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Finite element simulation of the composite continuous box-girder bridge with corrugated steel webs by CBCW

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In this paper, the detail of simulation of the Juancheng Yellow River Highway Bridge is presented. It is a composite continuous box-girder bridge with corrugated steel webs with a main span of 120 meters and span arrangement of 70m+11×120m+70m.

The type of prestressed concrete box-girder bridges with corrugated steel webs is a major improvement on traditional prestressed concrete box-girder bridges. The form has been adopted not only in simple supported bridges, continuous bridges and continuous frame bridges but also in extradosed cable-stayed bridges as well as cable-stayed bridges (HONG-WEI REN et al., 2008).

This kind of structure is rather complex and the structural behaviour can not be calculated exactly by the conventional beam element analyses method because of the presence of shear deformation of corrugated steel webs. Since the shear deformation of this kind of structure has a great influence on the vertical displacement, it is not negligible in the structural deformation calculation (HONG-JIANG LI et al., 2002; JIAN-YONG SONG et al., 2002; QI-YUAN ZHOU and XUAN-NENG GAO, 2006). Though the general 3-D FE software can be adopted to model the corrugated steel webs structure, but it is always time-consuming and not convenient in usage. Therefore, it is necessary to develop a customized FE module to deal with the simulation of this kind composite bridge.

The parameterized modeling module CBCW (Composite Bridge with Corrugated Webs) was developed based on commercial general software - ANSYS by its APDL and UIDL languages (JIAN-YONG SONG et al., 2006). It is divided into three parts including the pre-processor, solution and postprocessor modules. Based on the parameters inputted through dialog box interface, the model of composite bridges with corrugated webs can be established automatically.

In the FE model of Juancheng Yellow River Highway Bridge, the SOLID45 element is employed to model the top and bottom concrete plate, SHELL43 element model the corrugated steel webs, while LINK8 element model both the internal and external prestressing tendons, see Figure 1.

Cantilever construction method is adopted in the Juancheng Yellow River Highway Bridge construction. The main beam is composed of twelve standard segments, and displacement increment of each segment was measured under various load cases to verify the module CBCW. Construction simulation of the Juancheng Yellow River Highway Bridge is performed with the module CBCW, and the comparison between FEA and measured results is reported and discussed in the paper.

In order to verify the module CBCW, the comparison between the numerical and measured results is made. The comparison results of displacement increment of the twelve segments both at the maximum cantilever stage and at the stage of side span closure were discussed. It can be noted that the predicted results agree well with the measured ones whether at the maximum double cantilever stage or at the stage of side span closure. Meanwhile, if plane member system software is adopted, the numerical results calculated by either Euler beam element or Timoshenko beam element would lead to a great error. So it is suggested that the deformation calculation and construction control of this kind bridge should be conducted with the 3-D finite element model.

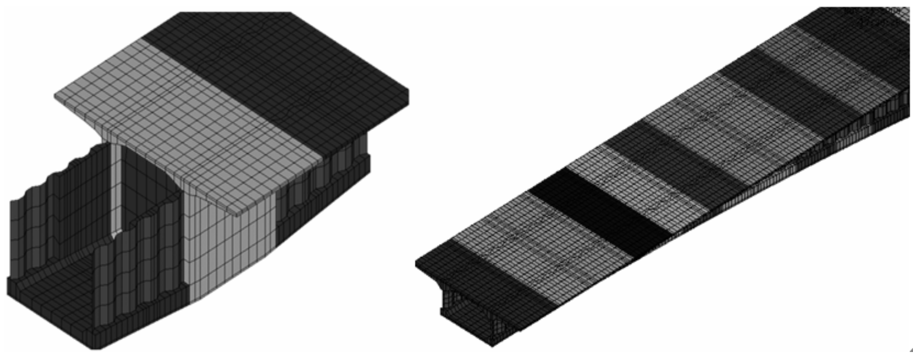

Figure 1. Local model of Juancheng Yellow River Highway Bridge.

The 3-D simulation module CBCW concerning the composite bridges with corrugated steel webs was proposed to deal with finite element analysis in the construction process. And it is verified during the construction control of the Juancheng Yellow River Highway Bridge.

1. There is no special simulation module for bridge structure in ANSYS software, while the module CBCW provides an easy and high-efficient tool for bridge engineers.
2. The solution and postprocessor module of CBCW combines with the latest highway bridge design specifications of China, which brings convenience for bridge designers.
3. The numerical results match measured results excellently, which turns out that it is credible to simulate this kind of bridges with the module CBCW.

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References

HONG-WEI REN, HAI-BO CHEN and JIAN-YONG SONG, 2008. Design and calculation analysis of prestressed composite box-girder bridge with corrugated steel webs, *Journal of highway and transportation research and development*, 25(8), 92-96.

HONG-JIANG LI, JIAN-SHU YE and SHUI WAN, et al, 2002. Influence of shear deformation on deflection of box-girder with corrugated steel webs, *Journal of Traffic and Transportation Engineering*, 2(4), 17-20.

JIAN-YONG SONG, TONG WANG and SHU-REN ZHANG (2002). Extracorporeal prestressed concrete composite bridge with corrugated steel webs, *Northeastern Highway*, 25(1), 38-40.

JIAN-YONG SONG, HONG-WEI REN, DE-GENG HUANG, 2006. Research on parametric modeling and calculation module of composite bridges with corrugated webs, *Journal of Highway and Transportation research and Development*, 23(3), 40-43.

QI-YUAN ZHOU, XUAN-NENG GAO (2006). Deflection calculation of tapered beam with shear effects by energy method, *Journal of Nanchang University (Engineering & Technology)*, 28(3), 295-298.