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Agenda

› Introduction to the project
› General layout
› Seismic
› Substructure Design/Construction
  › Tower foundations
  › South Anchor Block
  › North Anchor Block
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General

› Bridge site location approx. 50 kilometers East of Istanbul
› First phase of major infrastructure project in Turkey. New highway from Gebze to Izmir.
› BOT project, approx. $11 billion

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Project dates summary

› **Invitation to Tender May 2010**
  - Design & Build

› Tender conditions – Suspension bridge
  - Main span 1550 – 1700m
  - Total length 3km

› **Tender submission September 2010**

› Three bidding contractor groups – Japan(IHI), China, Korea,

› IHI announced preferred bidder Jan 2011

› Contract negotiations Jan–Sep 2011

› Bridge construction cost approx. $1.2 billion

› **Detailed design start Sep 2011**

› **Preparatory Site Works started Sep 2012**

› **Permanent Site Works started Jan 2013**

› Bridge completion early 2016
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General layout

- Concrete Anchor Blocks and Tower Foundations
- Tower Foundations at approx. 40 m water depth
- Navigational clearance profile 64x1000m
- South Piers supported on South Anchor Block (Integrated structure)
- Steel towers 250m high
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General arrangement - Bridge deck

- Orthotropic steel deck – dehumidified
- 3 traffic lanes each direction
- 14mm deck plate and 60mm surfacing
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General arrangement - Towers

- Steel towers / low weight / increased flexibility / fast construction
- Seismic load combinations and normal ULS combinations are more or less equal in governing the tower design
- Constructed by prefabricated elements – 22 blocks
- Horizontal joints by combined welding and bolting
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Tower erection

Panel erection
Block no. 12-22
Tower crane, 40t

Block erection
Block no. 1-11
Floating crane, 300t

Bolt friction connection in stiffeners
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General arrangement – Main Cables

- Sag-to-span-ratio 1:9
- Prefabricated strands
- 110 strands each with 127 nos. 5.91 mm diameter wires, 1760 MPa
- 781 mm diameter
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High Seismic Activity

› Progression of 20th Century EQs along the NAF
› 1999 EQs Surface Ruptures Map
› Gölcük 1999 EQ – 7.5 magnitude

› Izmit Site

From Barka et al., 2002
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General arrangement - Tower foundations

› Reinforced soil with steel inclusion piles (~200 nos. ø2m dia.)
› Gravel bed (3m thick) allowing caisson to slide during earthquake
› Pre-fabricated caisson (54x68x15m)
› Composite steel/concrete shafts (16m dia., t = 1.2m) with high robustness against ship impact
› Solid plinths with anchor bolts for fixing of the steel tower
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Construction stages - Tower foundations – Dry dock

Dry dock stage – Part of the caisson structure is constructed in a purpose built dry dock with a limited depth of approximately 7.5 m.
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Tower foundation construction – Dry dock
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Tower foundation construction – Dry dock
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Construction stages- Tower foundations – Wet dock

- Wet dock stage - The caisson is towed out of dry dock and the remaining part of the caisson as well as the steel shafts are completed in a wet dock in floating condition at an intermediate site with a minimum water depth of 15 m. The prefabricated steel shaft is lifted by cranes and placed on temporary support.
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Dry Dock – Tower Foundations
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Tower foundation construction
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Tower foundation construction – End September 2013
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Tower foundation construction

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Tower foundation construction – Steel shaft installation
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Tower foundation construction – Pile installation
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Tower foundation construction – Gravel bed placing
Immersion of the tower foundation by ballasting - Tower foundation is lowered into its final position by filling the caisson cells with ballast water.

It is noted that in order to maintain floating stability of the caisson in the stage where the main body gets immersed the caisson is tilted about 10 degrees.

The infill concrete in the shafts from level -21 m to -1 m is cast after the structure has been immersed.
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Wet Dock – Tower Foundations
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Wet Dock – South Tower Foundation
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Immersion – North Tower Foundation
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Immersion – North Tower Foundation
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Final position – North Tower Foundation
Gravity based solution founded on dense sand
Foundation massif 124x58x16m
Guitar shape to provide additional stability of excavation
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South Anchor Block Excavation

Design circular part
- Uniform water-pressures and soil-pressures
- Hoop structure, i.e. all panels in tangential compression
- No vertical distribution of forces in D-wall panels
- Compression transferred to junctions
- Reinforcement in D-wall panels 75 kg/m3
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South Anchor Block – D-wall panel reinforcement
Technical details for guitar shaped excavation;

› Diaphragm wall (all); thickness 1.0m, top level +1.5m, toe level -32.0m, length 33.5m
› Excavation level -15.0m, Platform level +1.5m, depth 16.5m
› Watertightness at base of the excavation achieved by 10m thick clay layer, underlaid by sand
› Construction time for D-wall and excavation: 6month
South Anchor Block Excavation
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General arrangement – South Anchor Block
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General arrangement – North Anchor Block

› Typical gravity based structure deeply embedded in rock - Foundation massif 50x66x22m
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North Anchor Block construction
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Progress– North Anchor Block
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Summary of Main Quantities

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<th>Structure</th>
<th>Material</th>
<th>Unit</th>
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Questions?