Izmit Bay Suspension Bridge – Settlement of Tower foundation: Monitoring and Consideration

Manabu INOUE
Bridge Engineer
IHI Infrastructure Systems
Kocaeli, TURKEY
manabu_inoue@iis.ihi.co.jp

Müslüm DURMAZ
Electrical Engineer
IHI Infrastructure Systems
Kocaeli, TURKEY
d_muslum@ihitr.com

Takanori SHIMA
Bridge Engineer
IHI Infrastructure Systems
Kocaeli, TURKEY
takanori_shima@iis.ihi.co.jp

Ahmet ÇELİKKIRAN
Survey Specialist
IHI Infrastructure Systems
Kocaeli, TURKEY
c_ahmet@ihitr.com

Brian FOGED
Geotechnical specialist
COWI A/S
Copenhargen, DENMARK
bfo@cowi.com

Thomas KASPER
Geotechnical specialist
COWI A/S
Copenhargen, DENMARK
tkas@cowi.com

Summary

This paper presents the settlement at the tower foundations of IZMIT Bay Suspension Bridge in Turkey. Due to the ground conditions, the consolidation and creep settlements of 0.64m for the north and 1.00m for the south is expected until the end of the bridge design life, respectively. The actual settlement is continuously measured and in good agreement with the prediction.

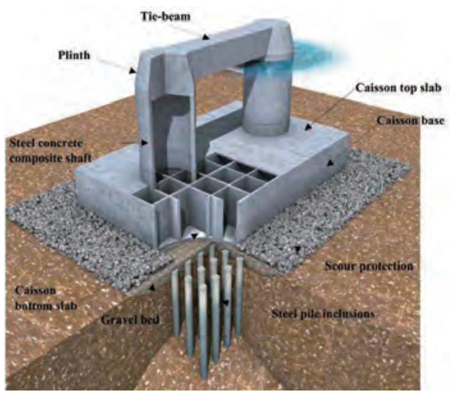
Keywords: IZMIT Bay Bridge, Settlement, Monitoring

1. Introduction

The IZMIT Bay Bridge, consisting of the North Approach Viaduct, the Suspension Bridge and the South Approach Viaduct, will carry the planned Gebze-Orhangazi-Bursa-Izmir motorway across the Sea of Marmara at the Bay of IZMIT between the Diliskelesi peninsula on the north and the Hersek peninsula on the south in Turkey. The bridge construction has started in January 2013 and will be completed in early 2016. The IZMIT Bay Bridge is arranged as a three span continuous suspension bridge having a total length of 566+1550+566=2682m. The north and south tower foundations are placed on the sea bed at EL.-40m where inclusion piles are driven to prevent differential settlement and shear failure of ground under large earthquakes. A 3m thick gravel bed separates the improved soil and the concrete caisson to provide the designated base isolation, i.e. a controlled sliding surface and a fuse for high amplitude earthquakes.

The tower foundation structure, on which the steel tower to support the main cable stands, consists of three main components, i.e.

- Steel inclusion and stone work in the ground
- Caisson and Steel concrete composite shafts
- Concrete plinth and tie-beam



The soil below the caisson is improved by a grid of steel pile inclusions (2m in diameter per each) to a depth of 35m below foundation level. The steel pile inclusions provide required vertical and horizontal bearing capacity. The top of the steel pile inclusions are filled by a gravel bed with 3m thickness, which provides a controlled connection to the top of the steel pile inclusions for horizontal and vertical load transfer without having a direct connection between the tower foundation and piles. The top surface of the gravel bed also provides a controlled sliding surface in case of big earthquakes.

Because of its ground condition, the north and the south tower foundations are settled both during the construction and at the in-service condition. The predicted settlement values during the construction are 320mm for the north and 640mm for the south, respectively. The settlement of 300mm during the 100-years-service-life is also expected.

2. Settlement

The time history of measured settlement data over pressure as of the end of October, 2014 is plotted in Figure 2. The line colored in red shows as-built data and the blue one is the prediction. The initial deformations (settlement) at the touchdown of the concrete caisson which was considered the most uncertainty in the prediction are in good agreement for the north and some 20mm greater than the prediction for the south, respectively. The difference with the consideration of as-built height of the tower caisson has been successfully compensated by adjusting the plinth concrete height. The tendency of settlement over pressure is in good agreement for both the north and the south.

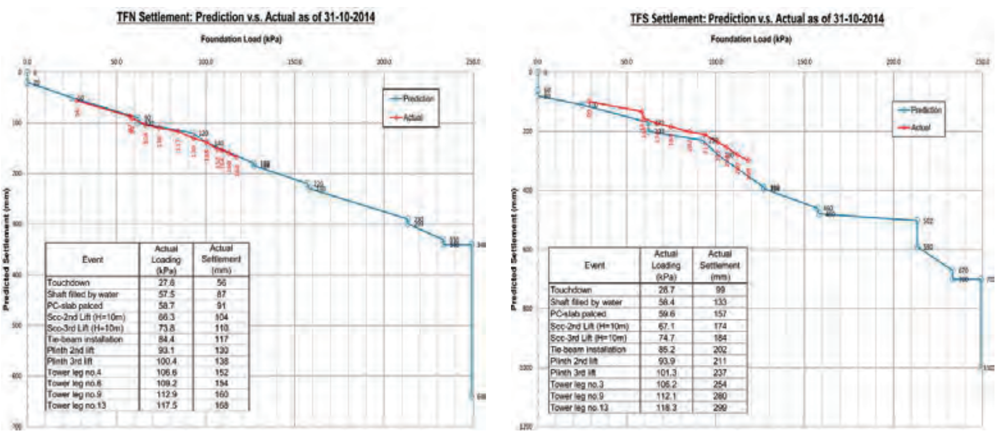


Figure 2: Settlement over pressure

At the initial stage, the rotational displacement around the bridge transverse axis fluctuated with the amplitude of maximum 0.08 degrees following a daily tidal current, however the fluctuation was being decreased with the progress of consecutive construction activities (increasing own weight). After concreting the hybrid shaft wall, the rotational displacement is rather stable and only a small rotation corresponding (temporary) loads on the tower which result in an additional bending moment is observed.

The as-built settlement and rotational displacement are continuously measured by two monitoring systems. Except the initial deformation/settlement at the touch down of the concrete caisson which was considered as the most uncertain in the prediction, the actual settlement is in good agreement with the prediction as of the end of November, 2014. The current primary and secondary settlement monitoring systems will be used some 1-2 year after the completion, and the permanent structural health monitoring system will continue to monitor the settlement until the end of the bridge life with some overlap period.

3. Acknowledgement

The authors are deeply grateful to NOMAYG joint venture, Nurol, Ozaltin, Makyol, Astaldi and Gocay for guiding us to successful progress and their permission on publication of this paper. The authors also would like to acknowledge the enormous individual and team efforts made by all those who have been involved in developing the design and the construction of IZMIT Bay bridge.