
IZMIT BAY BRIDGE
Kent J. Fuglsang
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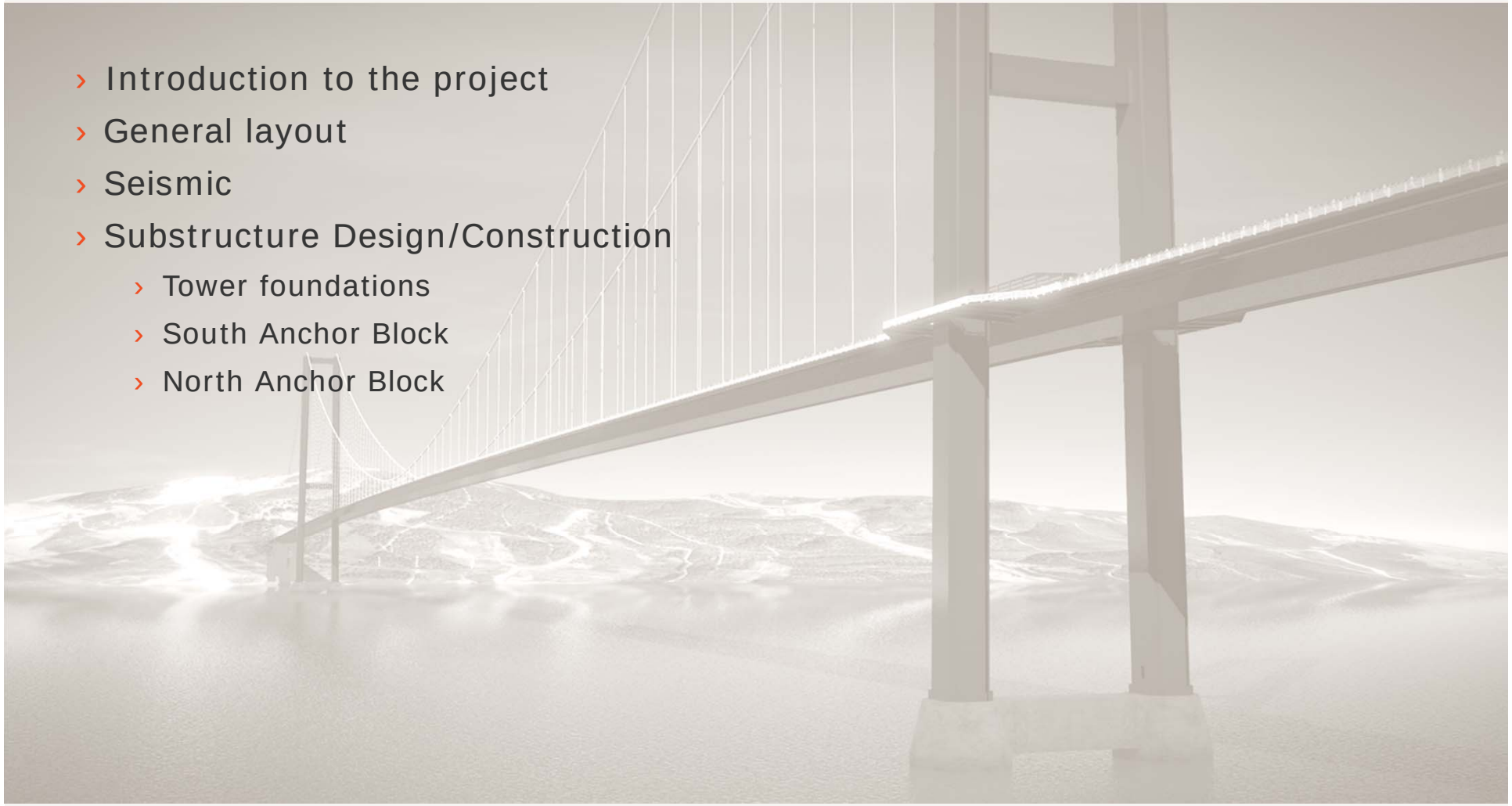
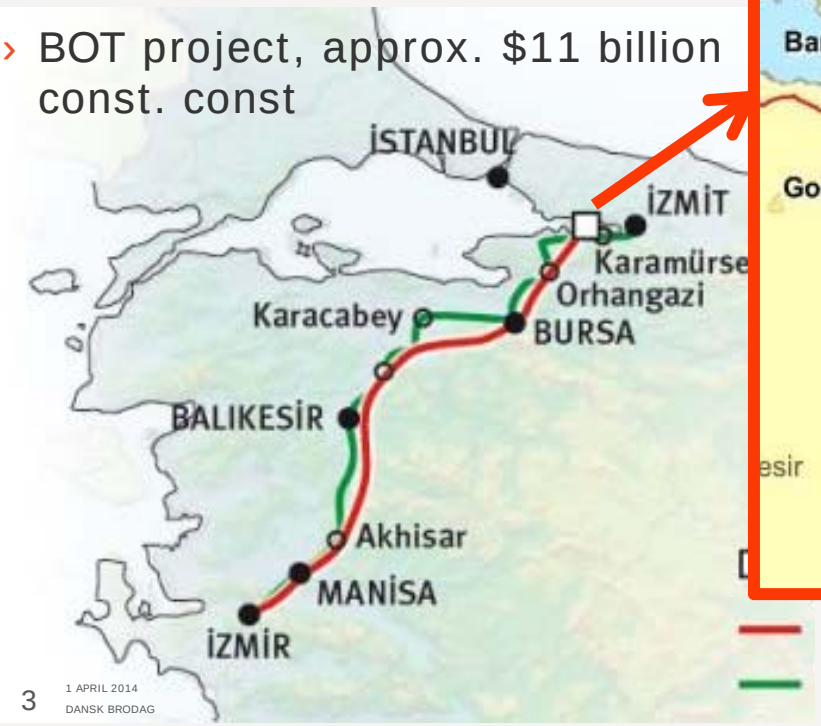
# Agenda



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

# 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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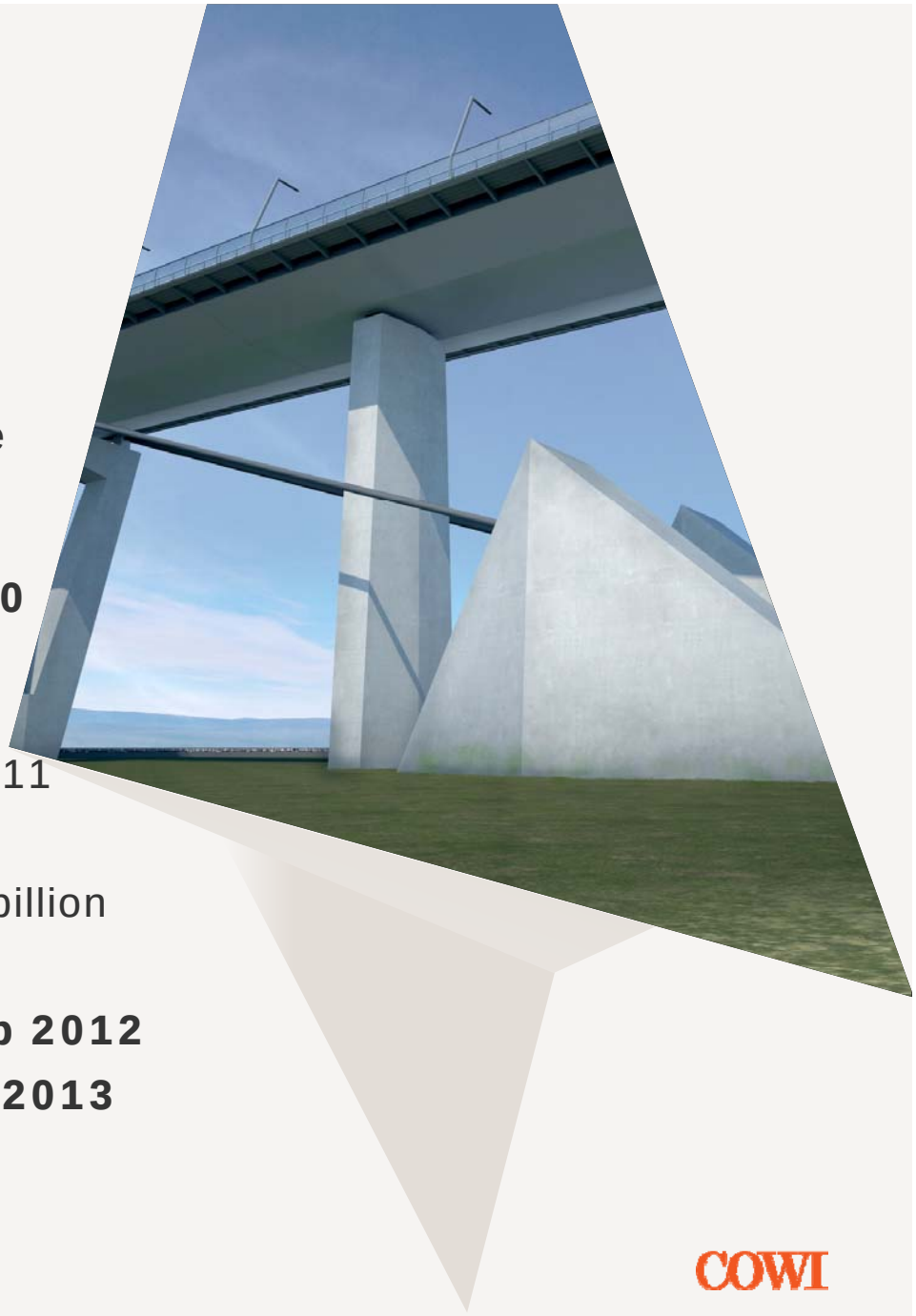
# Project dates summary



- **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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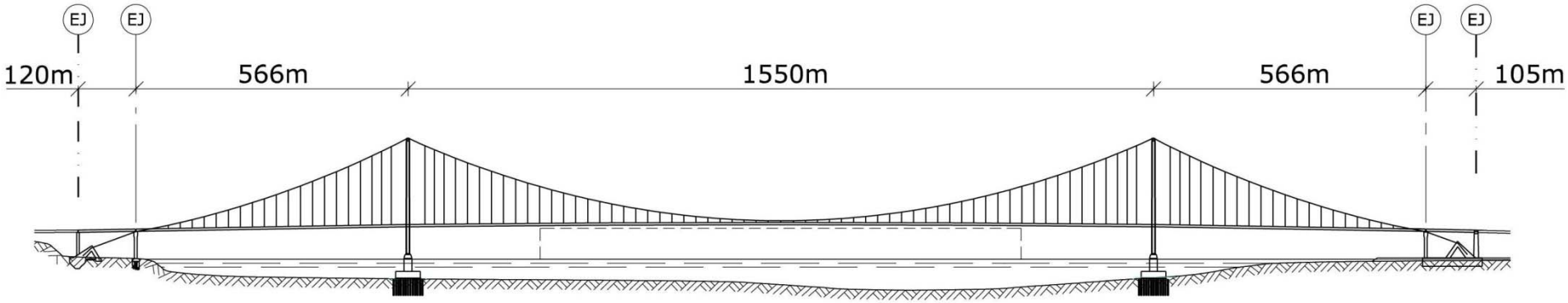
# General layout




- 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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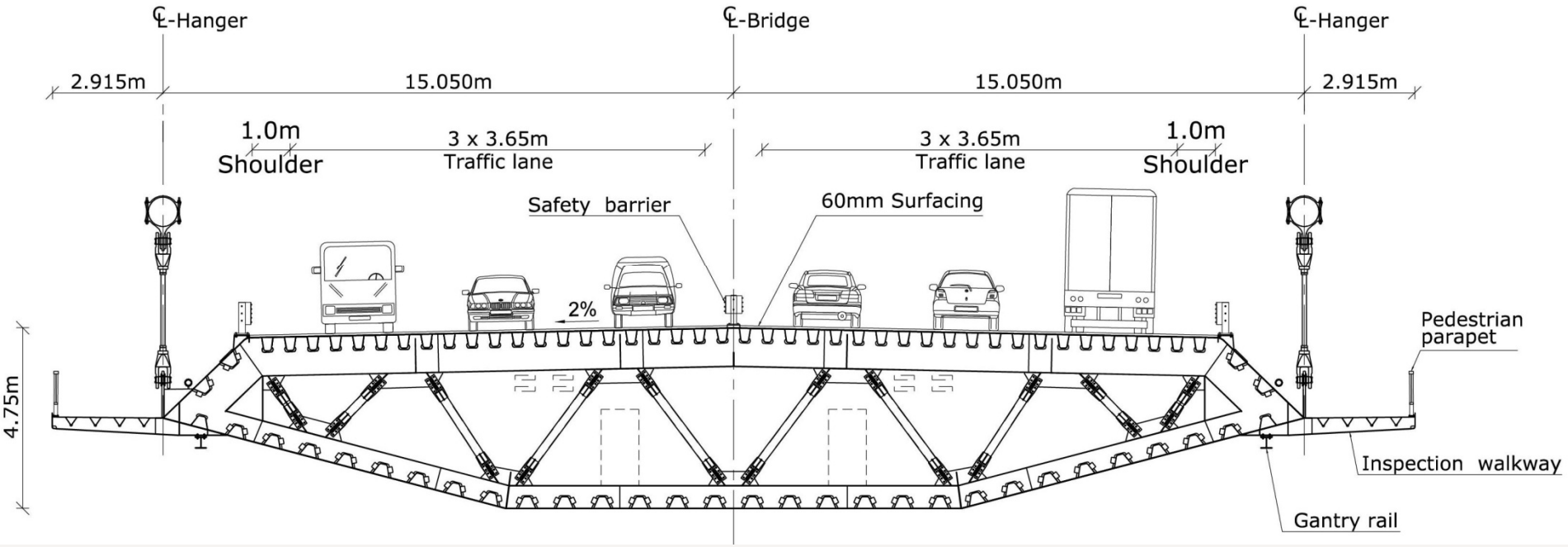
# General arrangement - Bridge deck




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



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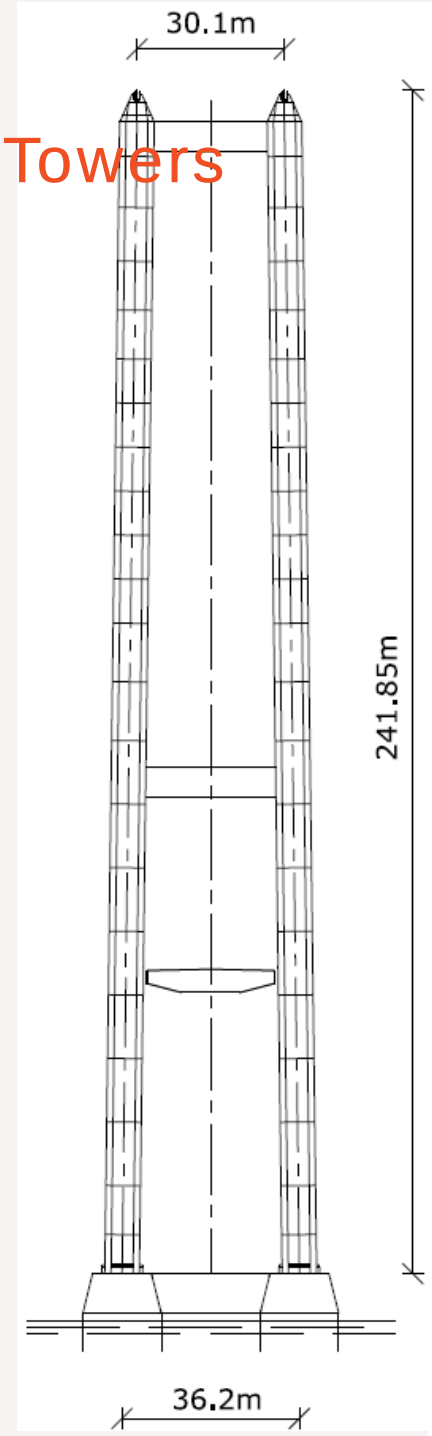
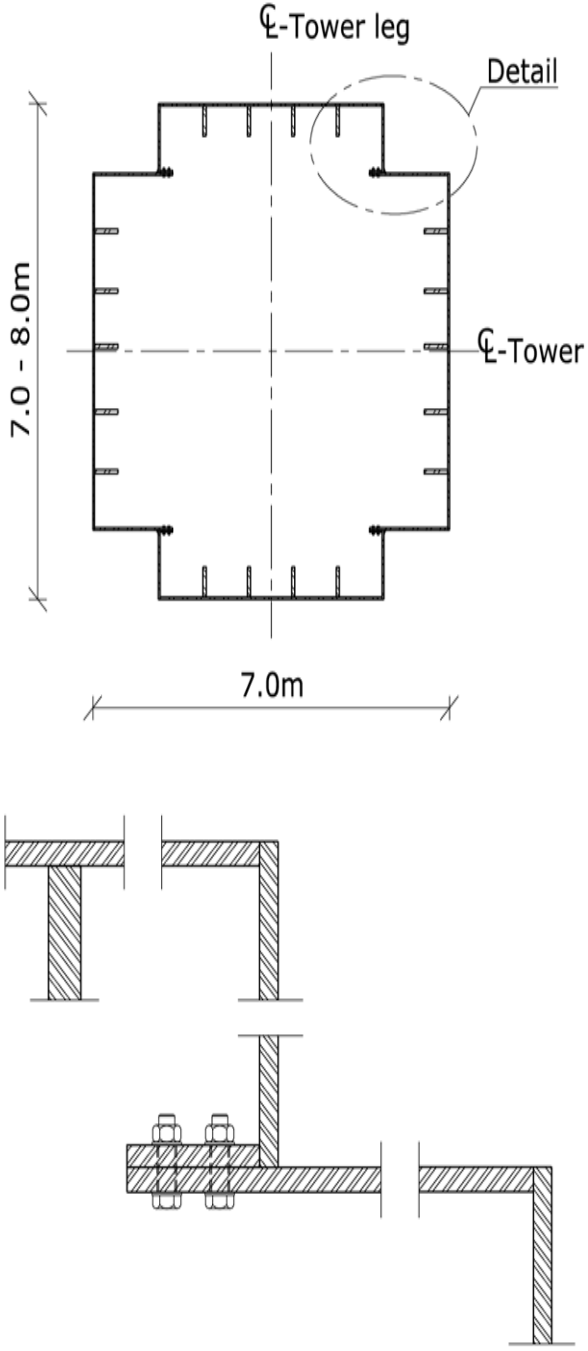
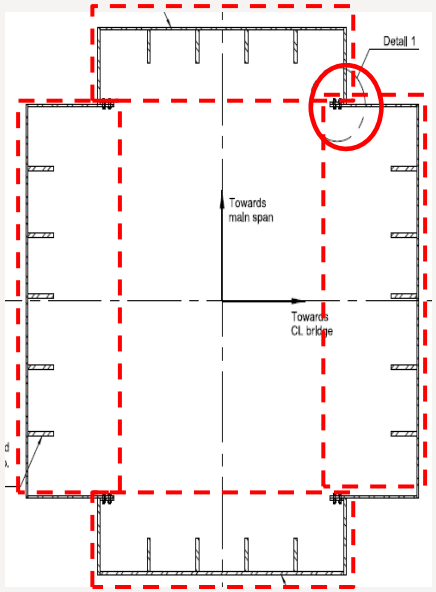
# General arrangement - Towers

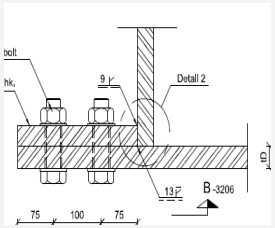
- Steel towers / low weight / increased flexibility / fast construction
- Seismic load combinations and normal ULS combinations are more or less equal in governing the tower design
- Constructed by prefabricated elements – 22 blocks
- Horizontal joints by combined welding and bolting

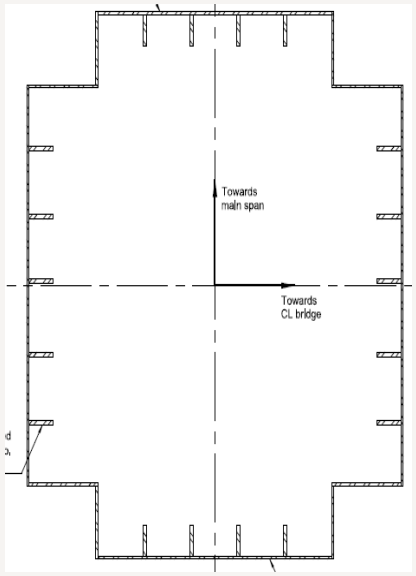


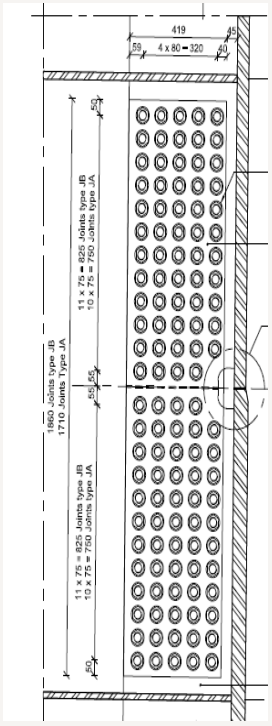



# Tower erection



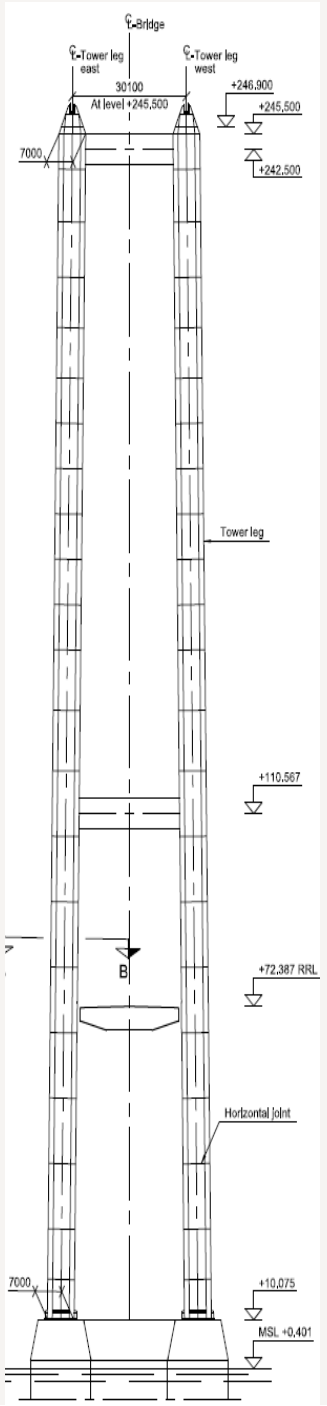



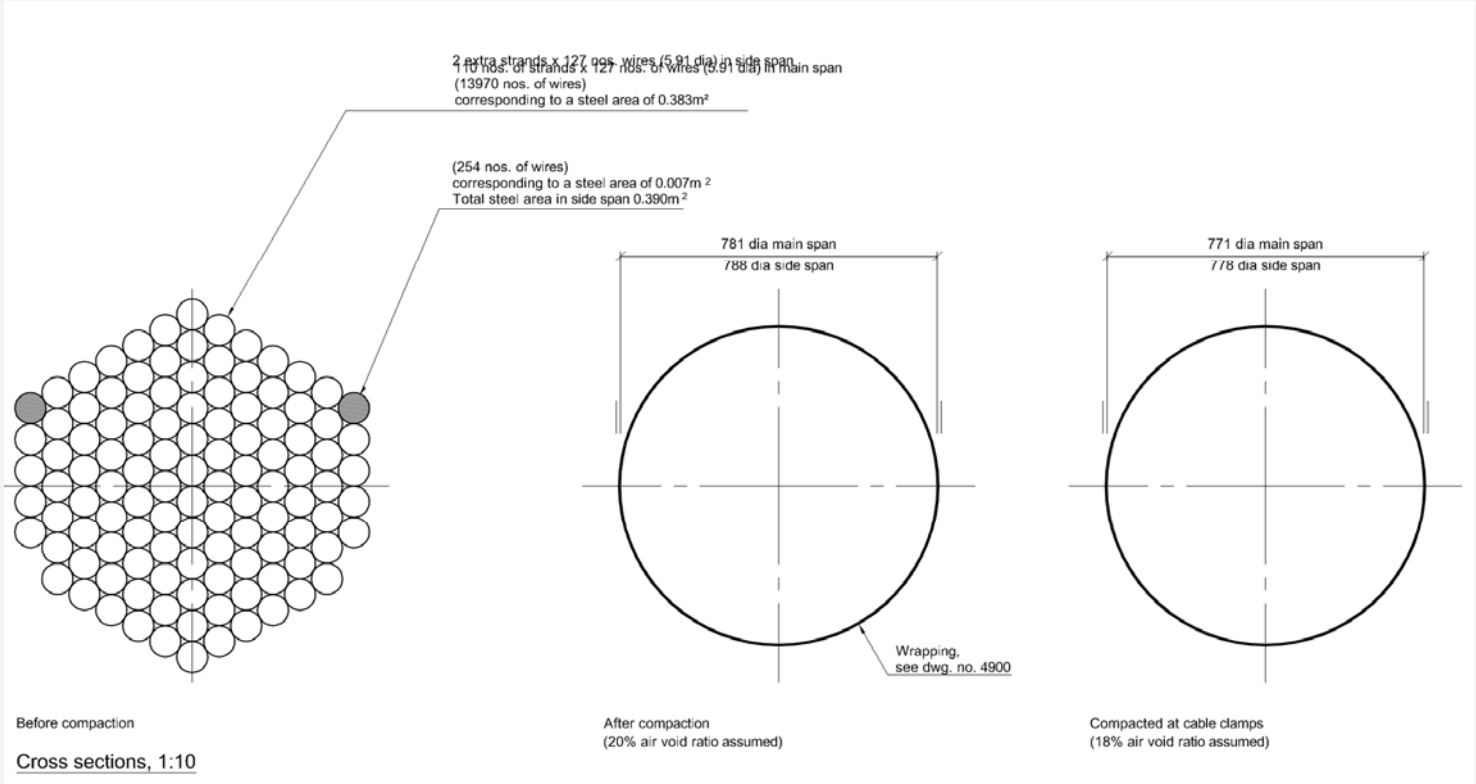

**Bolt friction connection in stiffeners**

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

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



# 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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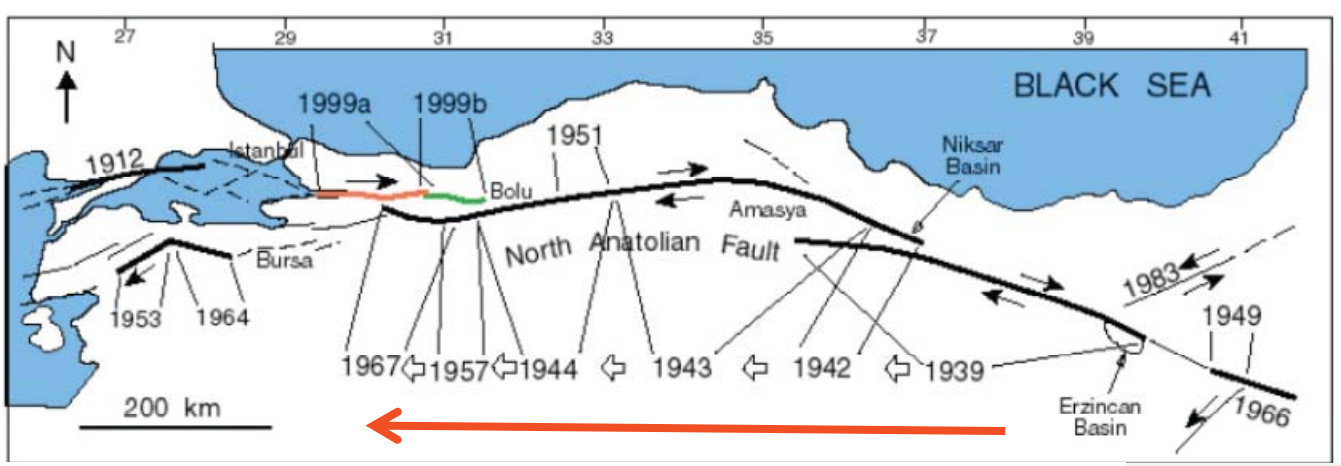
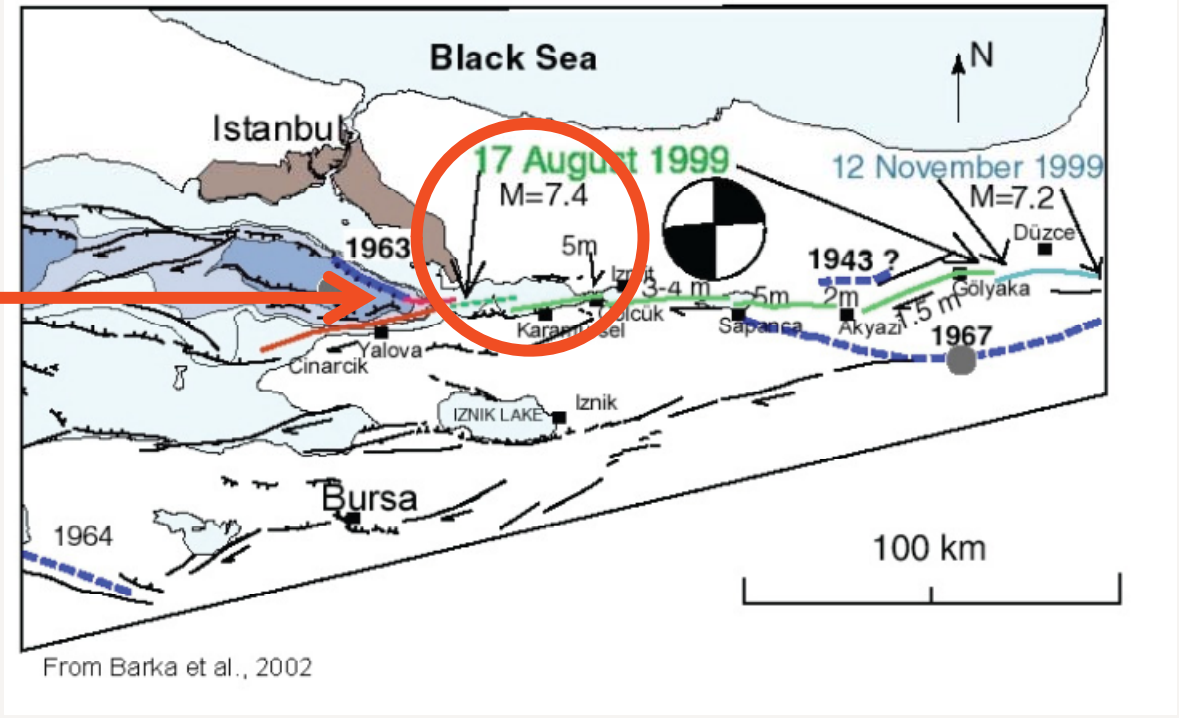
# High Seismic Activity

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



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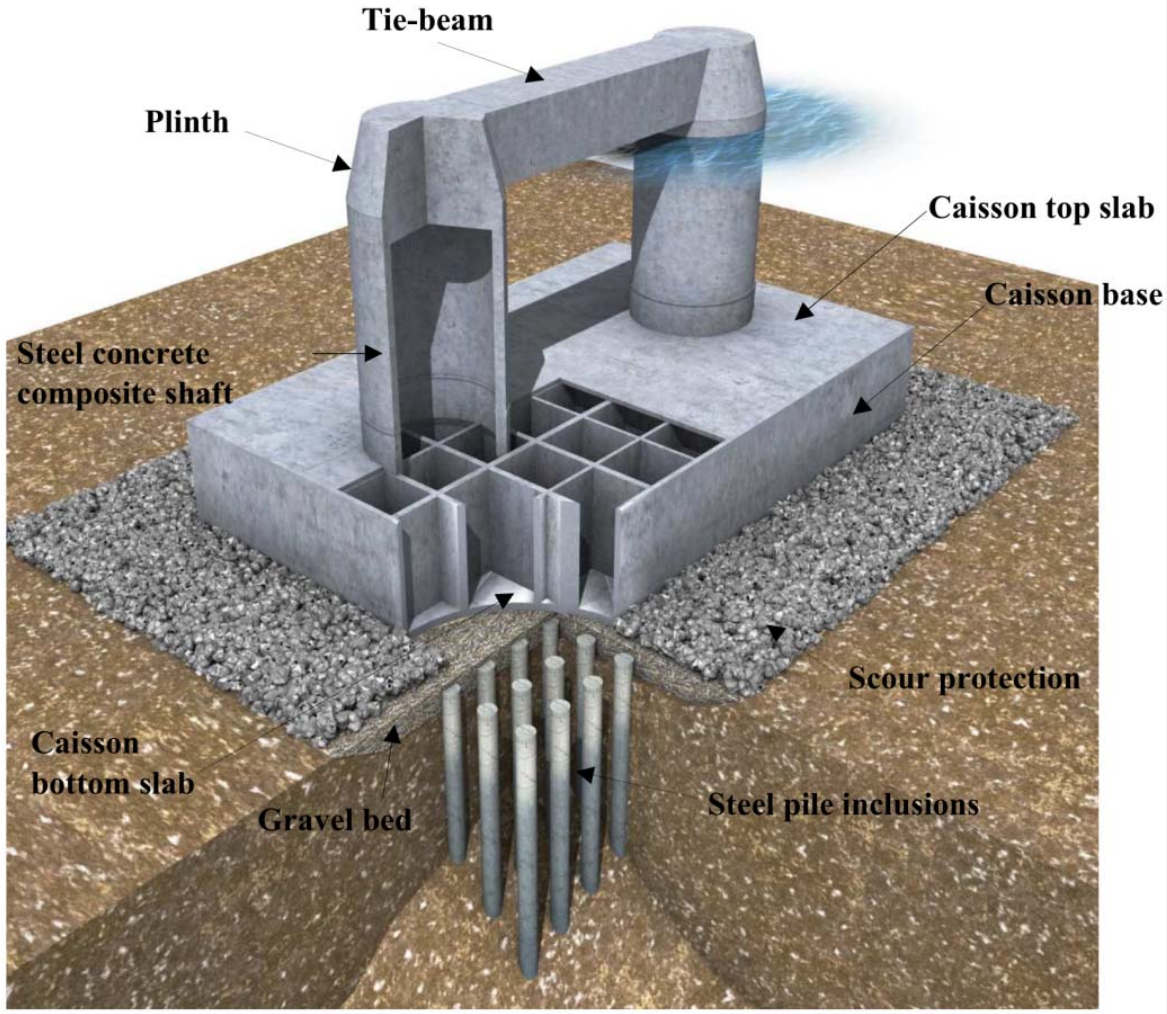
# General arrangement - Tower foundations




- 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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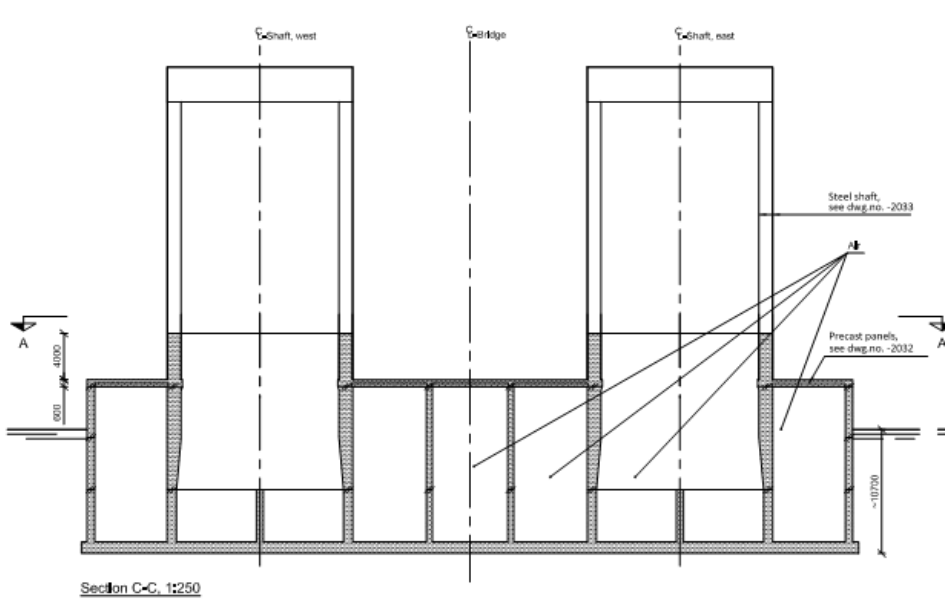
# Tower foundation construction – Dry dock

# 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.



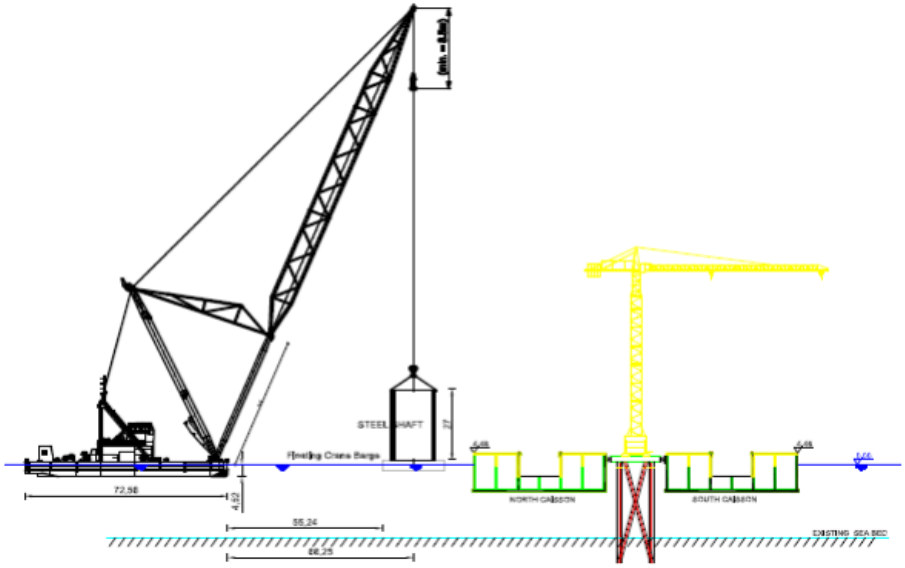




Figure 16 Installation of Steel Shaft



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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




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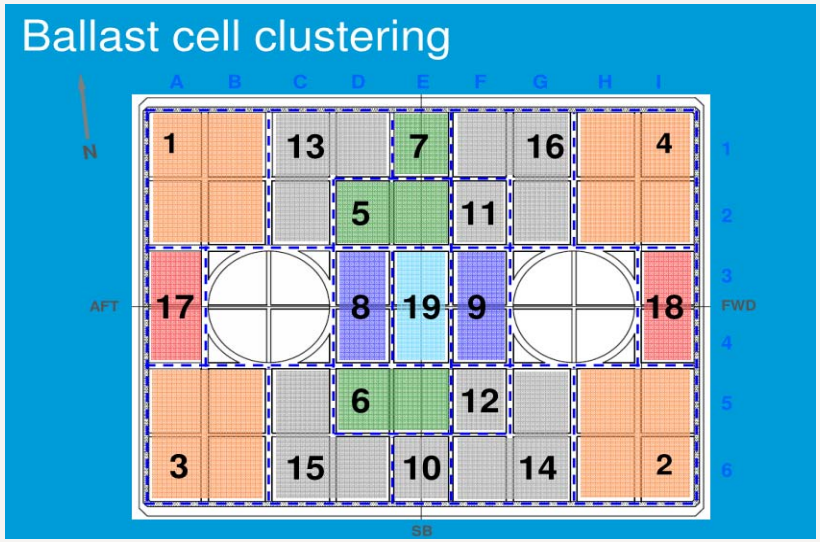
# Construction stages- Tower foundations - Immersion

- 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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# Tow out – North Tower Foundation



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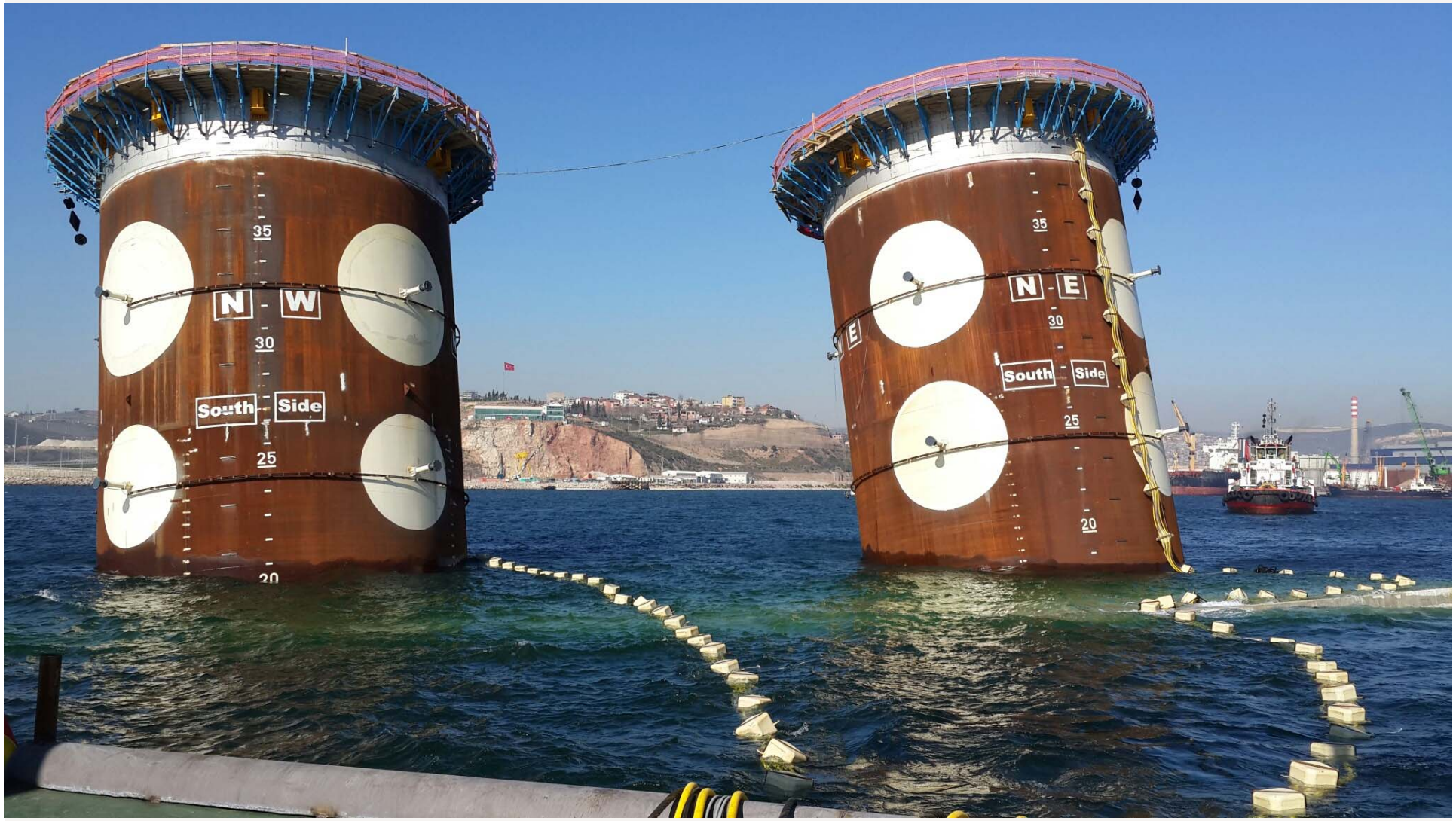
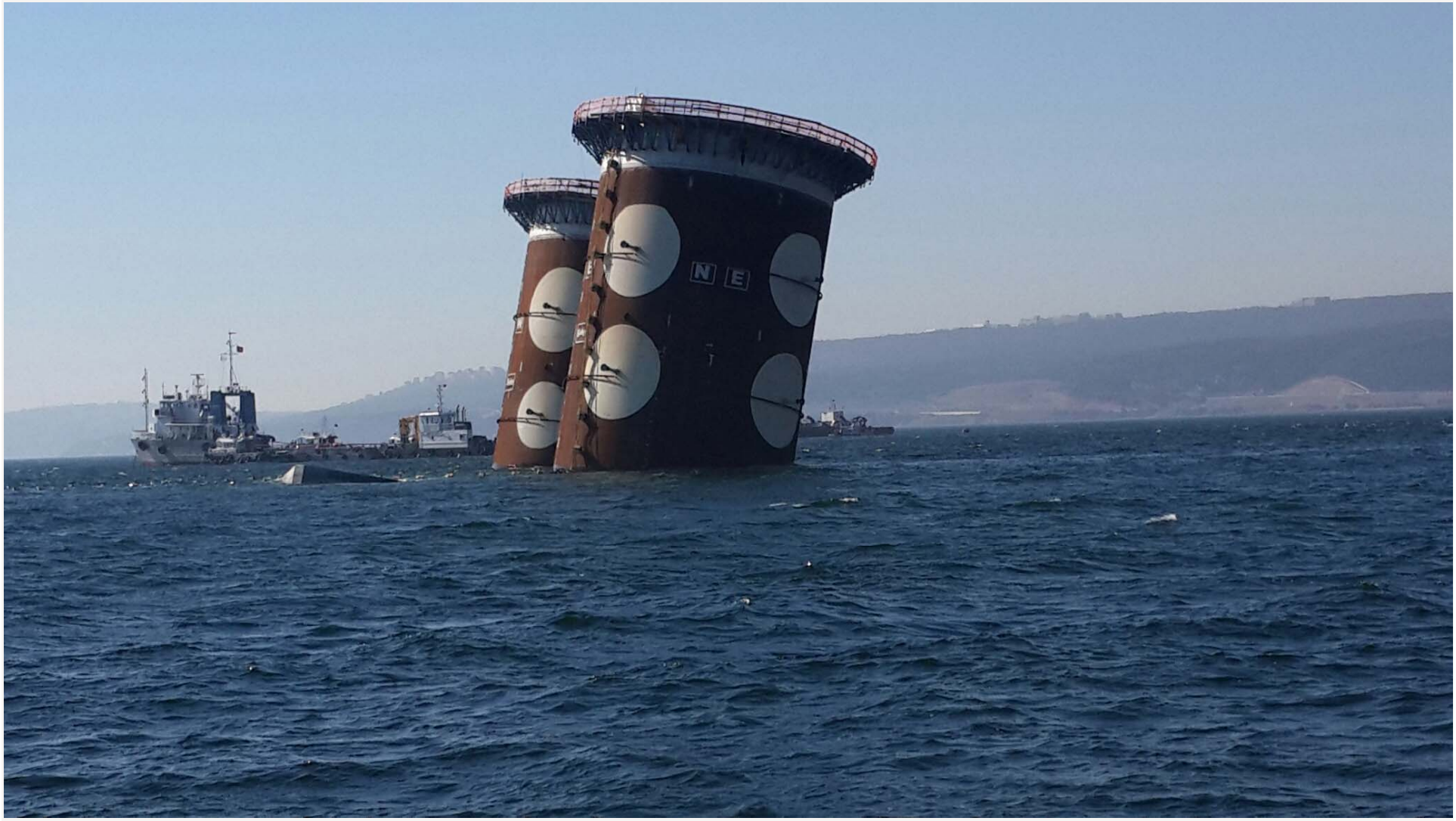
# Immersion – North Tower Foundation

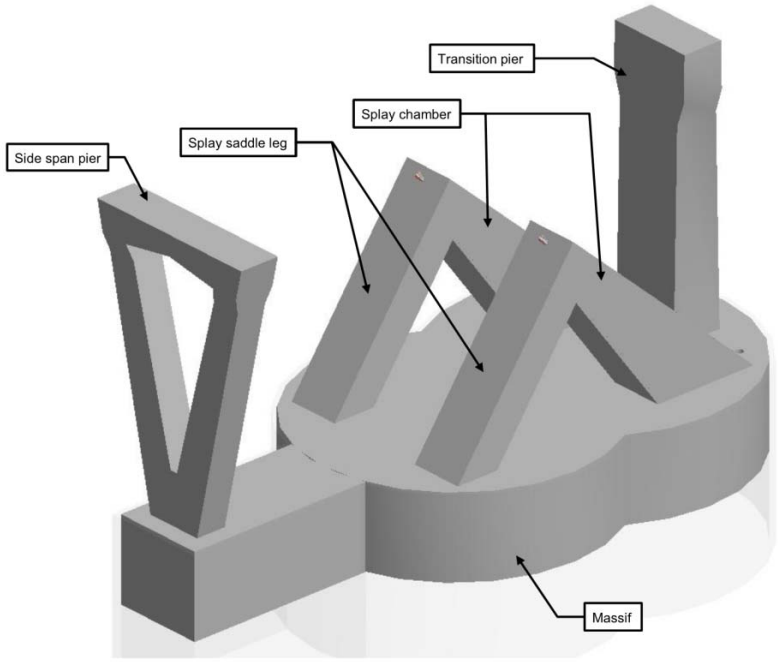


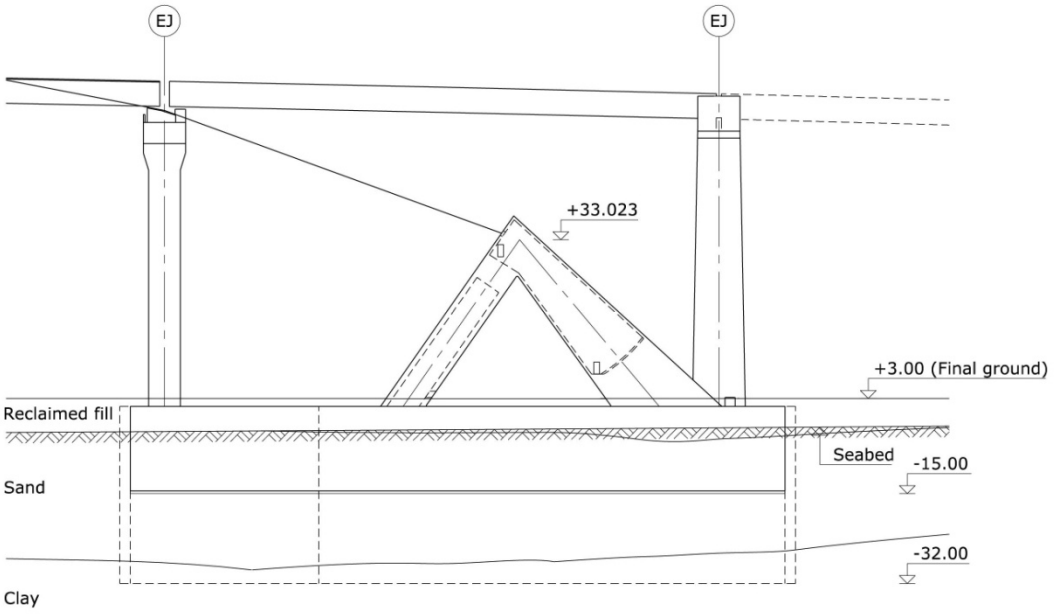
# Immersion – North Tower Foundation



# Final position – North Tower Foundation

# 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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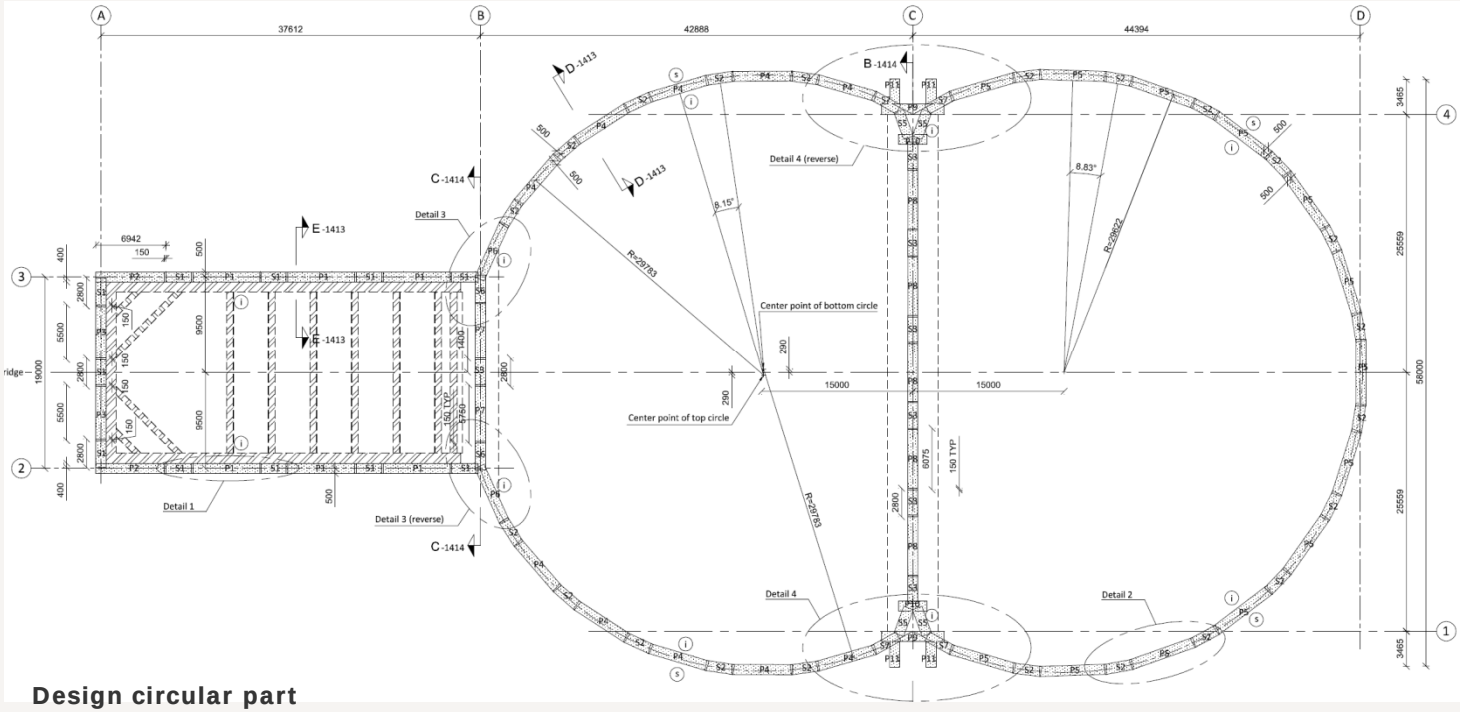
# South Anchor Block Excavation




**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

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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
- 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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# South Anchor Block Construction

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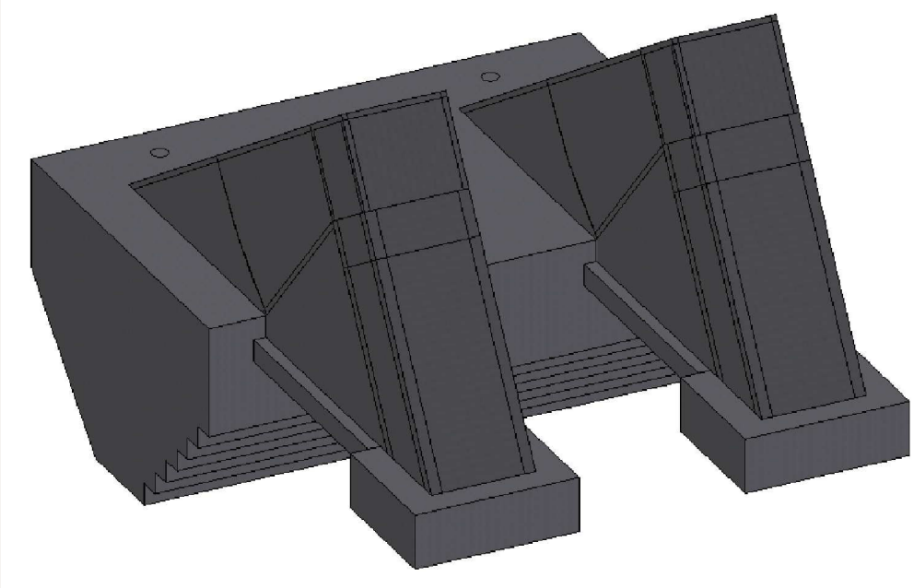
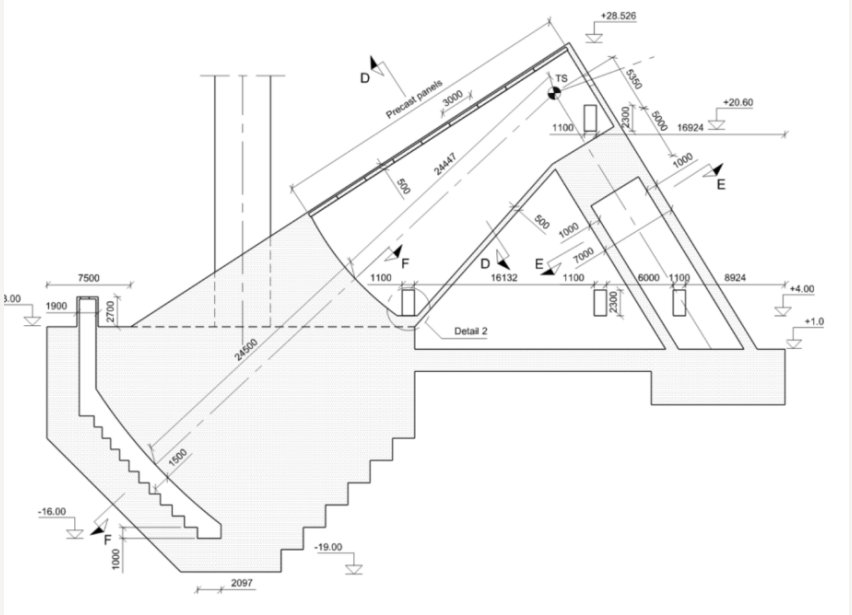
# Progress– South Anchor Block

# General arrangement – South Anchor Block

# 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

# 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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