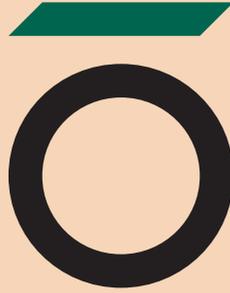


# TRIBUNE

ASSOCIATION  
INTERNATIONALE DES TUNNELS  
ET DE L'ESPACE SOUTERRAIN  
**AITES**



**ITA**  
INTERNATIONAL TUNNELLING  
AND UNDERGROUND SPACE  
ASSOCIATION



***ITA newsletter - la lettre de l'AITES***



## ST GOTTHARD: GREAT PROGRESS IN AN EPOCH-MAKING PROJECT.

Tunnelling on the northern Erstfeld and Amsteg lots of the Gotthard Base Tunnel is finished. The tunnelling teams celebrated breakthrough with the Herrenknecht Gripper TBMs, Gabi I and Gabi II, on June 16 and September 16, 2009. The two machines put in excellent drilling performances and both reached their targets 6 months ahead of schedule. Working in the western tunnel, Gabi II excavated and secured up to 56 meters of new tunnel per day.

The two Herrenknecht Hard Rock Machines Heidi and Sissi are also making good progress on the southern section from Faido to Sedrun. The final great breakthrough in Sedrun is scheduled for the end of 2010.

We wish everyone good luck and a safe journey in completing this epoch-making project.

### GOTTHARD | SWITZERLAND

**PROJECT DATA**



S-210, S-211  
 2x Gripper TBMs  
 Diameter: 8,830mm and 9,430mm (2nd section)  
 Cutterhead power: 3,500kW  
 Tunnel lengths: 13,425m, 14,088m, 11,098m, 11,118m  
 Geology: gneiss, granite, slate

**CONTRACTOR**

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 Zschokke Locher AG,  
 CSC Impresa  
 Costruzioni SA,  
 Impregilo S.p.A.,  
 Alpine Mayreder Bau  
 GmbH, Hochtief  
 Construction AG



S-229, S-230/  
 S-421, S-422  
 2x Gripper TBMs  
 Diameter: 9,580mm  
 Cutterhead power: 3,500kW  
 Tunnel lengths: 10,722m, 10,702m, 7,147m, 7,116m  
 Geology: gneiss, granite, slate

AGN CONSORTIUM:  
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 Tunnelbau  
 Schweiz (CH)/  
 STRABAG AG (A)



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# TRIBUNE

ITA newsletter  
la lettre de l'AITES

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**ITA·AITES 2010**  
WORLD TUNNEL CONGRESS AND 36<sup>TH</sup> GENERAL ASSEMBLY  
CONGRÈS MONDIAL DES TUNNELS ET 36<sup>E</sup> ASSEMBLÉE GÉNÉRALE

WELCOME BIENVENUE  
TUNNEL VISION TOWARDS 2020 VISION 2020 POUR LES TUNNELS

ASSOCIATION INTERNATIONALE DES TUNNELIERS AITES  
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# EDITORIAL

On behalf of the Tunnelling Association of Canada (TAC), I am extremely pleased to welcome all delegates and guests of the ITA-AITES World Tunnel Congress (WTC 2010) and 36th General Assembly, to beautiful Vancouver, British Columbia, Canada. As a member nation of ITA-AITES, the Canadian Delegation is very proud to host this year's Congress, and we sincerely hope that everyone who attends will have a positive, memorable experience. Our Congress Organizing Committee has spent countless hours over the last several years striving to

provide for all of you the very best possible event, whether for official meetings, technical presentations, social activities, or entertainment purposes, all structured within a new, state-of-the-art facility, in the heart of downtown Vancouver. Our Congress Theme "TUNNEL VISION TOWARDS 2020" is very appropriate as we progress into the second decade of the 21st century while dealing with serious world-wide issues such as future economic uncertainty in some sectors and the potential threats posed by global warming. The intelligent use of underground space and tunneling techniques will undoubtedly play an increasingly important role in providing environmental and energy benefits, as well as infrastructure development in populated areas.

While the Congress format will provide ample time in the schedule to find out what your Canadian and North American tunnel colleagues are currently doing, and to interact and network with others from our world-wide tunnel industry, I urge all visiting delegates to take the opportunity while in Canada, to see first-hand a relatively small but beautiful part of our vast country. During the recent 2010 Olympic Winter Games, television



audiences around the world were exposed to some of the magnificent scenery and outdoor amenities available, not only in Vancouver, but within a very short distance. There are very few places in the world where one can experience a modern urban city while being in close proximity to majestic alpine snow-capped mountains, rugged forested wilderness, vast ocean vistas, deep fiords, and abundant wildlife on land, in the air and at sea.

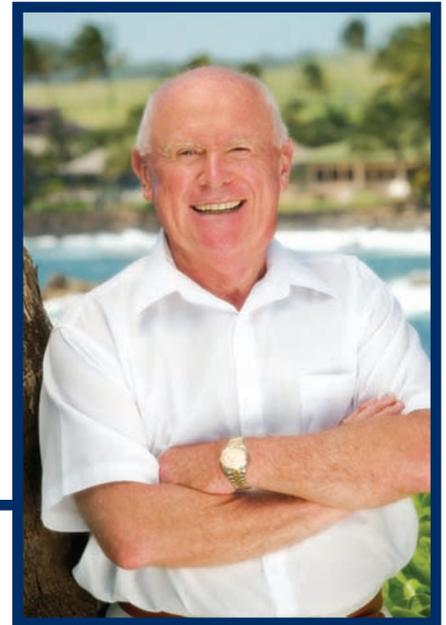
The Tunnelling Association of Canada is an organization

of individuals and corporations directly involved in the tunneling industry in Canada, managed by a small volunteer Board of Directors, with elected Officers. Our purpose is to initiate, pursue and serve the interests of Canadian professionals involved in the areas of tunneling, mining, underground spaces and related sciences, through the promotion of communication, education, conferences, workshops, publications, and social gatherings.

I wish all delegates safe travel to and from Vancouver, a very successful Congress and much success in all of your tunneling endeavors.

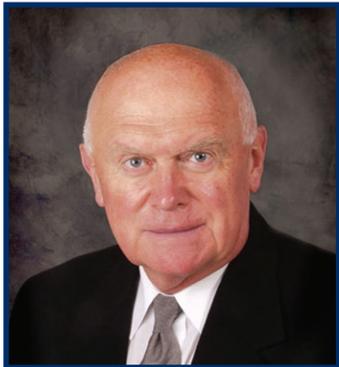
*Rick Staples,  
President, Tunnelling Association of Canada*

*On Friday, September 4, 2009, a memorial service for Dr. Dan Eisenstein was held at Bethlehem Chapel in downtown Prague, Czech Republic. In addition to the large extended Eisenstein family present, many of Dan's friends, schoolmates, acquaintances, tunnelling colleagues, and others within the tunnel industry from both the Czech Republic, and internationally, gathered to pay tribute to a man whose name and reputation was synonymous with the art of tunnelling and underground construction around the world. Representatives of the Tunnelling Association of Canada (TAC) present were president Rick Staples, and vice-president Rick Lovat. Many great memories of Dan's life and career were celebrated through presentations by family, close friends, and tunnel colleagues, including Jana Eisenstein Jr. (Dan's daughter), Jan Sperger, Milan Miessler, Jindrich Hess (Metrostav a.s.), Dr. Martin Herrenknecht (Herrenknecht AG), Claude Berenguier (Secretary General, ITA), Rick Staples (President, TAC), Prof. Vaclav Havlicek (Rector of CVUT), Doc. Josef Jettmar (Vice-Dean of Civil Engineering Faculty, CVUT), Dr. Karel Rossler (Metrostav a.s.), and Ivan Hrdina (President, Czech Tunnelling Association).*



# ZDENEK DAN EISENSTEIN, Ph.D., D.Sc., P.Eng.

**Professor Emeritus of Civil Engineering  
The University of Alberta: Edmonton, Alberta, Canada  
Past President AITES / ITA, Geotechnical and Tunnelling Consultant**



ON MONDAY, JUNE 1, 2009, CANADA AND THE international tunnelling community lost a top-class tunnelling professional in Dr. Z. D. (Dan) Eisenstein, after a relatively short, but intense battle with cancer.

Dr. Z. D. Eisenstein received his Undergraduate and Graduate Geotechnical education at the Czech Technical University in Prague between 1959 and 1965. Following a period of postdoctoral work in London, U.K., he accepted an academic position at the University of Alberta in Edmonton, Canada, in 1969, becoming a Full Professor in 1974 and a Professor Emeritus in 2001. Over the period of 1972 to 1983, Dr. Eisenstein completed four Visiting Professorships in Brazil (2x), South Africa and Germany. In 1990, he became an Honorary Professor at Pontificia Universidade Catolica, Rio de Janeiro, Brazil and in 1991 he received an Honorary Doctorate from The Czech Technical University.

Dr. Eisenstein's prime research and professional interest has been soft ground tunnelling, especially in urban environments. On this and other topics, he has published over 160 papers and has conducted over 100 lectures and presentations worldwide. Awards include honorary doctorates from Universities in Prague and Rio de Janeiro and no less than seven further achievement prizes in the field of Tunnelling and Geotechnical Engineering.

Dr. Eisenstein was an expert advisor and consultant on dams, foundations, deep excavations and tunnels for over 150 projects across the globe. Some of the tunnelling projects in particular included: the Channel Tunnel between the U.K. and France, the Westerschelde Tunnel in Holland, the Rio Subterraneo Tunnel in Buenos Aires, the Copacabana Metro Line in Rio de Janeiro, the City Link tunnels in Melbourne, the Edmonton LRT tunnels, the Mrazovka Tunnel in Prague, the feasibility studies for the Gibraltar Straits Tunnel and the Canada Line Subway tunnels in Vancouver. Most recently, he was the Chairperson of the Tunnel Advisory Panel for the Los Angeles Metropolitan Transportation Authority, a member of the Peer Review Panel for the Toronto Transit Commission and an advisor for the New York MTA.

Dr. Eisenstein was an active member of the International Tunnelling Association. He was elected Member of the Executive Council in 1987, First Vice President in 1989 and finally elected and served as the President of AITES / ITA over the period 1992 to 1995.

Dr. Eisenstein is survived by his wife, Jana and their two daughters and sons-in-law: Alice and Dave Langston, and Jana and Paul Levett. He also leaves behind his five adoring grandsons.

His pragmatism about the art of tunnelling will be sadly missed. ●

# Focus on Canada

## A PERSPECTIVE ON CANADIAN TUNNELLING - PAST, PRESENT AND FUTURE

### CANADA

Canada occupies most of northern North America, extending from the Atlantic Ocean in the east to the Pacific Ocean in the west and northward to the Arctic Ocean. The total land area is 9,093,507 sq km. It is the world's second largest country (after Russia) and its common border with the United States to the south and northwest is the longest in the world (about 8,893 km). Canada's 2006 census counted a total population of 31,612,897. Approximately 90% of the population is concentrated within 160 km of the US border. The topography is mostly plains, with mountains in the west and lowlands in the southeast. Climate varies from temperate in the south to subarctic and arctic in the north. One of the world's highly developed countries, Canada has a diversified economy that is reliant upon its abundant natural resources and upon trade, particularly with the United States. Natural resources include iron ore, nickel, zinc, copper, gold, lead, molybdenum, potash, diamonds, silver, fish, timber, wildlife, coal, petroleum, natural gas, hydropower.

Canada is a federation of ten provinces and three territories. In turn, these may be grouped into regions: Western Canada, Central Canada, Atlantic Canada, and Northern Canada (the latter made up of the three territories: Yukon, Northwest Territories, and Nunavut). Eastern Canada refers to Central Canada and Atlantic Canada together. Provinces have more autonomy than territories. Each has its own provincial or territorial symbols. Canada's two official languages, English and French have equal status in federal courts, Parliament, and in all federal institutions. Canada is governed as a parliamentary democracy. The Prime Minister's Office (PMO) is one of the most powerful institutions in government, initiating most legislation for parliamentary approval and selecting, besides other Cabinet members, senators, federal court judges, heads of Crown corporations and government agencies, and the governor general.

Canada's National symbols are influenced by natural, historical, and First Nations sources. The use of the maple leaf as a Canadian symbol dates to the early 18th century. Other prominent symbols include the beaver, Canada Goose, Common Loon, the Crown, the Royal Canadian Mounted Police and more recently, the totem pole and Inukshuk.

Hockey is a national pastime and the most popular spectator sport in the country. It is also the sport most played by Canadians, with close to 2 million participants. Canada's six



largest metropolitan areas - Toronto, Montreal, Vancouver, Ottawa, Calgary, and Edmonton - have franchises in the National Hockey League (NHL), and there are more Canadian players in the NHL than from all other countries combined. Canada has hosted several high-profile international sporting events, including the 1976 Summer Olympics in Montreal, the 1988 Winter Olympics in Calgary, and the 2007 FIFA U-20 World Cup. Canada is the host nation for the 2010 Winter Olympics in Vancouver and Whistler, British Columbia.

### INTRODUCTION TO TUNNELLING

The Tunnelling Association of Canada (TAC) promotes the use of underground space and modern technology because of its vital importance to rapidly expanding infrastructure. This strategy has been focused in encouraging innovation in tunnels in the areas of transportation, hydropower, rapid transit, sewage and waste disposal.

Measured against some other countries, Canada is a young country with a brief history of development of underground

# Focus on Canada

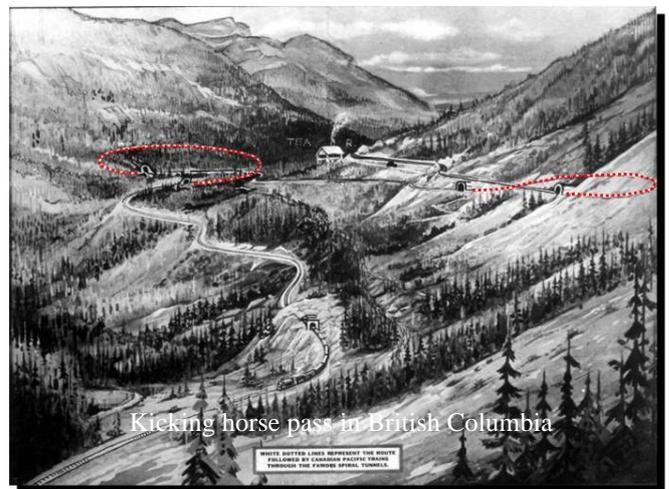
spaces. However, the development of tunnelling and the level of expertise within Canada have been extensive, with a large number of tunnels that have been completed in a variety of geological settings, both in soil and rock. The papers by Dr. Raymond Benson and Dr. Robert Legget provide an insight into this history (Ref 1 and 2).

## HISTORY – PIONEERING PAST

Canada's history is closely tied to the development of transportation systems. The first tunnel in Canada was constructed between 1854 and 1860 near Brockville, Ontario to provide rail access to the St. Lawrence River. It was 527 m long, with stone masonry used at each end to support soil, with an unlined central portion in competent sandstone. It was in operation for almost 100 years, and at one stage the invert was lowered to accommodate larger trains. The last train passed through the tunnel in 1969. The tunnel is now open to the public as a museum, featuring photographs of history of the construction.

From the late eighteenth up to the mid-twentieth century, most major tunnels in Canada were associated with railways including many on the trans-Canada rail lines through the Rockies. In 1885, the Canadian Pacific Railway (CPR) was completed across Canada. Its alignment avoided the use of long tunnels but many short tunnels were involved through the Rockies and around the northern shoreline of Lake Superior. Later came the Spiral Tunnels and the eight-kilometre Connaught tunnel (completed 1916) that reduced the grade through the Rogers Pass. In the 1980s, CPR constructed the 14-km long tunnel through Mount MacDonal, the longest railway tunnel in the Western hemisphere at the

Canada, through this work and a burgeoning mining industry, was at the forefront of tunnelling techniques. Further demands of our economic growth in the early twentieth century required larger road and rail tunnels to act as connecting conduits to the United States. Two famous rail tunnels, namely: the St. Clair railway tunnel between Sarnia and Port Huron, built with a Greathead shield equipped with a segment erector; and the first in the world, immersed twin-tube tunnel, the Detroit River Rail Tunnel between



Kicking horse pass in British Columbia

Detroit and Windsor, were placed in service in 1891 and 1910, respectively. St. Clair was the first tunnel in North America to be shield driven and the first in which compressed air was used. One hundred years later, a parallel 8.4 m internal diameter tunnel was constructed to provide increased vehicle clearances. This tunnel was the first major application of earth pressure balance boring machine technology and is still the largest TBM-driven soft ground tunnel in North America.

In 1912, in order to reduce travel time to reach Montreal, a 5 km twin track tunnel was drilled through the volcanic rocks of Mount Royal. In the 1930s, the Dunsmuir Tunnel under downtown Vancouver was constructed to connect the CPR to the docks on the south shore of Burrard Inlet. This tunnel was subsequently converted to a double-decker configuration for use by the Sky Train transit system.

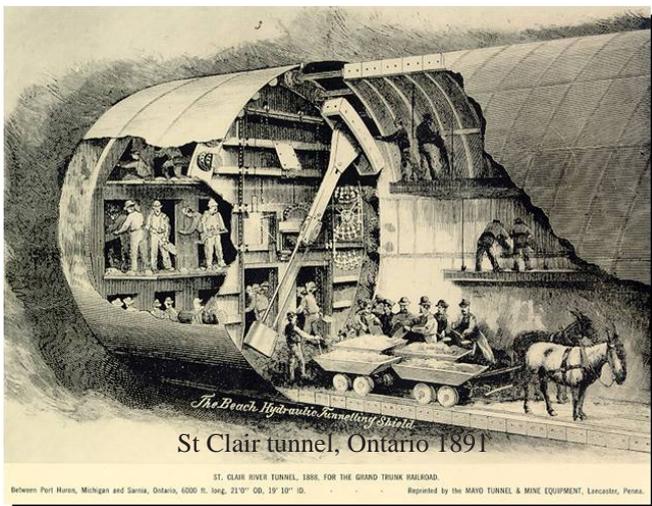
Rapid transit tunnels are relatively new in Canada. Construction of the first subway began in Toronto in 1949, using the traditional cut and cover method. Extensive tunnelling activities for subsequent subway expansion followed, using mechanized techniques, with segmental linings, initially of cast iron and later using concrete. These



Brockville tunnel, Ontario 1854-1860

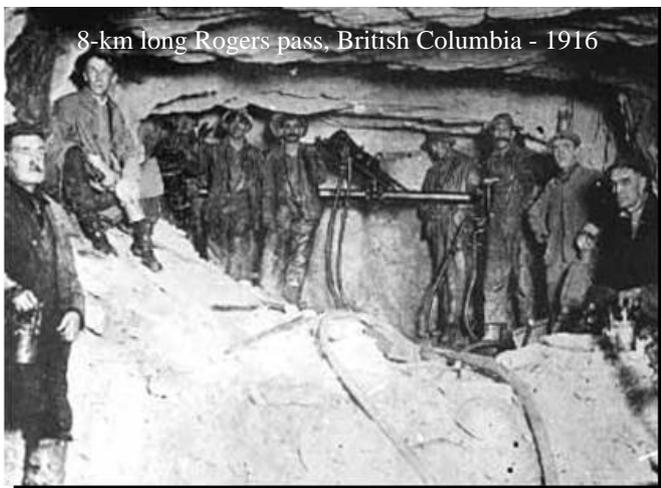
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# Focus on Canada



tunnels advanced the application of shield methods used with compressed air and saw one of the earliest applications of a soft ground tunnel-boring machine in North America.

Road tunnels are generally short and primarily located in the mountain regions of British Columbia on Canada's west coast or under watercourses in eastern Canada. Some of Canada's road major arteries are connected via immersed-tube tunnels that were constructed to provide crossings under major rivers. One is the famous Detroit-Windsor automobile tunnel, built in the 1930s and still in service today. Two other major tunnels include Montreal's Louis-Hippolyte-Lafontaine Tunnel (L-H-F) under the St. Lawrence River and the George Massey Tunnel, constructed in the 1960s under the Fraser River just south of Vancouver. Similar tunnels were built by cut and cover to pass under the Welland Canal in southern Ontario and the Cassiar Tunnel in Vancouver on the Trans-Canada Highway.

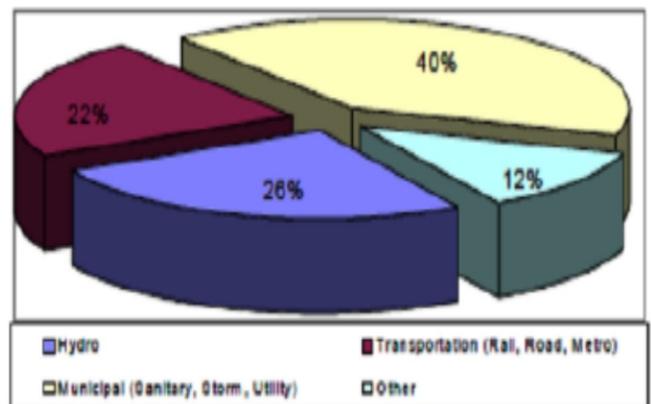


## STATISTICAL OVERVIEW

The greatest number of civil tunnels constructed in Canada can be credited to the development of municipal infrastructure. Such tunnels provide the municipal infrastructure required to sustain modern life in every city and town between the Pacific and Atlantic Oceans. Because of their normally small size, it is likely that no complete listing of these tunnels will ever exist.

Similarly, mine tunnels are often abandoned and forgotten when mining is complete, although the number and size of these tunnels outrank those required for civil works by a factor of about ten. The Canadian mining industry is known throughout the world, especially in hard rock exploration and tunnelling. Many of the mining methods have been transposed into civil engineering.

Transportation tunnels are of a paramount importance in our country, because Canada is a vast country, spanning five time zones from east Atlantic to the west Pacific coast. Developments of its transportation system and industrial base have been, and still remain, a tremendous challenge.



# Focus on Canada



In hydropower, large diameter tunnels are required for diversion and to supply water to the powerhouse. In Canada, hydropower is utilized for everyday needs, while a portion of the power is exported to the USA.

The major hydro power developments in Canada occurred in the mid-twentieth century. Tunnels in this category are often required to operate under high internal pressures, and may be either concrete lined or unlined, depending on rock conditions. For this reason, almost all tunnels for power are in rock. Dozens of projects of this nature were constructed in the mountainous regions of Quebec, Labrador and British Columbia.

In 1950s, Sir Adam Beck Two hydro complex was built on the Niagara River. Two 14-metre diameter tunnels, 10-km each, were excavated through highly stressed sedimentary rocks.



Since the 1950s, in British Columbia, great projects such as Portage Mountain, Mica, Revelstoke and others required major tunnelling works for water diversion and power facilities. The La Grande power complex owned by Hydro Quebec and the Churchill Falls project owned by Newfoundland and Labrador Hydro, are world-scale projects where rock tunnels and underground powerhouses are the norm.

## SIGNIFICANT PROJECTS

### 1 - Vancouver-Canada Line and Sky Train

Construction of the Vancouver transit system started in the 1980s with grants from the Federal and Provincial governments for a new light rail system. The first construction was completed in 1985, in time for the 1986 World Fair. The Sky Train system made use of a 1,400 m long tunnel constructed in the 1930s through downtown Vancouver for the railway system, extensively rebuilding and extending it to suit the requirements. In 2009, the Canada Line was completed in preparation for the 2010 Winter Olympics. EPB, twin tunnels with segmental lining, 2-km long were constructed under False Creek as part of a new transit link between International Airport, Richmond City Centre and downtown Vancouver.



### 2- Edmonton LRT

Edmonton started construction of a light rail transit system in the mid 1970s in preparation for the 1978 Commonwealth games, and was the first city in North America with a population of less than 1 million to build a modern light rail system. Although much of the system is above grade, tunnel sections were completed within the downtown area. The Sequential Excavation Method (SEM), a modification of NATM, was used to control running sands ahead of the tunnel face during construction of an extension to the original system in the mid 1980s. The first use of Slurry Tunnel methods in Canada followed with further expansion of the system in the 1990s. In 2004, a 600 m twin EPB tunnel was completed through difficult soil conditions. Future expansion of the system is planned.

# Focus on Canada

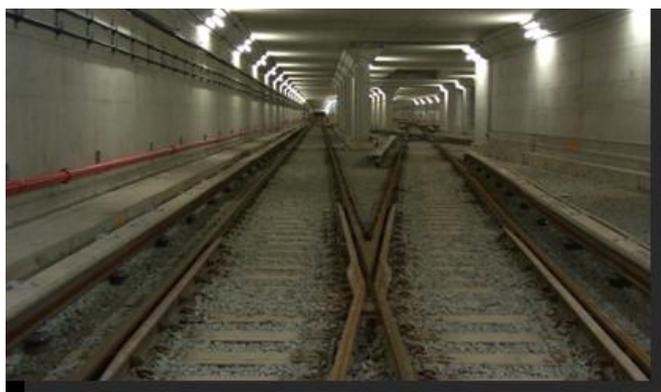


3 - Edmonton - Water and Wastewater Tunnels

The City of Edmonton has taken a unique (for North America) approach to development of its water and wastewater infrastructure. The city maintains its own tunnelling crews and owns several TBMs. Edmonton started tunnelling in the 1960s, when they were unable to get contractors to bid for initial tunnelling work. The City has constructed numerous tunnels, ranging in size from 900 mm to 6.25 m diameter, excavated by tunnel boring machines.

4 - Toronto - Sheppard Subway

Most recently in the 1990s, the 6.0 km Sheppard Subway line was constructed, for much of its length, using two pressurized face, 6-m diameter Earth Pressure Balance (EPB) Lovat tunnel boring machines excavating through glacial soil under the water table and demonstrating the huge improvement in advance rates and safety in tunnelling that has been achieved in the intervening years. EPB technology was selected as the best method to advance the tunnel through varying ground conditions in a densely populated urban environment and to avoid the need to use compressed air for excavation support. This was the second time that this type of TBM was used on a large tunnel in Canada.



5 - Montreal Metro

Construction of the Montreal Metro system commenced in the early 1960s in preparation for the 1967 World Fair (Expo). The tunnels were constructed in rock, using conventional drill and blast techniques with cast-in-place concrete lining. Later subway construction in Montreal made extensive use of roadheaders to excavate limestone. Extensions to the system were announced in 2008 are expected to commence in near future.



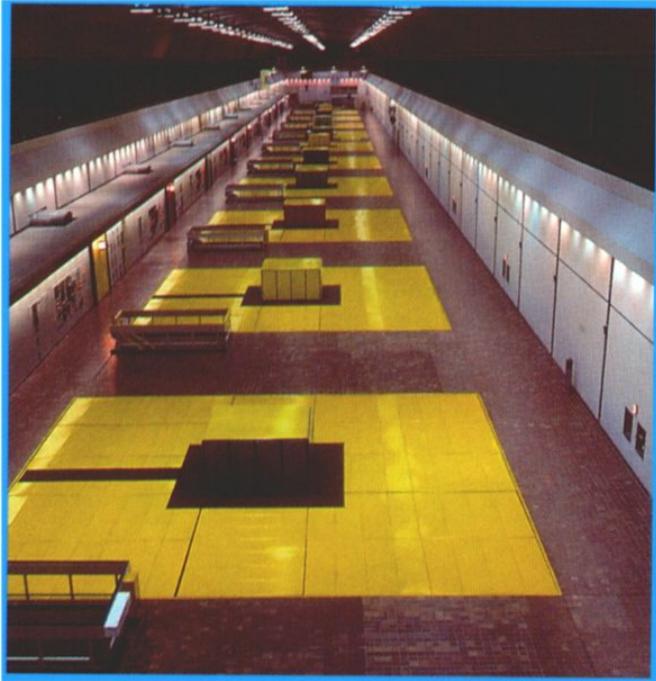
6 -Labrador - Churchill Falls Hydro

The Churchill Falls development is located in the heart of Labrador, Newfoundland. This giant development is, without doubt, one of the outstanding engineering achievements of the twentieth century, not only because it is the largest single underground hydroelectric power station in the world, but also because it was constructed in the remote wilderness. The underground powerhouse, 25 metres wide and 295 metres long, hosts eleven generators rated at 500 MW each. A controlled system of storage reservoirs 6,500 square kilometres in area was created by utilizing 64 km of dykes, 88 in all, with over half of these being classified as large dams using criteria of the International Commission on Large Dams. An average flow of 20,000 cubic metres per second passes through eleven penstocks with a rated net



# Focus on Canada

head of 310 metres. The underground caverns are situated within hard granitic rocks.



## 7 - Québec - James Bay Hydro

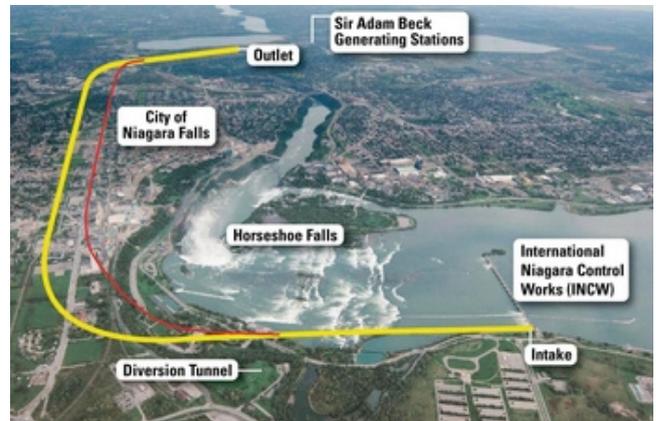
The James Bay Project (in French, projet de la Baie-James) refers to the construction by province-owned utility Hydro-Québec of a series of hydroelectric power stations on the La Grande River in northwestern Quebec, and the diversion of neighbouring rivers into the La Grande watershed. It is located between James Bay to the west and Labrador to the east and its waters flow from the Laurentian Plateau of the Canadian Shield. The project covers an area of the size of the State of New York and is one of the largest hydroelectric systems in the world. The project has cost upwards of \$20 billion US to build and has an installed generating capacity



of 16,000 megawatts, three times more than all of the power stations at Niagara Falls, eight times the power of Hoover Dam.

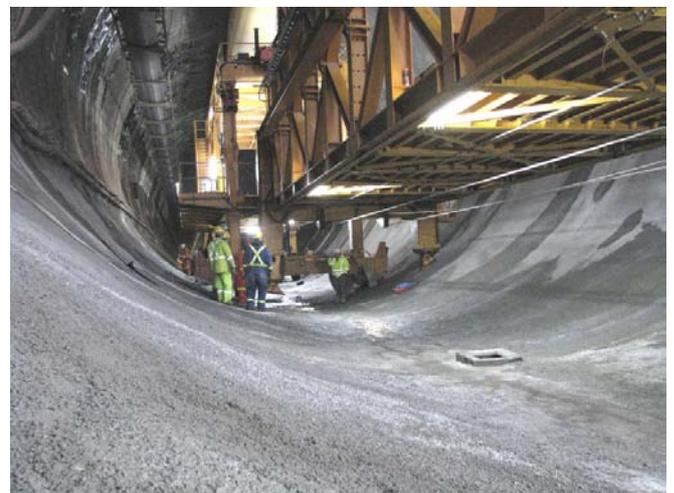
## 8 - Ontario - Niagara Tunnel

When someone says "Niagara Falls" what comes to mind? The spectacular Horseshoe Falls. The largest hard rock TBM in the world is hard at work, right now, drilling a massive tunnel deep beneath the City of Niagara Falls. It will be an incredible 14.4 metres wide and 10.2 kilometres long.



The purpose is to divert water from the Niagara River and carry it downstream to the Sir Adam Beck Generating Stations. Gravity alone will propel the water at 500 cubic metres per second. Niagara Tunnel will be a source of pride not only as an engineering feat, but also as a practical solution for meeting Ontario's energy needs through clean sources.

The Niagara Tunnel will provide enough clean water power



# Focus on Canada

to generate a further 1.6 billion kilowatt-hours of electricity annually—enough to meet the electricity needs of about 160,000 homes.

## 9 - North Vancouver - Seymour Capilano Project

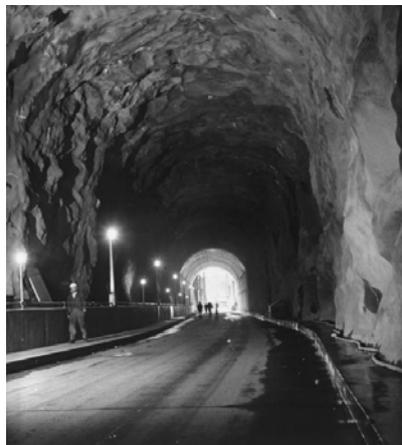
Construction of new water supply and treatment facilities is underway in the Lower Seymour Conservation Reserve (LSCR) and at Capilano River Regional Park. In order to treat water from both sources at one plant, water will be conveyed between Seymour and Capilano through underground twin tunnels.

The tunnels, 3.8 metres in diameter and 7.1 kilometres long, are being constructed 160-640 metres below ground level. When complete in mid-2012, these tunnels will transfer 1,100 million litres of water each day. Water from the Capilano source will get treated and disinfected at the filtration plant and will return to Capilano through a parallel tunnel, for distribution to residents throughout Metro Vancouver.



## 10 - British Columbia - Kemanó Project

Kemanó is a settlement situated 75 km southeast of Kitimat. It was built to service a hydroelectric power station, providing energy for Alcan to smelt aluminium (aluminum) ore. The powerhouse is built 427 m inside the base of Mt Dubose in a blasted cavern. It produces 896 MW of power from its eight generators, each of which has a capacity of 112MW. The plant comprises a 16 km tunnel, the width of a two-lane highway, drilled and blasted through the coastal mountains to carry water to the penstocks of the Kemanó powerhouse. The water plunges 700 m to drive the genera-



tors. The power transmission lines travel 82 km from Kemanó to Kitimat across some of the most rugged mountain territory in British Columbia, along the Kildala Pass, about 1,500 m above sea-level.

## 11 - Ontario - Saint Clair Tunnel

EPB technology was first used in North America to bore a 8.4 -m internal diameter tunnel under the St. Clair River in Sarnia – the largest EPB soft ground tunnel in North America. A Lovat soft ground TBM was used with segmental lining to support the tunnel. The tunnel was 8.4 m inside diameter and 1868 m in length, bored less than half a diameter below the river bed.

## 12 - British Columbia - Rogers Pass Tunnel

Rogers Pass tunnel was built in the 1980s through a high mountain pass in the Selkirk Mountains, used by the CPR and the Trans-Canada Highway. The pass is a shortcut across the "Big Bend" of the Columbia River from Revelstoke on the west to Donald, near Golden, on the east.

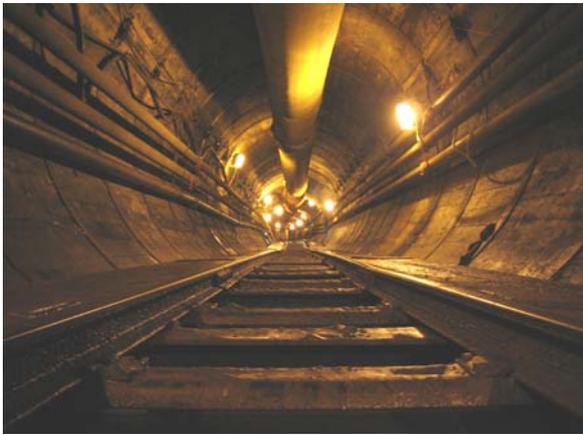


## 13 - Ontario - York Region Tunnels

Perhaps the largest network of sewer tunnels in Canada has been constructed for the York Durham Sanitary Sewer System. York Region is located north of the City of Toronto and does not have access to the shores of Lake Ontario. Prior to the 1970s, towns within the Region developed with groundwater supplies and local wastewater treatment systems, many discharging treated sewage into local water courses. In the 1970s and 1980s, the Province of Ontario undertook construction of a deep gravity sewer system, to pick up sewage from various towns and convey it to the

# Focus on Canada

neighbouring Durham Region for treatment prior to being discharged to Lake Ontario. Continued growth and development in the Region led to the need for additional capacity, and starting in 2000, York Region commenced a large construction program to extend the system and twin the main trunk sewer. Numerous projects have been completed to date totalling approximately 25 kilometres of tunnels; several projects are planned for coming years, including the 14 km South East Collector, which is scheduled to commence in 2010.



## 14 - Ontario - Nuclear Power Generation

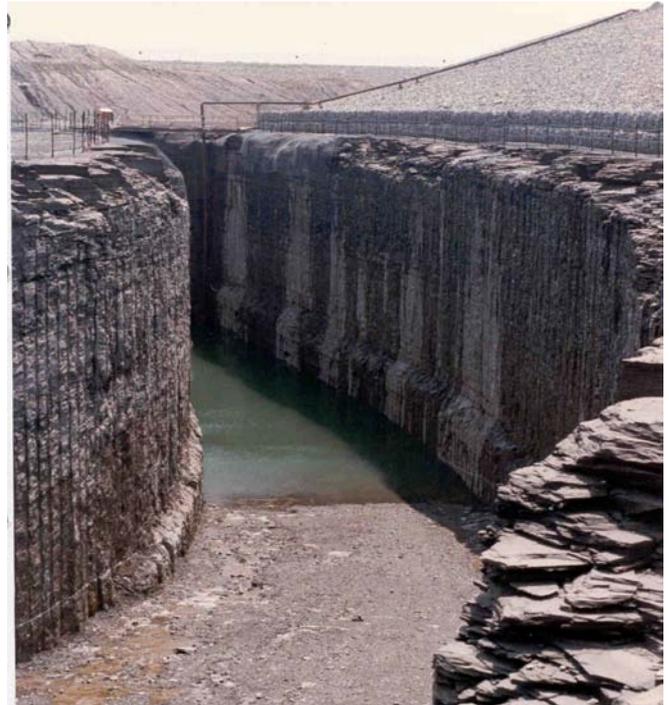
Nuclear power meets more than 50% of Ontario's electricity needs. Ontario Power Generation owns and operates the Pickering and Darlington Nuclear Power Stations. The two stations have a combined generating capacity of about 6,600 megawatts.

Bruce nuclear station is located at the east shoreline of Lake Huron, approximately 300 kilometres northwest of Toronto. At the time of construction Bruce was one of the largest energy complexes in the world, operating eight reactor units. Bruce is now a privately owned facility. The station's



total output is more than 6,200 megawatts of electricity.

A total of three intake tunnels were constructed under Lake Huron and Lake Ontario to provide cooling water to the nuclear stations. Tunnels were constructed by drill and blast method in late 1970s and early 1980s.



## 15 - Manitoba - Underground Research Laboratory

The Underground Research Laboratory (URL) is a facility owned and operated by Atomic Energy of Canada Ltd (AECL), a branch of former Ontario Hydro. The purpose of the URL is to study the feasibility of safe disposal of nuclear fuel in a stable excavation in a low permeability rock mass. The URL is located in the Lac du Bonnet granite batholith in Pinawa, Manitoba. Tunnels at the URL extend to depths

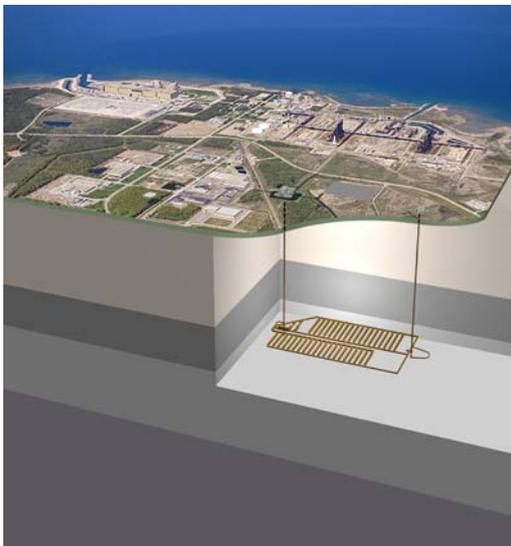


# Focus on Canada

of 440 m below the surface. This high stress environment demands intelligent engineering solutions to prevent major damage in areas of high stress concentration around deep excavations. Microseismic and acoustic emission monitoring as well as ultrasonic velocity measurements made by the Applied Seismology Laboratory help delineate and quantify the damage, which is important for observing possible routes for the transport of radionuclides into the surrounding groundwater.

## 16 - Ontario - Deep Underground Repository

Ontario Power Generation (OPG) has proposed the construction and operation of a Deep Geologic Repository (DGR) for the long-term storage of low and intermediate level nuclear waste on lands adjacent to the Western Waste Management Facility in Kincardine.

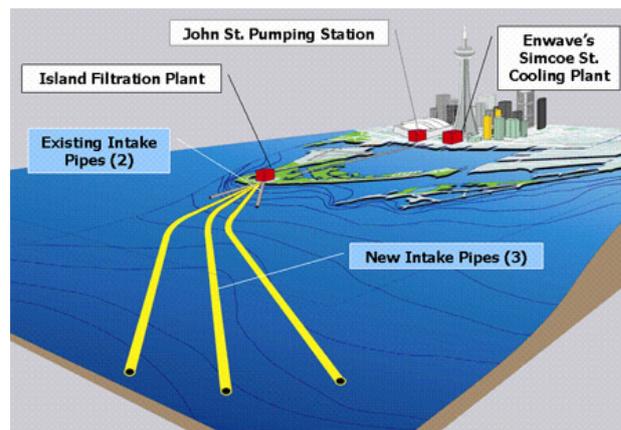


The DGR would be located 660 metres depth, within layers of limestone underlying a shale/limestone sequence typical for this area of Ontario. The repository will have design life measured in hundreds of thousand years.

## 17 - Ontario - Enwave Deep Lake Water Cooling System

Enwave's Deep Lake Water Cooling system uses cold water from Lake Ontario to cool buildings in downtown Toronto. The system comprises a series of typically 3.5 m diameter rock tunnels and shafts, hosting chilled water supply and return pipes. Customers include the Toronto-Dominion Centre, Royal Bank Plaza, Metro Toronto Convention Centre and Air Canada Centre. The system has enough power to air condition 100 office buildings or 3 million m<sup>2</sup> of building space. It is the largest renewable lake source cooling system of its kind in North America. The cooling system is a clean, renewable, and reliable energy source.

Compared to traditional air-conditioning, Deep Lake Water Cooling reduces electricity use by 75%, and will eliminate 40,000 tonnes of carbon dioxide annually, the equivalent of taking 8,000 cars off the streets. The Enwave system only uses water that is destined to meet the city's domestic water needs. Therefore, the Enwave system does not pollute the lake with a plume of waste heat.



## 18 - Lovat – Tunnelling Equipment Innovations

LOVAT is a Canadian company specializing in the design, manufacturing and assembly of tunnel boring machines. Richard Lovat established the Company in 1972. LOVAT specializes in shielded rock, mixed face, soft ground, earth pressure balanced (EPB) and slurry TBMs, and open-faced tunnel shields ranging from 2 metres to 12 metres in diameter. Lovat pioneered the EPB technology, first used at Saint Clair tunnel project in the early 1990s. LOVAT has supplied machines globally.

## CANADIAN UNDERGROUND CITIES

### Toronto

Toronto is the largest city in Canada. It is the capital of the province of Ontario, and is the business, financial and centre of the province. The city is situated on the northern shore of Lake Ontario, which provides part of the border between Canada and the United States. An underground city is a network of tunnels that connect buildings, usually in the downtown area of a city. Beneath the streets of Toronto is such an underground world full of stores, restaurants, and other amenities that allow the people to shop, browse, dine, or just explore. It comprises 27 kilometres of tunnels, walkways and approximately 1,200 shops. It links many impor-

# Focus on Canada



tant buildings and attractions downtown to five subway stations and accommodates 100,000 pedestrians daily.

## Montreal

At first glance Montreal does not appear to be overcrowded, but maybe that's because everyone is underground. More than 11 square kilometres make up this second city, the world's largest underground complex, with 4,350 hotel rooms, 2,727 apartments, 930 retailers, 68 metro stops, nine fitness centers, three skating rinks and two libraries.



## West Edmonton Mall

West Edmonton Mall, located in Edmonton, Alberta, Canada, is the largest shopping mall in North America and the fifth largest in the world, founded by the Ghermezian brothers who emigrated from Iran in 1959. It was the world's largest mall for a 23 year period from 1981 until

2004. West Edmonton Mall covers a gross area of about 570,000 m<sup>2</sup> and cost C\$1.2 billion to build. There are over 800 stores and services and parking for more than 20,000 vehicles. More than 23,000 people are employed at the property. The mall receives 28.2 million visitors per year and between 60,000 and 150,000 shoppers daily depending on the day and season. The mall is currently valued at C\$926 million.

## UPCOMING PROJECTS

In the hydropower sector, new sites are being studied. Newfoundland & Labrador Hydro proposes the development of a new generating station at Lower Churchill River (Gull Island), Labrador in association with the Province of Quebec. With an estimated capital investment of approximately \$4 billion and a capacity of approximately 2,000 MW, this renewable energy development has the potential to contribute significantly to the provincial and national economy during both the six-year construction period and the following production stage.

Hydro-Québec is progressing with the Eastmain - Sarcelle - Rupert project to divert water and develop a new hydroelectric plant on this system of rivers discharging to James Bay.

Engineering studies for an additional 300 MW electric power at Columbia Power Corporation's Waneta Expansion site are underway in southern British Columbia. BC Hydro is encouraging the development of small, private hydro generating sites. The Ashlu project near Squamish was commissioned in late 2009. There are several projects in development, which feature tunnels from 800 m to 16 km long. The Klinaklini Hydro Project, on the river of the same name on BC's west coast, will include a tunnel about 16 km long and significant shaft work near the powerhouse. Kleana Power holds the licence for the project. The Ryan River Project is near Pemberton, BC, close to the Vancouver - Whistler (site of the Winter Olympics) corridor where several small hydro projects have been developed. Ryan River will feature a 10 km long tunnel plus shafts.

In the transportation sector, new extensions to the existing subway, Light Rail Transit lines and commuter rail systems are planned for Toronto, Ottawa, Montreal, Calgary and Edmonton. Many of these extensions will involve significant tunnel works. Four Lovat EPB type tunnel-boring machines have been ordered by the City of Toronto for expansion of the subway system. On the Trans-Canada

# Focus on Canada

Highway, a tunnel is being considered to improve the road alignment through the Kicking Horse Pass in the Rocky Mountains. Also, a new US/Canada cross border tunnel between Detroit and Windsor is in the planning stage.

In British Columbia's rugged northwest, tunnels for access, ore transport, and drainage are required for large mining developments. Tunnels up to 16 km long are being designed.

In water and wastewater, a new outfall tunnel is planned for the Toronto treatment facility. Toronto and various other cities in Canada have ongoing sewer system expansions driven by residential development. Additionally, several cities have CSO abatement programs involving tunnelled storage. In 2010 Metro Vancouver will start construction of a new water supply tunnel under the Fraser River to meet current seismic design standards. Preliminary design of a

second tunnel, under Burrard Inlet and also for improved seismic performance, will commence in 2010.

These upcoming projects illustrate the worldwide trend to increasing use of tunnels for environmental and energy benefits, as well as for infrastructure development in populated areas. Canada, like many countries, expects to see increased use of tunnels in the future.

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### GROUND REFERENCE INFORMATION FOR BIDDING TUNNEL PROJECTS -

#### Current Practice, Shortcoming/Benefits and Future Challenges.

##### **Requirements for geotechnical investigations for a minimization of risks in shield tunnelling - Dietmar Placzek & Markus Thewes**

It is widely understood that the success of a shield tunnel drive depends on a thorough understanding of the ground conditions and its inherent risks. Once excavation has started, only limited modifications of the machine technology are possible. Still, downtime and damages occur despite this basic truth, and the preparation of technical regulations and directives, the development of sophisticated shield machine technology, and the existence of high-tech monitoring technology. These damages affect either the shield machine and its productivity or the surrounding environment, i.e. existing infrastructure and buildings. The causes of these damages are often diverse in nature, but in most cases can be attributed to the encountered ground conditions, which were not sufficiently investigated and described or which were incorrectly assessed for the design of the tunnel, its alignment and the deployed shield technology.

The increasing competition in the tunnelling industry and the shortage of skilled staff on both the client's and the contractor's side has led to a number of damage cases in the past. It can be observed that sometimes bids are placed at unprofitable prices and then the impending economic detriment is tried to be balanced by intense claim management. In many cases the ground risk is then erroneously being used by contractors in their claim argumentation. Clients in their procurement process sometimes are not aware of the far-reaching consequences of their decision because it is not the price that will decide about the success of the project. The best technical solution has to be found, has to be ordered and has to be reasonably compensated for a successful tunnelling project. Only then will it be possible in future to limit damages and excessive claim strategies as far as possible. The technical success of a high-quality construction project has to be back at the center of attention and has to be understood as a task that has to be solved based on partnership of all parties involved. It is therefore vital for the future to achieve the following objectives:

- Raise risk awareness among clients
- Apply standards and regulations strictly
- Involve special experts for geotechnics, planning, and tunnel technology
- Ensure thorough geotechnical investigation and reporting, always addressing (and quantifying as far as possible) all

issues regarding groundwater, face stability, settlements, excavation, soil conditioning, wear, stickiness, soil transport, depositing, segment design and other ground-related risks that may possibly occur.

- Improve training for those involved as designers, engineers and contracting companies
- Ensure mutual understanding of client and contractor of the risks described in the geotechnical reports
- Order the best technical solution to minimize the ground risk
- Involve recognized geotechnical and tunnelling experts for detailed reviews

##### **Ground Reference Information for Bidding Tunnel Projects- Current Practice, Shortcomings/Benefits and Future Challenges (Owner's Perspective) - Joe Gildner - Sound Transit (Seattle)**

For any heavy civil underground project, an Owner takes the lead role in allocating risks in the contract documents. Certainly, ground reference information is the cornerstone of an Owner's risk register and this information is one of the major factors that frame the bid documents/contract documents. A responsible Owner understands the fundamentals that observed/measured ground behavior is a product of both the "nature" of the hydro-geologic conditions and the "means-and-methods" employed to construct the underground workings. If an Owner believes they "own the ground" as their part of risk allocation process, then they must decide how they want to demonstrate this responsibility. The current practice is to provide a variety of geotechnical documents (e.g. Geotechnical Baseline Report, Geotechnical Data Report, etc.) in the bid documents and specify how each bidder may rely on these documents in preparing their bid. Owners need to understand that this practice has its benefits and shortcomings. In general, the benefits are derived by establishing a contract platform that promotes a fair and reasonable structure to resolve claims/disputes that are tied to ground conditions. Still, there are shortcomings because the potential for claims/disputes remains depending on the actual behavior(s) observed/measured. Understanding these benefits and shortcomings remains a challenge.

# WTC 2010 Open Session

## abstracts

### **Lawyers, Guns and Money – The perils of ground conditions and their commercial resolution - A. Dix**

There is strong evidence that the use of ground reference conditions for bidding tunnel projects results in greater certainty of project scope, cost and dispute resolution. This higher level of certainty may also result in greater costs up front and start up delay where GRC's are based upon detailed geotechnical analysis.

Critics argue these costs and delays are unnecessary bureaucracy, while proponents argue the GRC provides the essential reference point for managing the inevitable disputes.

International experience strongly indicates that a focus on ground reference conditions coupled with a clear contractual framework and a pragmatic approach on site to identifying the actual ground conditions encountered and their consequences are a proven technique for ensuring projects are delivered more fairly without inappropriate ground condition risk burdens falling on any of the parties.

With the ongoing vibrant growth in underground construction the future will see projects in increasingly difficult geological contexts – this will no doubt test the performance of GRC's and their relationship with the extreme conditions encountered.

### **Ground Reference Information and Risk Sharing, Different Countries – Different Solutions, Michael Rehbock-Sander, Amberg Engineering Ltd., Switzerland**

The description of the geological – geotechnical conditions, the definition of risks, the decision and implementation of the necessary investigation measures, to agree a risk sharing between the involved parties and the transformation and implementation of all these aspects in a contract is one of the key elements during the contract preparation and the construction of underground projects.

This topic is being handled in very different manners. It is also



different from country to country.

In Switzerland there is an established procedure which is considered to be fair for both parties. Besides this Swiss approach projects from Germany, France, Czech Republic, Southamerica and Asia will be described. The advantages and disadvantages from the clients and contractors point of view will be shown. This includes soft ground projects with low overburden (i.e. Kralovoposly tunnel in Czech Republic) as well as long and deep tunnels in mountaineous conditions.

### **Ground Reference Information in International Projects - A contractor view - U. Wadepohl, C. Gipperich Hochtief Construction AG**

Time and time again, cost increase and loss of time have occurred in tunnel projects due to changes in geotechnical conditions (differing site conditions), resulting in claims and not infrequently legal proceedings. The reasons for these changes might have been insufficient, inappropriate, misleading or even false description of geotechnical conditions. While it is always difficult to exactly predict geotechnical conditions, the description of these conditions must be appropriate to the challenges ahead. From a contractor standpoint this is as much a technical issue as it is a contractual one.

The description of the geotechnical conditions must always match the contractual framework.

This paper deals, from a contractor's perspective, with the requirements of geotechnical information for bidding tunnelling projects, always in relation with the contractual conditions. Experiences with various forms of geotechnical information are reported with an emphasis on Geotechnical Baseline Reports and the contractor's requirements for these GBRs are laid out.



*Presentations of the WTC 2010 Open Session will be available on the ITA website.*



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# Member Nations Report 2009

## AUSTRALIA

The ATS continues with its regular program of technical sessions at all regional groups. These are usually very well attended with new members attracted at each event. The new publication on the "The History of Australian Tunnelling" is a significant achievement for the ATS making much general information on tunnelling accessible to the public.

## AUSTRIA

The Austrian national committee of ITA participated in the World Tunnel Congress in May 2009 in Budapest/Hungary with about 15 colleagues.

In 2009 again several conferences concerning tunneling were organized in Austria. The most important conference was the well established "GEOMECHANICS COLLOQUIUM" in October in Salzburg which was as usual organized by the Austrian Society for Geomechanics. About 1000 participants from more than 20 countries followed the interesting topics presented by national and international speakers. In November the AUSTRIAN SOUTHERN RAILWAY LINK CONFERENCE 2009 with focus on the huge tunnel projects Koralm- and Semmering Base Tunnel was opened by Prof. Galler, chair of Subsurface Engineering at the Mining University of Leoben.

The SOUTHERN RAILWAY LINK is an essential railway link in the eastern part of Austria. This link belongs to the PANEUROPEAN CORRIDOR NR. VI connecting the Baltic region with the northern part of Italy. The Austrian Southern Railway Link Conference 2009 is a Forum focussing on the actual design and construction processes concerning the Tunnel Projects Koralm and Semmering Base Tunnel. More than 300 participants got the latest news of the design and construction steps of both projects. Concerning railway projects in 2009 again a various number of tunnelling projects, including very long

tunnels, have reached the preliminary and tender design step or have been under construction.

The new Koralm railway between Graz and Klagenfurt including the 33 km long double-tube KORALM TUNNEL forms a

key link in the so-called Baltic-Adriatic corridor. Meanwhile route selection and the relevant legal procedures, especially environmental impact assessment, were finished successfully. To investigate the ground conditions for the Koralm tunnel the construction of a system of investigation shafts and tunnels for the Koralm tunnel with a length of 10 km were started in 2003 and will be finalized by the beginning of 2010. Based on the results of this detailed investigation the construction works for



the Koralm tunnel - lot KAT1 - started in December 2008. Tendering of the 2 x 20 km long lot KAT2 started in November 2009, tender design of the third tunnel lot - KAT 3 - is under progress. Approximately one third of tunnel length will be excavated according to the principles of NATM applying reinforced shotcrete and rockbolts, 2/3 will be driven using TBMs and segmental lining. Civil engineering works for the Koralm tunnel are expected to be finished in 2018.

Two other important parts of the new Koralm railway are the tunnel chains "Granitztal" and "St. Kanzian".

The Tunnels Deutsch-Grutschen and Langer Berg form the TUNNEL CHAIN OF GRANITZTAL with a total length of 6.1 km on the western side of Koralm-tunnel. The design of both tunnels consists of two single track tubes linked with cross passages every 500 m. After completion of the approval processes in 2009, the preparation for the tender design already started.

Further more the planned Koralm railway route contains the TUNNEL CHAIN OF ST. KANZIAN including 6 tunnels. These are the tunnels Peratschitzen, Untersammelsdorf, Kühnsdorf, Lind, Stein and Tunnel Srejach. The design consists of double track tubes, either designed as cut and cover construction or as excavation using the NATM principles. All of these tunnels are quite short (total length smaller than 2.000 meters) and very shallow. Due to a very complex geotechnical situation including the existence of large amounts of lacustrine clay, several special works are planned including bored piles and jet grouted piles. To clarify technical and economical questions regarding these special works, a trial field for bored piles, jet grouting and drainage was developed.

The whole tunnel chain is divided into several lots, tender design of every single lot is now under progress, first construction works will start in 2011.

Along the Baltic-Adriatic corridor another huge project named SEMMERING BASE TUNNEL is situated between Styria and Lower Austria. The project with a length of 27km will consist of 2 single track tubes. At the moment the environmental impact study for the project is done, the route selection is finished and legal procedures are coming into the final stage. The geological investigation program is well on the way to define construction methods and sections suitable for TBM driving.

Looking at the railway route connecting Vienna with Salzburg several tunnels of ÖBB are under construction.

Three of them are belonging to the TUNNEL CHAIN OF PERSCHLING. The tunnels Reiserberg, Raingruben and Stierschweiffeld are situated between the cities of Vienna and St. Pölten and are characterized by tunnel driving with low overburden. Excavation works there have been finished in 2009, civil engineering works will last till 2012.

The BURGSTALLER TUNNEL with a length of about 2,2km is situated between Ybbs and Amstetten in Lower Austria. The project consists of a 1,8km long part as cut and cover construction and a 0,4km long part as excavation using the NATM principles. The excavation works started in August 2009 and are still in progress.

In May 2009 the successful breakthrough of the LAINZER

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TUNNEL in the western part of Vienna was celebrated. The tunnel with a length of about 13 km will connect the western with the eastern and southern routes of the Austrian railway network, civil works are still under construction.

The WIENERWALDTUNNEL, west of Vienna, with a length of about 12km – the breakthrough was celebrated in the year 2007 – is still under construction.

The whole route from Vienna to St. Pölten with a total length of more than 60 km including these tunnel projects will be opened to traffic in 2012.

In the Lower Inn Valley in Tyrol, ÖBB is currently constructing 32 km of tunnels as part of the northern access route to the Brenner Base Tunnel. Construction work, which began in 2003, is well advanced, with more than 29 kilometres of twin-track railway tunnels already excavated or bored. The project milestones in 2009 included completion of the tunnel engineering works in the area of Fritzens railway station and holing-through with two 13-metre slurry shield TBMs. Starting in mid 2007, almost 10 km of tunnel were driven in the loose saturated Inn Valley soils. The complex underground works for the Stans advance were also successfully completed. In addition to 1340 m of cut-and-cover tunnel construction, a 750 m section had to be sealed off with jet-grouted piles to form an air- and water-tight caisson for compressed-air excavation. Work on this section was performed beneath the existing railway line and the very busy Inn Valley Motorway. The intersection of the existing infrastructure with the tunnels for the new railway line and another new tunnel for a future extension to the existing line was one of the key projects. Cut-and-cover tunnel construction work on a 1600 m section is still in progress in the eastern area of this project. All completed structures will shortly be available to the railway engineering crews. The works are on schedule and rail services on the new Lower Inn Valley line will start in 2012.

Going south from Innsbruck the BRENNER BASE TUNNEL is under design. In the year of 2009 the environmental impact study was finalized and presented to the authorities in Austria and Italy. Construction – works for the exploration tunnel are already under progress.

Concerning the motorway projects it has to be mentioned that ASFINAG at the moment is operating 137 tunnels (112 twin tube tunnels and 25 single tube tunnels) with a length of about 305 km. Tunnels with a length of about 154 km are under design and/or construction.

Since 2001 ASFINAG invested about 3,7 billion Euro in tunnel safety including both the construction of new tunnels, 2nd tunnel tubes, civil and electro-mechanical measures and also new control centres.

Along the Phyrn motorway A9 the construction of the 2nd tube of tunnel Bosruck including repair and maintenance work of the 1st tube were in preparation in 2009. Special attention has to be paid to the high amount of water (up to 300 l/sec) and the geotechnical difficulties because of swelling rock called Haselgebirge consisting of gypsum and varying percentages of salt.

In the area of Salzburg and Carinthia the 2nd tubes for the Katschberg- and Tauern tunnel with a length of 5.418m respectively 6.246m and a gradient of about 1,5% - both are situated

along the Tauernmotorway A10 – are essential tunnel projects, which are under construction.

The western tube of the Pfändertunnel with a length of about 6.6km and a diameter of 11,92m is excavated by using a tunnel boring machine. The project is situated along the Rheintal motorway A14. The predicted excavation time period is 23 months.

The undercrossing of the Danube and the Lobau, a tunnel project



which is situated along the S1 – a motorway route close to Vienna – is under design. The project will consist of a double tube system and will have a length of about 8km.

The construction sector of ITA Austria informs that in 2009 ÖSTU-STETTIN again proved its widespread competence as contractor in many fields of underground constructions. Typical examples are the 2nd tube of the Tunnel Roppen with a length of about 5km situated along the Inntal highway A12, the railway twin tube tunnels of Osterberg in Germany with a length of about 2km each, the Urban Metro twin tube tunnels for the tram system in Linz with a length of about 1km each. Further underground projects in 2009 to be mentioned are the hydro power project Limberg II containing a complex system of underground facilities, to be finalised in 2010, the water supply tunnels of Modaksagar in Mumbai, India with a length of 7,5 km and an intake shaft with a depth of 95m. In Germany the construction of the Jagdberg ventilation shaft with a depth of 140m and a cross section of 50 m<sup>2</sup> was completed in 2009.

The consultants sector of ITA Austria informs that IL – Laabmayr & Partner, Consulting Engineers are working on major Austrian tunnel projects like the Tramway Linz, Harter Plateau Line, 2 x 0.98 km single-track tramway tunnels and together with ILF Innsbruck they are working on the tunnel Bosruck, a motorway tunnel with a length of 5,5km. Further more the Tunnels “Klaus”, “Traunfried”, „Spering“, „Falkenstein“, 4 motorway tunnels, 2nd tubes with a length of 2.9km, 2.2km, 0.8km, 0.5km are under overall design. Together with IGT the company of IL is working on the project of Tunnel “Götschka”, a double tube motorway tunnel, 2 x 4,43km. Last but not least IL is working on 6 motorway tunnels with a length of 0.4 – 2.0km. Concerning these projects IL is working on the design for the refurbishment of the Ofenauer and Hiefler Tunnel, 4 Tunnels along the Tunnel Line “Werfen”. GEOCONSULT is informing that the company was engaged in more than 100 projects worldwide. A major involvement in the metro systems of Budapest, Buenos Aires, Dubai, New Delhi and Singapore is worth mentioning. Also, services for interesting tunnel projects on the new HSR Nuernberg – Erfurt – Leipzig/Halle in Germany as Tunnel Tragberg, Osterberg and

# Member Nations Report 2009

Silberberg services have been performed. A special focus of Geoconsult's activities in South America have been the international road and railway corridors across the Andes, Agua Negra and Central Bioceanic Corridor (also known as Ferroviário Trasandino Central) as well as an intensified involvement in major mining projects. In the field of large caverns the services performed for the Strategic Storage for Crude Oil (SSCO) at Vishakhapatnam, India have to be mentioned as well as the successfully ongoing services for IRCON/Northern Railway for Tunnel 80 (Pir Panjal Tunnel), an 11 km long railway tunnel in the Himalayas. In Austria several tunnel inspection and rehabilitation projects, like Landeck, Gleinalm and Ehrentalerberg have been completed. In the field of geology/hydrogeology major contribution to the hydro power projects Kaunertal and Kühltai was given. GEOCONSULT's services as the lead company of an international consortium of design companies for management services during the environmental impact assessment and technical preparation stages for the Brenner Railway Base Tunnel project have been completed successfully. For the Koralm Base Tunnel, the main section of the new High Capacity Railway line from Graz to Klagenfurt, tunnel construction works will start in 2010. Also for this project GEOCONSULT is lead company of the design consortium. In 2009 GEOCONSULT opened new permanent offices in Innsbruck, Austria and Delhi, India.

## BELGIUM

ABTUS is a non profit association with open membership for individual and collective members (59 collective and 40 individual members).

In 2009, ABTUS held its General Assembly on 18.03.2009 with visit to the "Diabolo" tunnel works, participated in the General Assembly of ITA and the World Tunnel Congress in Budapest and organized a Studyday on 17.11.2009 "Latest developments in the design and the construction of tunnels"

### SIGNIFICANT PROJECTS UNDER CONSTRUCTION:

- Rail-connexion of the airport of Brussels to the high speed railway network : completion of 2 bored tunnels of 1100 m, cut-and-cover section of 1000 m, extension of underground station, installation of equipments going on, putting into operation foreseen for 2011
- Railway-tunnel "Liefkenshoek" under the river Scheldt in Antwerp : bored tunnel (5570 m + cut-and-cover sections 500 m and 1075 m) : works started in 2009, foreseen opening in 2014
- Railway-tunnel "Schuman-Josaphat" for creating a second North-South link through Brussels and better connecting the European headquarters to the airport : built in-situ, several combined methods : micro-TBMs, (fouilles blindées), underpinning, cut-and-cover, total length 1250 m, foreseen opening in 2014
- Railway tunnel in Leernes : renovation/refurbishment of this old tunnel, during operation in order to make it accessible for electric traction (length : 440 m, works to be finished end 2010)
- Road tunnel (120 m) under the main railway station in Ghent, foreseen opening in 2010

### SIGNIFICANT PROJECTS UNDER DESIGN :

- Closing of the motorway around Antwerp : tunnel under the river Scheldt : 1000 m, possibly included in a storm barrear
- Deep underground disposal of high level radioactive waste : gallery 250 m long, 220 m deep
- Road tunnel under the airport of Charleroi
- Section Charleroi-French border of the motorway E 420 : section of 13 km including 3 cut-and-cover tunnels (total 1700 m)
- Test cave for nuclear reactor : 70 x 47 x 43 m



### OTHER POSSIBLE SIGNIFICANT PROJECT :

- Shortcut in the motorway around Brussels : bored tunnel (single tube with 2 traffic levels, cars and public transport busses, multimodal approach) : around 10.000 m length

## BRAZIL

The most important actions of the Brazilian Tunnelling Committee (CBT) in 2009 were related to promoting underground construction in Brazil. Two main points were addressed: (1) attempts to convincing decision makers to adopt correct contracting practices for underground construction, and (2) convincing others about the advantages of underground works, i.e., Why Go Underground. Activities of the Working Group Mirror Groups continued in 2009. There are seven active mirror groups at CBT: WG-03, WG-05, WG-06, WG-12, WG-15, WG-18 and WG-19. The Brazilian mirror WG-03 translated the ITIG code of practice into Brazilian Portuguese. Other mirror groups have held meetings along the year. Full support has been given to Tarcisio B. Celestino, WG-12 Animateur, and to Andre Assis, chairman of the ITA Committee on Education and Training (ITA-CET). It is also worth mentioning that CBT was one of the fund donators for the foundation of ITACET. The tunnelling industry was very busy in 2009 in Brazil, especially with respect to the construction of hydroelectric power plants, with underground hydraulic schemes. Most of those belong to private investors. It is also important to mention that Petrobras (The Brazilian Petroleum Company) has definitely moved towards tunnelling as a solution to underpass environmental protection areas. The first TBM for rock started to be used in Brazil (a shaft-tunnel solution, 6 km long, to underpass the Serra do Mar rain forest in Sao Paulo State). Underground mass transit systems have continued in major cities such as Brasilia, Rio de Janeiro and Sao Paulo. In December, a new station (Ipanema - Gen. Osorio) excavated in rock was put in operation for the Rio de Janeiro Metro Line 1. The construction for the 14-km long all-underground Sao Paulo Metro Line 4 is at the final stage and operation is due to start in April. The 6-km long extension of Line 2 is also expected to go into operation in April. The bid for the construction of the 15-km long Line 5 is expected to be launched in the middle of 2010. Design of Line 6 is also expected to be bid in 2010. The City of Sao Paulo

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is about to launch the bid for construction of the Roberto Marinho urban highway tunnel, underneath a 3-km long urban park to be created as part of the actions for urban rehabilitation of an area in the Southern part of the City, coupled with real estate investments. The work will consist of two parallel, 3-lane, 2.7- km long tunnels. The bid for construction and concession of the 520-km long Campinas – Sao Paulo – Rio de Janeiro high speed rail line is expected to be launched in the coming months. The total underground length of the line will be in the range of 110km to be constructed by TBM and conventional tunneling.

## BULGARIA

The private Bulgarian company Geotechmin OOD is part of the GEOTECHMIN group which is engaged, among others, in underground and tunnel construction. In 2009 the company signed a contract with Metropolitan PLC for “Design and construction of Metrostation 11-II with the tunnel section after it and the adjoining underground parking lot above the two facilities”.

Unfortunately, the situation remains unchanged when compared to previous years with Bulgaria still lacking a national working group. There is no clearly structured national body (Tunneling Association) in Bulgaria at this time.

### SOFIA METROPOLITAN

Sofia subway network consists of three metrodiameters (lines), which intersect into a triangle in the central part of the city allowing each section of the metro route to be reached within a single change of lines. The total length of the entire metropolitan railway is 65 km with 63 metro stations. With the construction of all lines, the Metro is expected to transport over 1.2 million passengers per day.

The first metrodiameter is 29 km long and consists of 23 metro stations, 14 of which are already in operation. It was constructed using traditional tunneling methods. The specific building conditions and the hydrogeological characteristics along the route determined the combination of various construction technologies: the cut-and-cover method, the new Austrian tunneling method, and the Milan method.

The second metrodiameter is currently under construction. It is 17 km long and consists of 17 metro stations. It is scheduled to be completed by the end of 2012.

Metrostation 10 (MS-10) of the second metrodiameter is being constructed by applying the cut-and-cover method in a reinforced trench. The reinforcement is carried out by means of ferro-concrete cast-in-situ piles and anchors, and then shotcrete is laid as a base for waterproofing.

The construction of MS-10 tunnel section is being executed in a continuous manner (24 hours without interruption). The overall length of the tunnel is 792 m. By November 2009 180 m had been



built. The progress of tunneling works is 2 m per day. Part of the facility is being built by applying the cut-and-cover method, and for another section the well-known new Austrian tunneling method is being applied. This method involves: excavation works on the tunnel cross section by a tunnel excavator; primary lining with steel frames, reinforced steel mesh and 25 cm thick shotcrete; waterproofing and secondary lining.

The construction of Metrostation 11-II, which is carried out by Geotechmin OOD, has started at the beginning of 2010 (see the article below).

The technical preparation for the design of the third metrodiameter has also started in 2010. It will be 19 km long and will consist of 23 metro stations.

Initially the metropolitan was designed in accordance with Russian standards but now EU standards are generally being applied. This has resulted in the design of tunnels with smaller radius. In addition, EU standards rendered it possible to construct a metro station on a curve. These two things make easier the driving of the route through the city area which is permanently built-up.

Perhaps it will soon become possible to build an entirely underground metro station (so far all stations have been built by the cut-and-cover and Milan methods).



## CHINA

In May 2009, we held the eighth Mainland-Taiwan Science and Technology Seminar about Tunnel and Underground Works. The possibility and significance of Taiwan Strait Passage Project was discussed in the seminar.

China was the third largest delegation in the 35th World Tunnel Congress of ITA, which has 82 members, among them 68(HongKong and Taiwan) were presented at the congress and registered. China delegation presented 4 articles and 1 poster. Zhangyan, Secretary General and Guo, the representative of China, attended the 35th ITA General Assembly as a delegate.

In November 2009, we hold Symposium of 14th Annual Meeting of Waterproof and Drainage.

### CURRENT AND RECENTLY COMPLETED MAJOR TUNNELLING PROJECTS

- 1.Nanjing Yangtze River Tunnel
- 2.Yellow River Crossing Tunnel in South to North Water Transfer Project
- 3.Muzhailing Tunnel
- 4.West Qinling Tunnel
- 5.Taiwan Tunnel
- 6.Large Cross-section Underground Railway Tunnel on Straight Rail Transit Line in Beijing

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7.Zhongtianshan Tunnel

8.Zhengzhou Metro

9.Guangzhou Metro

10.Shenzhen Metro

11.Urban Metro in Shanghai, Beijing and Tianjin

The quickest development period of China's infrastructure construction has come. There will be 17 constructing railways with more than 100km tunnel in each in 2009. The total constructing tunnel length is 3229km. Lanzhou-Chongqing railway has the longest length of total tunnels, Guiyang-Guangzhou railway is the second. The total length of tunnels in Lanzhou-Chongqing railway is 528km, 463km in Guiyang-Guangzhou railway. China has passed 22 city Metro in 2009.

## CROATIA

ITA Croatia has been reorganized and re-established in 2009 according to new laws and regulation of Republic of Croatia celebrating its 15 anniversary. Professional seminars and presentations were held during the year spreading the use of underground space in society. First bilingual book about conventional tunnelling was published and distributed in 2000 samples in Croatia and 12 countries of the region.

Activities In Tunnelling Construction Has Been Reduced After finalization of the main highway network, only the rest is now in construction with restricted tunnelling activities in southern croatia. Most of tunnelling activities in construction were performed on second tubes of tunnels on round-about rijeka city that was opened for the traffic in summer 2009.

Intensive development of design, studies and preparation for construction has been performed on tunnels like : second tube of road tunnel učka (cca. 5300m), 2 tunnels on the new railway line zagreb-rijeka in vicinity of rijeka ( cca. 8 And 10 km length), underground galleries of hpp ombla . Dubrovnik and water supply tunnels of hpp dubrovnik ii in the length of 14 km and with the diameter of 7.0 M.

In feasibility study phase are tunnels like : railway tunnel ćićarija connecting rijeka city region with istira pepninsula( cca. 10 K,m length), underground parts of "metro" zagreb system (morethan 8 km of tunnelling in 1st phase) , underground roads and railway lines in dubrovnik city and connection toward airport čilipi.

Basic understanding is that it is much to be done in education of engineers and society about the possible use of underground space and that serious written materials like articles and books should be continuously published and distributed in society spreading the knowledge and understanding of necessary use of underground space, especially in urban areas.

## CZECH REPUBLIC

In 2009 the CzTA ITA-AITES continued preparation of the 11th international conference "Underground Construction Prague 2010". The Tunel magazine published by CzTA increased its content, quality and number of customers. CzTA organised 4 seminars and professional excursion Switzerland.

WGs for Shotcrete, for Conventional tunnelling and for Design

and calculations of underground structures continue in their activities..

The work on the currently largest tunnel construction project in the Czech Republic, the Blanka complex of tunnels, continued in Prague. The project consists of a 6.4km long section of the City Circle Road, comprising twin-tube tunnels 5.5km long in total. The work continues on the longest tunnel section, the Královská Obora section, which is 3.09km long ; 2.23km of this length is constructed by mining methods. One of the twin tubes broke through in January 2010.

The work is also underway on motorway tunnels on the Prague City Ring Road (an outer circle road), namely the Lochkov tunnel (1620m) and Komofany tunnel (1930m). The main items of the works in 2009 were the waterproofing and final lining.

In Brno, the excavation of the Královo Pole on the city ring road successfully continued. The over 1200m long twin-tube tunnel is driven through the Brno Clay, which displays unfavourable geotechnical properties. The tunnels pass through a densely developed area, where compensation grouting is successfully used to control settlement.

The excavation of tunnels continued on the last stretch of the D8 motorway leading from Prague to Dresden. The motorway overcomes the České Středohoří Mountains via the Prackovice and Radejčín tunnels. The construction was delayed by several years by ecological activists.

Of the projects to be implemented in the future, the greatest attention is attracted by the preparation of the construction of the Prague underground lines A extension. This exceptional project, on which Earth Pressure Balance Machines will be employed for the first time in the Czech Republic, commenced at the beginning of 2010.

## DENMARK

The Danish Society for Tunnels and Underground Works has during the year 2009 arranged 6 member meetings including two technical site visits. The first technical site visit covered design and construction of 3 fully automatic underground facilities for Copenhagen Municipality in the City Centre. The second visit and study tour covered a four day visit to the 57 km long railway tunnel, Gotthard Base Tunnel in Switzerland, including a visit to the 800 m deep Sedrun shaft and the Testing Gallery in Hagerbach.

Members of the society have participated in the ITA General Assembly in Budapest, Hungary from 23rd to 28th May 2009 including meetings in three ITA working groups. Members have also participated in activities within COSUF during 2009. One member is active member of PIARC's tunnel Committee including two working groups on safety and operation of tunnels bringing back news for the Danish tunnel industry.

The Metro-Cityring project, consisting of an extension of the existing metro with 15 km metro circle line (30 km tunnels) with 17 underground stations and 5 emergency and ventilation shafts, has progressed well during 2009. The extension will be operated independently of the existing system and will have its own main-

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tenance and service centre. There will be 5 interchange stations to existing railway and metro.

Tender documents for the project have been issued to a group of pre-qualified contractors. The project is being tendered under design and builds contracts. Bids will be received in April 2009 with the aim of signing a contract with the successful contractors in the autumn of 2010.

The civil works is being tendered in two lots, a northern contract covering construction of 7.2 km twin tube tunnels and 8 underground stations and a southern contract covering construction of 7.9 km twin tube tunnels and 9 underground stations plus the 1.1 km branch off twin tube tunnels. The civil works contracts include M&E installations but exclude the architectural and finishes works. A separate contract is issued for the transportation system containing signaling, track, and rolling stock and a 5 year operation and maintenance period for the full circle line including the operation and maintenance centre.

The tender documents define the performance specifications and the geometrical requirements and constrains. The stations will be constructed by open cuts within a box structure of retaining walls; the platform will generally be 19 m below ground, with some stations only 15 m deep and one station 25 m deep. The tunnels will be constructed in limestone of 2/3 of the alignment, whereas in the northern part of the alignment the tunnels will have to be constructed in glacial water bearing deposits of sand, gravel and clay till. The utilization of closed face TBM's are required. Clients consultant: COWI.

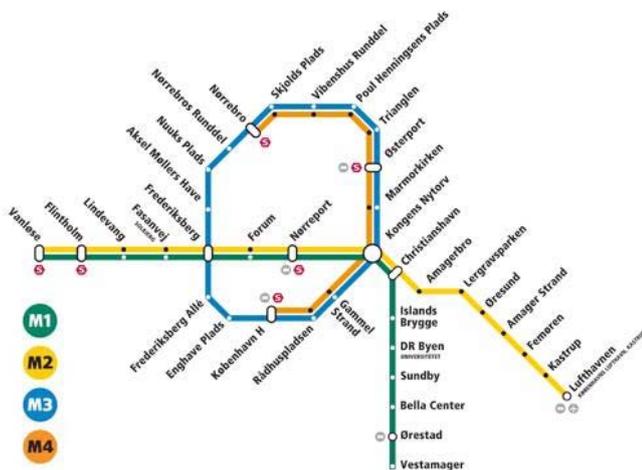


Figure 1: The two new Metro lines, M3 and M4, to be constructed as circle lines in the historical city center of Copenhagen including 17 new underground stations.

In September 2005 a proposal was published outlining a 12 km immersed road tunnel with 6 lanes linking the motorway system at the north with the motorway system at the south of Copenhagen (Eastern Bypass). The alignment followed the Copenhagen

Harbour Canal throughout and included an underwater parking facility. The cost was estimated to be close to 3 billion Euros. The proposal was very well received by public as well as by local politicians, because it was designed to remove a very substantial part of the road traffic from the centre of Copenhagen as well as providing better access to development areas east of Copenhagen Harbour. The scheme has been developed further by the City of



Figure 2: The existing and brand new Copenhagen Metro in operation.

Copenhagen together with the consultant Ramboll in 2008, and is now included fully or partly in two alternative solutions. In February 2009 The Danish Government presented their plan for the Danish Transport Policy until 2020. The plan states that the government will initiate a strategy analysis for the Eastern By-Pass. This work has begun and it is expected that the strategy analyse will be ready in 2011.

The proposed approximately 3 km new road link ("Northern Harbour Link") between Nordhavn and Lyngbyvej located north of Copenhagen has during 2009 been developed further. The two proposals comprise cut-and-cover and bored tunnels with a length from 0.5 to 2.5 km. In January 2009 the Environmental Impact Assessment (EIA) report was approved by the City of Copenhagen. A preliminary design has been prepared for two proposals in autumn 2009. The project is being developed by the City of Copenhagen and the consultant Ramboll. The project is planned to be tendered for construction works by the end of 2010 and is expected to take 4-6 years to complete.

The tender documents for a new road tunnel in Aarhus - connecting the Motorway system and Ring Road network with the Port of Aarhus that contains the largest container terminal in Denmark - is about to be completed. The construction works are to be tendered as "Design & Build" divided into two packages. Now, tender documents have been issued for one package whereas the package containing construction works of the tunnel itself has been delayed waiting some financial funding. By introducing another way of interfere into the existing traffic flow during the construction phase, the deadline for the completion of the construction works for the tunnel by late 2015 are still expected to be met. Apart from all structures, mechanical and electrical installations in connection with the tunnel-project itself, the tender has been extended to include operation and maintenance works of all installations with a concession period of 5 years

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after the inauguration day. In general the tunnel-package consists of a unidirectional cut-and-cover tunnel with two tubes each containing 2 lanes. The length of the tunnel including ramp structures is 2 km in total. The existing four lane Marselis Boulevard on top will be excavated and reconstructed in a modern layout during the construction phase. The client is the Municipality of Aarhus and consulting engineers are Ramboll. In the process of preparing the tender documents a new way of reducing pollution from traffic at the western exit zone of the tunnel has been introduced. The system will use recycling of polluted air from the west to the east whereas the harbor area in east has less strict demands for the limits of pollution.

The contractor PIHL is about to finalize a turnkey contract for construction of 3 fully automatic underground parking facilities with room for in total 840 cars for the client, Copenhagen Municipality. The 3 parking facilities are located at Nørrebro, Amagerbro and Islands Brygge. The facilities at Nørrebro and Islands Brygge are handed over to the Client, and the facility at Amagerbro will be handed over during the summer 2010. The contract includes all civil works and technical installations. The underground structures are constructed by reinforced concrete bottom slab and top deck. The walls are made by either reinforced bored piles (length approx. 19 m / Ø1200 mm) with a inner reinforced wall or sheet pile wall (HZ /AZ) without inner wall. Uplift anchors are installed and during construction the ground water is lowered by means of filter borings. The method of bored piles is used due to limit environmental impact from noise/vibration and geological reasons. In the depth of 10 - 12 m below ground level the Copenhagen limestone starts and the hardness varies from H1 to H5 (flint stone of layers 100 to 1000 mm). In spite of construction sites located in dense populated areas and the actual geological conditions, the contractor PIHL has been able to conduct the work without disturbances due to unacceptable noise or vibrations. The Copenhagen Municipality plans to establish another 3 facilities (total 375 parking spaces) in 2012-2013.

Close to Copenhagen Central Railway Station a new single track railway tunnel with a length of 120 m is undergoing detailed design. The tunnel will be build as cut-and-cover with a high degree of complexity due to a construction site next to existing main tracks in operation. The project goes out in tender by mid 2010 and the appointed contractor will start the construction works late 2010. The Client is the Danish State Railway using a JV of COWI and Grontmij - Carl Bro as consulting engineers.

Environmental Impact Assessment (EIA) of a new immersed tunnel under Roskilde Fjord is very close to be completed ready for the public hearing phase including political decisions. Two solutions for a southern alignment of approximately 700 m and 1.600 m IMT are a part of the investigations. Both solutions have been prepared by COWI as conceptual design covering two bores with two lanes each including interchanges and highways on both sides of the Roskilde Fjord. The Client is the Danish Road Directorate under the Ministry of Transport and Energy.

Latest news and status for the planning of the combined new 20 km road and railway link crossing the Baltic Sea between Rodby (Denmark) and Puttgarden (Germany) refer to: <http://www.femern.com/>



Figure 3 and 4: Construction of fully automatic underground parking facilities in the city center of Copenhagen

## EGYPT

ETS is an NG organization including 325 individual & 10 corporate members. ETS publishes a periodical newsletter every 6 months in Arabic, but abstracts of its monthly technical lectures & presentations (7 in year 2009) are included in English. ETS participated in the activities of ITA Annual Congress no.35 in Budapest, Hungary, May, 2009 and participated in the activities of numerous Working Groups of ITA .

The national W.Gs of ETS continued their co-operation & co-ordination with their respective W.Gs in ITA through correspondences by E-mail, fax, or ordinary mail.

The Greater Cairo Metro Line 3 is 30.5 Km from which a length of nearly 28.5 Km is underground together with 29 stations. The route extends from Cairo Airport to Imbaba. Additional branch to Mohandeseen of 3 Km, is added which shall be also constructed in underground. The line crosses under the River Nile twice. The planned capacity of the line when completed is 2.1 million passengers / day. The works on of the Cairo metro line 3 phase I, had already started in July 2007. This phase includes 4.5km in deep tunneling & 5 underground stations. Hoping to finish this phase by October 2011. Also, Phase 2 had already started in July 2009 parallel with phase 1& includes 6.5kms & 4 stations all underground. Hoping to finish this phase by October 2013. the tender documents for phase 3A are under preparation and it is planned to start at end of 2011. Also, phase 4A its tender documents will be started for preparation in 2011

The Feasibility Study of Line 4, phase I of Cairo Metro is already finished . The Study Area is defined by: a Phase 1 of the proposed Metro Line 4, running from a depot/workshop via the Grand Egyptian Museum to El Malek El Saleh Station with a length of about 16km; and a Phase 2 route between El Malek El Saleh via El Sawaha Square and direct to Ring Road Exit #18 with a length of about 18km, namely "Northern Route". In addition, an alternative Phase 2 route, starting from El Malek El Saleh to Nasr City with a length of about 23.5km, namely "Eastern Route" was evaluated and compared with the originally proposed northern route.

The transportation study for Greater Cairo Area had been finished proposing 6 lines of metro till 2022. Three further metro lines are recommended in this study in addition to the already 3 basic lines [lines 1 & 2 being finished , line 3 is now under construction].

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## FINLAND

The main activity of FTA in 2009 was the process of serving as the host for ITA –AITES 2011 World Tunnel Congress. FTA participated in the activities of ITA Nordic Forum, also. In Finland FTA initiated in organising a two-day Rock engineering seminar gathering 600 participants. FTA distributed industry guidelines and other publications to members and public. In the end of the year FTA hired a full-time Secretary General and moved to a new location in Helsinki.

Members of FTA have participated actively in the working groups, participating in WG 6 Maintenance and Repair of Tunnels, WG 12 Shotcrete Use, WG 18, WG 20 Urban Problems, Underground Solutions. FTA participated in ITA Nordic Forum activities, also.

The construction of Ring Rail Line started with the excavation of maintenance tunnels in 2009 in Vantaa. The Ring Rail Line will be 18 kilometres long and it will go under the Helsinki-Vantaa airport in an 8-kilometre twin tunnel. The line will provide high-standard public transport connections to the airport and it will be completed in 2014. The total cost estimate for the project is 590 million euros. [www.keharata.fi](http://www.keharata.fi)

Helsinki is the home to the most northerly metro system and it is currently expanding with "West Metro Project". Construction works began in 2009 in Ruoholahti. An existing maintenance tunnel in Ruoholahti is used for excavation towards Salmisaari. The west metro will be 13.9 kilometres long, comprising two parallel underground tunnels and seven new underground stations. In addition, excavation work will be carried out for fifteen vertical shafts designed for emergency exit, pressure equalisation, ventilation and smoke extraction. Nine work tunnels have been designed for construction and maintenance work. The objective for the west metro is to open in 2014. Costs are estimated at 714 million euros. [www.lansimetro.fi](http://www.lansimetro.fi)

Helsinki's City Planning Department prepared an Underground Master Plan in 2009. Helsinki is the only city in the world to have prepared such a plan. Much of Helsinki is already underground. There are maintenance facilities including tunnels for water mains, sewage pipes, district heat and district cooling. There are sports facilities comprising a swimming pool, an ice rink and a running track. The latest addition to underground Helsinki is a maintenance traffic tunnel opened in 2009 to serve the Stockmann department store. [http://www.hel2.fi/ksv/julkaisut/esitteet/esite\\_2009-8\\_en.pdf](http://www.hel2.fi/ksv/julkaisut/esitteet/esite_2009-8_en.pdf)

The construction works of P-Hämppi, underground car park with 900



parking spaces in Tampere started in 2009. <http://www.finnpark.fi/p-hamppi0.html>.

Onkalo project, concerning the final disposal of used nuclear fuel

in bedrock has been started. This underground research project will be continued about 100 years in the future. <http://www.posiva.fi/englanti>

## FRANCE

Since January 2009, the AFTES seeks efficiency, fosters collegiality : urban underground, education, internationalization and development some new topics including : promoting societal and environmental subsurface, major projects and tunnels of facilities underground, creating a master Bac+6 'Tunnels and Underground Space', communication and promotion of the association, a collaborative approach with learned societies, the evolution of the branch Plant Equipment and Products and changes in statutes and rules of the association.

20 active working groups (~ 300) including 4 new groups: GT6: Technology bolting, GT16: Effects of the subsidence and of vibration on buildings, GT32: Geological risks and uncertainties, GT41: Tunnels and Sustainable Development

On the website, 43 recommendations in French and 32 recommendations for free download in English (total 85 recommendations in French and 40 published in English)

### SAMPLE UNDERGROUND WORK 2009

#### Road tunnels:

Violay 2 x 3900 m A89 Rhône / Loire

Chalosse 2 x 700m A89 Rhône / Loire

Bussière 2 x 400m A89 Rhône / Loire

Toulon Sud 1000 m DREAL 13 - 83 Toulon

Rénovation du tunnel de la Croix Rousse 1850 m Grand Lyon

Galerie de sécurité du tunnel du Fréjus 12000 m SFTRF Savoie 73 Modane

Galerie routière parallèle au tunnel de la Croix Rousse 1800 m Grand Lyon 69



Metro tunnels

Prolongement de la ligne 4 1470 m RATP Ile de France Paris

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Prolongement de la ligne 12 3800 m RATP Ile de France Paris  
Mise en service du prolongement de la ligne 13 1900 m RATP Ile de France Paris  
Prolongement de la ligne D vers Oullins 1700m SYTRAL Lyon 69  
Dams  
Galerie hydro-électrique du Rizzaneze 6020 m EDF Corse  
Sewers  
Galeries hydrauliques TIMA2 VL9 Charenton -Valenton 800 m SIAAP Ile de France Paris

**SAMPLE UNDERGROUND WORK 2009 - 2011**Tunnel Prado-Sud routier situé sous la ville de Marseille (Bouches du Rhône)

Tunnel autoroutier de la Borne Romaine A8 (Alpes Maritimes)  
Tunnel routier de Monaco RN7-boulevard Charles III (Monaco)  
Mise en sécurité du tunnel routier actuel (mono directionnel) de Tende (Alpes Maritimes)  
Nouveau tunnel routier mono directionnel parallèle au tunnel de Tende (Alpes Maritimes)  
Tunnel routier de Paganin (Alpes Maritimes)  
Tunnel routier de Propriano (Corse)



Galerie de sécurité du Siaix (Savoie)  
Tunnel du tramway de Viroflay (Paris)  
Tunnels du tram-train de la Réunion  
Galerie de liaison électrique à très haute tension entre la France et l'Espagne (RTE)  
Tunnel ferroviaire de Saverne LGV Est (Vosges)  
Galerie assainissement Charenton -Valenton : Lots 1,2,3 (Paris)  
Amélioration du tunnel routier du Chat (Savoie)  
Galerie de sécurité et cycliste du tunnel du Chat (Savoie)  
Aménagement hydroélectrique EDF de Gavet (Isère)  
Tunnel routier de Saint Béat (Haute Garonne)

## GERMANY

15 DAUB members took part in the annual traditional D-A-CH-meeting 2009 involving Germany (D), Austria (A) and Switzerland (CH). The host was Austria. The meeting took place in Langenlois and was attended also by 17 Austrian and 6 Swiss colleagues. The ½ day technical seminar dealt with most challenging actual tunnel projects, which especially are constructed in swelling and high-pressure ground formations. The additional technical tour led to the Lainzertunnel in Vienna.

The 2009 STUVA Conference held in Hamburg from December 1st to 3rd, bore the motto "Tunnels – Key to Sustainable Mobility". More than 1,500 tunnellers from 28 nations turned up for one of the world's biggest events for underground construction in order to exchange experiences, consolidate new contacts and rekindle existing ones.

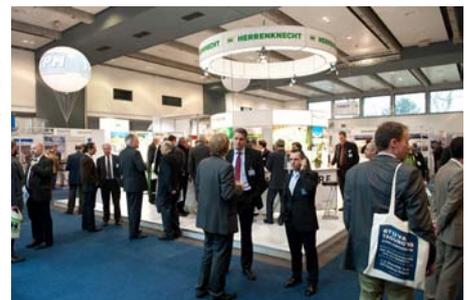
The conference was opened by Professor Martin Ziegler, the chairman of the STUVA Inc., and the participants were welcomed by the ITA president Martin Knights.

At this year's conference the topic of safety in tunnelling was accorded especially wide scope triggered by national and international events, as particularly the collapse of Cologne's Historic City Archives during the construction of the North-South Urban Light Railway provoked major uncertainty in conjunction with underground construction among the general public. The STUVA as one of the main organisations involved in underground construction in this connection provided a paper on safety and risks in tunnelling in the form of an interdisciplinary analysis and showed that tunnelling in general and especially in inner urban areas does not conceal incalculable risks providing certain rules are observed. KVB presented the consequences of the accident on behalf of the Kölner Verkehrs-Betriebe AG.



A further group of lectures devoted itself to the important subject of safety, on current developments in road tunnelling and retrofitting of tunnels, on legal and insurance issues, on outstanding major projects in Scandinavia, and on underground construction in the Hamburg area.

The 2-day exhibition that accompanied the conference in direct relation with the lecture programme occupied a net stand space of some 2,000 m<sup>2</sup> from 6,000 m<sup>2</sup> hall area. Here 128 German and foreign companies involved in execution, sub-contracting, planning and consulting



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presented their products and performances in the field of foundation engineering and tunnelling to a highly-qualified public.

The excursions on Day 3 rounded off the event and provided opportunities for consolidating an exchange of views and experience in a tried and tested manner.

Further information can be found under [www.stuva.de](http://www.stuva.de).

In connection with the STUVA Conference the ITA Executive Council met in Hamburg. At this occasion, the ExCo members could meet with the chairman of DAUB and the board of STUVA during a friendly evening, with the participation of 4 former ITA



presidents (Günter Girna, Alfred Haack, André Assis, Harvey Parker) and the present President Martin Knights.

DAUB run 4 working groups during 2009:

Financing of tunnels via PPP/BOT-projects

Recommendations for the selection of appropriate TBMs

Recommendations for designing prefabricated tunnel lining segments

Geological investigations for tunnelling

These working groups are of temporary nature and will be closed as soon as they have finished their special tasks. Members of these working groups are mostly also members of DAUB, but specialists from outside are also involved in some cases.

The results of the working groups are published in technical journals, preferably in "Tunnel" ([www.tunnel-online.info](http://www.tunnel-online.info)), but sometimes also in the German handbook of tunnelling (edited annually)..

The following excerpt shows some major tunnelling projects which were running in Germany during 2009:

ICE high speed lines (250 to 300 km/h): between Karlsruhe and Basel; partly upgraded and partly replaced, integrating two major bored tunnel projects of 9 and 6 km respectively in length. Each tunnel consists of two parallel single tubes with about 10.5 m excavation diameter. Inauguration is planned for 2011 to improve the traffic connections between Northern and Southern Europe via Lötschberg and Gotthard base tunnels in Switzerland.

Two further structures on the new/upgraded Erfurt–Halle/Leipzig route projects have been freshly tackled in the form of the Bibra (6.3 km) and Osterberg (2.1 km) tunnels. These tunnels – like the majority of the tunnels for the DB high-speed routes – are mainly built by conventional means. The Finne Tunnel (6.9 km), also part of this route, whose 2 tubes were excavated by shield drive, forms an exception. Blessberg Tunnel (8.3 km) and Silberberg Tunnel (7.4 km; both part of the Ebensfeld-Erfurt high speed line) are major tunnel projects that are still under construction.



Finne-Tunnel

DB project Stuttgart 21 putting the above ground main station underground by simultaneously turning it over 90° in plan view; this project involves besides the new underground main station nearly 40 km single/double track tunnels; intensive design work was started in 1997. After an intermediate slow down the project was reactivated in 2008/2009 and construction works started in February 2010. The entire project will be finished around 2015.

## GREECE

The Greek Tunneling Society has 335 members. In 2009 GTS organised a lecture by Jean Launay, a symposium on "Developments in Tunnel Construction Equipment" and a lecture by Dr Evert Hoek. It participated in a symposium on drilling and blasting techniques and in the 35th ITA G. A. and WTC 2009. It organised a technical visit at the Lavrion mines and the first underground facility for storing toxic waste in Greece. The WG on TBM selection and guidelines has submitted its first draft and it is being distributed to the members of the society for discussion. A workshop is organised for 2010 in order to discuss and finalise the report. The WG on final tunnel lining is going to submit its draft report in spring 2010. The WG on tunnel influence on slope stability has prepared an initial report and a final report is expected in the summer of 2010.

1. Athens Metro. At the Aghios Dimitrions – Elliniko extension of Line 2, the TBM continues its passage towards ALIMOS Station. At the Egaleo – Haidari extension, there is final lining construction, placing of the rail tracks and E/M installations. The Aghios Antonios – Peristeri – Anthoupoli extension of Line 2 is nearly concluded and will be operated shortly. Six (6) Joint Ventures have expressed their interest in the construction of the Haidari – Peraeus – Evangelistria extension of Line 3, (7.6 km long tunnel, with 6 modern stations). The budget of the Project amounts 515 million Euros.

2. Thessaloniki Metro. Works for the Thessaloniki metro are under progress involving



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13 stations, 9.5 km of tunnels (7.7 km to be bored by two TBM and the rest using cut & cover techniques) and a depot.

The first TBM (TBM1) reached SINTRIVANI crossover on 10/11/09, thus having constructed 2.714m of tunnel. The second TBM (TBM2) has bored 2.485m of parallel tunnel.

3. The highway tunnels of the main Egnatia Odos have been completed. Length (single bore) of twin tunnels in operation on Egnatia Road (main axis completed): 98.62km. Length of single bore tunnels under construction: five single bore tunnels, ~2.00km in the vertical axis of Egnatia Odos "Komotin – Nimfaia - Greek-Bulgarian Borders".

4. Three twin bore highway tunnels (T1: ~2km, T2: ~6km and T3: ~3km) with a total length of ~22 km, are under construction at the Tempi gorge along the Maliakos – Kleidi concession project.

5. Six twin bore highway tunnels are under construction for the Elefsis – Corinth – Patras – Pyrgos – Tsakona concession project (J/V Olympia Odos). These are the tunnels at Derveni (0.62 + 0.61 km), Mavra Litharia (1.18 + 1.14 km), Akrata (0.24 + 0.78 km), Platanos (1.63 + 1.57 km), Aghios Georgios and Koliri. The tunnel at Elia, the 6km long tunnel of Panagopoula and the Xylokastrou tunnel are to commence soon.

6. Along the Eastern Peloponnese highway, the second bore of Artemission tunnel, 1.4km long, was completed and delivered to traffic. The second bore of Rapsomati tunnel (1.4 km) is nearing completion.

7. Along the Ionian Highway there are going to be constructed four (4) twin bore tunnels with a total length of 6km (Klokova, Kalydona, Menidi and Skamia). Works have already started on two of the tunnels.

8. Along the Central Greece Highway, E65, the construction of six (6) twin bore tunnels with a total length (single bore) of ~20km has already started.

9. Along the national network, the tunnel of Gropa (1.5km) has been completed.

10. The design of the External Thessaloniki Ring Road is in progress, involving the twin, 3-lane tunnels of Seih Sou (2.2km), Panorama (1.8km) and Fillyro (1km).

11. Along the Egion – Patras railway section, budget of 685 million Euros, there is one twin bore tunnel in Panagopoula as well as structures for the underground alignment of the railway line in Aghios Vasileios, Rio and Patras. These tunnels with a total length of approximately 5km are at the tender stage.

12. Along the Kiato – Egion railway section, budget of 620 million Euros, there are 6 tunnels under construction (Melissi, Derveni, Platanos, Trapeza and Egio) with total length of 12km, 13 cut&cover structures with total length of 3.6km and 8 escape tunnels with total length of 2.15km.

13. The under construction high speed railway line from Athens to Thessaloniki, budget 1.8 billion Euros, includes many tunnels. Along the Tithorea – Lianokladi section there is the Kallidromo tunnel with 2 tubes total length 18 Km, and 7 Cut & cover tunnels with total length 1.080m.

14. Along the Lianokladi – Domokos section under construction there are 3 small double track tunnels with a total length of

1.62km and the twin bore tunnel of Othrys, 6.4km per bore, including 2 long escape tunnels.

15. There was a break through at the 18.5 km long Acheloos river diversion tunnel. A new project for the completion of the final lining has been advertised, the bids were submitted and the winner was selected. The 60 million Euros contract will be signed soon.

## HUNGARY

**WTC 2009, The World Tunnelling Congress 2009 successfully terminated.** The Congress had altogether 1112 participants from 51 countries worldwide. 170 engineers from 39 countries held lectures in the different conference rooms of the Budapest Congress Center. The poster exhibition had some 180 posters. The professional fair was attended by 62 companies. The professional events of the Congress were completed with the visit and presentation of 5 construction sites.

Within the frame of the Congress the ITA-AITES held its 35th GAM as well, with the participation of 40 out of the 55 member countries. 12 working groups and three special committees (ITA-COSUF, ITA-CET, ITACUS) had meetings for 2 days. Besides the event, the ITA-COSUF held a one-day conference.

The Congress was accompanied by a training course, with 100 participants from 10 countries and 17 lectures. This training was part and closing event of the 4-semester engineers training course, which started in 2007 with the cooperation of the Technical University of Budapest Engineers' Training Institute.



### NEWS ABOUT THE BUDAPEST METRO NETWORK:

In Budapest, the 4th metro line is under construction. Two parallel tunnels with inner diameter 5,2 m are being built with two TBM-s. The total length of the line is roughly 10 km constructed in two stages.

In the first 7 km long stage there are ten stations with connecting and ventilation tubes between them. The stations are constructed with diaphragm wall box structures as a cut and cover structure, but most of them has parts constructed with shotcrete supported method also. The TBM-s cross the structure ready stations. The connecting and ventilation tubes/tunnels are constructed with mining, shotcrete supported method also.

In 2009 the construction continued with structural works of five stations on Buda side and five stations on Pest side. The two TBM-s constructed 80% of the total length of 7km long running tunnels and reached the eighth station, Rakóczi square station.

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St Gellért square station is located beside the river Danube. One of the two main parts of the station is the cut and cover part with diaphragm walls and reinforced concrete horizontal supporting system, the other part is the closed mode structure with shotcrete external lining.

Fővám square station is located on the east side of the river Danube. The structure of this station is similar to the structure of St. Gellért station. The open method diaphragm wall box structure is between the closed method parts at both end of the station. The



shotcrete supported structures are constructed with the help of freezing.

Kálvin square station is the 7th station on the line, there is the connection with 3rd metro line. Here the complete station is inside a diaphragm wall box structure with specially shaped horizontal struts.

Rákóczi square station is the 8th on the line. Similar structural arrangement than St. Gellért square station, but the horizontal supporting system is formed differently. Here the horizontal supports are big horizontal frames with large oval openings in the middle. An interesting part, that on the edge of one frame the names of Rákóczi's lands are readable as a print in the concrete. (see picture below)



## ICELAND

The Icelandic Tunnelling Society which represents the ITA National Group Iceland is an independent group of tunnelling professionals with corporate and ordinary members. Members were heavily involved in investigations, design and construction of hydro and road tunnels in Iceland in the year 2009.

The year 2009 was relatively productive in terms of tunnel planning, design and construction. Work was completed on the Kárahnjúkar Hydro Project, a total of 73 km of tunnels. Work continued on the 5,5 km long road tunnel between Ísafjörður and Bolungarvík (Óshlið tunnel) with breakthrough in November. Work continued also on the 11 km long Héðinsfjörður road tunnels with the second breakthrough in April. Some other road and hydro tunnels are close to tender stage but due to the economic recession the future developments are somewhat obscured.

## ISRAEL

The group has two meetings and a workshop in addition to the participation in the annual conference of the IUCIE.

Most of the activity was concentrated in cooperation with the Israel Standard Institute in writing eleven parts for the new IS 5826 Standard on Tunnelling. Three of the standards (each part is a standard within the series) are already approved, two others have passed public Remarks and are in final editing and four other are being sent to Public Remarks.

We hope that the new standards will help to put all participants (designers, contractors, inspectors etc.) into a more formal order. The workshop was held on March 17 and included lectures by: Dr. Gerhard Sauer – State of the art concerning design.

Arik Glazer – Nilli Tunnel from a contractor viewpoint.

Shay Avidov - Nilli Tunnel from a project manager viewpoint.

Arnon Rozen – the Anabe tunnels.

In addition two meetings were held:

On April 30, Israeli standard IS 5567 – Safety in tunnelling works.

On July 9, the use of observational method in tunnelling. As the works for the new rail line from Tel Aviv to Jerusalem has started and will include 5 pairs of tunnels and an underground station, I expected that the coming year will focus on those works.

## ITALY

Società Italiana Gallerie is an open association (approximately 703 members), that promotes, coordinates and spreads the results of studies and researches in underground works. It publishes the "Gallerie e grandi opere sotterranee/Tunnels and large underground works" magazine (in Italian and English).

The working group activity in Italy, is mostly focused on the participation to the international working group for the occasion of the International world tunnel Congress.

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## RAILWAY TUNNELS :

**Milan-Naples High Speed/Capacity railway line, Bologna feed line.** The construction of the Underground station of Bologna Centrale (platforms 12-17) in an urban context is at an advanced stage.

**Brenner railway tunnel,** boring of the pilot tunnel (about 50 km overall) is in progress. Also Mules adit excavation has started

**Genoa-Ventimiglia railway line – Doubling of the track between Andora and San Lorenzo al Mare.** The excavation of 11 natural tunnels for an overall 15 km approx is in progress, partly via TBM of 11.84 m in diameter, partly by traditional excavation (section of about 125 m<sup>2</sup>)

## METRO TUNNELS :

**Naples, Line 1, Dante-Garibaldi extension,** excavation of line tunnels is over, excavation of 5 stations (Garibaldi, Università, Duomo, Toledo and Municipio) is in an advanced stage. All The stations are created after freezing the ground..

**Naples, Line 6,** The work concerns: a single tube tunnel of about 3,300 m to be created via an EPB shield of 8.30 m in diameter; 6 stations. Excavation works are in progress

**Genoa metro (De Ferrari-Brignole section),** Brignole station excavation is in progress

**Milan metro Line 3 – Maciachini-Comasina extension,** Excavation works of the Affori Centro, Affori and Comasina stations are over, they are pouring the final linings.

**Milan metro Line 5 – Garibaldi-Bicocca section,** Excavation works of the line tunnel (6,250 m in length and 8.5 m dia.) and of 8 stations are in an advanced stage.

**Rome metro Line B1 (Bologna - Piazza Conca d'Oro),** The works for the construction of three stations (Annibaliano, Gondar and Conca d'Oro) and about 4 km of line twin tunnel (excavated via two EPB shields of 6.5 m in diameter, able to operate under face pressure of up to 4.5 bar) are in progress.

**Rome metro Line C (S. Giovanni-Montecompatri/Pantano section),** Excavation works of line tunnels (18.5 km in length and 6.75 m dia.) by using 4 EPBS are in progress as well excavation works of the 12 underground stations.

**Brescia metro,** 14 km line tunnel (7 of which via an EPB shield of 8.10 m in diameter) are over, excavation of 8 underground stations are in progress).

## ROAD TUNNELS :

**Pedemontana Lombarda Motorway, Dalmine-Como, Gaggiolo pass connection,** The public tender is in progress

**Pedemontana Lombarda Motorway,** Excavation of 3 tunnels (3 km in total) is going to start

**Modernisation of Motorway A1 Milan-Rome-Naples, Valico by-pass,** Excavation of six twin tunnels (each tube about 180 m<sup>2</sup> cross-section), including the base one 8,700 m long, is in progress

**Modernisation of Motorway A1 Milan-Rome-Naples – Widening to three lanes between Florence North and Florence South.** Excavation of five twin tunnels (5,520x2 m total length) is in progress.

**Strada dei Marmi (Carrara ring road) Macina and M. Greco tunnel,** Excavation works using conventional methods of Macina tunnel (1,000 m in length and 13.50 dia.) and M. Greco tunnel (2,400 m in length and 13.50 m dia.), are in progress.

**Salerno-Reggio Calabria highway,** Works on the large areas sub-contracted for the construction of about 25 km of tunnels are in advanced stage.

**E90 motorway, SS 106 “Jonica” section, 11 tunnels,** Excavation works of the twin tunnels (6,671 km in total length, 6.5 m dia.) are in progress..

**Asti-Cuneo – Verduno and Alba tunnel,** The final design of the tunnels (total length about 4.5 km) is over.

**Frejus safety tunnel,** The final design, which provides for the creation of a tube about 8 m in diameter and 12.87 km in length, was approved.

**New tunnel at Colle di Tenda,** The project, which provides for the widening of the existing tube and the construction of a new 3,200 m long tube has been approved and financed by CIPE. Public tender has to start.

**Modernisation of Motorway A15 of Cisa,** The preliminary design of underground works (40 Km of road and railway tunnels) is in progress.

## KOREA

Korean Tunnelling Association (KTA) is a non-profit incorporated association based on membership (website: <http://www.tunnel.or.kr>). The board of directors is elected every two years. For the term 2008/2009, the board is composed of a president (Dr. Gyu-Jin Bae), two auditors, five vice presidents, 11 executive directors, and 41 directors. The current membership of the KTA stands at 2,123 individual members and 49 corporate members.

Nationally, the KTA publishes the Korean journal and magazine of “Tunnelling Technology” quarterly which report on all major tunnelling and underground activities in Korea, organizes conferences and seminars periodically, operates a number of specialized working groups to timely issues, and develops/revises the standards, specifications, guidelines for tunnelling in Korea. Internationally, the KTA interacts with the world leading institutes relevant to tunnelling technology, has technical site visits to prominent underground works, participates in ITA meeting and symposia, organizes international conferences and seminars, and introduces new overseas publications and guidelines to Korean tunnel engineers.

Major events during 2009 include:

March 18: The signboard hanging ceremony of the KTA Research Center (Director Prof. Hyung-Sik Cheong)

April 29: The 2009 KTA General Assembly and Annual Conference (300 participant; Fig. 1)

May 23~28: Participation of the 2009 ITA-WTC Budapest (60 delegates)

September 10: The 2nd Open Forum on Tunnelling Technology and Tunnel Picture Exhibition (350 participants)



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November 5~6: The 10th KTA International Symposium on Mechanized Tunnelling Technology (350 participants; Fig. 2)

December 6: Night for Tunnel Engineers (120 participants)

The KTA published technical reports and guidelines including:  
January: Design and Construction Guideline for Large Space Underground Structure

February: 2009 Tunnel Standard Specification legislated by the Korean Ministry of Land, Transport and Maritime Affairs

April: Guideline for Installation and Maintenance of Road Tunnel Disaster Prevention Facility

May: Virtual Project for Large Underground Structure (Fig. 3)

June: Manual for Tunnel Design Criteria

December: Tunnel and Underground Space in Korea (Fig. 4)

Quarterly: KTA Magazine on Nature, Human Being and Tunnel

Quarterly: KTA Journal on Tunnelling Technology

Nine working groups are currently active in the KTA such as Standard & Specification, Shotcrete, Geotechnical Investigation, Mechanized Tunnelling, Urban Tunnelling, IT in Tunnelling, Blasting Excavation, Tunnel Disaster Prevention, and Environments in Tunnel Construction. WGs held meetings as well as small group seminars regularly and reported their activities to the KTA magazine routinely.

Key members in KTA have conducted tunnelling technology-related research projects, which were granted by the Korean Ministry of Land, Transport and Maritime Affairs, such as Underground Space Construction Technology Research Centre (Prof. In-Mo Lee, 9.9 Million USD / 5 years), Rapid Excavation & Safe Tunnel (R.E.S.T) Research Center (Dr. Gyu-Jin Bae, 10.9 Million USD / 5 years), Rockfall & Landslide Prevention Research Center (Prof. Seung-Ho Lee, 11.5 Million USD / 5 years), Sub-sea Facility Shielding Technique Research Center (Dr. Hee-Soon Shin, 9.7 Million USD / 5 years) among others. These mega research projects cover various fields of tunnelling technology and will provide the state-of-the-art tunnelling technology for tunnel engineers in the future.

Numerous tunnelling projects have been running in Korea including:

Seoul Metropolitan Subway Line 9 (Fig. 5): It connects the east and west bound through the southern part of Seoul along the Han River. It has been constructed 25.5 km for the 1st phase (25 stations, 2001~2009) and will be constructed 4.5 km for the 2nd phase (2008~2013) and 8 km for the 3rd phase (2009~2015), respectively. Its construction is a challenge because of very poor geological conditions, a lot of groundwater and congested urban areas.

Keumjung Tunnel: Its length is 20.3 km and currently the longest tunnel in Korea. The tunnel has been constructed as part of the Kyungboo Express Railway 2nd Phase Construction Project (2002 ~ 2010) by TBM and NATM methods with consuming 600,000 persons and 170,000 pieces of heavy construction equipment. During its construction, the excavated muck is 2,800,000 m<sup>3</sup> equivalent to 350,000 dump trucks and the amount of concrete used is 230,000 m<sup>3</sup> equivalent to apartments for 5,000 residents.



Inje Tunnel: Its length is 12 km so it is expected to be the longest road tunnel in Korea. Its construction just started and will be completed as part of the 71.7 km long Chooncheon-Yangyang expressway by 2014.

Seongsoo-Cheongdam Section of double track electric railway Boondang Line: It is a river-bed tunnel (1.6 km in length), crossing the Han River in Seoul, was excavated with a shield TBM in soft rock, and will be completed by 2011.

Boryoung Subsea Tunnel: Although it is on the preliminary and tender design step, the Boryoung subsea tunnel has a length of 2.4 km connecting between Dacheon Port and Youngmok Port and will be the longest subsea tunnel in Korea. So, it is expected to facilitate tourism in those areas and decrease transportation/distribution cost very much.

Others: Solan Tunnel (railroad tunnel, 16.24km long), Busan-Geojea Submerged Tunnel (road tunnel, 3.7 km long), and Songhak Tunnel (double track electric railway tunnel, 5.98 km long).

## MALAYSIA

Meeting with Claude Berenguier (ITA Secretary General), Olivier Vion (ITA Executive Director), Leslie Pakianathan (TUCSS), Chun Nam Ow (LTA), Jeyatharan Kumarasamy (LTA), Bok Ngam Lim (LTA) & Wee Meng Sim (LTA) in Singapore on 28 September 2009.

The IEM Tunnelling & Underground Division had organized two (2) courses, two (2) technical talks and two (2) technical visits on Construction of Water Transfer Tunnel Project, Safety and Health in Construction Tunnels, Short Course on Risks Management in Tunnel Construction, Electrified Double Track Project Tunnels, SMART Tunnel Motorway Operation Control Room, Underground Structure Rehabilitation Design and Application, Site Visit to Construction Downtown Line Project in Singapore, Talk on M4, Metro Line 4 – Phase I, The Past and Future of Metro Construction in Budapest.

Underground projects : 2 Interstate Water Transfer Tunnel between Pahang & Selangor, Double track project for train – double/twin tunnel (2.25km long) – still under construction, 2 Water Transfer Tunnel / Hydro Electric Tunnel, Traffic Tunnel at Tropicana – under MBPJ, Besut – Water Diversion Tunnel, DBKL Project – Pipe roofing method.

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## THE NETHERLANDS

The Department of Tunnelling and Underground Works has over 650 members who meet 4 to 7 times a year. The meetings deal with both tunnelling and underground space projects, discussing new and ongoing projects and new developments in the field of tunnelling technology.

In Amsterdam work on the new North-South Metro Line continues. These include major works under and in front of the historic Amsterdam Central Railway station to accommodate an immersed tunnel element as part of the metro tunnel under the IJ river. TBM works under the historic old part of the city are now expected not to commence in 2010. This is due to serious delays that have arisen during excavation of the deep stations. Work on the Second Coen Tunnel, an immersed tunnel under the North Sea Canal near Amsterdam in the A10 motorway, have started in 2009. A new tunnel has been approved under the canal from Terneuzen to Gent in the south-west part of the country near Sluiskil. Contractors are expected to propose both immersed tunnelling and TBM driven tunnel solutions. The go-ahead was also given for a new tunnel project in the Hague. The Trekvljet bypass will provide a new access to the centre of the Hague via the Binkhorst Industrial Estate to the A13/A4 motorway intersection at Ypenburg. A 1,6 km bored tunnel is part of the proposed solution. In Delft work has started on the two km cut & cover tunnel carrying four railway tracks as part of the widening of the Rotterdam – the Hague railway line. The work includes a new underground station and car parks. The tunnel will replace the elevated railway which transverses the city of Delft. Proposal have been put forward by three groups for the A2 motorway project in Maastricht. Plans include a two km long tunnel for both motorway and urban traffic. The plans are partly financed by redevelopment of city areas adjacent to the project. In Rotterdam work is continuing on the Museum Park Underground Car Park. This facility includes an underground water storage basin. Also In Rotterdam the new underground metro station « Rotterdam CS », build as part of the northern extension of the existing North-South metro line has been finished. In Harderwijk works have started on a 23 m deep parking garage with a circular plan, build in diaphragm walls with underwater concrete

## NORWAY

The Norwegian Tunnelling Society with its 1020 personal- and 64 company members has accomplished another active year with good progress in distributing the latest development in rock excavation techniques. Main events of the year was the annual Rock Blasting conference and various courses and seminars related to underground technology in general and rock excavation in particular.

There are five permanent committees covering shot firers, development, international activities, information & public relations and finally conferences. Each of these appoints sub-committees (task forces) to cover specific projects. International committee is responsible for ita-matters, support the participation in ita working groups and international conferences in general. The

development committee initiates technological projects. During 2009 focus has been on health and safety as well as technology related to waterproofing in tunnels. The committee for conferences is responsible for arrangements, this year three. "Information" is promoting recruitment to the rock blasting and tunnelling profession as well as strengthen the image of the profession in general. The objective is to distribute correct and positive information on construction activities at large. The shot firer committee is arranging short courses for personnel from smaller companies involved in rock blasting as well as an annual 3 day seminar covering the latest techniques and is giving an update on new rules and regulations concerning rock blasting.

### TUNNELS AND CAVERNS UNDER CONSTRUCTION

1. New railway tunnel between Sandvika and Lysaker, 5,5 km double track tunnel
2. Frodeåsen railway tunnel, Tønsberg, 4 km double track tunnel
3. Gjevingåsen rail tunnel, Trondheim, 5 km single track tunnel
4. Access tunnel system to the Hardanger bridge
5. The T – connection, 9 km subsea roadtunnels
6. Ryaforbindelsen, 5 km subsea road tunnel
7. Lørentunnelen, 1 km underground road system
8. RV 64, The Atlantic ocean tunnel
9. RV 80, Saltapakken, 3 km road tunnels
10. Metro extension in Bergen, new tunnels and line
11. Kjosnesfjorden HEP, about 25 km of small section tunnels and shafts
12. RV 48 Helland – Havsgaardsdalen, road tunnel
13. Jøssingfjord underground hydroelectric power project
14. Boulanjåkka water transfer tunnel
15. Øksendaloverføringen water transfer tunnel
16. Sauda HEP
17. Storforshei, access tunnels for mine development
18. Underground parking facility in Moss
19. Many smaller projects

During the year 2009 the underground activity in Norway dropped with nearly 40 % compared to the year 2008. Excavated volume from underground openings reaching about 2,4 mill. m<sup>3</sup>. Total length of underground openings was in the range of 47 km. Excavation of road tunnels was by far the biggest sector with more than 1,2 mill. m<sup>3</sup> followed by hydro power tunnels with a volume of 0,5 mill. m<sup>3</sup>.

The outlook for 2010 is that there will be an increase in the rock excavation activity compared to 2009. Several railway and road tunnels are in the final planning stage and the Government is boosting their early start up.

## POLAND

On 9 – 11 September 2009 in Cracow the anniversary 10th Scientific and Technical Conference „Underground Construction” was held. There were approximately 100 participants and 35 papers were presented. The Conference was hosted by AGH University of Science and Technology, Cracow University of Technology and Cracow City Hall.

1. On September 28, 2009 a contract was signed between

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Warsaw authorities and the joint-venture winning the tender for designing and construction of the central underground section. The joint-venture made of Astaldi (Italy) acting as the Leader, Gulermak (Turkey), and Przedsiębiorstwo Budowy Dróg i Mostów (Poland) will build a 6.3 km underground line section (including 7 stations and 4,2 km of tunnels) for the price of approx. 1 billion EUR by 27th October 2013. The stations will be built using the cut and cover method, the single-track tunnels - with the use of 3 TBMs.

2. Design works are in progress connected with the road tunnel under the seaport channel in Świnoujście in the north-west part of Poland. As a result of an extensive analysis taking into consideration the complex environmental conditions, the final location of the passage was chosen and it was determined that the tunnel will be built using TBMs.

The passage will consist of 2 tunnels containing together 2 roadways with 2 traffic lanes. The total length of both tunnels will amount to over 4 km. At present activities are in progress connected with the organization of financing of the development.

3. The feasibility study phase has been completed for the road tunnel under the Martwa Wisła river in Gdańsk. Owing to the quite intensive vessel traffic to the shipyard and the relatively small width of the river (210 m), it was decided that the concept of tunnel construction using the immersion tunnel method should be rejected and the TBM method was accepted.

Two independent tunnels will be built with internal diameter of 13.50 m, containing two-lane roadways with a 3.5 m wide emergency lane. Each of the tunnels built using the TBM method will be 950 m long. The total length of the passage will be 1970 m including the sections to be built using the cut and cover method – 680 m as well as open approach ramps with length of 340 m.

4. Boring works have been completed on the road tunnel in the locality of Laliki on the S69 road in southern Poland. The tunnel was built in the geological formation called Carpathian flysch. The tunnel was bored using the NATM method. The total length of the tunnel is 678 m and the structure is composed of the main tunnel containing a roadway with 2 lanes and an evacuation tunnel with smaller dimensions situated at the distance of approximately 30 m from the road tunnel and connected with it by 4 passages.

5. A conception for the construction of a tunnel under the river Vistula in Warsaw has been elaborated. The tunnel will be used to transport wastewater from the left-bank part of the city to the currently modernized wastewater treatment plant situated on the right river bank. The tunnel with internal diameter of approximately 4.5 m will contain two delivery pipelines with diameter of approx. 1.6 m. The length of the tunnels between the shafts will be approx. 1350 m and the tunnel will be built using TBMs. The works are scheduled to commence in 2010.

## PORTUGAL

CPT, the Portuguese Tunnelling and Underground Space Commission, was created in 2006, as the Portuguese Group of ITA, inside SPG - Portuguese Geotechnical Society. SPG has 958 members, 152 being members of ITA and CPT. In 2009, CPT organized a Course on Tunnels and Underground Works in Urban Areas and joined AFTES and 4 other European countries in the organization of the International Congress of Lyon, 2011 (COLY). CPT organized also a booth with 7 Portuguese Firms in the technical exhibition during the ITA WTC 2009 (Budapest)

Working Group on Portuguese Tunnels – data collection is in progress, after a Seminar organized in Lisbon, May 2008. A book on Portuguese tunnels will be issued.

Four other Working Groups, as mirror groups of those in ITA are under development (Conventional Tunnelling, Health and Safety of Underground Works, Urban Problems and Underground Solutions, Risk in Tunnelling)

### Major projects :

The construction of the Porto Subway Line to Gondomar, including a 1 Km tunnel, is under progress

Tendering is being organized for the 2nd phase of the extension of Porto Subway (4 lines, 17 Km of tunnels, 29 Underground Stations)

The construction of the Red Line of the Lisbon subway, involving over 2 Km long tunnels, and two major underground stations, with a total excavation of 180 000 m<sup>3</sup>, was finished.

The extension of the Red Line of the Lisbon Subway from Oriente Station to the Airport, with over 3,5 Km long tunnels, was under construction.

Design studies for the high-speed railway lines Lisboa-Porto and Lisboa-Madrid, requiring a significant length of tunnels in the approach of densely urban areas, have also been ongoing.

Relevant activity concerning the construction of road tunnels in Madeira Island was carried on.

The Marão Road Tunnel (2 galleries, 5655 m each), was under excavation.

Tunnels and underground structures for the reinforcement of the hydroelectric power schemes of Bemposta, Picote, Alqueva and Baixo Sabor were under construction too.

Several underground power plants and hydraulic circuits for 10 new dams are in design.

## ROMANIA

A new special issue of "Constructii Subterane" Magazine has been published. The 6th National Conference of ART was held between 1st and 3rd of October, 2009, in Brazi – Raul Mare, Hunedoara County

After reviewing, according to European Norms, the following: « Guidelines waterproofing, maintenance and operation of underground structures for Bucharest Metro » and « Seismic Norm for Tunnel Designing in Romania », Working group "Research" sent to: Ministry of Transportation, METROREX SA (Metro system operator), Technical University of Civil

# Member Nations Report 2009

Engineering of Bucharest and General State Inspectorate for Construction, for approval.

## MAJOR PROJECTS :

- 1/. Romanian Government signed, in November, the agreement for the loan from European Bank for Investment - EIB, for beginning the works for Bucharest Metro Line 5, Section 1.
- 2/. It was signed the contract for starting the works for Comarnic – Brasov Highway (55 km long), which include a total of 15 km double-way tunnels.
- 3/. Continuing works to the hydropower development of the river Jiu on the sector Livezeni-Bumbesti includes 2 HPP located in the gorges area, connected by a headrace tunnel having a length of 20 km .
- 4/. Completion the special civil works on new metro station, Bazilescu station, built on existing tunnels.
- 5/. Running tenders for works on Sector 2 of Bucharest Metro Line 4: railway, waterproofing, installations, finishing works, signaling, traffic control etc.
- 6/. Completion and commissioning the underground road passage “Baneasa” (near « Aurel Vlaicu » Baneasa Airport), 0,4 km long.
- 7/. Works on Bistra – Poiana Marului Hydropower System, White River, first water supply tunnel with 2.8-km in length, 2.8-m in diameter.
- 8/. Works on Surduc-Siriu Hydropower System, Nehoiasu water supply tunnel, 18-km in length (14-km already done), 3.8-m in diameter, concreted on 13-km long.

## SLOVAKIA

The report evaluates and assesses the activities of the Association for the past period, which could be again considered as successful one taking into account a contribution to professional influence on tunnelling constructions implementation in Slovakia. The Board of Association has worked in the unchanged structure and composition of 11 members and two members of the Revision Commission. The Board negotiated and held talks 5 times last year.

In the first half-year, the activity of the Association came to a head and culminated by organizing the conference under the title „Fire ventilation and transport tunnels safety“. There participated 100 specialists from Slovak and foreign companies.

Lecturing experts from Austria, Switzerland and Germany were engaged and interested in their own presentations with demanding and difficult topics of tunnels safety.

This area substantially interferes and impacts costs and expenses for tunnels´ construction and subsequently influences a customer, who afterwards considers also other less ecological solutions. This seminar had exceptional and outstanding response in the professional public.

Moreover the Board organized the press forum with similar topic and issue, what has positively reflected in daily and also professional print media.

The Board within increasing of professional knowledge of university students, as well as awareness of the Association’s mem-

bers organized the seminar „Chemical ingredients and admixtures to concrete“ under extraordinary and exceptional interest of present participants. Lecturers were representatives of professional companies from Slovakia, the Czech Republic and Switzerland.

Consequently there was held an excursion at the tunnel Lalika in Poland.

Members of the Association Ing.Chomová and Ing.Frankovský elaborated the revision of technical regulation and directive for fire safety of road tunnels based on order of the National Motorway Company on behalf of the Ministry of Transport authorization.

Eventually, it is possible to state that STA devoted the year 2009 to the issue of security and safety of tunnels.

Among other activities, there still remains the creed or credo – tunnels need professionals, and so support and encouragement of students is pending all the time. Students participate at the congress „Betontag“ in Austria.

Financial situation of the Association is stable. The Association accepted further members in 2009, thus the total number is 49 members as of 31.12.2009.

## SLOVENIA

1) The Slovenian Association, together with University of Ljubljana, successfully organized 9th International Symposium on Tunnel Construction and Underground Structures, sponsored by ITA - AITES, which was held in Ljubljana, Slovenia, September 16 -18, 2009.

2) Slovenian and Croatian representatives of their respective Associations started with activities for publishing a brochure TUNNELS - Guidelines for good occupational health and safety practice in tunnel construction.

3) The Executive Council of the Slovenian Society of Underground Structures decided to celebrate the tenth anniversary by organizing the 10th International Symposium on Tunnel Construction and Underground Structures to be held in Ljubljana, Slovenia, November 16 -18, 2011.

4) Members of Slovenian Association presented papers at various international meetings and conferences in Europe and overseas countries.

Our members participate in WG 17 and WG 5. Due to WG 17 meeting in Budapest, Jakob Likar had presentation: KARAVANKE TUNNEL AFTER 18 YEARS IN OPERATION (SLOVENIA)

1) After several damages were discovered in the inner lining of the road tunnel in the centre of Ljubljana the reconstruction immediately followed in September 2009. All civil and electromechanical works were finished in a short period of time and the tunnel was opened for traffic on November 11, 2009.

2) The reconstruction of the old tunnel Ljubno, 260 m long, with three lanes, i.e. two traffic lanes and a retreat lane, which forms part of the road connection Karavanke – Obrežje, started with civil works in the autumn 2009. Technical solutions of the reconstruction were conditioned by specific properties of hard soil (called “sivica”) due to its swelling potential. The experience

# Member Nations Report 2009

gained through the construction of the new tunnel tube forms a good basis for economic and high quality civil works in the existing old tunnel tube, which was constructed more than 40 years ago.



3) Reconstruction works in three 150-year old railway tunnels in the alignment Sežana - Ljubljana are now under way.

4) After the contractor was selected, construction works started on the twin tube Markovec Tunnel, approx. 2.2 km long on the motorway section between Koper and Izola near the Adriatic coast. The structure of the rocks in the tunnel consists of flysch rocks with sandstone and marl layers which are tectonically disturbed in some parts. A section of the tunnel, about 600 m long, will be constructed bellow a shallow surface which is occupied by private houses and infrastructures.

5) Geological and geotechnical exploration works are close to the designing process on the new second track railway alignment between DIVACA and KOPER, and successfully started in 2009. The construction works on the new alignment, which includes about 20 km railway tunnels, will start in 2010, according to the plan.

6) In future we can expect some new projects on railways and road tunnels, particularly on the 3rd NEW DEVELOPMENT AXIS, and we are anticipating some rehabilitation works in old tunnels (either on rails or roads).

## SWITZERLAND

During the year 2009 the Swiss Tunnelling Society has organized and carried mainly the following events:

Swiss Tunnel Congress in June 2009. This annual main event has attracted more than 800 participants and took place in the prestigious Lucerne Congress Hall. The congress dealt with general and technical features of the Gotthard Base Tunnel and other projects in Switzerland and foreign countries. Next to this lectu-



res a colloquium was held on the previous day with the topic 'TBM-Tunnelling in Soft Ground'. The congress was combined with extended visits to five construction sites in Switzerland. The proceedings of this conference are available on our website. The STS organises each year two excursions. The excursion in April paid visit to the Cross-City Link Zurich, Weinberg tunnel and the excursion in October to the A5 Bypass Visp. Excursions are open to everyone and both were well attended.

For the first time STS organised in September an evening lecture, this time with Dr. Robert Sturk, who spoke about the challenging Hallandsås Project in Sweden. The lecture was held at the ETH Zürich. It will be organized twice a year in future.

Interaction with other national underground industry societies takes place in two parts: The meeting with the tunnelling societies of the German speaking countries in September (the German DAUB and ITA Austria) in Langenlois in Austria and organised by ITA Austria and in November with AFTES, ABTUS, AETOS, SIG und CPT in Martigny, organised by STS. Beside the general exchange of information the scope of these meetings included also presentations on special topics and a site visits.

On the international level, STS members were active in different working groups and committees of ITA. STS also launched its candidature to host the World Tunnel Congress 2013 and the 39th General Assembly in the city of Geneva. It would be a great pleasure for the STS, if the candidature was successful and we could welcome delegates and participants from all around the world.

In 2005, STS started publishing the 'Bulletin', which is edited twice a year. The 'Bulletin' can be downloaded from [www.swiss-tunnel.ch](http://www.swiss-tunnel.ch).

1. Gotthard Base Tunnel: As of January 1, 2010, of the total of 151.84 km of tunnels, galleries and passages of the Gotthard Base Tunnel, 141.82 km, or 93.4 %, have been excavated. [www.alptranist.ch](http://www.alptranist.ch)

2. Ceneri Base Tunnel: In the north portal of the Ceneri Base Tunnel at Vigana, driving under the A2 motorway continues. At Sigrino, the north-west drives in the caverna operativa (CAOP) are complete. In the south-west tunnel, driving continues with good advance rates. [www.alptranist.ch](http://www.alptranist.ch)

3. Cross-City Link Zurich: The Weinberg Tunnel, the under crossing of the southern part of the main station Zurich, with mining and cut-and cover methods and the crossing of the Sihl for the station Löwenstrasse are the core construction sites of the Cross-City Link in Zurich and under construction now. Commissioning will be in 2013. <http://infra.sbb.ch/bauarbeiten/weinbergtunnel.htm>

4. West Bypass Zurich N4/N20: The Western Bypass of Zurich with the Uetliberg Tunnel was opened for traffic on the 04.05.2009. It includes the Uetlibergtunnel (4'410m), the Aeschertunnel (2'160m) and the Hafnerbergtunnel (1'385m). [www.uetlibergtunnel.ch](http://www.uetlibergtunnel.ch)

5. Islisbergtunnel: On 13. November 2009, after almost eight years of construction, A4 motorway in Knonaueramt was opened for the traffic. It includes the Islisbergtunnel (4.95 km). [www.islisbergtunnel.ch](http://www.islisbergtunnel.ch)

6. Bypass Biel, A5 Eastern Branch: Together with the construc-

# Member Nations Report 2009

tion of the Western branch the Bypass Biel will influence the city for at least twelve years. The Eastern Branch under construction consists of the 1.5 km long Büttenberg tunnel and the 2.5 km long Längholztunnel. [www.a5-biel-bienne.ch](http://www.a5-biel-bienne.ch)

Other tunnel projects in Switzerland : the list of tunnels under design or construction sees many more projects. To mention just a few of them:

Tunnel Engelberg, [www.zentralbahn.ch](http://www.zentralbahn.ch)

Umfahrung Lugano (Vedeggio-Caserte)

Zentralbahn Lucerne, tunnels Hubelmatt and Allmend, [www.ausbau-zentralbahn.lu.ch](http://www.ausbau-zentralbahn.lu.ch)

A8 Umfahrung Lungern, Tunnel Lungern, [www.a8-ow.ch](http://www.a8-ow.ch)

A13 Umfahrung Roveredo, Tunnel San Fedele, [www.gr.ch](http://www.gr.ch)

A28a Umfahrung Saas, [www.gr.ch](http://www.gr.ch)

A16 Transjurane, tunnel Moutier, tunnel Neu-Bois, tunnel de Bure. [www.a16.ch](http://www.a16.ch)

Bypass Visp, Tunnel Visp, Tunnel Eyholz, [www.a9-vs.ch](http://www.a9-vs.ch)

CEVA, [www.ceva.ch](http://www.ceva.ch)

## TURKEY

The name of the Organization is TURKISH ROAD ASSOCIATION (TRA). There are seven National Working Groups in the Association. TRA is an independent and open Association. The members are combined of individuals, organizations and companies of public and private sector. TRA published several books and some National Conferences are at planning phase.

The working groups and important events of the year 2009 are: 1) Planning Working Group, 2) Road Construction Working Group, 3) Bridges and Tunnels Working Group, 4) Maintenance Working Group, 5) Traffic Safety Working Group, 6) Highway and the Environment Working Group, 7) Intelligent Transport Systems Working Group. The working groups organized various meetings, national conferences, exhibitions and published some books, reports and booklets.

In 2009 the contract of second subsea tunnel through Marmara Sea was signed according to Built-Operate-Transfer (BOP). Planning and design facilities have been carrying out Subsea tunnel with a length of 3.34 km and diameter of 12.4 mt will be driven with TBM. The Project consists also cut and cover and NATM tunnels. Tunnels will serve to automobiles and buses.

In Marmaray Project construction has been continued in 2009 with some delays due to archeological works. It is planned to finish construction in 2011. Two current metro projects in Istanbul are Kadıköy-Kartal with 53 km tunnels and Taksim-Yenikapı with an approximate length of 5 km.

Design and construction of two main routes for speed railway (Eskişehir-Köseköy and Ankara-Sivas ) are continuing. They consist of 39 tunnels with length of 39 km and 7 tunnels with 10 km respectively.



In highways , number of tunnels in operation increased to 171 with an approximate length of 118 km. 49 tunnels ( 29 km) are under construction, design of 145 tunnels ( 36 km) are going on.

## UNITED KINGDOM

The British Tunnelling Society continues to be active in providing its extensive membership with a range of professional, technical and social activities throughout the year. Monthly meetings are held at the Institution of Civil Engineers in Westminster and are open to non-members. Tunnelling engineers on visits to London are particularly welcome. In addition the BTS continues to produce technical guidance on a range of tunnelling-related topics.

1 During 2009, BTS working groups were drafting guidance on best practice for monitoring of underground construction. were capturing knowledge on timber support techniques.were revising the BTS Specification

2 The Compressed Air Working Group has met to consider issues affecting work in compressed air including real time Doppler monitoring of the workforce, the use of MRI scanning in place of x-ray, high pressure exposures and to review existing national guidance on the topic.

3 BTS continues to assist with an employers' training forum to deliver National Vocational Qualifications in tunnelling at operative level.

4 BTS has continued to interact with MPs through its Parliamentary Lobby Group.

5 BTS interfaces with other UK professional groups interested in geotechnical matters through membership of the Ground Forum.

6 BTS supports the ICE's Panel for Historic Engineering Works – Tunnels sub-panel.

7 BTS contributes to the work of various British and CEN standards relating to tunnelling and tunnel machinery.

8 BTS ran two successful training courses in 2009, one on tunnel design and construction and the other on health and safety in tunnelling

London Underground are beginning a major programme of complex tunnelling to provide additional escalator capacity and interchange capacity ahead of Crossrail.

A major collapse has occurred in the headrace tunnel which has closed the power station at Glendoe. A contract for the recovery of the tunnel is expected to be let early in 2010.

Various tunnels were being designed or constructed for water, sewerage and cable utility services including extensions to Thames Water's London Water Ring Main, a number of cable tunnels for the national electricity grid and the national gas grid.

Major tunnel refurbishment works are underway on Bell Common tunnel on the M25 motorway.

Breakthrough of both tunnel faces at the A3 Hindhead tunnel was achieved.

# Member Nations Report 2009

The major interceptor sewer tunnel under construction in Belfast to collect sewage currently being discharged into Belfast Lough was completed

The contract for the first phase of Tideway – a major sewage storage and transfer tunnel system in London to reduce storm discharge into the Thames – was let at the end of 2009.

The 2nd Tyne Tunnel – a combination of two short sections of SCL tunnel, cut and cover box and immerse tube tunnel is underway.

Further baggage tunnels at Heathrow T5 have been completed

## UNITED STATES OF AMERICA

Despite many of the impacts on other construction sectors, business in the tunneling and underground Construction continues at a steady pace supporting large state and local infrastructure programs in the Water, Waste Water, and Transportation sectors. The numbers of projects in the design and under constructions holding steady and a couple of projects on hold, such as the Port of Miami Tunnel, are now free to move forward. Increasing demands for water, and water quality improvements are drivers in continued local and regional funding of water and sewer tunnels across the U.S. One of the larger programs coming on line finally after a lengthy planning phase is the Washington DC Water and Sewer Authority's Combined Sewer Overflow Program consisting of four tunnel segments, the first of which will be the Blue Plains Tunnel with an RFQ due date of March 2010. A list of over 40 US tunneling projects is attached.(see ita website)

The interest and demand for tunneling expertise has shown up in the attendance of our various short courses and annual tunneling conferences. The Rapid Excavation and Tunneling Conference (RETC) was held in Las Vegas and well attended as usual. In September, the UCA sponsored a short course on Shaft design and construction which was well attended.

Chairmanship of the Underground Construction Association of the US changed this year as Brenda Bohlke stepped into the role of Past Chair and David Klug assumed the role of Chair for the next two years and Jeff Petersen of Kiewit assumed the position of Vice Chair. Tom Peyton was nominated to the Board of the Society of Mining Engineers just as he was scheduled rotated off the UCA Board.

The Underground Construction Association continues its quarterly Tunnel Demand Forecast, published quarterly with our Tunnels and Underground Construction (TUC) magazine. This document is updated regularly and documents the various projects through concept, design and into bid and construction. A copy of the March 2010 issue lists the various large active projects across the US and Canada and provides descriptions and status.

Noteworthy: Highway tunnels are going larger in the U.S. : The Port of Miami has received the funding and the consortium franchise has received notice to proceed, will be the largest highway bored tunnel in the US. Seattle's fast track double deck highway

tunnel through downtown will quickly top the Port of Miami tunnel. Four teams have been qualified and Requests for Proposals are expected out at the end of May. Two new freight tunnels the early design and planning stages in New York: one of which is the Cross Sound Link Service Tunnel providing truck bypass of NYC with a tunnel crossing of Long Island Sound. The second is freight rail tunnel providing access to and through New York City.

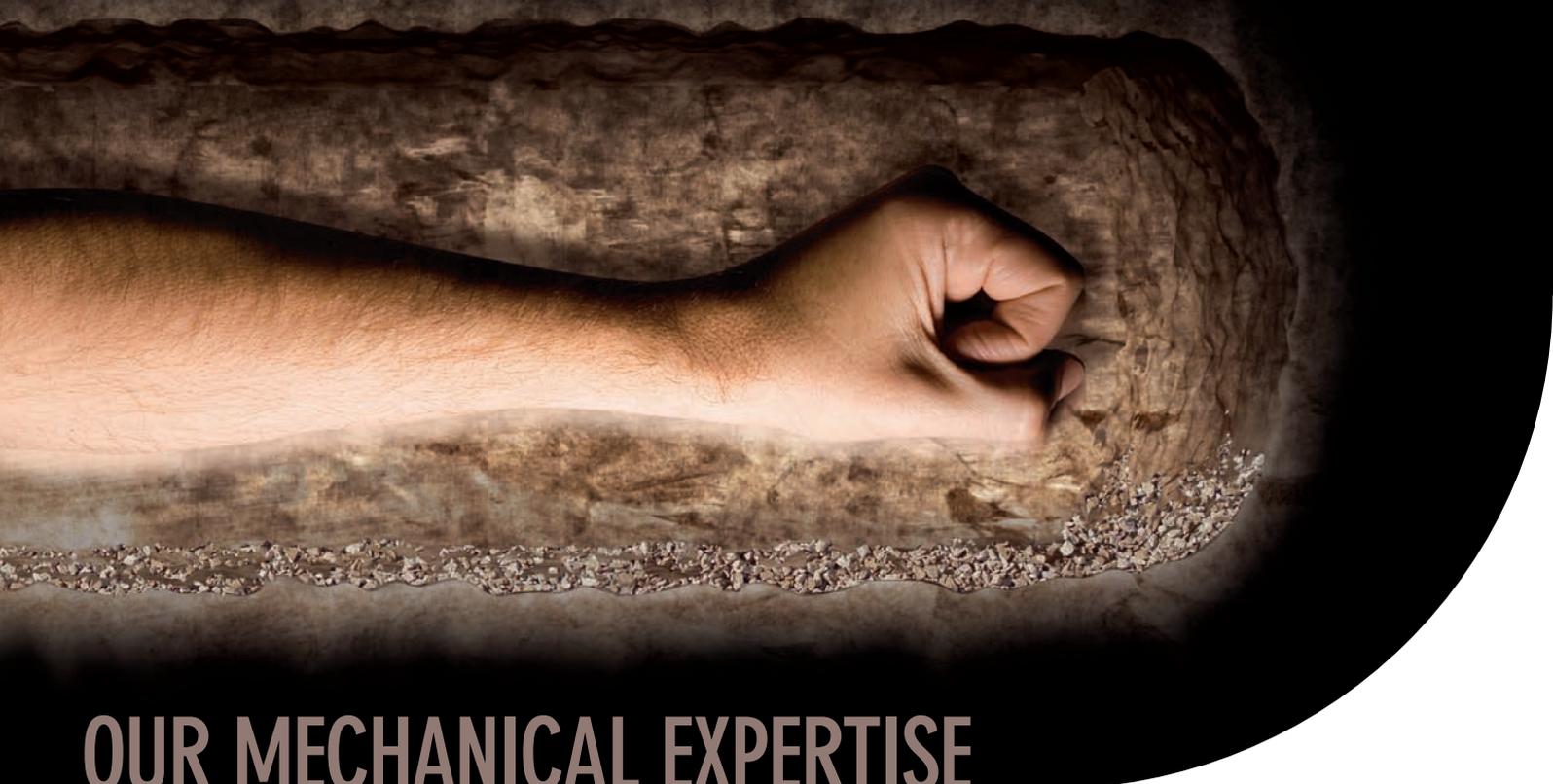
California continues the highway tunnel work on Devils Slide bypass of Rt. 1 and plans to bid the Fourth Bore of the Caldecott tunnels through the Berkeley-Oakland Hills and cross the Hayward Fault zone.

New York and New York City continues construction on various transit and rail projects as well water tunnel projects including the bidding of the Access to the Core Rail Tunnel projects: Manhattan, Palisades and Hudson river Tunnels. Work continues on the No. 7 Line, the Second Avenue Subway, and the 34th Street Caverns.

Transit continued: Other major cities across the US have been just as busy with completion of the Gold Line extension in Los Angeles and planning for an extension with the Subway to the Sea. Further up the coast, in the SF Bay area, BART is extending south into Santa Clara County, and the SF Muni Third Avenue extension.

In the water sector the Harbor Siphons Tunnel is approaching an spring 2010 bid date, while the Number 3 Delaware Aqueduct. San Francisco Public Utility Commission has several water and sewer tunnels designs on the books and approaching a spring 2010 bid dates on the New Irvington Tunnel . The Southern Nevada Water Authority continues it's proactive development of the Lake Mead No. 3 Tunnel and the IPS 2 Connection. The Arrowhead tunnels holed through to wrap up a challenging but successful program for Southern California Water.

NFM TECHNOLOGIES. TUNNEL BORING MACHINE MANUFACTURER.



## OUR MECHANICAL EXPERTISE WORKING FOR YOUR PROJECTS

NFM Technologies is a manufacturer of tunnel boring machines from 4 m to over 15 m in diameter, for any type of geology, making large-scale projects possible for rail, road or water infrastructures.

NFM Technologies' broad range of competences as an OEM in the cutting-edge mechanical sector means that it can propose innovative technical solutions, integrating specific requirements for each project and guaranteeing a high level of equipment reliability.

Whether for improving access to regions, developing infrastructures, or improving quality of life, our expertise is available to meet with your needs.

Christian Membré. Photo credits: Frank Benn, Dörmann, Linde



Hard-rock TBM



Soft ground TBM



Dual mode TBM



NHI GROUP

Creator of underground spaces

TUNNELS AND GALLERIES: Rail | Road | Water

[www.nfm-technologies.com](http://www.nfm-technologies.com)

# ITA “Prime Sponsors” Report

## IMPLENIA

### Gotthard Base Tunnel, lots Bodio, Faido and Sedrun:

Two parallel single track rail tunnels 37km in length and two multifunctional stations (MFS).

Complex geological condition (highly tectonized areas, rock under high pressure, kakiritized slate, gneiss and sugar-grained dolomite).

MFS with longitudinal and lateral caverns, four enlargements for crossovers between the tunnels, crossovers, side tunnels, an exhaust air tunnel and fourteen exhaust air shafts.

In Sedrun the access to the tunnel is provided by a one kilometre long tunnel and two shafts, 800m in depth, in Faido by a one kilometre long tunnel with an incline of 12%.

The two MFS were excavated by drill & blast method, 70% of the concrete lining is completed.

The parallel tunnels are excavated by gripper-TBM, 80% of the tunnel length are completed.

### Durchmesselinie Weinbergtunnel (Transit tunnel under the Zurich main station)

Section 3 of Durchmesselinie (cross rail link) is the 4.5 km long Weinbergtunnel and an underground track alignment widening tunnel under Zurich main station to a new part of the station (realized by undercutting).



The tunnel runs under the city centre of Zurich.

The first 4138m of Weinbergtunnel are excavated in solid rock with an open

mode mixed-shield TBM. The remaining 280m undercrossing the river Limmat are executed in slurry-shield mode.

Parallel to the main tunnel, an escape & rescue tunnel is driven by means of a hard rock TBM with a diameter of 4.75 m.

The access to the widening under the main station was started from a 25 m deep shaft. The shaft is supported by diaphragm walls. It is situated directly next to the station in a highly frequented public traffic area.

### Pumped Storage Scheme Nant de Drance, Valais, Switzerland:

The project involves the construction of a pumped storage power station with various caverns situated between the two storage lakes Emosson and Vieux Emosson. The access to the new cavern of the power station is situated 1900m above sea level.

Access to the plant is provided from the valley through a five kilometre long tunnel system. The difference in altitude between intake and turbine is overcome by two vertical pressure shafts.

The main access tunnel will be driven by a hard rock gripper TBM, shafts, access tunnels, caverns and presser tunnels by raise-drill and drill & blast.

### Other main tunnel projects:

Bypass tunnel of Lungern, Canton Obwalden

N16 Jura Highway tunnel  
Sous le Mont, Canton Berne

Ceneri Base Tunnel, lot  
Vigana, Canton Ticino

Zentralbahn, dual track widening and relocation to underground, Canton Lucerne

Tunnel of Roppen, two-lane motorway tunnel, Austria

Special Tunnel Works : large diameter pipe jacking with slurry shield micro TBM, Zurich main station for Weinbergtunnel



## LOVAT

Lovat designs, manufactures and services tunnel boring machines used in everything from telecommunications to metro tunnels.

Since 1972, our highest priority has been safety in the tunnel. We believe that innovation, efficient design and manufacturing excellence are all driven by a “safety-first” culture, leading to superior results.

In 2008, Lovat combined its underground expertise with the resources of Caterpillar, a company that understands large scale manufacturing and the importance of research and development.

Together, we have increased our commitment to the tunnelling industry, while continuing to provide first class services and customer satisfaction.

Lovat and Caterpillar recently opened a new 20,440 square meter manufacturing and logistics center, a second plant to serve the growing demand for tunnel boring machines.

Lovat’s successful tradition of personal, one to one customer service, both locally and internationally, continues unchanged.

### 2009 at a Glance

#### LOVAT Manufactures 250th TBM

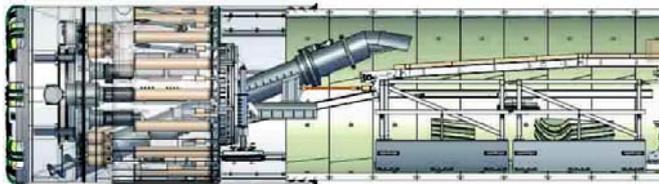
Building on the past 37 years of innovation and success, LOVAT is proud to announce the completion of its 250th TBM, named “Theodora”. The LOVAT MP132SE EPB TBM was used in the construction of the Thames Water’s West Ham Flood Alleviation Scheme located in East London, UK.



# ITA "Prime Sponsors" Report

## **Lovat received order for 4 New TBMS for the Toronto-York Spadina Subway Extension Project.**

The announcement was made on August 7th, 2009 after several dignitaries toured the Lovat facility. "I am proud to highlight that here in the GTA, a local company will use its expertise to build an essential piece of machinery for the construction of this extension," said Bob Dechert, MP for Mississauga-Erindale



## **MAPEI**

Mapei is located in Milan, Italy, with 63 subsidiaries worldwide including 56 production plants in 25 countries in the five continents. Mapei is a market leader in the development and application of chemical products used within the Construction Industry.

The "Underground Technology Team" (UTT) is the division of the MAPEI Group fully dedicated to the underground activity. Underground construction has a unique character, due primarily to the complexity and severity of conditions within this work environment. It is therefore necessary to apply an extremely high level of specialization and completely dedicated product systems, such as those developed and produced by MAPEI. The range is wide and complete and includes products for the following areas:

Admixtures for concrete and sprayed concrete;

Mechanised tunnelling by TBM;

Injection and consolidation with chemical resins or cement-free binders;

Waterproofing by means of synthetic membranes, chemical resins or cementitious products;

Tunnel repairing using premixed mortars;

Tunnel coating by paints, osmotic grouts or ceramic coating (adhesives and tile joints), etc.

During the year 2009 MAPEI-UTT's activities continued to increase and develop in those countries where the division is already well established in addition to new markets.

UTT confirmed its position as market leader in supplying alkali-free accelerators (MAPEQUICK range) for sprayed concrete in various European countries. Many and



important projects of ground consolidation and waterproofing were carried out as well by injecting cement-free hydraulic binders (MAPEJET SYSTEM). In addition, UTT enlarged its market position in

mechanized tunnelling by entering as a primary supplier into TBM projects with its foaming agents (POLYFOAMER FP, STABILFOAM range), admixtures for backfill grouting (MAPEQUICK CBS SYSTEM), greases (MAPEBLOX range).

In the year 2009 MAPEI also entered in the worldwide market with high-quality waterproofing synthetic membranes (MAPEPLAN range) for any kind of underground applications. Celebrating 10 years birth of UTT division, Mapei can now offer a full and complete range of products for any application in underground construction, with the most efficient and specialized solutions for a higher production.



## **MEYCO - BASF**

MEYCO Global Underground Construction, part of BASF Construction Chemicals, is a leading supplier offering customized solutions, innovative product technology, specialized equipment and engineering knowledge. Tackling all your underground engineering problems safely and cost and time effectively, MEYCO has been instrumental in bringing new methods to the tunneling and mining industry: Expanding Horizons Underground

### **Sprayed Concrete**

As demand increases for a durable, safe and environmentally preferable sprayed concrete; the switch from dry to wet mix applications continues. MEYCO provides the full range of alkali-free accelerators, superplasticizers, hydration controlling admixtures and fibers to meet these requirements.

### **Sprayed Concrete Equipment**

With more than 50 years of experience in manufacturing and supplying sprayed concrete equipment, MEYCO Equipment supplies the market with a complete range of sprayed concrete equipment, manufactured to the highest industry standards:

Wet and dry spraying machines

Fully equipped and modular spraying mobiles for mechanized and/or automatic spraying

Accelerator dosing pumps and sprayed concrete testing units



# ITA “Prime Sponsors” Report

## Injection

MEYCO offers a complete range of chemical injection systems including high performance Microcements, Colloidal Silica, Polyurethanes, Polyurea-Silicates as well as tunnel lining repairs.



## TBM Solution

Our innovative total solution approach makes TBM drives more successful, even in highly challenging ground conditions. MEYCO has the largest range of products and services available for TBM tunneling, suitable up to the largest diameters used today.

## Waterproofing

MEYCO's innovative spray applied waterproofing membrane, applied in a sandwich structure between sprayed/cast concrete shells, provides excellent bonding between membrane and concrete. This enables the construction of cost-effective waterproof single shell tunnel linings.

## Fire Protection

Excellent protection properties, high durability and a controlled, minimal thickness are some key features of MEYCO Fireshield 1350. This spray applied thermal barrier is ideal for new build tunnels and existing tunnel linings with limited available space.

## Service

Our global presence supports seamless technology and service transfer for international contractor and design teams. MEYCO's professional technical and site support for products, equipment and application are recognized as the best service in the industry.

We were involved in a number of successful projects in 2009 across all these technologies.

## NORMET

For over 40 years Normet has developed manufactured and marketed equipment and vehicles for mining and underground construction. In addition Normet provides a comprehensive range of Life Time Care services e.g. maintenance, service programs, spare parts and training around the equipment and the



processes they are used for.

Normet's offering consists of solutions for the following underground customer processes:

- Concrete Spraying and Transport
- Explosive Charging
- Lifting and Installation
- Underground Logistics
- Scaling

Company's headquarters is located in Iisalmi, Finland and manufacturing is done both in Iisalmi and Santiago de Chile. Sales, Marketing and Product offering is managed from Switzerland and customers are supported from 23 locations worldwide.

In 2009 Normet has strengthened tunnelling offering, presence and support by for example starting to develop its new TBM Applications –product line, which is headed by Mr. Egil Engesrønning, and by employing tunnelling experts. For example Mr. Odd-Bjørn Kleven is now heading Normet's tunnelling sector and special projects.

Thanks to the in 2008 and 2009 built own distribution network Normet is able to support tunnel projects worldwide.

For building of tunnels for 2014 Sochi Winter Olympic Games transport infrastructure

Normet delivered concrete spraying equipment (Spraymec 7110 WPC) and special equipment for the assembly of steel arches (Utilift 2000 BAQ).

During 2009 Normet has supplied several tunnel projects in Europe; France, German, Switzerland, Spain, Norway, Sweden and Finland. For example in Germany concrete sprayers and man lifting and installation vehicles has been delivered for the building of tunnels for the Ebensfeld – Erfurt railway line. The line will be part of the Berlin - Munich high speed railway.

At the end of the year Normet entered to a supply contract with the Joint Venture of Leighton Asia and Leonhard Nilsen & Sonner (LNS) of Norway for equipment and after sales services for the building of sewage conveyance system in Hong Kong (HATS). Normet will supply the JV with concrete sprayers, rock haulers together with Multimec cassette system for material transport including Multimec 6600 cassette carriers and platforms for injection and for explosive charging, cassettes for utilities, concrete transportation and for basic material handling and transport.

In 2010 Normet will further develop its presence, offering and support for tunnelling customers worldwide.



# ITA “Prime Sponsors” Report

## SIKA

### Major Success using Innovative “Harmonica Tunneling Construction Method.”

In many key projects, growth in all Regions has been nearly exponential.

Indeed, Sika has become strongly positioned on the Russian market, especially on the Key Project of Sochi. The city will host the XXII Olympic Winter Games in February 2014, a first for Russia. Upon award of the Olympics to the city of Sochi, favored resort of some of Russia’s national leaders, Sika Russia, based in Moscow, opened an office in the future Olympic city in anticipation of the demands of Russian building and construction companies. Investment for extensive infrastructure will amount to some USD 12 billion, and will include the Olympic Village, a highway and double-track express train line from the airport Adler to Krasnaya Polyana with numerous tunnels and viaducts, hotels of all categories, a high bypass around Sochi and a new port among other building projects. Participation here has enabled Sika to strongly penetrate the Russian market.

Through close collaboration with various partners, Sika Russia is now sought by construction companies for its excellent support, both technically and commercially. The following are examples of some of the projects for which Sika supplies chemistry for concrete, shotcrete as well as for sealing. Following some examples:

Link Sochi-Adler (Black Sea) to Krasnaya Polyana (~60 km) site of alpine events:

Tunnel n°1, highway-railway, 2’420m’ - Contractor UGSK, Tunnel n°4, twin track railway, 450m’ - Contractor KTSK LLC, Tunnel n°5, highway-railway, 2’814m’ - Contractor BTS-Hidrostroy, Tunnel n°6, double-track railway, 425m’ - Contractor KTSK LLC.

Sochi by-pass: just completed

Tunnel n°6, highway - Contractor Tunneldorstroy, Adler airport: 12’000 sqm of ground

Sika Products supplied for the tunnels and the airport: Sika ViscoCrete, Sigunit, SikaFloor and SikaPlan Membranes

Sika AG, celebrating its 100 anniversary in 2010, is a globally active company supplying the specialty chemicals markets. Sika’s product lines feature high-quality concrete admixtures, specialty mortars, sealants and adhesives, damping and reinforcing materials, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

## BABENDERERDE

As a German company, with subsidiaries in the US and in Brazil, we provide consulting services for tunnel and underground projects worldwide. Dedication and focus on quality has allowed us



to deliver successful projects for Clients and Contractors. Most recent services include design work for highway tunnels under water straits, technical specifications for mechanized tunnelling, construction management services for railway-

projects, as well as inspections and trouble shooting for TBMs in difficult situations. New projects around the world have broadened our experience in contracting modes such as DBB, D&B and PPP.

Our TPC software, engineered to monitor all aspects of mechanized tunnelling, has been enhanced to provide comprehensive and user friendly reports. Tunnelling data, shift reports, quality management data and production statistics –all can be easily accessed from a central client’s computer or through the internet.

## COWI

COWI is an international consultant company with 6000 employees working within Engineering, Economics and Environment. We work with a full range of engineering services within selected regions. Globally we work within selected services of which tunnels and underground structures is one.

Within the tunnels and underground structures the positive trends we have achieved in recent years have continued.

Research and development

Technically, we are well advanced in respect of steel fibre reinforced concrete elements, which are used instead of traditional steel reinforcement. Steel fibre reinforcement was used for the first time as lining for Copenhagen’s district heating tunnel. We are now also using steel fibre reinforcement in Abu Dhabi where, in collaboration with the Italian contractors Impregilo, we have entered into a contract for a ten-kilometre bored tunnel with 80-metres deep shafts. The tunnel is to be used for transporting wastewater.

### Metro in Copenhagen

Our largest project is the Cityringen metro line in Copenhagen, with Metroselskabet I/S as our client. The project has been put out to tender after two years of intensive work on planning, design and approval. When completed, the project will include 16 kilometres of bored tunnels, 17 underground stations and four shafts.

# ITA "Supporters" Report 2009

Tunnels for road and rails in Korea, Sweden and Venezuela

Our work continues in South Korea on the Busan project, which involves the world's deepest and most technically complex immersed tunnel. All the tunnel elements are now in place, and the tunnel will be completed in the course of 2010.

Turning to Stockholm, Sweden, we have completed the detailed design of the Söderström railway tunnel for Züblin-Pihl JV. Construction work is in full swing, and the first immersed tunnel elements are about to be pre-cast and made ready to be submerged.



We have also won the contract for the Marieholm tunnel in Gothenburg, where we are to be responsible, on behalf of the Swedish Road Administration, for the planning and tender design of a new immersed tunnel under the River Göta.

Our work continues on the Maracaibo tunnel for Odebrecht Brazil, and we have just completed the scheme design for the ten-kilometre combined road and rail tunnel.

China and Qatar. The world's largest immersed tunnel projects

In China we have just completed the tender design for the Hong Kong-Macao-Zuhai link, in a joint venture with the HPDI. The project includes a six-kilometre immersed tunnel for road traffic. We have also completed the feasibility study for the Doha Bay Crossing in Qatar. The project, with several immersed tunnels under the bay, involves approximately 15 kilometres of tunnel including submerged traffic interchanges. With its total of eight lanes for road traffic, this will, when finished in approximately eight years, be the largest immersed tunnel project anywhere in the world.

## DOOSAN

Doosan is Korea's oldest business group with a proud history of 113 years, and has grown and developed for more than a century. Doosan E&C was established in 1960 and has continuously strived to become a leader in Korea's construction industry by utilizing its ample technological knowledge and extensive experiences in plant facilities, housing, civil engineering, and general construction. Doosan E&C is one of the most experienced companies in high-speed rail and subway construction, and was first

to use the large caliber shield T B M technique in subway construction in Korea. During



2009, Doosan E&C continued to experience growth in the NATM and bored tunnel business. One of many tunneling highlights last year was Subway Line No.9-Section 909, located in Seoul, Korea. 7.720m Dia. of slurry shield TBM with 17 inch disk cutters, capable of producing 56,000 kN of Thrust and 8,100 kN-m of Cutter-Torque in Maximum, is bored through gravel, boulder, rock and mixed ground for tunnel length of 3,614m. Shield TBM bored 1.5m underneath an existing box structure of the national assembly building and 0.64m beside existing footings of bridge. Some recent tunneling projects are summarized below;

Daegu Subway Line No.2 Section 1 : Tunnel - 1,280m(NATM), 1 Station

Shin Bundang Subway Section 1 and 3 : Tunnel - 23,563m(NATM and open-cut), 7 Stations,

Bundang Subway (Hangang Riverbed Tunnel) : Tunnel - 1,692m (EPB Shield TBM), 1 Station

Seoul Metro Section 704 : Tunnel - 1,205m(EPB Shield TBM), 2 Station

Gangnam, City Circular Highway, Section 5 : Length - 12,470m (4 Tunnels / 12 Bridges)



# PROBLEM SOLVING UNDERGROUND



Once the contract is signed and site prepared, it's time to excavate. But even the best-laid plans can be slowed down by actual ground conditions. Robbins' advanced tunnel construction machinery, expert teams and innovative approach have successfully completed hundreds of boring projects around the world. From project planning to tunnel completion, we ensure your job is a success—no matter the obstacle.

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