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Special report: TBM transportation

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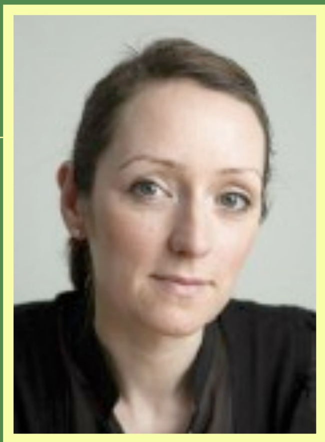
welcome



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TBM Logistics

From helicopters flying TBM segments to the Philippines to construction of a machine on the side of a mountain in China, the industry faces some incredible challenges when it comes to accessing the remote sites where major boring equipment is required. Planning the logistical journey to the project location can be more challenging than the bore itself, especially when unexpected events introduce added complications.

In this special report T&TI looks into the transportation challenges associated with getting TBMs to their customers and examines the key issues facing the project logistics sector today. Freight forwarding experts from firms such as the UK's Abnormal Load Services (ALS) and the Canadian office of German firm Rohde & Liesenfeld describe the market conditions and provide valuable advice on choosing logistics partners. TBM manufacturers such as The Robbins Company of the US, Italy's Seli and Germany's Herrenknecht describe interesting challenges overcome in getting to site. Ports such as the Port of Vancouver explain how their facilities are enabling the movement of major cargo.

As these organisations tell us, the challenges are many, especially as the global economic downturn puts increasing pressure on prices. Logistics companies are concerned about the growing trend to opt for lowest cost providers through online bidding processes known as reverse auctions. Freight forwarding companies warn that a side effect of basing awards purely on cost is a deterioration of quality standards. They complain that reverse auctions for freight eliminate all factors of ranking safety standards, methods of transport, certifications and licensing, instead relying purely on price to make their awards.

Providers using these processes argue that only firms meeting quality criteria are allowed to bid and therefore they are simply getting better value from their existing partners.

Reverse auctions are not particularly suited to the movement of complex oversized equipment. Logistics experts say that such a procurement tool is most appropriate for homogenised loads. In an industry where bespoke solutions are required for as many as half of all TBM orders and containerisation is not possible for many TBM components, the use of reverse auctions has to be questioned, especially as the size of machines continues to increase.

Bernadette Redfern

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contents

On the cover

The Port of Vancouver on the Columbia River in America's Pacific North West is creating a niche in the project cargo market by increasing it's heavy lift capacity (see p17-18).

ZOOMLION

Zoomlion Mobile Cranes

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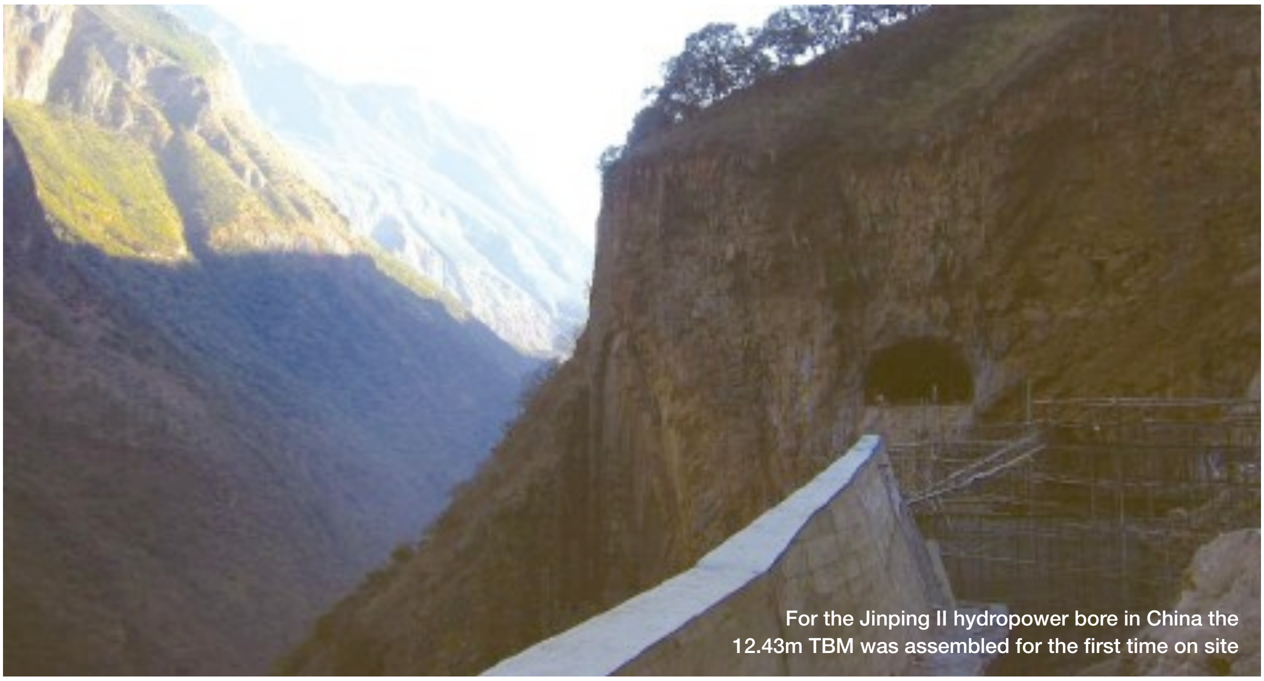
Final destination

The challenges in getting TBMs to site can be just as difficult as the bore they are intended to undertake and good planning makes all the difference



For the Jinping II hydropower bore in China the 12.43m TBM was assembled for the first time on site

For both manufacturers of tunnelling equipment and the buyers receiving it, transportation of TBMs can be one of the most challenging aspects of a project. Navigating enormous pieces of equipment through narrow mountainous roads, over bridges of limited capacity and over water courses of variable depth can present logistics experts with a range of scenarios.

Most eventualities can be planned for but the potential also exists for completely unexpected events. Firms contacted by T&T International cited earthquakes, snowstorms and an absence of rainfall leaving river beds dry, as examples of nightmare scenarios encountered on the route to site. For example, on the 13km long Umiray Angat acqueduct tunnel in Philippines, a lake that the machine was due to be transported over by barge became dry when the rainy season was shorter than expected. Parts of the Robbins TBM, the Seli back-up, rolling stock (along with all materials such as cement, fuel, spares and consumables) had to be transported by helicopter to the site. "For the heavier transports of the equipment components, special 10 ton lifting capacity helicopters had to fly from Malaysia to the Philippines," says Seli President Remo Grandori.

Grandori also gives other challenging transportation examples such as the Beles Headrace (12km) and Tailrace tunnel (7km) in Ethiopia. "The two Seli 8m shielded TBMs and all auxiliary equipment had to be transported to site along a very narrow and difficult Ethiopian road crossing the Blue Nile over a limited capacity bridge. Heavier components had to be transported along an alternative, longer route."

In China, Robbins had to ensure that its 12.43m mixed shield TBM arrived at the site of the Jinping II hydropower project before the low water season began in November. The early arrival meant that the machine was assembled for the first time on site in a 20m by 26m assembly chamber (see feature page 8).

Aware of the criticality of the arrival of TBMs to project schedules, manufacturers are doing their upmost to ensure their machines can be transported efficiently. "Seli designs by default all its TBMs and back-up system in a way that all components can be containerised except for a few major components on the larger

"SELI designs by default all its TBMs and back up systems in a way that all components can be containerised."

Remo Grandori, *SELI President*

TBMs, but these anyhow are designed to cope with the limitation imposed by the access road/rails to the site," says Grandori.

This can make a big difference to the cost of shipping. Moving stackable containers is much more cost effective than large bespoke TBM components, especially if ports don't not have heavy lift cranes on shore. "In the absence of shore cranes we can deploy one of our heavy lift vessels with a crane capacity of 500t. This is all reflected in the price," explains Peter Schauer, CEO of Orion Shipping. The firm specialises in the global movement of large scale equipment and machinery

"The ship required will depend on the point of origin. Ports like Baltimore and Houston have sufficient shore or floating cranes so our loading equipment is not required. In some African and Asian destinations we have to offload from the ships."

Such measures, together with careful planning by logistics and shipping firms, means that most deliveries go smoothly, however, a large proportion of schemes require extra planning to ensure logistical challenges are overcome. Seli estimate that a third of TBM deliveries require special attention due the the remote nature of the site or other logistical issues.

Another area of attention for firms is the need to access TBMs inside the tunnel for the repair or substitution of major components like main bearing and ring gear. "In the Gibe II tunnel project in Ethiopia, SELI had to rescue a TBM buried by a 40 bar mud flow, dismount it in the tunnel and transport all components for repair at the outside portal, transport the repaired component again into the tunnel where the entire TBM was reassembled and could start again to excavate," explains Grandori. "All this operation in a remote area of the planet where the delivery time of a component was ranging from three to six months."

Another pressure for the logistics industry is the increasing size of TBMs which frequently need to arrive at congested urban locations. "Until few years ago the max TBM diameter was in the region of 12 meters but in recent years, larger TBMs up to 15.5m have been built (especially for road tunnel applications) and even larger TBMs up to 17m will be built in the future," says Grandori. "Normally these large TBMs are to be utilized in urban areas, where the limitations in transports can be very severe due to the existing city road system, that very rarely can be modified or upgraded."

The biggest award to date was made in July with Herrenknecht supplying a 15.5m machine to the Bologna road extension in Italy. The machine is likely to be delivered from the Herrenknecht headquarters in Schwanau located in Southern Germany, not far from the River Rhine. "So a lot of transportation starts with truck to the port of Kehl and then via ship on the River Rhine to another river or canal or to the port of Rotterdam," says a Herrenknecht spokesperson.

At the same time the logistics market in general is facing economic challenges. "The market itself is either feast or famine," says Schauer. "There were times when heavy lift vessels have not been obtainable and buyers had to wait six months for them to be free. Right now there are a number of ships available. There seems to be no rhyme or reason to it. Ship owners are always seeking new opportunities - there is no crystal ball," he says.

Shipping firms say that as a result of this uncertainty, prices are fluctuating wildly. Aware of the increasing competition among freight forwarders and shipping firms, manufacturers are driving harder bargains with transport companies. Buyers must beware when putting cost at the top of the decision making triangle as experienced firms warn that safety and quality can be the casualties of cost cutting.

The shipping perspective

Nickolay Sokolov, *CISN Navigation*

CIS Navigation manages two trans Atlantic liner services, Canada States Africa Line (CSAL) and Atlantic Ro-Ro Carriers (ARRC).

From our perspective, the key factor, when considering moving a heavy and an oversized load, is making sure that both ends are able to handle the cargo. It is imperative that all parties do their homework, and that lifting and receiving abilities are checked at both the loading and the discharging ports.

Another key issue is ensuring that the packing list provided by the shipper is accurate and it shows the correct weights and dimensions. We have had a situation when we were moving some heavy units from a North American port to Africa. We were successfully able to load the cargo onboard our vessel using the shore cranes at the port. However, when the vessel arrived at the destination port, we learned that the cargo was actually heavier than declared and as a result the receiving terminal was not able to receive the cargo. Alternatives had to be quickly looked for and resulted in major additional expenses which were not budgeted for. In the worst case scenario any carrier would have taken the cargo to another port where it could be discharged and the shipper would have suffered heavier costs.

Most projects are long term and even with the economic downturn they were still executed but the downturn has made the shipping market very competitive. Due to general shortage of cargo and a surplus of empty vessels looking for business, the freight rates fell abruptly. Today most competition is primarily based on price, but the cheapest ocean freight might not always bring the savings it promises. Experience and expertise in handling project cargo is extremely important when deciding on the performing transport group. Their history and completed jobs portfolio must be studied prior to making the decision.

In general, transshipment options should be avoided where possible. Just like when choosing the air fare, any passenger tries to avoid connecting flights simply because it is inconvenient. It is long - that is if you catch your connecting flight, otherwise it is extremely long - and finally it is simply scary. Who likes take off and landing? Similarly in ocean transport, the shippers should try to avoid many trans-shipments as they open room for potential cargo damage during re-handling, potential delays etc.

Shippers should generally look for a transport group which will provide direct, reliable and on-time service. That is exactly our motto at CISN.

"There were times when heavy lift vessels have not been obtainable and buyers had to wait six months for them to be free. Right now there are a number of ships available."

Remo Grandori, *SELI President*

Robbin's Chinese challenge

Transportation of a 12.43m diameter TBM to the Jinping II hydropower project in China challenged Robbins to assemble a TBM on the side of a mountain

The Jinping-II hydroelectric project, located in the remote mountains of Sichuan Province, involves construction of what is to become one of China's largest underground power stations. The Jinping-II site is unique in that it will utilize a natural 180 degree bend in the Yalong River (a tributary of the Yangtze) to generate 4800 MW of hydropower every year.

On September 18, 2008, a 12.43m Robbins Main Beam TBM was launched on one of four 16.7 km long sections of headrace tunnel after a unique onsite assembly process. The equipment was initially assembled and tested at the site, rather than in a manufacturing facility, utilizing a method called Onsite First Time Assembly (OFTA). The hydroelectric project features four parallel headrace tunnels, two of which are being excavated by TBMs and two by drill and blast. A nearby fifth tunnel is being excavated by a 7.2 m TBM to draw down ground water in advance of headrace tunnel excavation. Both machines are still excavating the tunnels today.

Onsite First Time Assembly (OFTA) was selected for the 12.4 m TBM due to a requirement for fast track project scheduling and a limited seasonal window for delivery to site by river. The OFTA process, developed by the Robbins Company, allows machines to be assembled at the jobsite without need of pre-assembly in a manufacturing facility.

Above: **Components for the TBM were shipped via barge during the rainy season in order to avoid drought conditions in the Yalong river.**

The process was first utilized in 2006 on the 14.4m diameter TBM at the Niagara Tunnel Project—the world's largest hard rock TBM. OFTA has since been used on several projects around the world, resulting in reduced TBM startup schedules and cost savings due to decreased shipping costs and man hours.

Key components of a successful OFTA programme:

Quality control of component manufacture to ensure proper fit up at site

Absolute control of the total system bill-of-materials, to ensure that everything required for the system is sent to the job site

Logistical planning and control, to ensure that everything arrives at the job site in the order that it is required for efficient assembly and use of storage space

Resources planning, to ensure that all tools and personnel of every type and quantity required for assembly are on site when required

Advance alternative recovery planning, in order to be ready to react quickly to possible failures in any of the above steps

OFTA was identified as essential for the Jinping project because it would enable early shipment of large components of the TBM. Rapid shipment of the large components was needed in order for them to be moved via barge on the Yangtze River before the low water season between November and April. The area sees vastly different seasonal rainfall, with the May to October rainy season accounting for as much as 95 per cent of annual rainfall. It was therefore critical that the machine arrived before the rain stopped. “We were planning to ship the large TBM components to Sichuan province by barge on the Yangtze River from Dalian. The river has a low water season so we had to plan our shipments to avoid that period because the barges cannot travel in low water,” explains project manager for the scheme Steve Smading, who is now Robbins Cutter Department product manager.

All of the heavy structural parts of the TBM were manufactured in a facility located in Dalian in Northeast China. Under the original site assembly plan, pre-assembly of some TBM components should have begun on site in late November 2007. That assembly schedule required that all of the parts arrive at the Le Shan dock near the city of Chengdu on the Yangtze River in early November 2007 before the low water season started.

However, by the end of the summer of 2007 the original assembly schedule was delayed because the site was not ready to receive the equipment. Additionally, the Yangtze River experienced unusually heavy flows that year. For these reasons the decision was taken to partially assemble some critical parts in the Dalian factory before shipping. The main bearing, gear, and pinions were installed in the cutterhead support so the ring gear – pinion mesh could be verified. Later, the muck chute, side supports, roof support and front support were attached. The remaining components were assembled for the first time on site.

At the end of 2007, all of the heavy structures were loaded on a barge, shipped up the river and placed in a storage yard near Chengdu until the job site was ready to receive them. Though all of the structural components of the TBM and backup were manufactured in China, sub-systems such as hydraulic, lubrication, water, electrical, and ventilation were manufactured and tested in facilities in the USA or Europe before being shipped to the site.

Much of the challenge of the assembly was a result of the remote location. Once at the site, the 12.4m machine was erected in an underground assembly chamber measuring 20m wide x 26m high. Limited space required that many of the smaller TBM components, the parts imported from outside China, and all of the back-up structures be staged about 90 km away in the town of Manshuiwan, where warehouse space and a large outdoor yard were provided by Ertan.

Below, top: Sub-assembly of critical components for the Robbins TBM was done in manufacturing facilities prior to shipment to the jobsite
Below, bottom: The 12.43m machine was assembled in a chamber using Onsite First Time Assembly (OFTA)

Above: **Components such as the main bearing and seal assembly were shipped via barge on the Yangtze River**

Every morning a coordination meeting was convened to plan which parts should be sent to the site for the next day. "We planned daily shipments. The site manager would send a list of required parts to our people in the staging area who would identify the needed parts and get them loaded onto trucks. Trucks would arrive at the jobsite every afternoon with the parts needed for the next day's scheduled assembly work," says Smading.

Because of the remote location and because the TBM had not been previously assembled, it was necessary to equip several shipping containers as workshops. A hydraulic workshop was set up with the hose ends and adapter fittings needed, as well as a high production hose crimping machine. Similarly, an electrical container, a tool container, a workshop container and an office container were mobilized in the assembly chamber.

Assembly of the TBM and back-up system began in July 2008 and finished on September 17, a schedule comparable to that for site assembly of a large diameter TBM which has been pre-assembled in the factory. Crews then walked the TBM and the first three back-up gantries 200 m forward from the assembly chamber to a launch chamber. The vacated assembly chamber was then used to erect the conveyor system and six more back-up gantries.

The Jinping experience proved that OFTA is a useful method of assembly, particularly for large diameter TBMs. Depending on the size and complexity of the tunneling machine being produced, and whether the machine is new or refurbished, the savings in both schedule and cost can be substantial. On a small, 3.0 meter simple machine the savings in schedule can be as little as a month or so and perhaps 5,000 man-hours and $100,000 in transport cost. On a complex 10m or larger machine the savings in schedule can be as much as several months. Eliminating the transport to factory for preassembly of such large machines can reduce transport costs by more than a $1m.

However, the reduced costs noted here are generally dwarfed by the large commercial gain inherent in delivering a major tunneling project on a shorter schedule.

The assembly sequence itself was not 100% error free but it proved that corrections can be made onsite as quickly as in a factory, even on a job site as remote as this. Early in the assembly it was discovered that the bushings in the gripper carrier ways had not been finished machined in the factory. Shipping the part to a Chengdu factory, the nearest large city, was not possible due to the heavy damage to local roads and machine tools, caused by the severe Sichuan province earthquake in May 2008. A machining contractor in Shanghai was therefore employed to bring a portable boring unit to the job site and make corrections to the part. The part was line bored onsite in only three days.

The OFTA process also required intense training for the site workers, to ensure the quality of the final product. Robbins had as many as 16 supervisory personnel from the USA and Europe and 26 engineers, mechanics, and electricians from Robbins (China) Underground Equipment Co. at the peak of the assembly effort. Despite these challenges, which included record snowstorms as well as the magnitude eight earthquake that hit Sichuan province, the TBM was successfully assembled and launched in only three months.

Left: **The 12.43 m Robbins TBM was launched in September 2008, following an onsite assembly that took just three months**

A Manila thriller

When a lake in the Philippines dried out project contractor Seli developed an innovative way to get the remaining tunnelling equipment to site

Left: The 4.8m TBM during assembly at the project site

The plan devised for getting the 4.88m double shield Robbins TBM with Seli back up and rolling stock out to the site of the 13km Umiray Angat aqueduct in the Philippines was quite straightforward. "The TBM, back-up and all auxiliary equipments were supposed to be dismounted in relatively large components and transported by barge," explains SELI President Remo Grandori.

Unfortunately things did not go according to the original plan. The dry season extended for much longer than was usual or anticipated and the lake over which equipment would be moved dried out, so the team had to come up with an alternative plan for transportation.

The TBM and back-up systems were to be taken to a project on the site of the Umiray Angat water system. The network of aqueducts and reservoirs is the main water resource for the Philippine capital of Manila. Water is moved through the Umiray Tunnel into two reservoirs, the Umiray and the Angat, before being transported via a series of tunnels, basins and aqueducts to two water treatment works. The network has undergone a number of improvements over the past 20 years in an effort to improve efficiency, prevent leakage and maintain supplies into Manila. The client was Manila's Metropolitan Waterworks and Sewerage System (MWSS).

MWSS contracted Italy's Seli to bore a 13km diversion tunnel which would take water to a mini-hydroelectric power station. The finished bore would be 4.3m internal diameter precast segmental lining of 200mm thickness. The geology of the ground was Young (Late Eocene) volcanic sequence composed of 50-120 Mpa agglomerates, basalts and tuffs with inter-layered sedimentary rocks including limestone close to the Umiray Portal area where overburden was low. The tunnel was excavated from a single portal.

However before the work could begin, the TBM, equipment and materials had to reach the site. "The lake dried up before the transport of the equipment along the lake was completed. Helicopters were the only option to transport the residual components of the TBM," says Grandori. This included the back-up equipment, rolling stock, spare parts for excavation, and materials such as cement, fuel, steel and other consumables. "For the heavier components special 10 ton lifting capacity helicopters had to fly from Malaysia," he says.

In fact a combination of 10t capacity helicopter with three 1t capacity helicopters, were used to move the equipment and materials. The smaller aircraft were used throughout the 24 month project period to continue to bring materials to site. "The transport with helicopters lasted almost two years, i.e. the time that was necessary to bore the tunnel," says Grandori.

The project was completed in February 2000 and despite the disruption caused by the weather, Seli and the team delivered successfully.

Q&A

Remo Grandori, *SELI President*

Tell us about the TBM that was used in the Umiray Angat tunnel?

The TBM was a Robbins 4.88 m Double Shield TBM complete with SELI back-up and rolling stock. SELI was the contractor for the project

What was the original logistics plan?

The TBM, back-up and all auxiliary equipments were supposed to be dismounted in relatively large components and transported by barge.

When the lake dried out were helicopters the only option or did you have other choices?

The helicopters were the only option to transport the residual components of the TBM; residual components of the back-up and of the rolling stock, as well to transport all materials and spares for the tunnel excavation and lining.

Where did you get the helicopters from?

From Malaysia the 10 ton capacity helicopter that was used in the initial phase to transport the residual equipment and three 1 ton capacity helicopters to transport the materials throughout the 2 years of tunnel excavation.

What did using helicopters mean for the TBM? Did you have to break it down into smaller pieces?

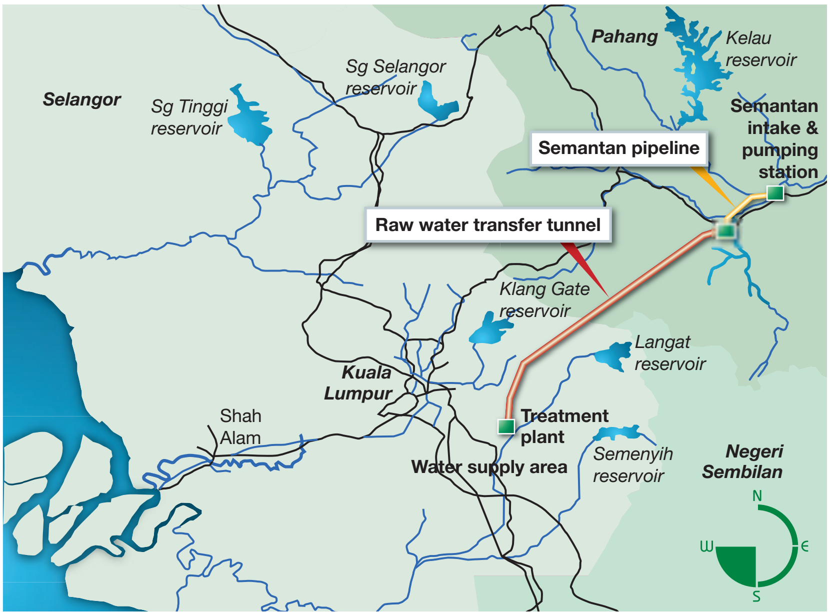
The main components of the TBMs were already transported to site when the lake dried up. The remaining components of the TBM, the back-up decks and the locomotors were dismounted in pieces not exceeding the helicopter capacity

What would you say the key lessons were from this experience?

We understood and proved to ourselves that is possible to serve a TBM site for two years with a transport maximum weight capacity of 1 ton.

Multiple machines for Malaysia

Bridge capacity constraints and speedy assembly requirements have dictated the transportation strategy for three 5.2m TBMs



Simultaneous delivery of TBMs, some of the most complex machines in the construction industry, is no easy task. In Malaysia construction of the Pahang-Selangor raw water tunnels is necessitating the delivery of three 5.2m Robbins Main Beam machines within a tight delivery window. To achieve this the first two machines have been been built at a workshop in Shanghai from components manufactured in the U.S. and China. The third machine was built at the nearby Jui Ba facility.

Each machine has now been assembled and the next step is transportation of the TBM and continuous conveyor system from Shanghai to Port Kelang in Malaysia. Once at the port, the components are trucked over 50km east to the jobsite. The first TBM is now onsite and the second is on its way.

"One of the most difficult processes is finding a single shop that can manage the volume of fabrications and machining. The delivery times for the

Far left: **The Pahang Selangor Tunnel, Malaysia's largest infrastructure project, required the simultaneous assembly of three 5.2m TBMs in Shanghai and required the support of local firm Jui Ba**
Left: **Assembly of the first of the TBMs was completed in early July 2010.**

Malaysian TBMs are one month apart, which means that at one point you are disassembling and shipping the first machine, testing the second machine and starting assembly of the third machine," explains Mike Kolenich, manager of projects for Robbins. On average, each TBM requires a skilled crew of 20-30 fabricators, welders and technicians, but shorter delivery schedules can require up to 60 people in two shifts. "We have an experienced group in China that has been building machines for many years," he adds.

Assembly of TBM number 3, the first machine to be built, was completed in early July 2010. This began with core components, including the main bearing and back-up structures and finished with installation of the electrical and hydraulics systems, as well as outer components including cutterhead pieces and ground support. "We perform all of the same quality inspections in our shops, regardless of location," adds Kolenich. "At the end of assembly there is a two to three week no-load testing period to ensure that each machine is set up and functioning properly per the contractual and engineering requirements."

The entire logistics strategy was the result of a series of planning sessions between Robbins and the contracting joint venture of Japan's Shimizu Nishimatsu with Malaysian firms UEMB and IJM. Constraints such as the weight limit of bridges (55t) leading to the site were a key part of the discussions and as a result the heaviest load did not exceed 53t. "The assemblies were shipped with consideration of both the road capacity near the jobsites in Malaysia and to expedite the assembly at the jobsite," says Kolenich. "We shipped each of the 20 rolling deck structures and ramps assembled. We disassembled any critical component and packed them inside containers. Any additional structure was packaged as a kit within the decks. The major structures of the machine were shipped in large assemblies that allowed for handling and quick installation at the site."

In total the team took just four weeks to disassemble the first TBM and get it packed and delivered to Shanghai Port. "The greatest challenge to the shipping was making sure everything arrived at our shop in Shanghai per the schedule. We had to consolidate loads and constantly plan around late deliveries from suppliers," says Kolenich.

Once the shipments arrive in Malaysia the TBM and backup system are transported by road to the job site requiring 52 truckloads of cargo consisting of 35 breakbulk and 17 containers. Each conveyor system with 5km of belt and structure required 31 container loads. For all three machines and three conveyors the rough estimate will be 249 truck loads. "The challenge in Malaysia [for the first TBM] was getting all of the trucks to the jobsite, unloading and sending them back to ship in the allotted time," says Kolenich.

Despite an earlier delay when some shipments from Europe were detained in Chinese customs for 6 weeks rather than the two weeks expected, the first TBM still arrived at the Langat Ceria jobsite in Pahang 1.5 months earlier than planned. The second machine is now on its way and the project is on track to begin launching the first of the three machines in December with the second and third being launched by March 2011.

Malaysia's longest water tunnel

Running along 44.6km with 35km of this as a TBM bore, the Pahang to Selangor raw water transfer project is Malaysia's longest water tunnel. The purpose of the scheme is to collect water from the Semantan River and move it by gravity along to a water treatment plant in Kuala Lumpur. This area is at the heart of Malaysia's economic and industrial development but demand for water has grown with the regional economy and existing resources are not expected to meet future demand. In contrast neighbouring Pahang state to the east possesses ample resources as three major rivers (the Bentong, Telemong and Kelau) run through it, making a transfer scheme the most appropriate option to serve the growing city.

According to the client, Malaysia's Ministry of Energy, Green Technology and Water, the bedrock along the tunnel consists of metamorphosed rocks of the Karak Formation for the initial 3.5km from the inlet and the remaining bore will be in granites. The upper and lower ends of the tunnel will be dug using NATM. The inlet and outlet conduits are designed as cut-and-cover type culverts of horseshoe shape with vertical walls. They will be 4.0m in width and 4.7m in height.

The inlet connecting basin is located on the hill about 300m from the Karak-Telemong road and the outlet conduit ends about 3.5 km north of the existing Langat treatment plant. The tunnel route passes through the main central mountain range which typically has elevations exceeding 1,200m. The tunnel itself has a longitudinal slope of 1/1,900 and a design discharge of 27.6m^3/s.

The 4.8m diameter TBM cutter head was split into three segments of 104t

Beefing up for bulk

By increasing its heavy lift capacity, the Port of Vancouver is creating a niche for itself in the project cargo market

Nestled on the Columbia River, the Port of Vancouver is a logistical load centre for the Pacific Northwest. Thanks to an $8m investment in new heavy lift cranes it is one of the few ports in the area that specialises in bulk, break bulk and project cargo. "We purchased 140 metric tonne Liebherr 500f crane in September 2006. This was so successful that in 2009 we purchased a second," says Alastair Smith, senior director of marketing and operations at Port of Vancouver USA. Acquired from Germany the first crane cost $3.4M in 2006, but exchange rate fluctuations meant that the same equipment cost $4.6M three years later in 2009.

By making this investment, Port of Vancouver has seen major growth in the volume of large cargo such as wind turbine components that are traded through the port. "It was a strategic decision made back in 2006 when we recognised that no one else had the ability to do heavy lifting onshore. It gave us a niche and has created a tremendous amount of new business," says Smith.

Used in tandem the cranes can lift a minimum of 210 tonnes but with additional software this can be extended to 280t. However the single configuration of 140t was adequate for the movement of a 7.6m TBM needed in Portland Oregon. The availability of the new crane made the Port a logical choice for Norway's Star Shipping (which has since become Grieg Star Shipping). The firm has a long term agreement with the port and had been contracted to bring in a Herrenknecht 7.6m TBM to the US. The $12m machine is currently being used in the construction of a new 9.5km sewer tunnel and has been named Rosie – in keeping with Portland's historic reputation as the City of Roses. To date it has completed over 2.1km of its bore and according to client The City of Portland, is expected to complete construction at the end of 2010.

"It was really pretty simple. The main piece had been split into three sections - each approximately 104 tonnes," says Smith. "Lifting points had already been identified and we attached the high strength wires to these and lifted it into a specialised truck. The segments never touched the ground," he says. The remaining components were packed in specially fabricated shipping crates custom built to suit the machinery. The segments and crates were then moved by road to the construction site in Portland approximately 10km away.

With heavy lift facilities having added so much to the Port, why have others not followed suit? The answer lies in West Coast jurisdictional disputes over the operation of the machines. The nature of the unionised industry has led to

Above: **The new Liebherr heavy lift cranes have a 140t capacity**

protectionist action from organisations representing local Longshoremen. Objections are raised to the operation of equipment such as heavy lift cranes by trained operatives from outside the union and local area. Unfortunately insurers may insist that only trained professionals can utilise the equipment and these are not local staff, leading to a catch 22. "To overcome this we have provided a full training programme for the Longshoremen for each of the cranes," says Smith.

With the labour issues resolved the port has been able to capitalise on its new facilities, which can mean big savings for TBM manufacturers. Without heavy lift cranes on shore, buyers and manufacturers must turn to heavy lift vessels for the movement of freight and this means chartering ships at a significant cost. "Rather than paying for a whole vessel the customer is just paying for the space it requires," says Smith.

For most ports the requirement to move TBMs is infrequent and Port of Vancouver is no exception. Much of its heavy lift is related to the wind energy sector as the US builds up its renewable generation capacity at an impressive rate. According to the US Department of Energy installed capacity at the end of 2009 stood at 34,863MW. Capacity at the end of 2006 was just 16,907MW.

"The heaviest components are the nacelles (generators) which can weigh up to 92 metric tonnes. The tower sections which in total might weight 180 metric tonnes, are lifted in three or four pieces, the heaviest being about 68 metric tonnes," says Smith.

In terms of onward movement the port has a range of options from barge to road and rail.

"We are in the process of a major rail expansion which will see capacity increase from 55,000 to 160,000 cars. We have completed the first three phases of this and it is due for completion in 2017," says Smith. A number of rail companies serve the port including Canada National, Canada Pacific, Union Pacific and Burlington Northern Santa Fe Railway (BNSF). Smith says that the project schedule could be accelerated if a major customer chose to locate at the port and would contribute regular rail freight. "For example we have just been nominated by the world's largest mining company BHP Billiton as they are in the process of erecting a potash facility at the port. Our current timetable fits in with their plans so in this case there is no need to advance the programme," says Smith.

Successful capacity enhancements and facility investments are intended to attract more businesses to the port area and increase the economic contribution of the port to the State of Washington. "We have invested in increasing our capabilities and we are now a premier port for project cargo," says Smith, ensuring a bright future for heavy lift in Washington.

About the port

The Port of Vancouver was established almost 100 years ago in 1912 to ensure public ownership of the trade docks on the Columbia River. Its location on the Columbia/Snake River system makes it a natural transportation hub for cargo to and from the Pacific Rim. The ports key trading partners are Japan, Australia and China although it trades with most other parts of the world including Europe and South America.

A multitude of transport options connect in to the Port of Vancouver. Onshore national highways running both north-south and east-west are adjacent to the port, along with rail services from four major train lines running into Canada and down to Mexico as well as east to Chicago. The $137M West Vancouver Access Project should see rail capacity almost triple by 2017.

Approximately five million tonnes of cargo is moved through the port in an average year by an average of 500 ocean vessels and river barges. The port itself runs along 6.4km of shoreline housing five marine terminals and 13 shipping berths. It has a channel depth of 13.1m. Terminal five houses the port's unit rail facility for handling of bulk, break bulk, wind energy and project cargo commodities by rail into and out of the port.

In terms of employment 2,300 people work at the port with 94 staff directly employed, and the remainder working in businesses located within the port complex. Activities from the port are estimated to create 15,500 jobs per annum in the local area. Economic benefits to the state are estimated at $1.6bn per annum.

Top imports in 2009 were steel, cars, wind turbines and pulp. Top exports were wheat, scrap steel, bulk minerals and pulp.

Below: **Port senior director of marketing and operations Alastair Smith says investing in heavy lift has created a niche for the port**

Buyer beware

Jan Beringer of freight forwarding experts Rohde & Liesenfeld argues that price should not be the main criteria when it comes to choosing your TBM delivery partners.

Increasingly in today's global shipping market, involving the movement of tunnel boring machines, price is replacing expertise and experience in the freight decision making process of manufacturer's and buyers. Tunnel boring machines are heavy and over-dimensional cargo components that are released for shipment after a long lead time of manufacturing. Why would manufacturers take any risk in the shipping of these components for a marginal saving in freight costs?

Within the market a low cost trend is emerging for freight contracting. Some firms only award shipping based on lowest cost and that eliminates all variables of ranking shipping methods by risk evaluation, reviewing engineered load drawings, evaluating methodology and looking at past experience. If you are not lowest bidder, you are not going to get the contract.

So what should buyers and manufacturers be looking for when contracting freight intermediaries like project freight forwarders to arrange for the shipment of their tunnel boring machines?

The first question that should be asked is has a packing list been prepared by the manufacturer to reflect the weights and shipping dimensions of the broken down machine and has this packing list been reviewed by numerous decision makers in the manufacturing plant to ensure that the weights and dimensions are realistic?

A shipping plan is only as good as the information that is used to prepare it. Too often, major problems occur at the time of dismantling and shipping out of a tunnel boring machine, because weights or sizes of individual components have increased. This normally means that road permits that have been applied and trailer configurations with axle groupings that have been delivered to the plant for loading, all have to be cancelled and the whole process has to be started from

Above: Jan Beringer

scratch. Would it not have been better to err on the side of having placed a realistic weight on the packing list? At this point, the finger is always pointed at the trucking company to find a solution to the problem and inevitably no one ends up happy with a delay in loading out a tunnel boring machine.

Other key questions to ask surround the lifting strategies. It is important that shipping drawings have been prepared by the manufacturer showing the side and end view of major components, as well as the centre of gravity and lifting points. The freight forwarder should prepare engineered drawings of the heaviest and largest components of the tunnel boring machine, loaded on trucks and/or rail car configurations, and these should be available to be reviewed as part of the review of the bid process for freight. Dimensional clearances should also be obtained by the freight forwarder for the proposed rail movements and lifting studies should be prepared for loading at all transfer points.

It should also be ensured that the proposed movement of the tunnel boring machine is based on the use of qualified, licensed and insured trucking companies and riggers.

When it comes to shipping, customers need to ask if ocean shipping arrangements are based on use of scheduled ocean liner vessel departures or is a charter vessel booking involved? If the proposed shipment is based on a charter vessel, what contingencies are in place if the charter vessel is late or cancelled or the tunnel boring machine is late in delivery and cannot make the proposed loading date at the port? Lowest cost, based on a charter vessel, can represent huge unexpected cost impacts and delays to a tunnel boring project if all parties are not clear about a contingency plan.

Another key issue is where are the tunnel boring machine components going to be stowed in the ocean vessel, under-deck, on-deck or both? Ideally, manufacturers and buyers should have a clear understanding (up front) of how their cargo is going to be loaded. They must also check whether the shipping price includes supervision at loading at the manufacturing plant, at transfer points, at load port and at discharge port? In the event of damage will there be independent survey reports available for insured interests?

In assessing bids the buyer/manufacturer should ask if the bidder is able to provide three references of successfully executed tunnel boring machine transports to/from overseas destinations. It is also important to know whether the bidder has experience in both the country of origin and country of destination. Too often, lack of experience at either end can cause serious delays and cost overruns to a project.

If components are going to be loaded into containers, does the loading party have the capability and experience to load and secure the equipment into containers. What evidence is there that the equipment will be secured to seaworthy standards, or that the container will not be overloaded to a point of imbalance. The liability attached to a container moving on public roads, railways, waterways, ports and ships is enormous if cargos are not loaded properly. A proper stowage plan and loading plan for all containers should be reviewed in advance of releasing any container shipments. The container also has to be properly handled. Placing screws or bolts into the floor of a container or welding to the inside of a container will represent damage.

Covering all of these points in the bidding process for freight is important and often the lowest bidder cannot provide for all of these points, since expertise, documentation, engineered load drawings, supervision and written logistics plans cost money to produce. Money that is well spent if the on-time and reliable delivery of a tunnel boring machine is the required end result.

Emerging trend: reverse auctions

Another cost saving trend that is emerging in the heavy-lift shipping sector is the process of online bidding – known as a "Reverse Auction" for the contracting of freight. This process has only one objective, to use the reverse auction process to allow for bidders to compete against one another by lowering their freight bids on heavy-lift cargo movements through a web based portal. This process could mean that proven carriers with properly maintained equipment and safety records lose out to low-cost operators.

Manufacturers of heavy equipment, including the tunnel boring sector, have a responsibility of implementing safety and quality standards beyond the time that shipments leave their manufacturing locations until such time that they have safely been delivered to their end locations. A reverse auction for freight eliminates all factors of ranking safety standards, methods of transport, certifications and licensing to a factor of strictly price. This could be seen as a worse case example, a completely inexperienced transport intermediary directing the movement of trucks carrying heavy-lift cargos through road systems, port facilities and onto ships with only one objective, lowest price. Will this lead to trucks being loaded and transporting heavy-lift cargos without proper permits in place, with a disregard to the condition of equipment being used and without the necessary pre-planning and documented processes in place to ensure safe handling?

The importance of cargo markings showing where to lift cargos, identifying centers of gravity, specifying crane or forklift handling, protecting machined surfaces, and planning in advance how to secure heavy-lift cargos are well understood by experienced intermediaries. The price of freight is not just what it costs to pay trucking companies, port facilities and ocean carriers. It is the cost of man hours, processes and supervision to ensure that heavy lift cargos are given the attention that is required to move them safely. Heavy lift cargos cannot be left to move through the supply chain like a courier shipment. Manufacturers and buyers of heavy lift cargos need to think carefully about the risks of using lowest bidder and reverse auctions for contracting freight to ensure that the end result "to safely deliver their equipment to the end location" is not compromised.

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The continuous improvement in the quality and safety capacity of our machine fleet aims to provide our customers with the best possible service.

Ask the expert

The UK's Abnormal Load Services general manager commercial and projects Roger Gibbs talks to T&TI about the project market

In terms of TBM and tunnelling project equipment movement, how active do you expect the markets that you serve to be over the coming 12-24 months and how does this compare to the general project freight market?

We anticipate an increase in TBM and tunnelling project equipment delivery opportunities over the next 12-24 months as numerous contracts are scheduled to move forward. In the Uk these include Thames Tideway, Crossrail and National Grid. New opportunities emerging internationally include Russia, Asia and South America. ALS has already demonstrated its capability to handle TBM deliveries on a global basis.

What trends are you noticing in terms of movement requirements?

TBM diameters are increasing but design advances enable shipment in knocked down (KD) format. There is often a trade-off between the additional cost and time required to dismantle/reassemble the TBM, and the increased freight and handling costs for larger and heavier components. Delivery of larger and heavier components can sometimes be restricted or prevented by physical constraints and/or prohibitive regulations. ALS is working closely with numerous TBM manufacturers and tunnelling contractors to provide the most efficient and cost effective solutions for door to door delivery of equipment.

A trend identified by shipping firms is the use of reverse auctions. What are your thoughts on the use of this contracting mechanism?

Reverse auctions are best suited to unit load and homogenous bulk cargo contracts, which cover uniform quantities, routes and cargo specifications. TBM and tunnelling project equipment deliveries frequently require bespoke logistics solutions tailored to the exact needs of the cargo. These solutions can only be provided by service providers with the necessary experience, resources and skill sets and price is just one of a number of key criteria influencing the award of the delivery contract for project cargoes.

Which ports would you say are best equipped for moving through this type of equipment and why?

Larger unit load (i.e. container and/or ro-ro trailer) ports may be unable or reluctant to handle oversize and heavy TBM and tunnelling project cargoes, due to their focus on and preference for high volume throughput. These ports typically invest in a highly mechanised cargo handling solution, employing stevedores and operatives who have limited skills and experience in the handling of oversize and heavy breakbulk cargoes.

Ideally TBM and tunnelling project equipment should be loaded from the nearest port to the source of supply and discharged at the nearest port to the launch portal. This is not always possible due to considerations such as the availability of suitable berths and cargo handling equipment, and suitable road or rail access, plus the availability of scheduled shipping services and/or the willingness of shipowners to deviate their vessels at reasonable cost.

What are the biggest challenges associated with moving TBMs?

Access to launch and reception portals is sometimes restricted due to height, width and/or weight limitations. TBM deliveries are often subject to strict deadlines, which can only be achieved through careful and thorough advance planning and preparation in respect of route surveys, obtaining permits and booking the specialised equipment required - i.e. heavy road haulage equipment, special rail equipment, open-top or flat-rack isocontainers, mobile cranes and chartered vessels.

Additional considerations include the provision of police and private escorts, removal and replacement of street furniture, liaison with the utility companies for lifting of overhead wires (power and telecom) and removal of other obstructions such as overhanging vegetation

Above: Roger Gibbs

Can you tell us about past TBM/tunnelling equipment logistics contracts where you have had to deliver under challenging circumstances?

ALS was contracted by AMEC in 2007 to manage two separate transfers of the 6.10m diameter TBM and ancillary equipment engaged on the London Docklands Light Railway extension, from the reception portal in Woolwich, on the south bank of the River Thames, to the launch portal in KGV Dock, on the north bank. The two portals were less than 1km apart, and the preferred transfer solution was to use a river vessel. This was found to be impossible as our surveys proved there were no suitable berths available to support either a ro-ro operation or the use of heavy mobile cranes. Access to the reception portal was also very restricted due its location on a very small site within a confined residential and commercial area. A road haulage solution was finally agreed, closely monitored by London's Metropolitan Police. The TBM cutting head and shields were moved at night under police escort on a 55km journey involving several road closures and also temporary closure of the Dartford Tunnel under the River Thames to other traffic to allow these abnormal loads to achieve a safe transit. All deliveries were completed on schedule and within budget.