DOI: 10.24904/footbridge2017.09456

DESIGN AND VIBRATION SERVICEABILITY EVALUATION OF PEDESTRIAN SPACE ARCH BRIDGE

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Summary

Wirye bridge with a width of 7.3m and an extension of 109m is a pedestrian space arch bridge crossing the highway of 70m width. Due to the on-site conditions of crossing a highway with high traffic volume, steel pipe girder and steel deck was installed by small-block erection method after erecting arch rib and vertical members with single lift installation method. It is possible to mount the steel pipe girder and the steel deck more easily by installing a cross beam in advance that connects the vertical members each other to reduce the deformation of the vertical member. And the cross beam can improve the structural safety of the buckling through the decrease of the unsupported length by the vertical member acting as both-end supported conditions instead of cantilever during construction period. As a result of the serviceability evaluation for deflection and vibration, it was presented that Wirye bridge satisfied with serviceability criteria for deflection and vibration. In addition, vibration comport evaluation according to ISO 2631-2 verified that the exposure time of fatigue-decreased proficiency boundary for vertical and horizontal directions was evaluated to be more than 24 hours, and that the human function due to vibration is not degraded within 24 hours on bridge.

Keywords: space arch bridge; pedestrian bridge; steel pipe girder; cross beam; vertical member; serviceability; vibration comfort evaluation

1. Bridge status

Wirye bridge is a space arch bridge that crosses the highway. The plane alignment is straight and the vertical alignment slope is 5%. The total span is 109m and the vertical is 15m+14.5m+4@12.5m+14.5m+15m spacing. The overall width including the maintenance passage is 7.3m.

2. Constructability

For the bridge construction, a erection bent was installed in a place where it would not interfere with highway traffic. The bridge members were divided into 9 blocks and constructed using 550ton and 250ton crawler cranes. The construction of the bridge was planned that the arch ribs and vertical members were installed and then the steel pipe girders were erected on the vertical members. In this case, it is possible to mount the steel pipe girder and the steel deck more easily by installing a cross beam in advance that connects the vertical members each other to reduce the deformation of the vertical member. And the cross beam can improve the structural safety of the buckling through the decrease of the unsupported length by the vertical member acting as both-end supported conditions instead of cantilever during construction period.

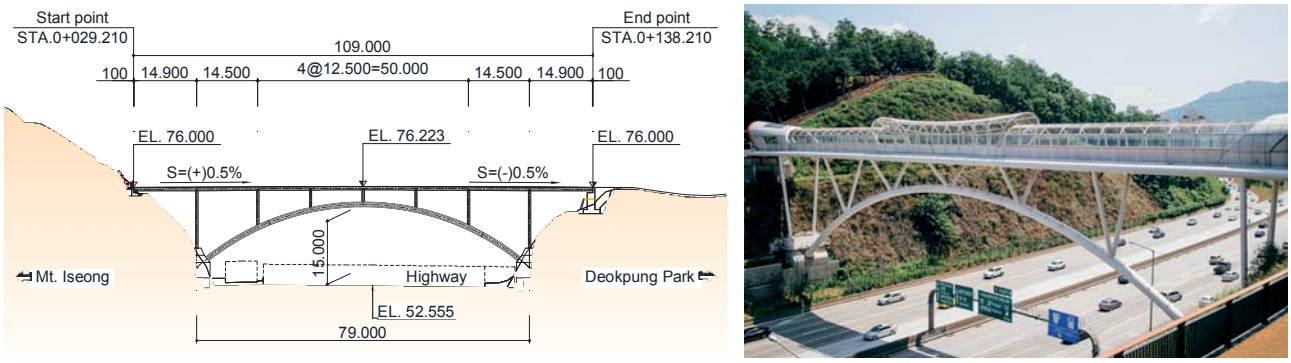

Fig. 1. Wirye bridge, a) Longitudinal section, b) Completed structure

3. Serviceability

3.1 Vibration serviceability evaluation

When the natural frequency of vertical direction vibration is close to 2Hz, the amplitude of vibration in the vertical direction is increased and it induces pedestrians discomfort. Therefore it is necessary to ensure that the natural frequency of vertical direction is not 1.5 ~ 2.3Hz. With the same concept, it is necessary to ensure that the frequency of horizontal direction is not close to 0.8 ~ 1.2Hz in accordance with the Eurocode 2 (EN 1992-2). As a result of eigenvalue analysis, the natural frequencies for the vertical and horizontal directions of Wirye bridge were estimated to be 2.56Hz and 1.22Hz, respectively.

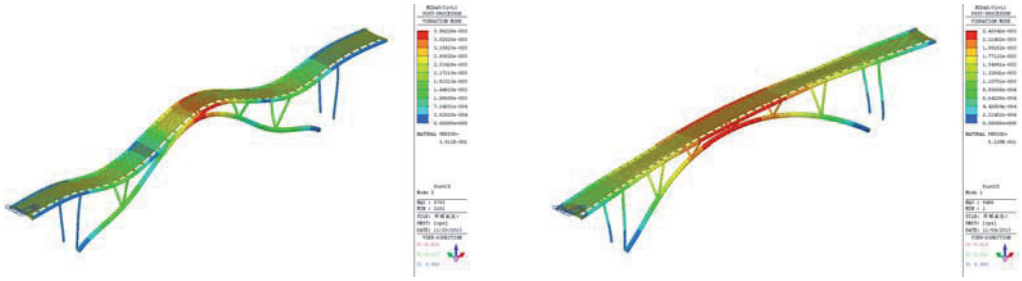

Fig. 2. Vibration mode shape, a) Vertical direction, b) Horizontal direction

3.2 Vibration comfort evaluation

In order to evaluate vibration serviceability, the possibility of resonance for vertical and horizontal directions was reviewed. As a result, it was verified that vibration serviceability is satisfied for Wirye bridge where the natural frequencies of each direction were out of the resonance frequency range. However, it is considered that a more detailed examination is needed because the structure is slender against vibration caused by unexpected cause. Therefore, vibration comfort analysis is performed according to ISO 2631-2. As a result of vibration comfort evaluation according to ISO 2631, it was verified that the comfort for the vertical direction vibration starts to decline when the stay for more than 16 hours. On the other hand, it was verified that the comfort for the horizontal direction vibration is not decreased even if it stays more than 24 hours.

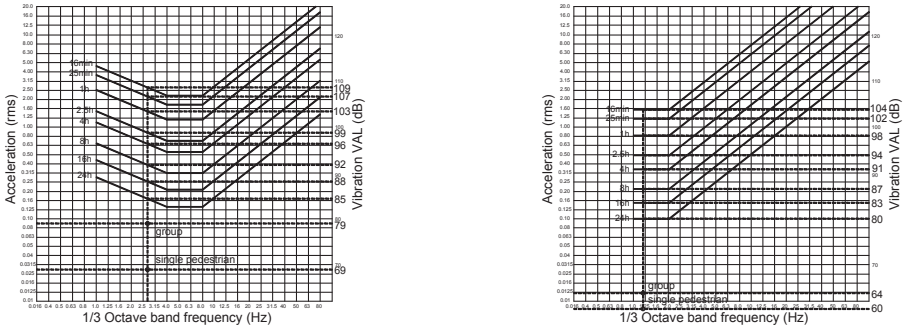

Fig. 3. Vibration comfort evaluation, a)Vertical direction, b)Horizontal direction