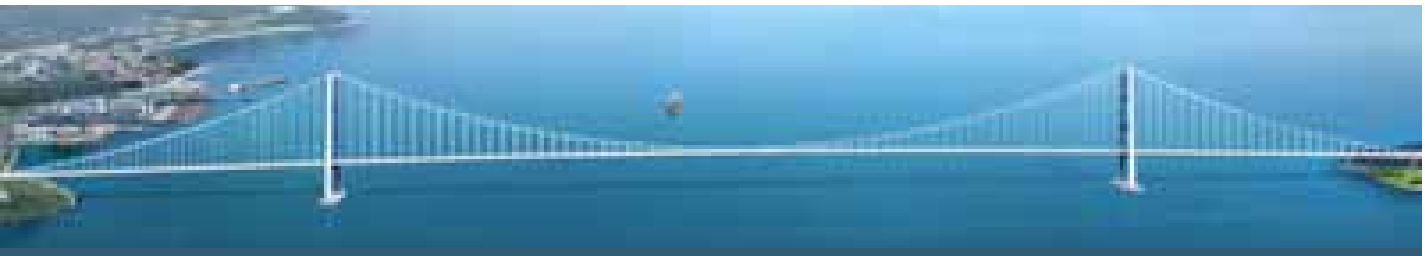
Izmit Bay Bridge Crossing, Gebze-Izmir Motorway



Integrated Onshore / Offshore Site Investigation for Izmit Bay Suspension Bridge crossing the North Anatolian Fault zone, Turkey

Fugro was retained by the NÖMAYG Joint Venture to assist with geotechnical, geological, and seismological evaluations for the 3-km-long suspension bridge crossing of Izmit Bay, Turkey. To this end Offshore and Onshore Geophysical Surveys, Deepwater, Nearshore and Onshore Geotechnical Investigations, and Trenching and Geologic Mapping were successfully completed in four months due to the urgency of the project. Additionally, advanced laboratory testing, integrated site characterization, conceptual foundation design and earthquake engineering interpretations were performed to provide a basis for tendering the project

Izmit Bay which is southeast of Istanbul connects to and extends northeast of the Sea of Marmara. The proposed bridge crosses the Bay at its narrowest constriction where the width of the Bay is reduced from a typical width about > 8 km, down to about 3 km. The current bridge alignment and preliminary bridge foundation locations are shown on the figure below.

The bridge is located in one of the most seismically active places in the world. The site spans the plate boundary between the Anatolian plate on the south and the Eurasian plate on the north, and, as such, has the potential to experience significant earthquakes associated with the relative motion accommodated on the North Anatolian Fault (source of the 1999 Izmit and Duzce earthquakes).

Understanding the geological, seismological and geotechnical setting and developing appropriate design crtieria in a very short time-frame was critical for Tendering the bridge contract. NOMAYG selected Fugro as the only contractor able to provide all required services, meet the challenging 4-month schedule, and provide a product that would be respected by potential bridge construction contractors.

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Fugro performed an extensive site investigation designed to address the following issues:

- Regional fault setting with a focus on understanding the location of the North Anatolian Fault in the project vicinity
- Alignment area geology and site conditions, with a focus on evaluating variations in near-surface site conditions within a few hundred meters of the proposed bridge alignment, and potential shallow geohazards that may impact the proposed bridge.
- Foundation stratigraphy in an area within approximately 100 to 200 meters around the proposed bridge foundations.

Fied works included:

Offshore Survey

- Regional grid: 80 km2 of geophysical and bathymetrical survey
- (Seismic, Side scan sonar; Bathymetric survey)
  Detailed Grid: 4,5 km2 of geophysical and bathymetrical survey

Onshore Seismic

- 9 line km seismic reflection
- 19 Test Pits
- 2 km of trenching

Offshore Geotechnical survey

- 46 Cone Penetration tests (CPT (U)) to 20…80 m
- 19 Sample Boreholes to 120 … 200 m incl.
- Borehole logging and geophysical measurement and in-situ-testing

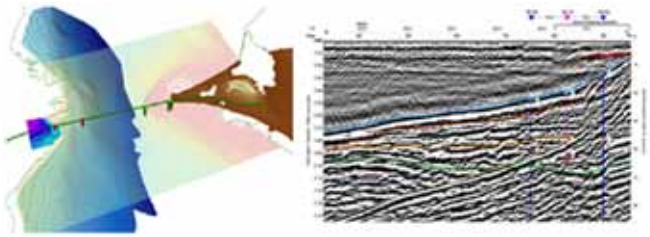
Onshore Geotechnical survey

- 54 Cone Penetration tests (CPT (U))
- 11 Sample Boreholes in soil and rock to 120 … 200 m incl. Borehole logging, geophysical measurement and in-situ-testing

Laboratory Testing

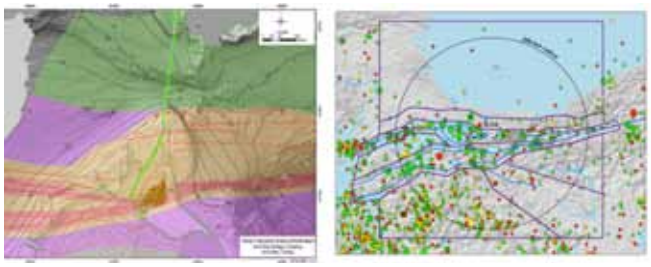
- Classification testing; Extensive static, dynamic and cyclic Laboratory testing on soil and rock

An integrated approach to site characterization was adopted for the project. In this approach, the stratigraphy in the geotechnical explorations, i.e. borings and cone penetration test (CPT) soundings, were compared and integrated with the interpreted stratigraphic relationships imaged by the geophysical surveys. All of the geophysical and geotechnical data were captured in a Geographic Information System (GIS) database. The GIS was used to shorten the overall timeframe for the site characterization and allowed project design to proceed concurrently with the geotechnical and earthquake engineering interpretations.



Fugro developed the Design Criteria for the Izmit Bay Bridge and performed earthquake engineering interpretations to assist with the preliminary design that included:

- Development of seismotectonic model of the region
- Probabilistic Seismic Hazard Analyses
- Nonlinear site response analyses
- Development of design ground motions with incorporation of fling effects
- Probabilistic Fault Displacement Hazard Analyses



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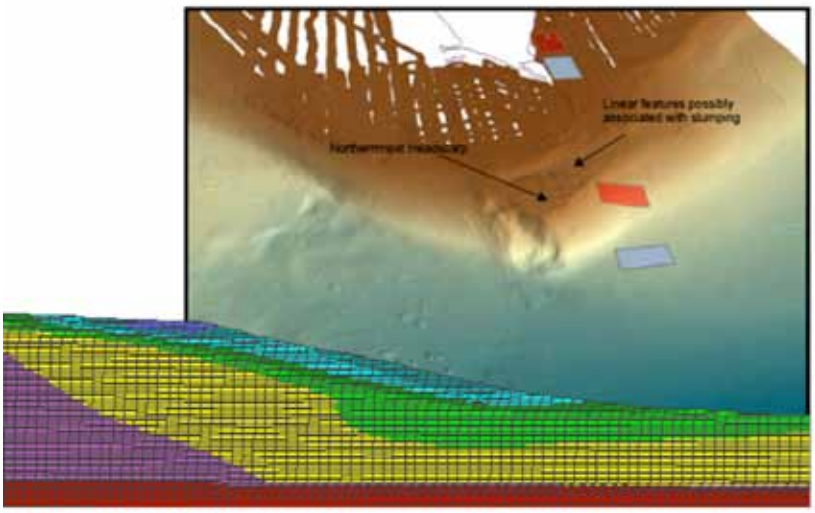
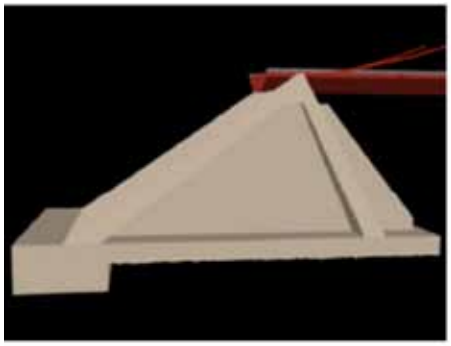
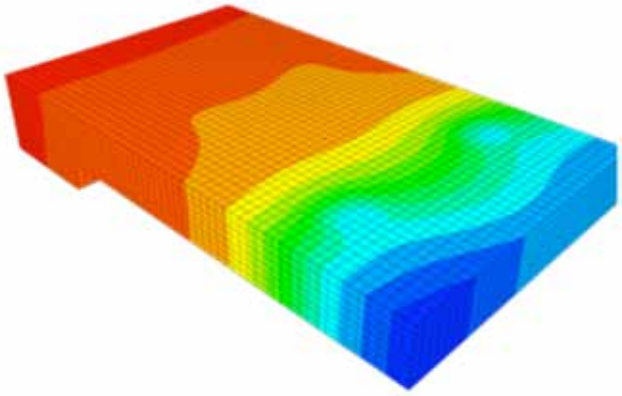
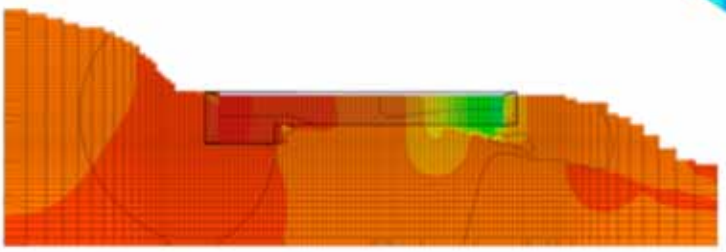
Fugro also performed advanced nolinear 2D and 3D finite difference analyses to assist with the preliminary foundation design of the bridge that included:

- 2D nonlinear finite difference analyses with FLAC to evaluate the potential for slope instability and lateral spreading near the bridge foundation locations
- 2D and 3D finite difference analyses with FLAC to assist with the preliminary design of the North Anchorage of the bridge that is founded in rock
- 3D finite difference analyses with FLAC to assess pile group effects for the preliminary design of the two Tower foundations and the South Anchorage of the bridge.









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