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Marmaray project: The project and its management

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Abstract

This paper will discuss the Marmaray Project in its entirety, how the Project is organised, funded and managed. It will also briefly discuss the contract strategies that formed the basis for the final version of the BC1 Contract which is relevant for this conference and which was signed in 2004 and contains the tunnels under Istanbul and the Istanbul Strait including the deep stations at Yenikapi, Sirkeci and Uskudar.

Apart from presenting the Project some management topics mentioned in two of the papers being presented at ITA2005 will be combined and presented at a global level in this part of the session: Marmaray Project, ''Project Management'' and ''Contract Strategy and Minor Tactics''.

Keywords: Marmaray project; Bosphorus Strait; TKGN Joint Venture; Avrasyaconsult

1. The Marmaray project

The Marmaray Project provides a full upgrading of the worn out commuter rail system in Istanbul, connecting Halkali on the European side with Gebze on the Asian side with an uninterrupted, modern, high-capacity commuter rail system.

Two existing railway tracks on both sides of Bosphorus will be fully upgraded to three tracks and connected to each other through a two track railway tunnel under Istanbul and the Bosphorus. The line goes underground at Yedikule, continues through the Yenikapi and Sirkeci new underground stations, passes under the Bosphorus, connects to the Üsküdar new underground station and emerges at Sögütlüçesme (see Fig. 1).

The entire upgraded and new railway system will be approximately 76 km long of which approximately 13.4 km are underground. The main structures and systems include the immersed tube tunnel, bored tunnels, cut-and-cover tunnels, at-grade structures, three new underground stations, 37 surface stations (36 of them new), an operations control centre, yards, workshops, maintenance facilities, upgrading of existing tracks and a new third track at-grade, completely new electrical and mechanical systems and procurement of modern railway vehicles.

2. The history of the underground structures and the funding

The idea of a railway tunnel under the Bosphorus Strait was first raised in 1860. However, where the tunnel under the Bosphorus crosses the deepest parts of the Strait, the techniques at that time would not allow the tunnel to be on or under the seabed, and therefore the design indicated a ''floating'' type of tunnel placed on pillars constructed on the seabed. A similar but upgraded design was developed in 1902 also showing a railway tunnel under the Bosphorus, but this design indicates a tunnel placed on the seabed (see Fig. 2).

The immersed tunnel technique that will be used in the Marmaray Project to cross the Bosphorus Strait has been developed since late in the 19th century. The first immersed tube tunnel ever built was constructed in North America for sewer purposes in 1894. The first immersed tunnel for traffic purposes was constructed in the United States-the

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Fig. 1. The Marmaray Project along the coast line of the Marmaray Sea. The white portion is underground and the red portions are at grade.

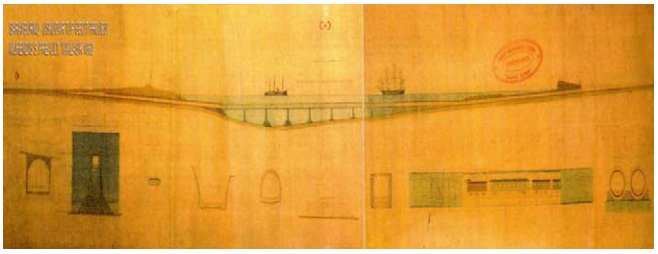

Fig. 2. One of the design drawings from the first project suggested in 1860 showing an outlined design.

Michigan Central Railroad tunnel in 1906–1910. In Europe, Holland was the first country to adopt the technique, and the Maas Tunnel in Rotterdam was opened in 1942. In Asia, the first immersed tunnel was constructed in Japan-the two-tube road tunnel (Aji River Tunnel) in Osaka, opened in 1944.

The first comprehensive feasibility study to construct a mass transit railway connection from west to east in Istanbul was carried out and reported in 1985. This study concluded that such a connection would be feasible and cost-effective, and the alignment we see in the project today was selected as the best of a range of alignments. The studies from 1985 were refined and then concluded in 1996–1998. It was again confirmed that the project would offer many advantages to the people working and living in Istanbul, and it would ease the rapidly growing problems regarding traffic congestion in the city. In 2003–2004, the feasibility study was again updated, and in this update the latest traffic developments of Istanbul were included.

In 1999, a funding agreement between the Republic of Turkey and the Japanese Bank for International Cooperation (JBIC) was signed. This loan agreement forms the basis for the funding of the Bosphorus Crossing portion of the Project, which represents some 35% of the costs for the entire railway project. In 2005, another funding agreement of a similar amount (650 million Euro) was signed between Turkey and the European Investment Bank (EIB). The remaining funding for the project is being guaranteed by the Government either by loans from International Financing Institutions and or by private funding.

3. Special challenges

The Marmaray Project offers many special challenges of which the most important ones are:

- The Immersed Tunnel under the Bosphorus will be the deepest built so far with its deepest point being some 58 m under the water surface.
- The area of Istanbul will most likely experience a seismic event of up to magnitude 7.5 during the lifetime of the Project.
- The deep stations and tunnels will have to be constructed in an area where civilization can be traced more than 7,000 years back in time. Preservation and rescuing of Historical Heritage is therefore a focus point not to be neglected.
- The geotechnical conditions of the Bosphorus Strait are of such a nature that the connection between the Bored Tunnels and the Immersed Tunnels will constitute a special technical challenge when it comes to seismic conditions.
- The ultimate capacity of the Commuter Rail system will be not less than 75,000 passengers per hour per direction. This places special requirements on safety of people in the tunnels and deep stations.
- The marine works will have to be performed in very deep waters in a waterway that carries more than 50,000 ships every year through it and on top of that a vast number of ferries and passenger boats crossing the Strait (see Figs. 3–5).

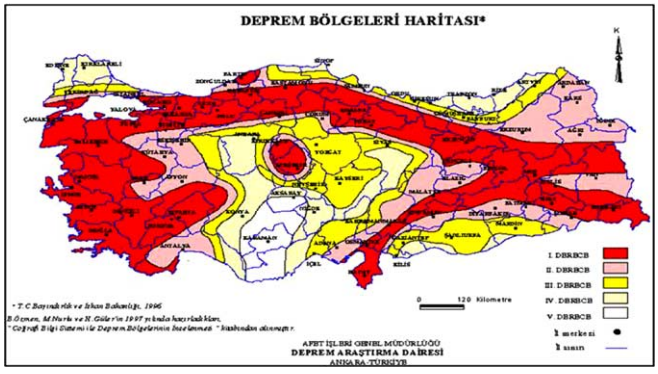

Fig. 3. It can be seen on the seismic map of Turkey that position of the Immersed Tunnel is in the most critical Zone.

Fig. 4. One of the 50.000 ships passing in direction north–south in the Istanbul Strait every year.

Fig. 5. The dredge that has to operate alongside the ship traffic in the Bosphorus.

4. Organisation and management

The organization ultimately responsible is the Parliament of the Republic of Turkey. The responsible ministry reporting to the Parliament is the Ministry of Transportation. The responsible directorate for the implementation of the Project and reporting to the Ministry of Transportation is the General Directorate of Railways, Harbors and Airports Construction, the DLH.

The responsible organisation for the Engineering and Consulting Services for the Project was selected via competitive bidding. Avrasyaconsult was the successful bidder and this organisation is reporting to DLH and is the Employer's Representative on the Construction Sites.

Avrasyaconsult is an international team of four partners from Turkey and Japan, and the team is assisted by international consultants from USA and local consultants from Turkey:

Pacific Consultants International (PCI) from Japan is the lead partner of Avrasyaconsult and amongst the largest consultancy companies in the world. Yuksel Proje Uluslararasi A.S. – the local partner, is amongst the leading consultancy companies of Turkey and has an extensive experience from similar projects in Turkey and abroad. Oriental Consultants from Japan brings as partner extensive experience on immersed tunnel expertise into the team. JARTS from Japan brings as partner extensive experience on railway expertise into the team.

These four partners form the Joint Venture which is in association with Parsons Brinckerhoff International, Inc. (PBI) from the USA which brings special expertise related to immersed tunnels and electrical and mechanical tunnel installations into the team. Furthermore, the Joint Venture is in association with Terzibasioglu Musavir Muhendislik Ltd. Sti. (TMM) and Yerbilimleri Etud ve Musavirlik Ltd. Sti (SIAL) both from Turkey which bring special expertise in underground structures and geotechnical engineering into the team.

The successful Contractor for each Contract will be the responsible organisation for the detailed design and construction of the structures and systems, and will be reporting to the DLH representative on sites, Avrasyaconsult.

The TKGN Joint Venture was the successful bidder on the Bosphorus Crossing Contract. The Joint Venture was formed by four partners from Turkey and Japan:

TAISEI CORPORATION from Japan, which is the lead partner of the Joint Venture and recognised as one of the biggest Construction Companies of the World with experience in tunnelling works. KUMAGAI GUMI Co. Ltd also from Japan and involved in many tunnel and underground structures in Japan and Asia. GAMA from Turkey is one of the leading construction companies with international experience with similar structures; and NUROL, also from Turkey, having international experience from similar structures.

The CR1 and CR2 contracts described later are in the pre-award process, and therefore the Contractors have not yet been selected.

5. Purpose and objectives

The intended purpose of the Marmaray Project is to provide bi-directional, safe, robust, reliable, comfortable, durable, cost-effective and uninterrupted train transportation of passengers and freight throughout the Istanbul area of Turkey, on both sides of as well as under the Bosphorus Strait for a design life of 100 years.

The Objectives of the Marmaray Project are:

- to open for commercial operation on or before 15th March 2010;
- to stay on or below the cost estimates and to stay on or above the income estimates established July 2004;
- to establish the Project to the required quality and;
- to meet all fitness for purpose, performance and minimum criteria as described in the contract documents for all Contracts.

There are three quality aspects built into these objectives; time, cost and technical quality. At a given point in time only two of them can have first priority and the third must take second priority. In the early phase it is common to give first priority to time and technical quality, and therefore these two facets will automatically take priority over cost. Later in the Project when the minimum requirements for quality have been defined the first priority can be given back to time and cost by following the quality (see Fig. 6).

6. Management principles

The policies established for managing the Project and the Avrasya organization are:

- to manage by objectives, delegation and follow up;
- to manage by controlled processes and pro-activity;
- to limit the need for reactive processes by taking due care in time;

Fig. 6. The Project Logo symbolizes Europe to the west, Asia to the east, a concrete tunnel connecting Europe and Asia, the basis is environmentally sustainable solutions and efficiency and everything is all about people.

- to manage by obeying and observing "the 7 C's":
  - Clarity.
  - Commitment.
  - Communication.
  - Coordination.
  - Cooperation.
  - Consistency, and
  - Continuity.
- to respect the integrity of each staff member of the team and request the same from each staff member;
- to ensure that management systems are based on ISO9000/2000 but continuously adjusted to serve the purpose of the Project, and
- to ensure that implementation and operation is achieved with respect for the environment and the people that will be directly or indirectly affected by the Project.

7. Contract strategies

When discussing contract strategies, consideration on three main strategies is imperative. Which basis should be used for the Conditions of Contract, which type of contract should be used and how many Contracts should be led?

There are many stakeholders involved in these decisions; the funding agencies, the employer, the other governmental organizations and the consultants all contribute with arguments for and against certain solutions.

Since the first loan agreement was signed back in 1999 and until consensus was finally reached, most–if not all–options using these main strategies have been evaluated.

To ask for bids for the entire Project in one package was actually suggested by the employer back in 1999. There are definitely some advantages, but also some disadvantages in using this strategy. To ask for bids of the Project in as many small packages as possible-up to some 25 different packages-has also been proposed, considered and analyzed in the early stages back in 2002. The decision was – as often – to arrange something in between. Therefore, the Project is now split into 3 Contract packages. The Bosphorus Crossing Contract BC1, the Commuter Rail Infrastructure and Systems Contract CR1 and the Rolling Stock Contract CR2.

The type of contract has also been discussed intensively. In the early phases and in the first loan agreement is was indicated that the BC1 contract would be a Design and Build type of contract, the CR1 would be a traditional Employer's Design type of Contract, and the CR2 would be a typical Procurement type of Contract. However, due to developments in technology, fine tuning of the alignment and final discussions related to strategy, it was decided to change the type of contract for CR1 into a Design and Build type of contract similar to the BC1 contract.

The first Contract to be sent out for bidding was the BC1 Contract. As mentioned, this Contract was always supposed to be a Design and Build type of contract. It was therefore considered whether a tailor made contract should be developed or it would be better to use a standard type of contract. As it often is, the standard type of Contract was selected because these types of contracts have been used on many other projects, and therefore the industry has in general some experience and background knowledge about how such conditions work out in reality. Consequently the FIDIC EPC/Turnkey Projects General Conditions of Contract – the "Silver Book" – was used.

This set of general Conditions puts most risks related to unforeseeable conditions on the Contractor if not decided otherwise in the Employer's Requirements and the Particular Conditions of Contract. It was therefore decided to prepare an extended risk sharing mechanism. The main reason for doing this was that it simply is the cheapest way forward for the employer. The main principles have been, that the party who can best control or mitigate a risk must also accept responsibility of that risk (see Fig. 7).

Fig. 7. Civilisation goes more than 7000 years back in time in Istanbul. The project is facing a major challenge in obeying the efforts required to ensure that all buildings and structures are unaffected and assuring that finds are preserved.