Contract BC1

Railway Bosphorus Tube Crossing Tunnels and Stations (Marmaray)
Project Location

1st Bridge

2nd Bridge

Railway Bosphorus Tube Crossing, Tunnels and Stations
Longitudinal Section
Particular Design Conditions

- Design Basis Earthquake: Mw = 7.5
- Countermeasure to Liquefaction
- Huge Water Pressure: Max. 60m
- Rapid Current
  - Upper Layer (N to S): Max. 5 knots (2.5m/sec)
  - Bottom Layer (S to N): 1 ~ 1.5 knots
- Fire Resistance: 100 Mw Fire
  - Train with Petrol Fire
IMMERSE TUNNEL
Construction
Bird View Istanbul Strait Crossing
Immersion Procedure

Access shaft

Placing Barge

TBM Tunnel Boring Machine

Asian Side

European Side
Tunnel Cross and Longitudinal Section

- Armor Protection
- Tunnel Armor Protection
- Anchor Release Band
- General Backfill
- Selected Locking Fill
- Foundation
- Immerse Tube (1387m)
- Sea Bed
- Armor Protection
- Seismic Joint
- Seismic Joint
- E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11

(m)
Typical Cross Section of Immersed Tunnel Element

Vehicle Structure Gauge

Escape Way

Squeeze
Comparison Major Tube in the World

Depth of Tube Bottom (m)

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosphorus</td>
<td>60</td>
</tr>
<tr>
<td>BART</td>
<td>41</td>
</tr>
<tr>
<td>Hampton roads</td>
<td>37</td>
</tr>
<tr>
<td>2nd Hampton Roads</td>
<td>37</td>
</tr>
<tr>
<td>Interstate</td>
<td>36</td>
</tr>
<tr>
<td>Baytown</td>
<td>33</td>
</tr>
<tr>
<td>Baltimore Channel</td>
<td>32</td>
</tr>
<tr>
<td>Channel</td>
<td>32</td>
</tr>
<tr>
<td>Parana</td>
<td>31</td>
</tr>
<tr>
<td>Fort McHenry</td>
<td>31</td>
</tr>
<tr>
<td>Thimble Shoal</td>
<td>30</td>
</tr>
<tr>
<td>Tama Tunnel</td>
<td>30</td>
</tr>
</tbody>
</table>
Tuzla Dry Dock TUBE Fabrication
Immersion Procedure

Before Immersion (Anchoring Completion)

Marmara Sea Side

Black Sea Side
Slurry Type TBM TUNNEL Construction
TBM Excavation Route

European Side

Kazlicesme
Yedikule
Yenikapi
Sirkeci
Bosphorus Strait
Uskudar

Asian Side

Airilikcesme

TBM Excavation Route:
- **Kazlicesme**
- **Yedikule**
- **Yenikapi**
- **Sirkeci**
- **Bosphorus Strait**
- **Uskudar**
- **Airilikcesme**

TBM Excavation Route:
- 2170m: TBM EPB
- 3343m: TBM Slurry
- 4620m: TBM Slurry

Business
TBM (Slurry Type) \( \phi = 7,640 \text{mm}, L = 11,000 \text{mm} \)
Tunnel Inside (Asian Side – Sept. 07)
Tunnel Inside (Asian Side – Uskudar Station Breakthrough – July 09)
NATM TUNNEL Construction
Emergency CROSS PASSAGE
(44 Places 200m Interval)
Uskudar Cross Over Tunnel Model

Temporary Shaft

1st Temporary Tunnel
50.5m

2nd Temporary Tunnel
29.0m

Crossover Tunnel
127.2m

3rd Temporary Tunnel
68.0m

To Uskudar station
Uskudar Cross Over Tunnel Excavation
Lining Concrete
Bird View of Uskudar Station Area

Immersed Tunnel

Uskudar Sta.
Station Excavation
U/W Concerns

- Project of almost prototypical nature – deepest ever submerged
- “atypical” connection sea-land tunnels
- Strong bi-directional current in the Bosphorus straight
- Heavy ship traffic with “reckless” ship owners at times
- Due to deep tunnels high water pressure and hence water tightness issues
- An overseas contractor moving in unknown cultural environment
- Land tunneling under densely built up (historic) areas