Izmit Bay Suspension Bridge – Geometry Control during Tower Erection

Masashi KAN'O
Bridge Engineer
IHI Infrastructure System
Tokyo, Japan
masashi_kano@iis.ihi.co.jp

Mitsuhiro KUDO
Bridge Engineer
IHI Infrastructure System
Tokyo, Japan
mitsuhiro_kudo@iis.ihi.co.jp

Mitsuhiro YAMANE
Bridge Engineer
IHI Infrastructure System
Tokyo, Japan
mitsuhiro_yamane@iis.ihi.co.jp

Tsuyoshi TANAKA
Bridge Engineer
IHI Infrastructure System
Tokyo, Japan
tsuyoshi_tanaka@iis.ihi.co.jp

Shuji YAMAMOTO
Bridge Engineer
IHI Infrastructure System
Tokyo, Japan
syuji_yamamoto@iis.ihi.co.jp

Ahmet Çelikkıran
Surveying Engineer
IHI Infrastructure System
Istanbul, Turkey
c_ahmet@ihitr.com

Summary

The construction of the Izmit Bay Suspension Bridge has started in January 2013 to be completed early 2016. The tower is steel construction reaching over 246.5m above sea level and to be completed by end of 2014, followed by the cable erection in 2015. The papers describe the surveying method to control tower geometry within designed tolerance during construction.
Keywords: suspension bridge, steel tower, surveying, GPS

1. Introduction

The tower is 235.425m high steel tower consisting of two tower legs and two cross beams as shown in Figure 1. The south tower and the north tower are identical in the geometry and in the details including the steel grade and plate thickness. At each step of the tower erection, the geometric position of the erection top is surveyed by the global positioning systems (GPS). The surveyed data are collected to a monitoring center located at the north and south site office by the wired network. The survey system includes monitoring of environmental condition, such as wind and temperature. The values measured by the survey system are utilized to evaluate the geometry of the tower at each erection step.

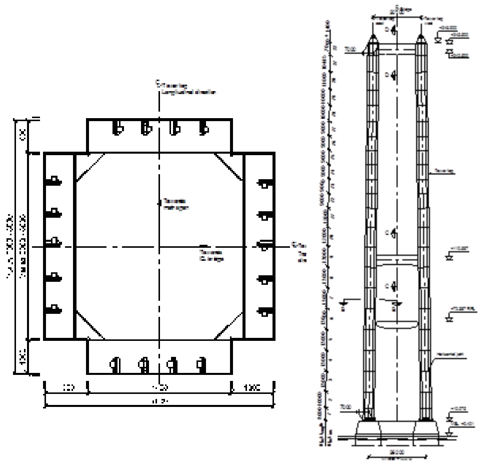

Figure 1 General Arrangement of Tower

2. Survey System

GPS system is chosen, because the erection top of the tower is supposed to be in motion during the survey work due to wind effect, thus optical instrument may not accurately measure the moving top, whereas GPS system is not affected much by wind for capturing the position in motion. The survey points shall be at four points on the reference line marked on the outer faces of the tower leg block provided during the trial assembly that gives the center of the tower leg block by intersecting of two lines each made by connecting

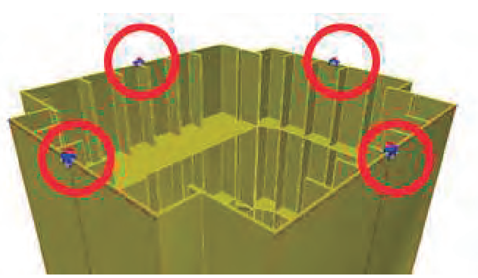

Figure 2 Surveying point on Tower leg

confronting two points. The surveyed data by GPS system provides the tower geometry affected by environmental loadings such as temperature and wind and by installing of temporary structures/equipment to the tower. The geometry control is made for real geometry of the tower not affected by those loadings and temporary structure/equipment. Thus these influences are quantified with model computation based on environmental data collected and information of temporary structure/equipment.

3. Geometry Control

The global geometrical tolerances of the tower are specified according to design requirement. Additionally, the tower leg shall be constructed within the verticality tolerance of h/2500 (deviation from straight anywhere along the tower leg). As for sequence, after installation of new tower leg block on previous block and temporary connection of vertical stiffener, GPS instruments are placed on top of new erected block, and gathering the positioning data including sensor data related with environmental affection during the survey. Secondary, after processing of positional data, evaluation of sensor data related with environmental affection and quantification of loading by temporary structure/equipment, the real geometry without affection from environment and can be modelled. Finally, the prediction of the tower geometry is made by adding the geometry of un-erected tower blocks obtained from the trial assembly on the geometry of erected tower leg blocks obtained by GPS survey corrected to eliminate the effect of environment loading and temporary structure/equipment as shown in Figure 3. The tower geometry shall be controlled during the construction so that the tower will be completed within the global tolerance. If the prediction of the tower geometry shows the tower being constructed and completed outside the tolerance, the position of newly erected tower leg block shall be adjusted at horizontal joint on previously erected tower leg block with shim plates at the matching piece, i.e. change of distance between two blocks and/or create angle break between two blocks, so that the predicted tower geometry stays within the tolerance. The matching pieces, provided in trial assembly at fabrication phase at four corners for full section erection blocks and eight corners for panel-erection blocks (Figure 4), have initial set-up of shim plates for adjustment.

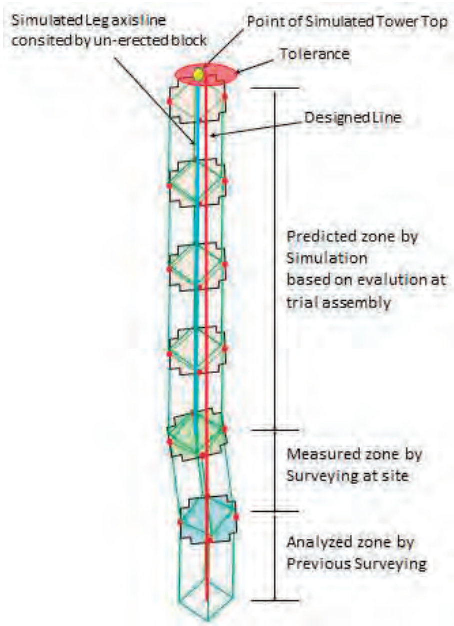

Figure 3 Prediction of Tower Geometry

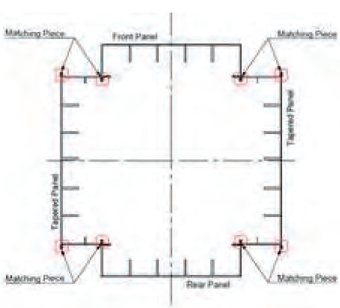

Figure 4 Arrangement of Matching Piece

4. Conclusion

By applying the geometrical control method described in this paper, the tower of IZMIT Bay Bridge has been successfully controlled within the tolerance with consideration of deviation in the elevation, which results from the difference between the prediction and the actual of Tower basement settlement.