours away, by car, bus or train, are some of the most spectacular landscapes Europe has to offer, with high mountains and deep fjords that are perfect for hiking or biking trips. The west coast of Norway also offers the unique experience of glacier skiing. Glacier skiing resorts are open for the majority of the summer and offer the unique experience of skiing in warm temperatures. The Norwegian Young members group and



the organising committee for WTC 2017 have already started planning a number of post conference tours for young people to experience the Norwegian countryside.

And if the paper presentations or events at the conference are not causing the adrenalin to pump fast enough, the international extreme sports week (Ekstremспортveko) will be held in Voss (less than two hours from Bergen) in the last week of June. The annual Ekstremспортveko is the largest sport and music festival of its kind. It hosts competitions in kayaking, rafting, mtb-bmx, skateboarding, skydiving, paragliding, hang gliding, multisport, freeride, big air, climbing, BASE and longboarding. It also offers a unique opportunity for people inexperienced in extreme sports to try the majority of the above activities within a week! Further information on the event can be found at <https://ekstremспортveko.com/>.

### Why should you hang out in Bergen?

If summer skiing and skydiving seems a bit too much, Bergen has built a reputation over the years as being one of the most exciting cultural cities in Norway and Scandinavia. Historically, several influential classical composers

and musicians have spent their lives in Bergen. This includes the violinist Ole Bull, Soprano Sissel Kyrkjebø and the world famous composer Edvard Grieg. Grieg was one of the leading composers in the Romantic era and is still considered one of most influential classical composers. The main venue for the conference, The Grieg Hall is named after the composer and the hall even has an in-house philharmonic orchestra.

More recently, several international pop musicians from Bergen have risen to fame, this includes Kurt Nilsen (World Idol), Sondre Lerche, Kings of Convenience, Datarock, Ylvis ("what does the fox say?") and Kygo. In recent months, the young artist Aurora Aksnes (AURORA) has also got some traction internationally and seems to be the next big thing coming from Bergen. This also means there are a number of good concert venues to discover new musicians or just hang out listening to good music.

While in Bergen it is a must to visit the Wharf of Bergen (Bryggen). Even though the local brewery (Hansa) is named after the Hanseatic League, the Wharf is arguably the most famous legacy of the Hanseatic period. The Hanseatic League was a commercial and defensive

confederation of merchant guilds and their trade cities that dominated maritime trade in Northern Europe and the Baltics from the 13th Century.

Bergen was the headquarters of the Hanseatic League in Norway and dealt with the majority of fish, and fish oil, trading to the continent. When the Bergen Kontor (Office) was closed in 1775, it had greatly influenced the city both economically, socially and culturally for several hundred years. Even today, there are still families with German or Hansatic names in the city and much of the city's architecture is clearly influenced by this period. The Wharf of Bergen was included on the UNESCO list of World Cultural Heritage sites in 1979, due to its distinctive architecture and Hanseatic style.

### We look forward to seeing you!

Whether you're hanging out at a concert arena listening to Kygo or AURORA, hiking in the Norwegian mountains, rafting or skydiving in Voss, enjoying a beer at the Wharf or just attending the conference we are confident you will thoroughly enjoy WTC 2017 in Bergen. We are excited and look forward to seeing you there!

*On behalf of the WTC organising committee.*

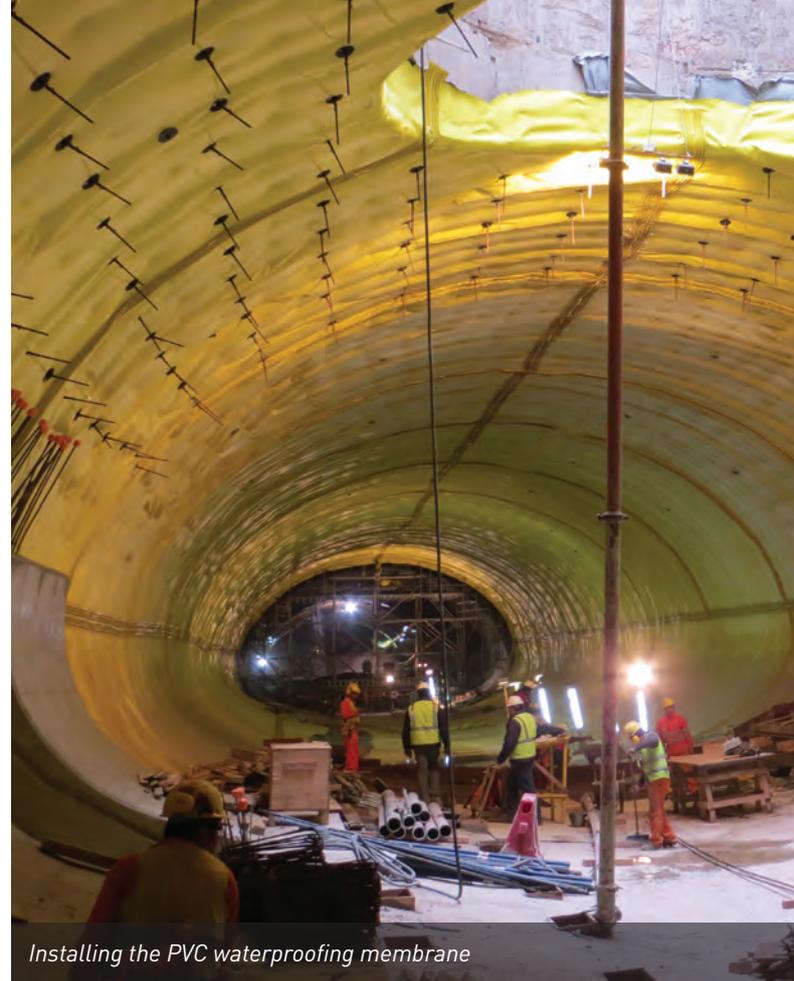
# Learning Experience in Latin America

Daiana Dottori completed her civil engineering studies at the National Technological University of Buenos Aires in 2006. She has spent the last four years working on the Buenos Aires Underground's Line H Extension, for the Geoconsult Group, as a Project Coordinator, where she has gained valuable experience providing on site technical assistance for the project's underground structures.

Four years ago, when Geoconsult's Buenos Aires branch-office hired Daiana Dottori to work on the northbound extension of the Buenos Aires' Metro Line H, she felt privileged to have the opportunity to join such a major project at an early stage of the works. Running north to south on the west side of the city's downtown area, Metro Line H will ultimately connect two of Buenos Aires' main railway

stations, Once and Retiro, completing an orbital link that will provide greatly improved connectivity for commuters. The Line, which opened in 1997, is currently being extended both to the north and the south, adding a further 3.5km of metro line.

The \$440 million contract for the northern extension commenced in 2011, using sequential excavation methods (SEM tunnelling) to construct 2km of twin-track tunnel



Installing the PVC waterproofing membrane

through the region's stiff cemented silts and clays, and is now close to completion. The new route runs from the existing Corrientes Station (just north of Once) to Plaza Francia, serving three new underground stations at Córdoba, Santa Fe and Las Heras.

Two of these stations were mined and feature 135m long caverns with a cross section of 220m<sup>2</sup>; while the last station (located at the northern end of the project) was built using the Cut and Cover method and features a 150m long by 22m wide station box. The extension also includes the construction of a 400m long parallel twin cavern for the train depot at the southern end of the line, beyond Parque Patricios Station, and an additional 250m long parallel twin cavern for the nearby maintenance facilities. At the north end of the alignment the extension also crosses three existing metro lines.

Daiana joined Geoconsult as part of the detailed design team (formed by Geoconsult and SRK), for the Techint/Dycasa contracting joint venture. The

design team provides technical assistance on site for all aspects of the underground construction works. In addition to project coordination during the design stage, Daiana's responsibilities include supervision of the underground construction and support activities, as well as monitoring ground behavior and ensuring compliance with the specified construction methodology.

Over the last four years, Daiana has been able to witness each and every step in the design and construction of this major project. From the initial excavation of a drainage system, which was constructed to draw down the groundwater table; to the excavation of the main running tunnels, which were accessed from ramps built at the surface; and the complex mined excavation of the large station caverns; to the highly sensitive and complex solutions adopted in order to pass under and over the existing operational Metro lines; Daiana has gained a unique first hand view of the implementation of a major underground infrastructure



Excavation of a 'side drift' heading at the end of a cavern



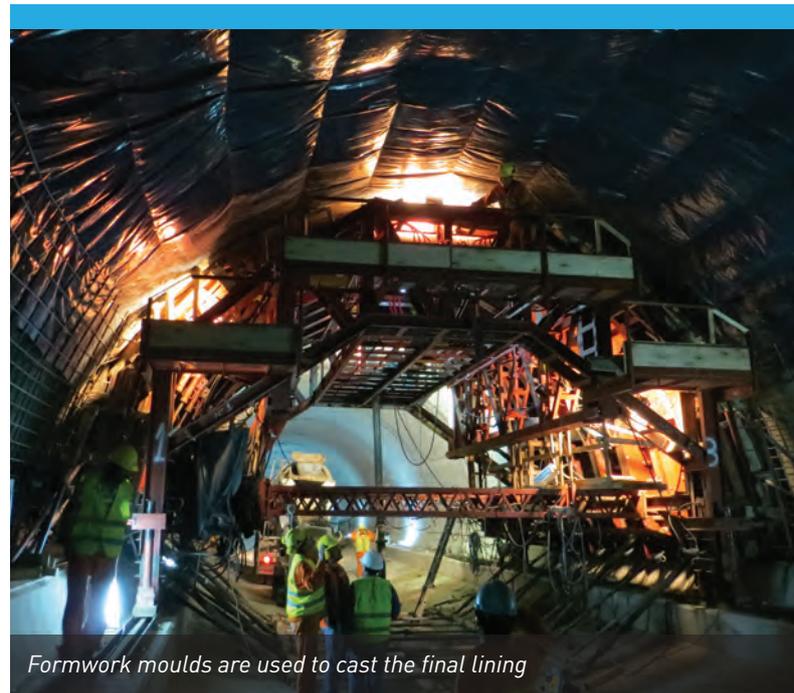
of variable width (between 0.6m and 1m) depending on the underlying soil quality and deformation constraints imposed by the environment and the proximity of buildings and adjacent structures. The final tunnel lining consists of cast-in-place concrete, designed to carry the full hydrostatic water pressure and to provide the required watertightness along the structure's lifetime.

Geoconsult's contract involved regular visits to all excavation headings to observe and map the geotechnical and hydrogeological conditions and evaluate the geotechnical behaviour of the excavation. These evaluations supported decisions on adjustments to the length of excavation advances, invert closure, lining thickness, the use of additional reinforcement, and improvement or modification of the drainage system, etc.

Over the course of the project, Daiana has seen ideas, analysis and engineering judgment turn into a detailed design and then later being implemented

project from desktop designs to the finished construction works.

The excavation method adopted for the running tunnels was a full-face top heading excavation, supported by a 150mm thick shotcrete (sprayed concrete) lining, borne on elephant feet (local widening of the shotcrete lining to allow for load transfer to the ground)



Formwork moulds are used to cast the final lining

on site: "Especially having been involved from the very beginning, it's been really rewarding to see this project entering operation. The experience I have gathered during the project development, as well as the lessons learned during construction, have given me an excellent understanding of complex project development, especially considering the difficult project location (in a densely built up urban area)."

#### Upcoming projects in Argentina and Latin America

Argentina has a challenging agenda of large underground infrastructure projects. However, due to the recession that characterised the last government, only a small number of tunnelling projects have entered construction in the last four years. Now, with a change in government at the end of 2015, the chances of a number of these major infrastructure projects gaining the funding to proceed have significantly increased.

These include: The 14km long Agua Negra Road Tunnel, which

will connect Argentina with Chile through the Andes mountain range; The Ribereña Highway, which involves the construction of a tunnel underneath Puerto Madero on the eastern side of Buenos Aires; The Sarmiento Underground Railroad, a 32km rail tunnel in Buenos Aires; the Rio Subterráneo Sur, a 24km tunnel for the provision of potable water to the southern districts of Buenos Aires; and the Arroyo Vega Tunnel, a flood relief tunnel in Buenos Aires.

Over the last decade in Latin America, the commodities boom, and a period of favourable economic conditions, pushed forward a large number of underground infrastructure projects, including mass transit systems, water and sewer tunnels, hydropower projects, underground mine projects, and road and rail tunnels.

The current economic slowdown in the region has led to the cancellation or postponement of some projects. But it is expected that the region will continue to develop tunnelling projects, even if at a slower pace than before. **B**



Daiana Dottori in her element

# Strong Beginnings in Brazil

The Brazilian Tunnelling Committee (CBT) established its own Young Members Group in mid-2015, prompted by the ITA-AITES and sharing the same goals and objectives as the ITAYM. The inaugural CBT-YM event was opened by Jairo Pascoal Júnior, Vice-President of CBT, followed by the ABMS Treasurer Artur R. Quaresma Filho (Brazilian Association of Soil Mechanics and Geotechnical Engineering). Akira Koshima, the Former President of CBT, gave an overview of the 25 year history of the Committee to the young audience.

The CBT-YM Chair Marlísio O. Cecílio Jr. and the Vice-Chair Eloi A. Palma Filho emphasized the importance of bringing young underground construction professionals together on a national level. They also reported recent activities from the WTC2015 event, in Croatia, including the release of Breakthrough magazine, and encouraged active participation in the WTC2016 event.

As the start of a wider initiative, CBT-YM will organise lectures by young professionals, with assistance from senior engineers, on a quarterly basis. At the first Young Member meeting, geologist Mariana K. Caldo gave a presentation on the use of in-situ testing, as applied to Brazilian tunnelling projects, with the assistance of Marcelo dos Santos, a professional with extensive practical experience in this field.

The lecture proved to be a success, with more than 80 of the 154 registered members of the CBT-YM group in attendance. The lecture theme was deliberately chosen to represent the early stages of a tunnelling project and to coincide with the new publication "Strategy for site investigation of tunnelling projects", by the ITA's Working Group 2.



01

**01**  
Mariana K. Caldo and Marcelo dos Santos give a lecture on the use of in-situ testing at the first CBT-YM meeting last July

**02**  
The CBT-YM technical visit to the Siemens factory in Jundiaí, São Paulo

## First technical visit

The CBT Young Members began 2016's activities with its first technical visit. On February 3rd, the Young Members Group had the opportunity to visit the Siemens factory in Jundiaí, São Paulo.

The day was very productive. Prior to visiting the company's industrial manufacturing facilities, young engineers attended technical presentations given by Siemens professionals on product lines relating to tunnelling and underground construction

applications. More specifically, electrical mediums and low voltage installations were discussed, as well as control and automation systems.

Following the presentations, a question and answer session was held, where a clear synergy emerged between the two parties; both on the side of the Young Members who were keen to gain new knowledge and the manufacturer wanting to meet the demands of tunnelling professionals. 

02

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