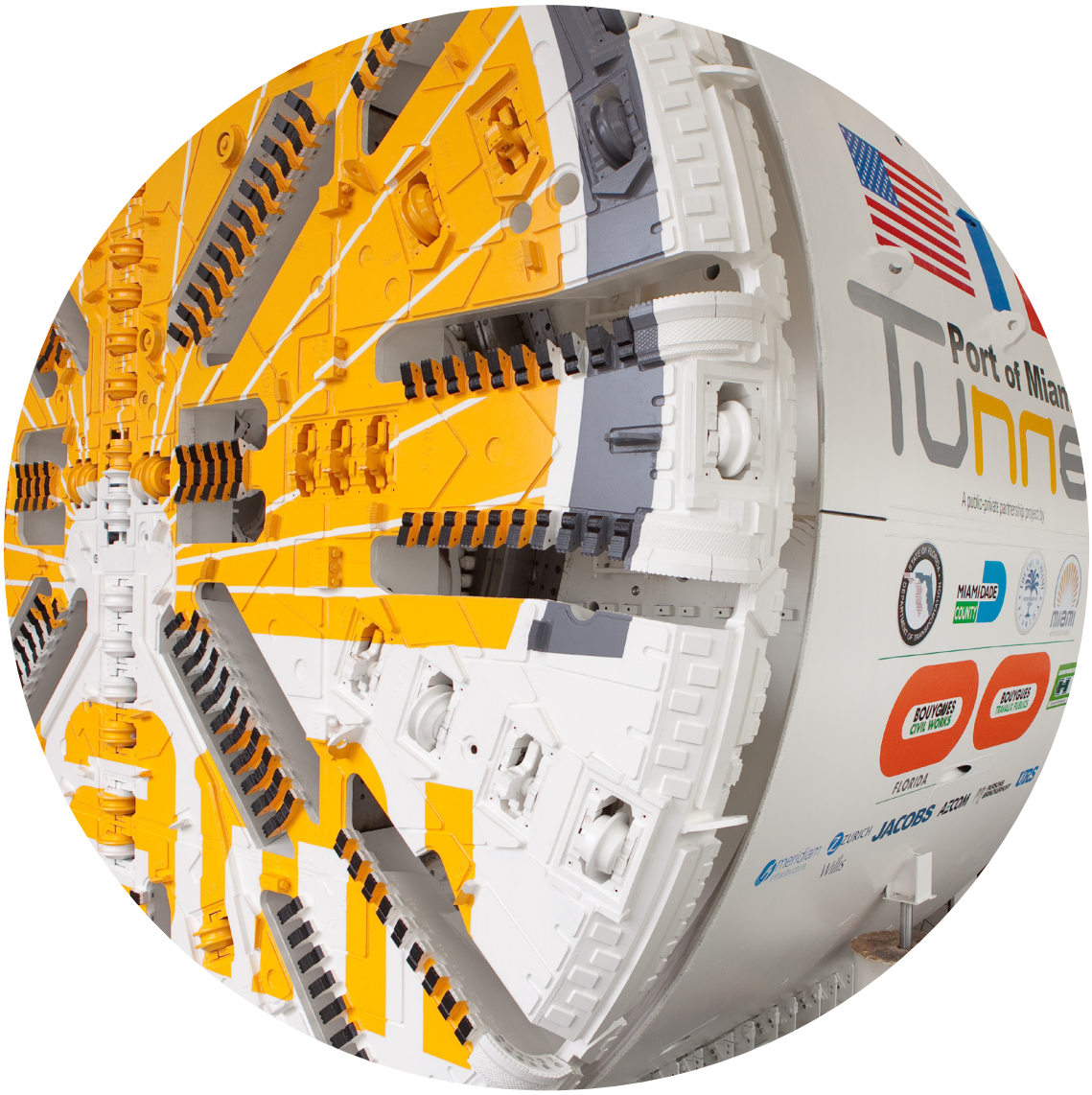
CASE STUDY

MIAMI ACCESS TUNNEL: MANAGEMENT OF GEOTECHNICAL RISK



- **CONTRACT INNOVATION:** MECHANISM TO DEAL WITH GROUND UNCERTAINTIES

PROJECT VALUE: $900M

TUNNEL LENGTH: 4200 FT (1280M) EACH TUBE

TUNNEL DIAMETER: CUTTING DIAMETER 42.3FT (12.9M); INTERNAL 37FT (11.3M)

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MADE IN MIAMI: A DEMONSTRATION IN MANAGING COMPLEX TUNNELLING

Construction of the $900m twin-bore Miami Access Tunnel presented substantial risks – involving machine tunnelling in difficult ground conditions beneath the city's Government Cut waterway. The tunnel drives were completed on time and under budget, however, through sophisticated risk allocation and highly diligent project management.

On 6 May 2013, a massive Tunnel Boring Machine (TBM) broke through into its reception box on Miami's Watson Island, at the end of a second tunnel drive beneath the city's Government Cut waterway. As it emerged, on schedule and under budget, the TBM marked a successful conclusion to a process of **risk management** stretching back over a period of four years and more.

In 2009, the Florida Department of Transportation (FDOT) signed a 35-year public-private concession agreement with MAT Concessionaire LLC for the financing, delivery and operation of the Miami Access Tunnel. This in itself was a significant milestone.

The public private partnership secured the long-term financing needed for construction and operation of this vital and major new infrastructure, valued at $900m. It also meant FDOT and its public partners could access market expertise for taking on the technical challenge of the MAT project and managing the risks involved.

As a method of construction, tunnelling is generally regarded as high risk, due to the often **variable and hard-to-predict nature of ground conditions**; beneath the Government Cut, the geology was expected to consist largely of layers of soft and porous sedimentary rock.

"The tunnels could not go deeper, into stronger or more reliable material, due to gradient restrictions for the road link between islands only just over a kilometre apart. So the risks were compounded by shallow cover, of less than the diameter of the tunnel between the top of the TBM and the waterway above," says Meridiam's Lead Technical Expert Parviz.

"The two tunnels also had to be bored with a single TBM and in close proximity to each other, to allow interconnecting escape passages to be built, so there was substantial risk of ground movement in the first tunnel as the TBM passed for a second time."

As Meridiam's Lead Technical Expert, Parviz provided key technical input to MAT Concession. The project team dedicated to overseeing construction of the MAT would perform a critical role, working with the project sponsors and contractor Bouygues Civil Works Florida (BCWF) to manage the risks involved.

"Two principal reasons can be highlighted for the tunnelling success: the way the contract was drawn up, and the manner in which the work was managed as it progressed. It was a **very good partnership**, with a lot of discussion between FDOT, the concessionaire and BCWF," Parviz says.

"The contractual structure was particularly well thought out. It was done in a way that **transferred risk to the contractor and incentivised** it to avoid additional work and delays, but still **made bids affordable**. The risks were clearly defined by FDOT, so contractors could price for them."

Risks of additional costs arising from geotechnical conditions would be shared between FDOT and MAT Concessionaire. The contract regime made the concessionaire fully liable for the first $10m. FDOT was allocated responsibility for costs over $10m up to $160m. MAT would be liable for further costs up to $180m and above that either party had the right to terminate the contract, or negotiate cost-sharing.
Further detail was ironed out in negotiations leading up to the signing of the concession agreement, as Parviz explains: "From an early stage, we were careful to ensure BCWF had a **pass-through lump sum contract**. This protected Meridiam by passing all geotechnical risk onto BCWF and made sure the contractor could only be paid for additional work if FDOT agreed its claim. We then played an active role in working with BCWF to ensure its design was suitable for the ground conditions," Parviz says.

MAT Concessionaire and BCWF were aided by information that FDOT could provide after completing a **detailed ground investigation**. Costing more than 1% of the circa $600m construction contract, FDOT's study of the underlying geology was thorough for projects of its size.

This resulted in a design that incorporated substantial amounts of soil and **ground improvement**, including formation grouting ahead, above and around the TBM to give it more solid ground to tunnel through, with less risk of water ingress. Then, with contracts signed, BCWF added its own boreholes and regime of soil testing to build up the comprehensive picture of the ground conditions. "This revealed the need for some changes," Parviz says.

The TBM designed for the job was an Earth Pressure Balance (EPB) machine. This would turn material into a consistent 'cake' as it was excavated, so allowing pressures in front and behind the cutting head to be balanced for smooth and rapid tunnelling, without sudden breakages or inflows of material.

"The material encountered lacked the necessary quantity of fine material for the EPB machine to create this cake, so **significant changes to the TBM were needed**, adding a system of hydraulic removal of material, with control of water at the cutting face," Parviz says.

"We held extensive discussions with BCWF, helping its project

team reach its decisions on changes to the TBM. The contractor also decided to increase the amount of formation grouting to be carried out ahead of the tunnelling to add greater certainty. It was interesting to see that the contractor, incentivised to avoid delay, didn't hesitate to spend the additional money and took the risk without certainty of being paid for this." Credit goes partly to the very experienced project manager and tunnelling team that Bouygues brought to Florida, Parviz adds.

In due course, BCWF considered claiming for additional payment. Here again the MAT Concessionaire team worked with the contractor to make its expectations reasonable – aided by **clear procedures agreed by MAT and BCWF for dealing with claims** arising from changes to ground conditions.

Parviz says: "we debated this at length with BCWF beforehand and ultimately the dispute review board rejected the contractor's claim for costs from altering the TBM. The contract was thorough and the specifications clear: the machine had to be capable of working in both conditions."

The claim for additional grouting costs was upheld, however, because the extra work was deemed necessary by the review board due to the risks involved. The contract provided for these costs to be shared between FDOT and BCWF.

Most importantly, the tunnelling finished **on time and under budget**. "Every aspect of the job was discussed with the contractor to find the best solutions, including the dismantling of the TBM at the end of the first tunnel drive. We saved time by keeping the machine head whole for turning it around and then sending it off in the other direction," Parviz says. "For construction of the five cross-passages as well, a lot of discussion was held in coming up with ground-freezing as a safe method. The project went well in difficult conditions." ■

THERE AND BACK IN UNDER TWO YEARS

The Miami Access Tunnel was built to provide a new direct road connection between the Port of Miami on Dodge Island and the mainland interstate highway network. This was designed to aid growth of the port with better road access, while diverting port traffic from the city's downtown area.

It could be done by building a new crossing of the 1km wide Government Cut to connect the port with the MacArthur Causeway on Watson Island. Construction of a bridge was ruled out by constraints of port operations, the depth of the Cut and environmental considerations. Out too went the idea of an immersed tube tunnel for the same reasons; leaving twin bored tunnels as the preferred option for the new crossing.

The overall project also included widening the MacArthur Causeway Bridge between Watson Island and the mainland – a major undertaking on its own – as well as construction of new road layouts at each end of the new tunnel.

For excavating the tunnels, a massive Tunnel Boring Machine, 13m in diameter and over 130m long – and named Harriet after abolitionist Harriet Tubman by a local Girls Scout group – was assembled in a 15m deep pit excavated on Watson Island.

Harriet was launched on 11 November 2011, installing precast concrete segments of tunnel lining as she went, on an eight-month journey to Dodge Island. Harriet took just six months to complete the second tunnel, arriving back on Watson Island on 6 May 2013 and paving the way for construction of dual-carriageway highway within each tunnel bore. The Miami Access Tunnel was opened to traffic on 3 August 2014. ■