

Research on Proper Diaphragm Layout of Long-span Continuous Steel-Box-Girder

Ling BAI

Research Professor
China Academy of Railway
Sciences
Beijing, China
bailing@rails.com.cn

Ling BAI, born 1971. Her main research area is related steel bridge fatigue, optimization and maintenance.



Xing FANG

Research Associate
China Academy of Railway
Sciences
Beijing, China
fangxing@rails.com.cn

Xing FANG, born 1980. His main research area is related steel bridge fatigue, optimization and maintenance.



Summary

Mechanical behaviors of the steel-box-girder(SBG) under eccentric load are analyzed. And then it is deduced that proper layout of diaphragms in SBG should be discussed from the point of view of controlling the distortional warping stress which is very complicated to calculate. Although several current standards already provide how to calculate the distortional warping stress, the long-span continuous SBG is beyond the application scope of these standards. Hence, here it is put forward that the distortion warping of the single-room rectangular-box-girder is regarded as the bending of the beam on elastic foundation (BEF) based on the similarity between the distortion warping control differential equation of the single-room rectangular-box-girder and the bending control differential equation of BEF. By this analogy method, the distortional warping stress of the single-room rectangular-box-beam can be solved more easily. Finally, the distortional warping stress of the Chongqi Main Bridge, whose SBG has the longest span and longest length in China, is calculated by this analogy method and thereby the reasonable rigidity, type and section area of its diaphragms are suggested. These suggestions are all adopted by the designer and used in the actual girder.

Keywords: steel box girder (SBG); distortional warping stress; diaphragm layout; beam on elastic supports analogy (BEA).

1. Introduction

SBG is one of main structural types of long-span steel bridges. The reasonable space and rigidity of its diaphragm can effectively keep its section shape under eccentric loads, reduce deformation and stress caused by the section distortional warping and improve the transverse distribution performance under loads. Therefore, in the design of the continuous SBG bridge, it is necessary to study how to calculate the distortional warping stress and arrange diaphragms reasonably and how the diaphragm layout affects the distortional warping stress. As to the diaphragm layout, there isn't any related provision in any Chinese design standard by now while BS5400 and Japanese standard give some related provisions listed below.

- The distortional warping stress formulas in BS5400-3:2000 [1] are based on the investigation and test research results fulfilled by Merrison Committee[2]. However, these formulas are established on the assumption that the diaphragm can restrain the section distortion effectively.
- In Japan, there are detail provisions about the type, space and rigidity of the diaphragm in *Steel Highway Bridge Design Manual*.

But the long-span continuous SBG is beyond the application scope of above standards. And it is time consuming and inconvenient if the diaphragm design is conducted by finite element method (FEM) of shell element. Therefore, here the analysis method of the distortional warping stress and the proper diaphragm layout are studied. The study results are used in the Chongqi Main Bridge, which is the longest span and longest length SBG bridge in China.