IZMIT BAY BRIDGE

Agenda

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- General introduction to the project
- Tower Foundations
- South Anchorage
- Questions

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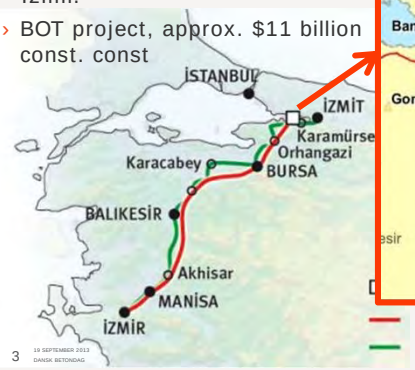
General

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



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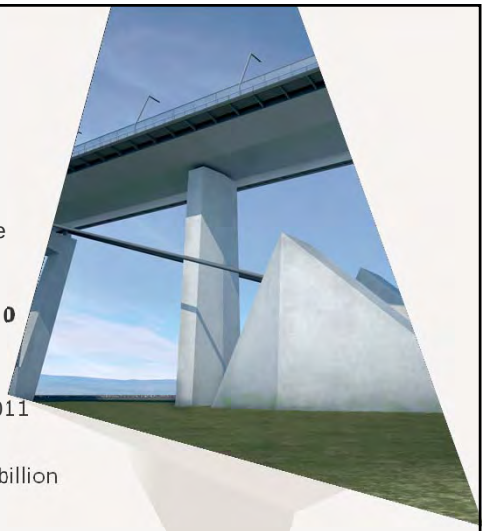
Project dates summary



- **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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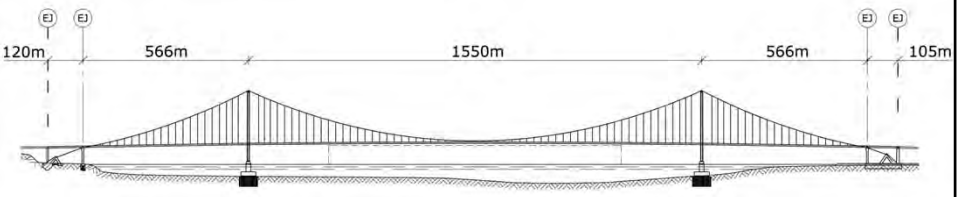
General layout



- 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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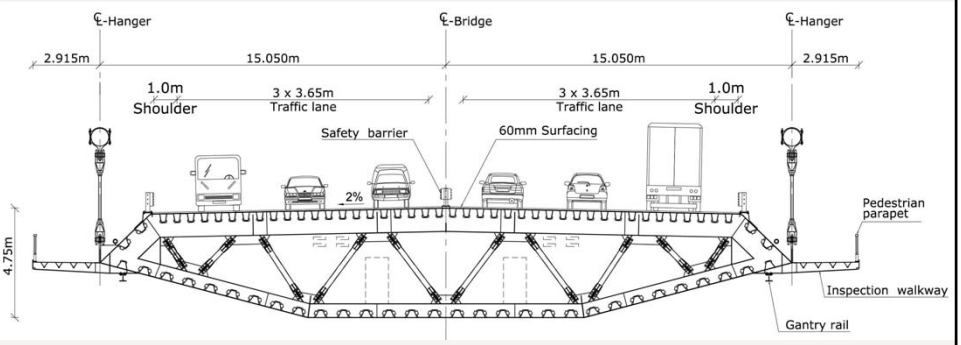
General arrangement - Bridge deck



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

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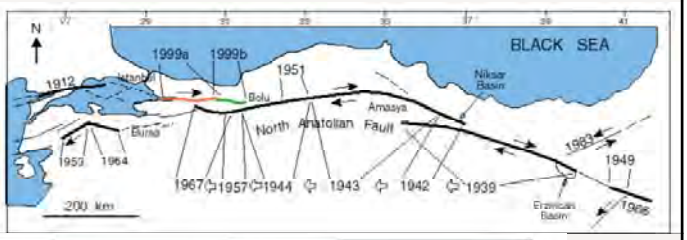
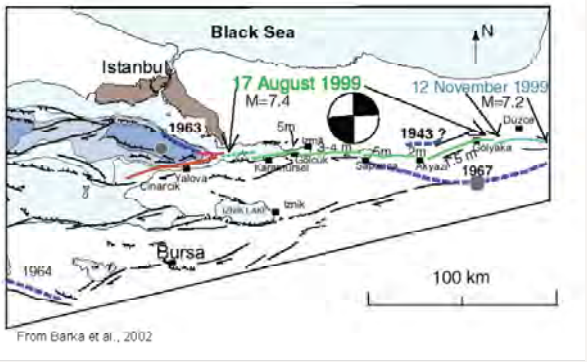
High Seismic Activity

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





From Barka et al., 2002

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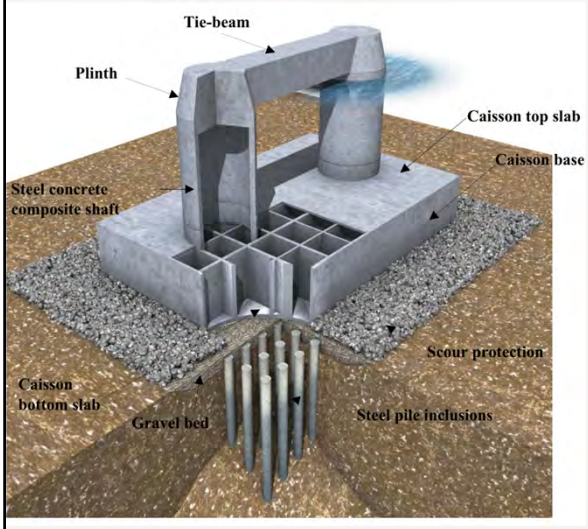
General arrangement - Tower foundations



- 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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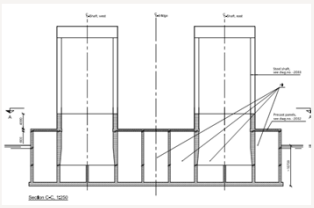
Construction stages- Tower foundations

› Dry dock stage – Part of the caisson structure is constructed in a purpose built dry dock with a limited depth of approximately 7.5 m.

▪ 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.



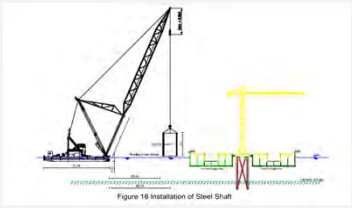


Figure 16 Installation of Steel Shaft

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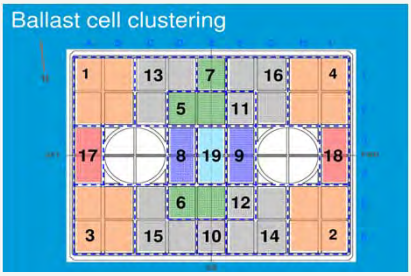
Construction stages- Tower foundations

› 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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Tower foundation construction

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General arrangement – South Anchor Block

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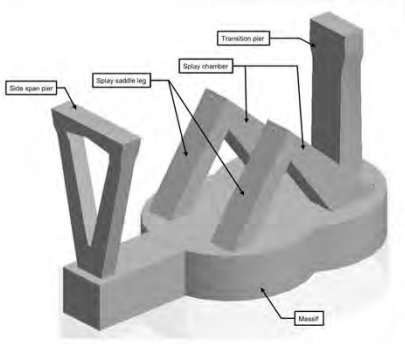
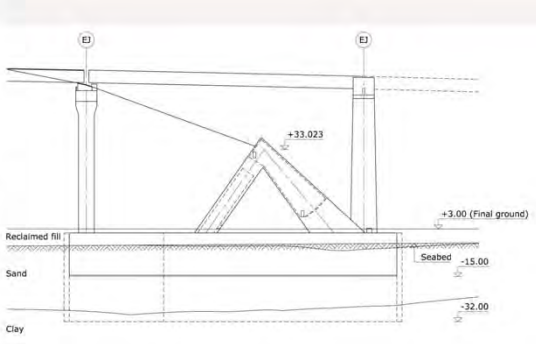
General arrangement – South Anchor Block





- 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

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
- Dual-circular shaft; diameter x length = 58m x 124m (3 level major concrete struts, left in final structure)
- Rectangular part; width x length = 18m x 38m (3 level tubular steel struts)
- Seismic ground acceleration (short exposure time, during construction), kh = 0.122 x g
- Watertightness at base of the excavation achieved by 10m thick clay layer, underlaid by sand
- Construction time for D-wall and excavation: 6month (saved time 3 strut level x 1.5month = 4.5month)

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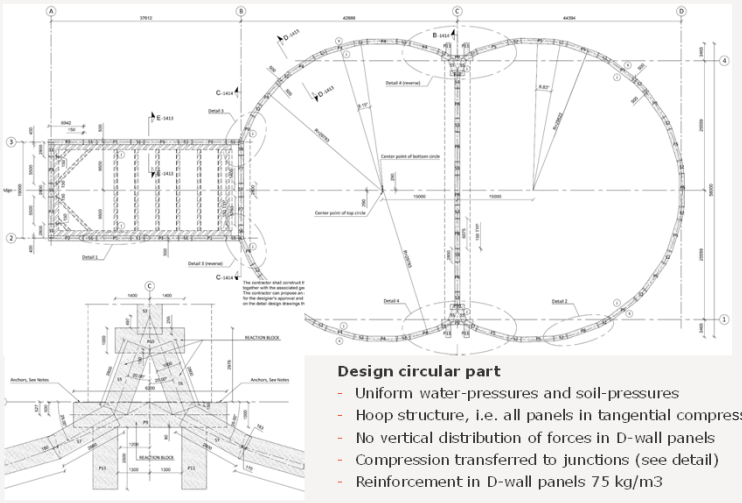
South Anchor Block Excavation



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 (see detail)
- Reinforcement in D-wall panels 75 kg/m3

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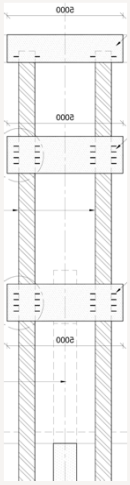
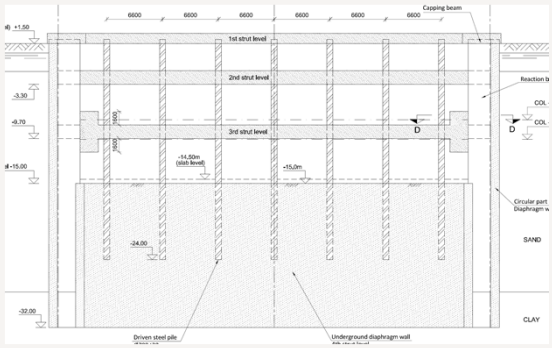
South Anchor Block Excavation





Design large RC struts

- Forces transferred from junction to junction (previous slide)
- Vertical force distribution by reaction beams (made up by D-wall panels)
- Horizontal struts/columns, w x h =5,0m x 1,6m, length 40m
- RC structs cast in sync with excavation sequence (step-by-step)
- RC struts are left / cast into the permanent anchorblock structure

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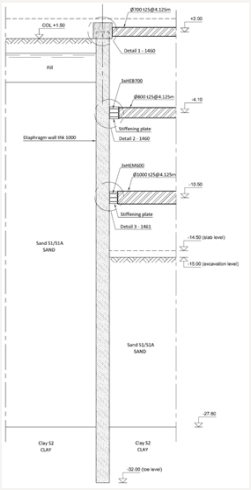
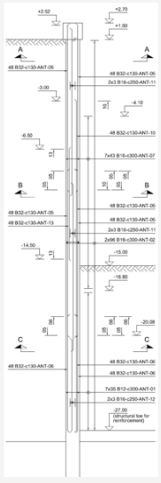
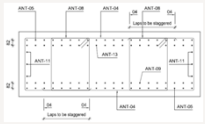
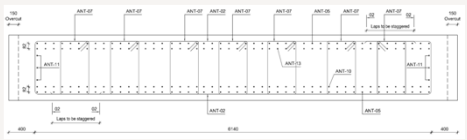
South Anchor Block Excavation









Design rectangular part

- Wailing beam and steelstruts at 3 levels
- Vertical reinforcement is D-wall panels
- Primary and secondary D-wall panels
- ULS requirements only (no SLS requirements)
- Reinforcement in D-wall panels 160 kg/m3

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South Anchor Block - Excavation

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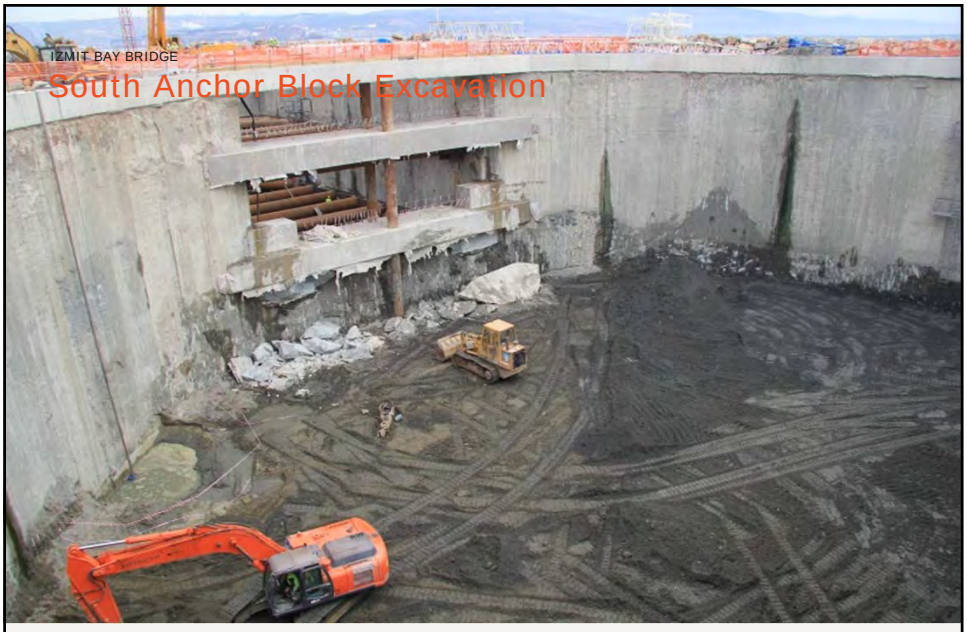
South Anchor Block Excavation



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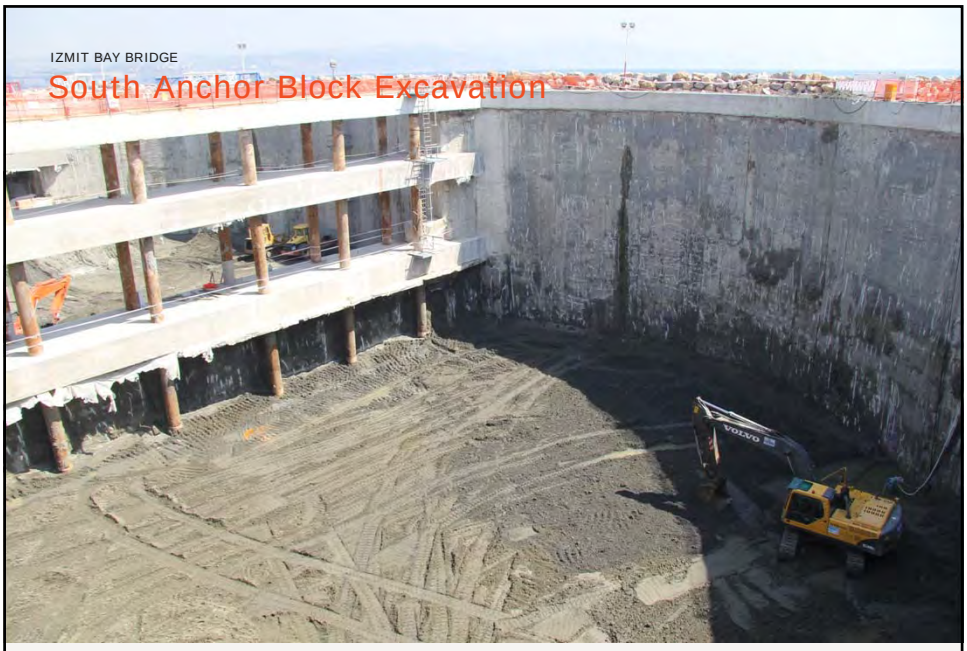
South Anchor Block Excavation



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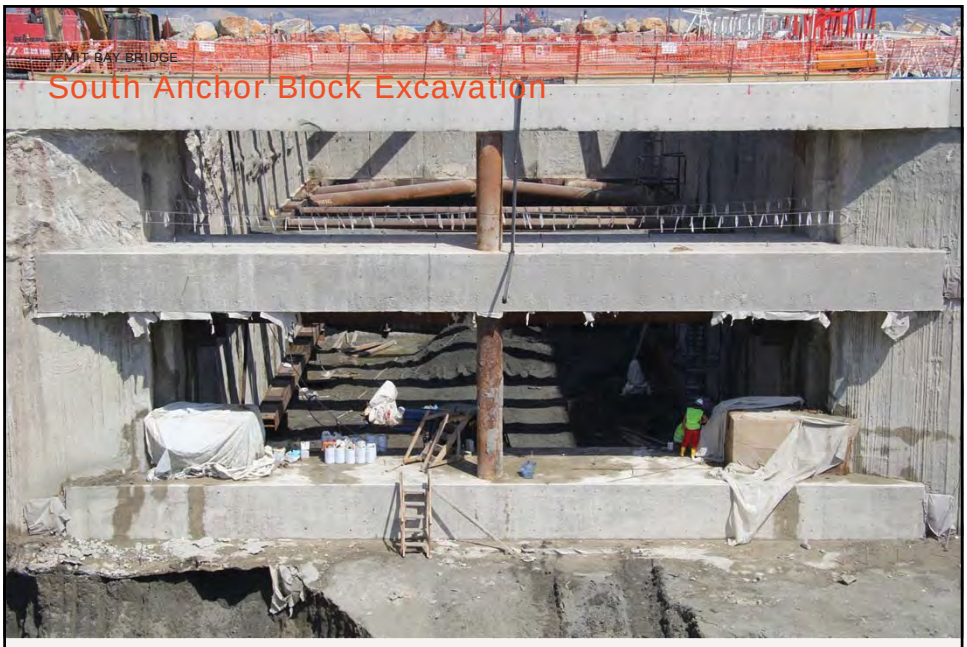
South Anchor Block Excavation

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South Anchor Block Excavation


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South Anchor Block Excavation

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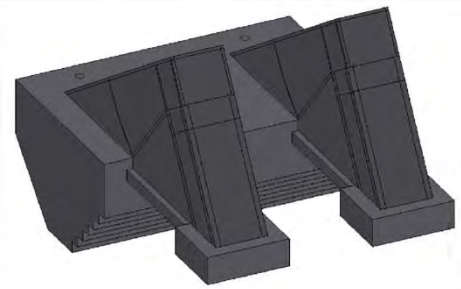
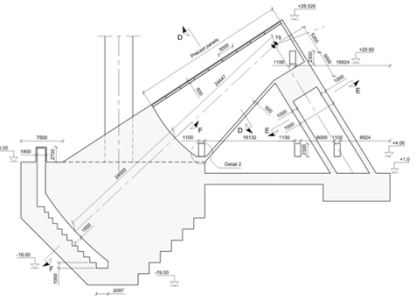
General arrangement – North Anchor Block

› Typical gravity based structure deeply embedded in rock - Foundation massif 50x66x22m





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North Anchor Block construction

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Summary of Main Quantities

Structure	Material	Unit	Quantity
Anchor blocks	Concrete	m^3	130000
Tower foundations	Concrete	m^3	45000
Steel inclusions	Steel	ton	16000
Towers	Steel	ton	17000
Main cable	Steel	ton	18000
Bridge deck	Steel	ton	33000

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Questions?

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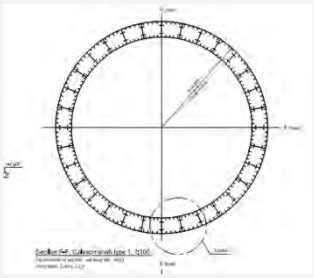
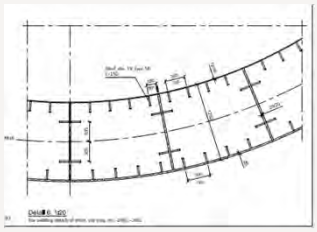
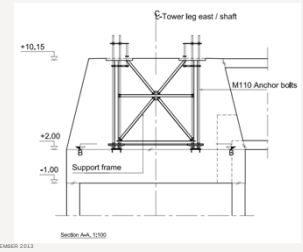
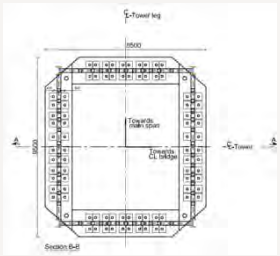
General arrangement - Tower foundations









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Design Parameters - Tower foundations

Main key driving design parameters

› High seismic design loads
- Bridge located in high seismic area

› High global, local ship impact loads (Global ship collision force is 246 MN)
- Considerable ship traffic can be found in the Izmit Bay and the tower foundation is placed in the waterway.

› Construction time, Constructability
- Short construction time
- Tower foundation on the critical path

› Construction stages
- Dry dock, Wet dock, In-situ work
- Towing and mooring of caisson
- Critical immersion and ballasting operations

Conclusion : Robust design required

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Added value- Tower foundations

- **Added value in relation to seismic events**
  - Gravel bed acting as a fuse under seismic loading - Base isolation for high amplitude earthquakes and reducing the peak seismic loads transferred to the structure.
  - The damage to the foundation structure and the steel inclusions will be better controlled and the risk of severe damage will be significantly lower than compared to other foundation concepts without base isolation.
- **Added value in relation to ship impact**
  - The frame structure consisting of the two composite shafts and the upper tie beam provides high robustness and capacity against both global and local ship impact. Hence, no separate ship impact protection system is required. In particular, the composite shaft with infill concrete provides a very effective design in relation to both global and local ship impact forces.
- **Added value in relation to construction time**
  - The prefabrication of the caissons in a dry dock allows carrying out construction works for the caisson and the steel inclusions at the same time or independent of each other.
  - The concept of base isolation and soil improvement significantly reduces the size of the tower foundation compared to a concept without soil improvement. A reduced tower foundation size results in an important reduction in terms of the construction time but additionally also for the preparatory works related to the dry dock.
  - The prefabrication of the steel works for the shafts can be performed in parallel to the fabrication of the cellular caisson structure in the dry dock. Additionally, advanced temporary structures such as buoyancy tanks etc. can be avoided as the relatively light structure (shafts not filled with concrete at time of immersion) has a positive effect on the floating and immersion properties of the caisson.

Conclusion : Robust design achieved

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