

WTC 2015
SPECIAL EDITION

MINING & CONSTRUCTION



This special edition of Mining & Construction highlights infrastructure developments currently underway in Central and South East Europe.

Atlas Copco

Europe's new tunnels take shape

Connecting people
Linking nations
Improving traffic flow

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Tunneling for fut



Atlas Copco



ture prosperity

INTERNATIONAL TUNNELING EXPERTS gather in Dubrovnik, Croatia this May for the 41st World Tunnel Congress and General Assembly – and the choice of venue is no coincidence.

CENTRAL AND SOUTH EASTERN EUROPE is expected to be the EU's most active region over the next two decades with the focus on major infrastructure development, according to Davorin Kolić, President of the Croatian Association for Tunnels and Underground Structures.

ALREADY THE REGION IS BUZZING with a number of significant projects underway including highways, bridges and tunnels – and there are many more in the pipeline.

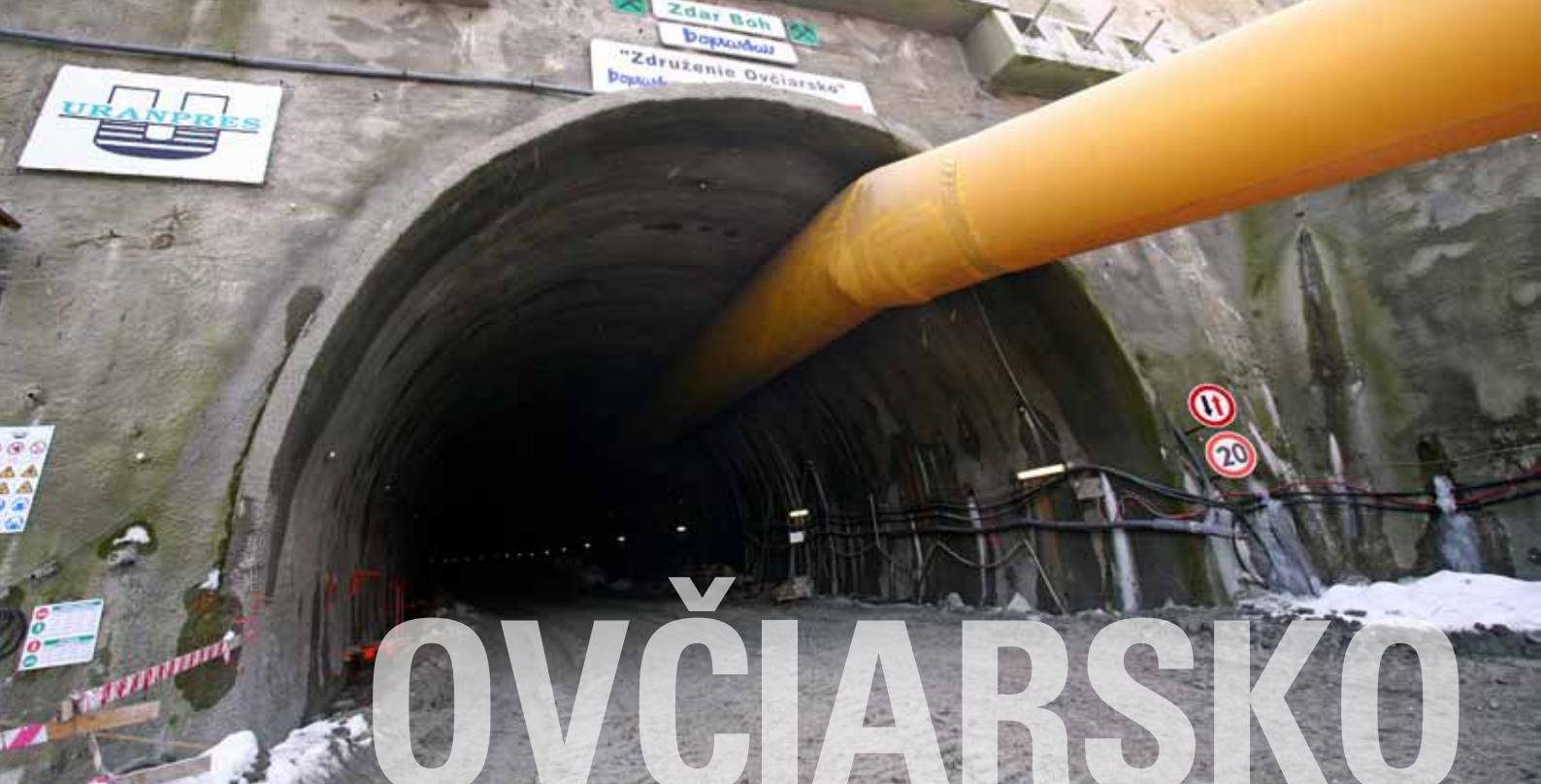
SLOVAKIA IS PRESSING AHEAD with numerous investments in infrastructure. Four new tunnels are now in use with a total length of 8 015 m. There are currently eight tunnels under construction, with a total length of 16 727 m.

THESE TUNNELS INCLUDE Ovčiarisko, Žilina, Višňové, Šibenik and Čebrat on the D1 highway, plus Považský Chlmec, Svrčinovec and Pol'ana on the D3 highway. Additionally, there are plans for a further 22 tunnels, representing a total length of 49 385 m.

IN SERBIA, NOW AN EU CANDIDATE, the main arteries known as Corridor 10 and Corridor 11 have strategic importance for the country and the economy according to Zorana Mihajlović, Serbian Deputy Prime Minister and Minister of Construction, Transport and Infrastructure.

WITHIN THESE CORRIDORS there are also several tunneling projects currently under development at Manajle, Predejane and Sarani.

IN THIS SPECIAL EDITION of the Atlas Copco magazine Mining & Construction we invite you to take a look behind the scenes at some of the most important developments designed to improve transport and communication, and above all, prosperity for all.



OVČIARSKO

The challenge in the ground



The Ovčiarisko tunnel in northern Slovakia is located on the D1 highway on the southside bypass of Žilina. The D1 is part of the E 50 international transport route that runs from Paris via Nuremberg and Prague through Ukraine to Russia.

Ovčiarisko is actually one of two tunnels (the other is at Žilina) that form part of a €427 million contract to develop an 11 km section of this vital international link and also includes 11 bridges and numerous access roads.

The contract for the entire section was awarded to a consortium of four companies – Doprastav, Strabag, Váhostav and Metrostav. Doprastav is responsible for the tunneling and has subcontracted this work to Uranpres, supported by its sister company EKOFIN.

With plans to open in January 2018, Ovčiarisko is designed as a twin-tube project, 2 367 m in length and is being driven simultaneously from the east and west.

More than 500 m have been driven from the west but excavation at the eastern end

is behind schedule. Geotechnical problems brought work to a standstill soon after it began in August 2014, but was resumed in March 2015.

Tackling the 'nightmare'

"From the geological point of view, this is one of the most difficult tunnel construction projects in Slovakia," says Igor Jurik, Project Geologist at Ovčiarisko. The northern part of the country is very mountainous, he explains, and soft rock, in particular a type of clay known as Flysch, is often encountered in the Slovak part of the

Western Carpathians. In fact, this formation is so common that it is practically impossible to avoid.

Jurik continues: "We have two types of geology in the tunnel, an older type with fairly stable rock that is not too bad to work in, and a younger type of Flysch, which is a nightmare." Flysch is characterized by low strength and high porosity. It also disintegrates in contact with water and swells.

In addition, the geology frequently varies along the entire tunnel alignment. At the western end, the first 300 m was fairly stable, but then began to fluctuate every

“This is one of the most difficult tunnel construction projects in Slovakia.”

Igor Jurik, Uranpres Project Geologist at Ovčiarisko.





Shotcreting the tunnel with a Pontenza wet mix concrete spraying unit from Atlas Copco Meyco.

The construction team has to constantly switch excavation methods. Right, an Atlas Copco breaker is checked in the service workshop.

few meters. This has forced the company to constantly switch methods; drill and blast in the good formation, hydraulic hammers and excavators in the poor quality ground.

Having to change equipment and crews every few meters to deal with these variations is tough, to say the least. As a result, the rate of advance can be anything from 0.5 m to 2.5 m in a single production cycle.

"The right technology has to be used depending on the geology so it's not possible to use just one method. We have to adapt to what we find," says Jozef Valko, Senior Construction Manager, adding that this situation also places high financial demands on the project.

"At first, we thought we would only be able to use drill and blast for about 20 to 25 percent of the tunnel," he says, "but now we expect this to rise to 50 to 60 percent." That's good news for the overall advancement of the project. For drill and blast in competent rock, two Atlas Copco Boomer E2 drill rigs are used. These are equipped with COP 2238 rock drills as well as rods,





Above, view of the Ovčiarisko twin-tube portals at the eastern end.



Right, view of the portal from the western end. Ventilation is provided by Serpent fans and ducting.

Far right, the tunnel uses state-of-the art concrete spraying technology.



» shank adapters and bits from Atlas Copco Secoroc.

The rigs are also used for portal stabilization work to install the Atlas Copco Secoroc Symmetrix system. This method involves the installation of steel pipes or casings, set in an umbrella pattern in the crown, providing extra support ahead of drilling and blasting.

The crews work seven days a week with two 12-hour shifts per day. In each shift, they try to get through a complete cycle of drilling and blasting the top heading and bottom bench of the face, although this is not always possible. This does not mean that the drill rigs have to stand idle, however. When they are not drilling blastholes they are drilling holes for rock bolts. The bolts comprise grouted, hydraulic and fibreglass variants as well as self-drilling anchors.

When installing the SDAs – a common solution for unstable ground such as sand, gravel, silt, and clays – two Atlas Copco M400NT Mai pumps are used for the injection grouting. Wire mesh is also used.

Another key piece of equipment used for rock support is the Atlas Copco MEYCO Potenza unit for wet mix concrete spraying, and there are two of these in operation. MEYCO was acquired by Atlas Copco in April 2013 from chemical giant BASF Construction Chemical and this represents state-of-the-art concrete-spraying technology. Coincidentally, BASF also supplies ground support at the Ovčiarisko site.

When working in the soft rock, the team switches to MB 1700 hydraulic breakers from Atlas Copco mounted on excavators.

Ventilation is provided by two high

pressure Atlas Copco Serpent fans together with 2.4 km of high quality PVC-coated ducting. All of the equipment is supported by a service contract which is managed by ISOP, Atlas Copco's distributor in Slovakia, headed up by Jozef Parobok.

ISOP has a stipulated response time of two hours and workshops at both western and eastern portals. The larger of these at the eastern portal can accommodate the Boomer E2 drill rig, and there are containers on site for spares and consumables.

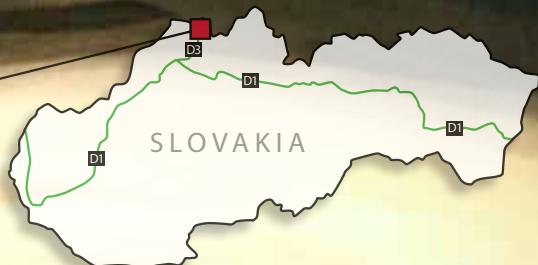
“The right technology has to be used so we have to adapt to what we find.

Jozef Valko, Uranpres Senior Construction Manager at Ovčiarisko.



POL'ANA

Linking two nations



From November 2016 the Pol'ana tunnel will be the first road tunnel that motorists will pass through as they drive from Poland into northern Slovakia on the D3 highway.

Located in the Čadca district of the Žilina region, the Pol'ana tunnel is part of a 13 km stretch between the towns of Svrčinovec and Skalité. This section includes two tunnel projects, Pol'ana

(898 m) and Svrčinovec (445 m) as well as 17 bridges including what will be the highest bridge in Slovakia.

Once completed, the new highway will reduce driving time from Svrčinovec to the Polish border. In addition, it will substantially reduce the impact of traffic and improve the environment for nearby communities.

Funded by the European Union and

the Slovakian state, the project is estimated to cost €329 million and is being undertaken by a consortium of four contractors – Váhostav, Doprastav, Strabag and Metrostav.

The Pol'ana tunnel itself has an estimated cost of around €29 million and is being built as a joint venture by Czech company Metrostav and Slovak company Doprastav.



» Excavation at Pol'ana started in July 2014 and the tunnel is to be completed in August 2015.

The tunnel will have a cross section of approximately 105 m² and it will have a single tube with one lane going in each direction. There will be two one-side emergency bays, an escape gallery (or support gallery, which in future may become a second tube), plus three access passages connecting the support gallery with the main tunnel.

Excavation started at the western portal from where about 350 m of top heading have been driven so far, including the excavation of 250 m of bench and 155 m of invert. "Still, advance has been slow due to the highly complicated geological conditions," says Jiří Břichnáč of Metrostav, Site Manager at Pol'ana.

The geology in this part of the country also includes the Carpathian Flysch, characterized by alternating layers of claystones and sandstones in different stages of weathering and tectonic damage. This means that even though the tunnelers use the New Austrian Tunneling Method (NATM), they are also obliged to frequently change excavation method.

"In some sections of the tunnel, where we have more competent rock, we use drill and blast and in the sections where we have soft

rock, we use hydraulic hammers on excavators," he says. "But there's no consistency. Every step is different and takes a long time. We have prepared for every eventuality with explosives for the hard rock and self-drilling anchors for the soft material."

In the sections with more competent rock, an Atlas Copco Boomer E2 drill rig is used to drill the blast holes. "We try to go through two blasting cycles per day but it depends on the rock and is not always possible," Břichnáč continues, explaining that the work is carried out seven days a week with two, 11-hour shifts per day.

The drill rigs are also used to drill holes for the 9 m long, 51 mm diameter self-drilling anchors that are installed in an umbrella pattern to support the tunnel face. "We only use self-drilling anchors because

the material we will be drilling in varies so quickly and so dramatically," says Břichnáč. He adds that when drilling holes for installation of the anchors, the drill rigs sometimes work non-stop for 11 hours.

When working in the soft rock, Atlas Copco's MB 1700 hydraulic breaker mounted on an excavator is used. A smaller, single boom Boomer 281 drill rig is used in the adjacent support gallery and Atlas Copco Secoroc supplies all of the rock drilling tools. "We have a high consumption of drilling tools, especially the drill bits, as the rock is very abrasive," says Břichnáč.

For concrete spraying work, two Potenza concrete spraying units from Atlas Copco MEYCO are used in addition to wire mesh, steel arches and the self-drilling anchors.

“The D3 highway and the Pol'ana tunnel will greatly contribute to the transport network.

Jiří Břichnáč Site Manager for Metrostav at the Pol'ana Tunnel.





Tunneling at Pol'ana is being carried out 7 days a week with two 11-hour shifts per day.

Excavation of the eastern portal is due to start in May 2015. "The idea is to eventually have the same setup for drilling, shotcreting, excavating and loading in both tunnel headings," says Břichňáč.

The larger rigs were supplied by ISOP, Atlas Copco's distributor in Slovakia and, together with Atlas Copco in the Czech

Republic, help to keep the equipment up and running.

"Daily service of the machines is done by Metrostav but we have a contract to service the equipment after they've worked a certain agreed number of hours," says Pavel Jindráček, Product Manager for Atlas Copco Central Europe. "The hours differ depending

on the type of equipment and we carry out the larger repairs and more complex servicing."

Břichňáč concludes: "This is a very complex project, but I believe both the D3 highway and the Pol'ana tunnel itself, will make a great contribution to this country's transport network." ◎



While the Pol'ana tunnel is under construction work goes on up above to extend the D3 highway involving a total of 17 bridges.



POVAŽSKÝ CHLMEC

Speeding up the traffic flow



Located north of the city of Žilina on the D3 highway between Strážov and Brodno, the Považský Chlmec tunnel is one of the most interesting projects currently underway in Slovakia.

It includes two bridges, one of which will pass over the Hričovská Priehrada dam and stretch for about 1.4 km, making it one of the longest bridges in the country. This bridge will connect directly with the 2.2 km long Považský Chlmec tunnel and from here motorists will drive onto another bridge, this time taking them over the Kysuca River.

"This means that drivers will travel through approximately 4.25 km of bridge-tunnel-bridge structures without touching normal roads," says Anton Petko of HOCHTIEF CZ, Production Site Manager at the Považský Chlmec tunnel.

The project aims to divert traffic from Žilina in order to increase the speed and flow of traffic from north to south. The Slovak government estimates that 8 800 cars per day will be travelling along this stretch by 2041. Moreover, the new highway will reduce noise and emissions and

contribute to the development of the region.

Financed by the Slovakian state, the entire project will cost approximately €284 million and has been undertaken by a consortium made up of EUROVIA SK, HOCHTIEF CZ and Stavby Mostov Slovakia. HOCHTIEF CZ is responsible for the tunnel construction.

The Považský Chlmec tunnel will feature two tubes with a dual carriageway in each tube. The total length will be 2.2 km (north tube: 2 252 m, south tube: 2 189 m). There will be seven cross passages

“Unlike most tunnels, this one is being developed from the inside out.



Anton Petko Production Site Manager for HOCHTIEF CZ at the Považský Chlmec tunnel.

including emergency passages and two lay-bys. Excavation of the tunnel started at the beginning of 2015 and the construction is scheduled for completion by summer 2016.

Drilling from the center

Excavation has started from the mid-section going in opposite directions towards the western and eastern portals. “Unlike most tunnels, this one is being developed from inside out, rather than the other way round,” says Petko. The construction will eventually be carried out simultaneously from six locations with four faces in the center.

Excavation of the western face started in February this year and preparation work at the eastern portal is currently underway. HOCHTIEF CZ expects about 250 tunneler to be working two 12-hour shifts, 24 hours a day, seven days a week.

Similar to other tunnel projects in northern Slovakia, Považský Chlmec also has the challenge of being developed in complex and difficult geology. Again, the geology is mainly composed of Flysch, featuring alternating layers of claystone, sandstone and conglomerates.

“The most competent rock here is still quite poor,” says Petko, explaining that the quality varies widely throughout the tunnel

alignment. Added to this is the extent of the cross section up to 97 m² and a maximum overburden of 124 m which requires a huge earth removal operation.

The tunnel is being excavated using the New Austrian Tunnelling Method (NATM), combining drill and blast with hydraulic hammers mounted on excavators. “We expect 80 percent of the development to be done using drill and blast and 20 percent using the hydraulic hammers and excavators,” says Petko.

Drilling and blasting is being done with two Atlas Copco Boomer E2 drill rigs, including a new model featuring the latest RCS 5 rig control system. “This is the first Atlas Copco Boomer with the latest RCS version in Slovakia,” says Pavel Jindráček, Product Manager Underground Rock Excavation for Atlas Copco Central Europe.

The operators received training on this system at the beginning of this year and eventually there will be three Boomer E2 rigs on the site. Two of these will be used for drilling blastholes and one for anchoring.

Drilling, blasting and anchoring is carried out in two 12-hour shifts per day. “At the moment, we’re working on one face

only but eventually we’ll have several faces open, each going through these three steps. And of course, the length of each step will depend on the geology,” says Petko.

Považský Chlmec also employs two Potenza concrete sprayers from Atlas Copco MEYCO which are used for spraying concrete as primary lining support after blasting and mucking out. The reinforcement work also includes wire mesh, steel arches and radial rockbolts.

The equipment on site is supported by ISOP, Atlas Copco’s distributor in Slovakia, with additional support from Atlas Copco Czech Republic if required. The service contract includes spare parts and consumables on site and a response time of up to two hours for a service technician.

“I have worked with Atlas Copco equipment for many years, I know the machines are good, but one of the main reasons we decided to go with them is the fact that they’re established in this market and are well placed to offer us the best technical support and service,” says Petko.

“The schedule is a major challenge,” says Petko. “We have to excavate more faces and with 97 m² of cross section, that’s a challenge in itself as it amounts to lots of mucking. But we’re on track!”



The Atlas Copco Boomer E2C drill rig going into action.



Constructing the roof of the “turtle” entrance to the Považský Chlmec portal.



ČEBRAT'

The region's most demanding task

The new Hubová – Ivachnová section of the D1 highway in Slovakia, which includes the Čebrat' tunnel, is one of the region's most demanding projects in terms of engineering, design and cost.

The 15.3 km section passes through difficult terrain with undulating topography and complex geology. The terrain includes part of a national nature reserve, the Tatra National Park, and the Lisková Landslide, one of the most famous active landslides in Slovakia.

At various points, the highway crosses the Váh River and a railway line or runs parallel with the railway line along the riverbank. In total, the section includes 21 bridges and one tunnel, Čebrat', which runs under the Čebrat' hill.

"The whole section is very challenging as there is not one kilometer of it that runs continuously over flat topography," says Pavel Jindráček, Product Manager Underground Rock Excavation for Atlas Copco Central Europe.

By building this section, the government expects to considerably relieve the traffic in the city of Ružomberok, located at the

foot of the Čebrat' hill, as well as reduce traveling time through the region.

Currently, the time required to reach the existing section of the D1 along the original road and through local villages and Ružomberok is 18 minutes. The new highway will cut this to just seven minutes and simultaneously increase safety, improve traffic conditions and contribute to a better environment.

With an estimated cost of €465.7 million, financed by the Slovak government and the European Union, the section is being built by a consortium comprised of Czech company OHL ŽS and Slovakian contractor

Váhostav-SK. The contract was awarded in December 2013 and the project is expected to be completed by June 2017.

OHL ŽS is responsible for the excavation of the Čebrat' tunnel and has subcontracted Slovenské Tunely to help it carry out the work. "We've divided it up with OHL excavating the southern tube and Slovenské Tunely excavating the northern tube," says Tomáš Just of OHL, Site Manager at Čebrat'.

Čebrat' will be a twin-tube project featuring a 2 026 m southern tube and a 2 011 m northern tube. Each tube will have dual carriageways in each direction. The tubes will

“ The geology in the western portals is a real challenge. We have to consider alternatives.



Tomáš Just Site Manager for OHL at the Čebrat' tunnel.

be interconnected by seven cross passages, which are being excavated at intervals of up to 280 m.

Two of these will be located at emergency laybys in each tube to be used by emergency vehicles. The other five passages will be available for pedestrians. The tunnel will have a clearance height of 4.8 m and will be equipped with a modern communication and monitoring system.

The Čebrat' hill is 1 054 m above sea level and the geology is complex, comprising limestone, dolomite, clays, sandstone and marlstone, among others. Apart from short sections at the portals, the tunnel is being driven through variable quality rock.

"Some sections are not too bad but, they're not great either," exclaims Just. The strength of the rock also varies, with an average of 25 MPa, including areas with poor rock quality, and there are also occasional occurrences of ground water influx to deal with.

Excavation work started in September 2014 at the eastern portal of the southern tube. Excavation at the eastern portal of the northern tube started three months later, in December. Just explains that the original plan was to start excavation from the eastern portals and then eventually from the western portals so that the tunnel would be driven from both ends simultaneously.

"The geology in the western portals is a real challenge so work has been temporarily stopped while we look at different alternatives, including driving the tunnel all the way from the eastern portal or even extending it," says Just. Work is expected to resume in the fourth quarter of 2015, but they are pressing ahead with the rest of the tunnel. Work at Čebrat' is carried out seven days a week, 24 hours a day with two, 12-hour shifts per day.

More than 2 km of the Čebrat' tunnel have been excavated using the New Austrian Tunnelling Method (NATM). Advance rates depend on the quality of the rock. "The quality varies so much that we could easily have a meter of poor quality rock followed by 2.5 m of good quality rock," says Just. As a result, the rock is sometimes broken using drill and blast and sometimes using an Atlas Copco MB1700 hydraulic breaker on an excavator.

For drill and blast, two Atlas Copco Boomer E2 drill rigs are used. Ján Klein, of Slovenské Tunely's Maintenance and Equipment Manager at Čebrat', explains that the rigs are also used for drilling the holes for rock bolts.

In one 12-hour shift the rigs are normally at the tunnel face for two hours and then drilling for bolting for one hour.

The excavation face is divided into top

heading and bench with the top heading 5.4 m high. In terms of support Čebrat' uses a mix of primary and secondary lining with the first layer of concrete 100–250 mm thick and a secondary lining of reinforced concrete in the portals and in sections with poor geology.

In addition, welded mesh of one or two layers is used along with lattice girders and grouted self-drilling anchors 3–6 m long as well as Atlas Copco Swellex bolts.

For the concrete spraying, Čebrat' uses two Meyco concrete sprayers – a new MEYCO Potenza, currently being used in the north tube and a second-hand MEYCO Spritzmobil, currently being used in the south tube.

The tunnel ventilation is ultimately designed as a longitudinal system with six pairs of jet fans. During excavation, ventilation is provided by one fan in each tube. For the project, Slovenské Tunely acquired 500 m of new Atlas Copco 1.8 m diameter flexible ducting to use with the fans they already own.

Slovenské Tunely has a service contract with ISOP, the Atlas Copco distributor in Slovakia, which includes a response time of 6 hours for any major service issue as well as spare parts and also includes training for the operators, on both the Boomer E2 and Meyco concrete spraying equipment.

*Below, second from left: Ján Klein, Slovenské Tunely, Tomáš Just, OHL with Atlas Copco representatives and a MEYCO Potenza unit.
Inset: The Boomer drill rig and drilling crew.*



MORE TUNNELS UNDERWAY

Svrčinovec Tunnel

The 445 m long Svrčinovec tunnel is part of the Svrčinovec – Skalite section of the D3 highway and it is being built by the same consortium of companies that is building the Pol'ana tunnel. The whole section itself is being built by the consortium formed by Váhostav, Doprostav, Strabag and Metrostav.

Svrčinovec will be one of the first five tunnels that drivers arriving from Poland will go through when using the D3 highway (Pol'ana will be the first). Currently about 10 m of the top heading excavation from the western portal have been finished. The tunnel is planned to be completed in Spring 2016.

Equipment being used in Svrčinovec includes one Atlas Copco Boomer L2 drilling rig, one Meyco Potenza concrete spraying unit and one GIA service platform. Most of this equipment has been delivered by ISOP, the Atlas Copco distributor in Slovakia, which also holds a service and spare parts contract and has a warehouse on site.

Žilina Tunnel

With a length of 687 m, the Žilina tunnel is located on the Hričovské Podhradie – Lietavská Lúčka section of the D1 highway. It is being built by the same consortium of companies that is currently building the Ovčarsko tunnel. Žilina is estimated to be excavated in spring 2016.

Some of the equipment being used in the construction of the

tunnel includes two Atlas Copco Boomer L2 drilling rigs, two Meyco Potenza concrete spraying units and two GIA service platforms. Delivered by ISOP, the equipment is supported by a service contract for all the equipment and a specific spare parts delivery contract for the Meyco and Boomer machines.

Višňové Tunnel

Forming part of the Lietavská Lúčka – Višňové - Dubná Skala section, which has been called the “most demanding and technically difficult section of the D1 highway,” the 7.5 km long Višňové tunnel will be the longest tunnel in Slovakia. The highway section is 13.5 km long and will include five bridges and also the second longest tunnel in Slovakia. It is intended to reduce congestion on the existing route, some parts of which are handling some 30 000 cars per day. In addition, it should reduce journey times for drivers and help to cut the number of accidents.

Costing €410 million, the Višňové tunnel is being built by a consortium formed by the Salini-Impregilo and Dúha companies. Excavation work at the tunnel, which will pass under the Malá Fatra Mountain, will start in the spring this year. Work is expected to be completed in late 2019.

The investor driving all tunnel construction in Slovakia is the Slovak National Highway Company.



MANAJLE & PREDEJANE

Preparing for EU membership

In seeking to become a full member of the European Union, Serbia is improving the quality of its transport and infrastructure. A number of substantial projects are currently underway, one of which is the construction of the Manajle and Predejane tunnels on Corridor 10 between the southern Serbian city of Nish and the Macedonian border.

At present, this section of Corridor 10 only has two lanes and is often overloaded with trucks heading south to Macedonia and Greece. Accidents are frequent, especially in summer when the road is jammed with European holidaymakers but the tunnels will ease the congestion and also bring environmental and safety standards into line with EU regulations.

The entire project, which is estimated to cost more than €50 million, is being developed by Euro Alliance, a consortium of two Bulgarian companies with Euro Alliance Tunnels as the main partner and Roads & Bridges Ltd responsible for building the corresponding roads and

bridges, for the state-owned company Koridori Srbije.

Longest in Serbia

At 1.8 km, Manajle will be the longest road tunnel in Serbia. It will be a twin tube project (one for each direction of

“We have been delayed by the geology which is more complex than we anticipated.

Stojan Petrovzski Euro Alliance General Project Manager.





traffic). Ten kilometres to the north is the Predejane tunnel which has the same design and construction team. One of the Predejane tubes will be 870 m long and the other 1 050 m.

The operation at both sites is continuous and based on two 12-hour shifts with a combined workforce of 170. According to Stojan Petrovski, General Project Manager for both tunnels, most of the engineers are from Bulgaria and about 90% of them are skilled. "It's difficult to find skilled workers here so we brought our own," he says. "They have a lot of experience of working on other similar projects."

Site preparations began in September 2013 and both projects are due for completion in March 2016.

Petrovski says: "So far we've developed about 40 percent of the tunnels but we have

been delayed by the geological conditions which are more complex than we first anticipated," says Petrovski.

As in Slovakia, the geology features pockets of good, competent rock as well as poor ground. "It's not even proper rock; it's pure clay," says Petrovski. This variability means that the project requires frequent changes of tunneling technology; drill and blast in competent rock and hydraulic hammers and excavators in the poorer sections.

The company uses the New Austrian Tunnelling Method (NATM) that provides optimized tunnel support behind the face.

Unpredictable advance rates

According to the original project study for Manjle and Predejane, the company was expecting to use drill and blast for most of the drive. "That would have been much faster

of course, but because of the geological conditions, we've been forced to work this way, making progress slower," says Petrovski.

Advance rates depend entirely on the geology. In good ground, it can be about three meters per shift. "We don't necessarily see this as a huge problem though," Petrovski says. "This is the situation and we just have to deal with it." Helping them deal with it is the equipment employed in each tunnel. Blasthole drilling in the good rock sections at both sites is carried out by Atlas Copco Boomer E2 and Boomer L2 drill rigs. "We have two units, one of each model at each tunnel. The Boomer E2 rigs are from Atlas Copco Rental and the L2 units are our own machines that we brought over from Bulgaria," explains Velin Mahov, Construction Manager for both projects.



Drillers Ruman Kamburov, Yulian Cholakov and Plamen Baldjiev at the Manjle tunnel face.



Above, the portal of the Manalje tunnel which at 1.8 km will be the longest in Serbia.

Right, Velin Mahov Construction Manager, Euro Alliance.

Far right, an Atlas Copco drill rig in the Predejane tunnel between shifts.



One of the rented rigs is a new unit featuring the RCS 5 computerized rig control system for positioning and high precision drilling. When it arrived, Atlas Copco specialists were on hand to train the operators on how to use it with maximum efficiency.

When working in the poorer rock Atlas Copco MB 1700 hydraulic breakers mounted on excavators are used. The company has three of these which were also brought from Bulgaria: "They've served us well in other projects so now we're using them here," says Mahov.

Pipe-roofing in weak zones

In the weaker zones, pipe roofing is used

for crown support. This gives less overbreak and ensures safety for the workers. Here, the Boomer drill rigs come in handy once again to drill the holes and install the pipes in an umbrella pattern. In addition, two Atlas Copco UnigROUT grouting units, one for each of the tunnels, are used for grouting the pipes.

In one shift, seven pipes, each 15 m long, are installed. "This is normal," says Mahov. "We just need two days to finish a whole pipe umbrella." Once the pipes have been installed, the company uses four Atlas Copco M400T pumps for injection grouting of self-drilling anchors.

Ventilation is provided by five different

fans, one of which is a new Atlas Copco Serpent AVH 125 which has a flow rate of 14–42 m³/second and 37–110 kW of nominal power.

All of the equipment is covered by a service agreement which stipulates the presence of an Atlas Copco service technician on site from Mondays to Fridays to monitor the machines, conduct preventive maintenance and replace parts. Atlas Copco has to respond to any issues within 24 hours.

Besides Serbia, Euro Alliance is active in tunnel construction projects in several countries at the same time including four in Germany, two in Spain and two in Bulgaria.

ŠARANI

On budget and on schedule



As one of the five tunnels currently being built on the 40.3 km section of the Ljig-Preljina road in Serbia, the Šarani tunnel is extraordinary. This section of Corridor 11 connects Serbia's northeastern border with Romania and its southwestern border with Montenegro on the Adriatic Sea.

In addition to the tunnels, it also involves the construction of 78 bridges. The five tunnels are Brdjani (length 455 m), Savnica (270 m) Veliki Kik (200 m), Ljig-Golubac (25 m) and Šarani, which at approximately 900 m is the longest.

"Two of the tunnels are being excavated using the cut-and-cover method while the other three, including Šarani, are classic tunnels," says Zoran Kovačević, Energoprojekt's Chief Engineer of Technical Operations & Construction.

Energoprojekt Niskograndna plc has been subcontracted to excavate the Šarani drive and is one of five Serbian companies working in a consortium alongside AzVirt, the Azerbaijan construction company, which is the main contractor for the civil works. The client is the state-owned Koridori Srbije (or Corridors of Serbia).

The project is financed by a €370 million loan from the government of Azerbaijan, of which €41 million has been allocated for the construction of the Šarani tunnel.

Šarani will be a twin-tube tunnel (883 m and 887 m). Construction began in March 2013 and is expected to be completed before year-end 2015.

"We are currently on budget and on schedule and expect to remain so until the end of the project, despite the fact that advance has been difficult due to the geological conditions," says Kovačević. Excavation of the second tube is expected to be completed by June after which they will start to prepare the tunnel for use, working on the concrete lining, road construction, electricity installations and more.

Kovačević explains that the geology here is difficult for any form of underground work as the ground is composed of Serbian Serpentine, a changeable type of rock that becomes soft on contact with water. "In practice it turns into mud," he says,

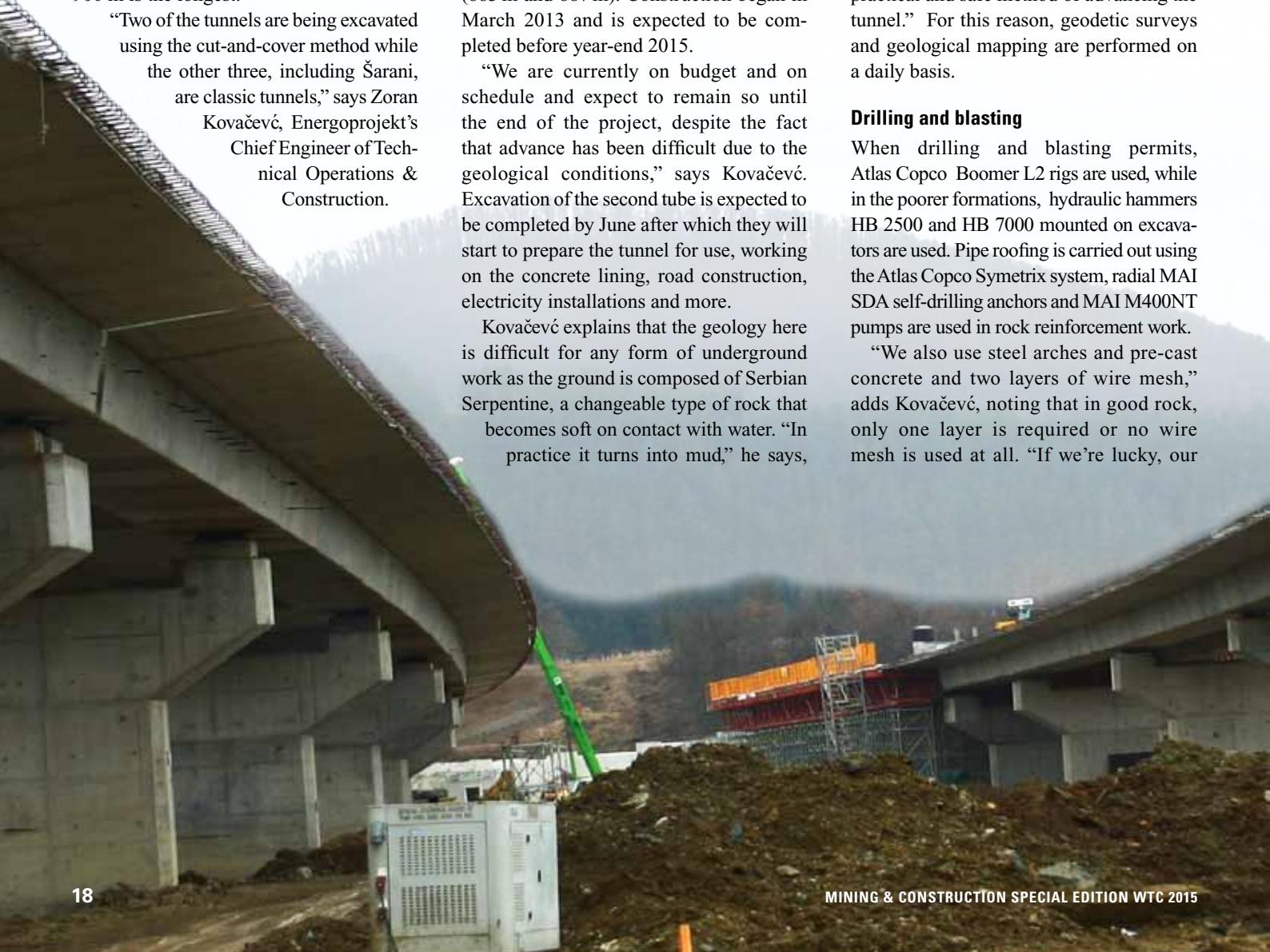
adding that the quality of the rock is not sufficient for the drill and blast technique all the time which would have made excavation much faster.

The fluctuation within the rock formation is naturally challenging. "From one area with relatively good rock where we use drill and blast, to an area with very soft rock where we have to employ other methods, it can easily change within 20, 50 or 100 meters," says Kovačević. "We simply don't know, so we have to continuously monitor the conditions to decide on the most practical and safe method of advancing the tunnel." For this reason, geodetic surveys and geological mapping are performed on a daily basis.

Drilling and blasting

When drilling and blasting permits, Atlas Copco Boomer L2 rigs are used, while in the poorer formations, hydraulic hammers HB 2500 and HB 7000 mounted on excavators are used. Pipe roofing is carried out using the Atlas Copco Symetrix system, radial MAI SDA self-drilling anchors and MAI M400NT pumps are used in rock reinforcement work.

"We also use steel arches and pre-cast concrete and two layers of wire mesh," adds Kovačević, noting that in good rock, only one layer is required or no wire mesh is used at all. "If we're lucky, our



“We have to monitor conditions continuously for safe and practical methods.

Zoran Kovačević Chief Engineer, Tec. Operations & Construction, Energoprojekt.



shotcrete only needs to be about 20 cm thick but often it can be over 30 cm,” he says, adding that this is proof of the poor quality of the ground.

Šarani also employs three Atlas Copco UnigROUT grouting platforms, two of which are UnigROUT Flex M E22. Ventilation in the tunnels is provided by a fan fitted with 1 400 m of Atlas Copco flexible ducting.

The work is non-stop, seven days a week and with two 12-hour shifts per day. “We have about 150 workers here with most of them divided into three crews, so we can have two crews working and one resting,” explains Dušan Dovatov, Chief Engineer of Technical Operations Maintenance, at Energoprojekt.

“For example, we could be drilling and blasting for several shifts and then the quality of the rock changes and we could be using the rigs for pipe roofing with the Symmetrix system. If it changes again, we could be drilling to install the Atlas Copco R32N and R32S self-drilling anchors.”

Due to this unpredictability, pipe roofing has had to be used for about 70 percent of the tunnel. The method reinforces the ground ahead of a tunnel face. A steel casing is installed in an umbrella pattern around the tunnel profile, forming a protective arch under which the tunnel can be advanced safely. The pattern consists of 144 mm diameter, 3 m long pipes for a wall thickness of 6.3 mm.

“Although we can’t always use the rigs for drill and blast when the rock is bad, the machines are still highly utilized and their productivity is good,” says Kovačević.

“This

is the first time I have encountered this type of rock and if I hadn’t seen it, I wouldn’t have believed it. It’s an interesting challenge but we are rising above it!”



The Atlas Copco hydraulic hammer breaking the “bad” rock.



One of the two Atlas Copco Boomer L2 drill rigs used for blasthole drilling.



Working in tough ground: Zoran Kovačević, and Dušan Dovatov of Energoprojekt.





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