Exploration of large-span steel box-concrete composite continuous rigid frame bridges

Hong XIANG
Doctoral student
Chongqing Jiaotong University
Chongqing, China
Xianghong04@163.com
Hong XIANG, born 1973, received his civil engineering degree from Chongqing Jiaotong University, Chongqing, China. His main area of research is related to steel-concrete composite structures.

Zhixiang ZHOU
Professor
Chongqing Jiaotong University
Chongqing, China
zhixiangzhou@cqjtu.edu.cn
Zhixiang ZHOU, born 1958, received his civil engineering degree from Southwest Jiaotong University, Chengdu, China.

Summary

Based on the existent study of prestressed concrete (PC) continuous rigid frame bridges and steel-concrete composite bridges, a new type of steel box-concrete composite continuous rigid frame bridge (SBCB) constructed by cantilever means is proposed in this paper. Analysis of an exemplary 245m-span bridge design justifies the feasibility and reasonability of SBCB which can fully make use of the respective material advantages of steel and concrete and effectively decrease the main beam self weight, enabling relatively smaller substructure sizes but much larger spanning ability. In addition, SBCB is basically robust against the usual defects of harmful excessive deflection due to concrete cracking and creeping. With the same quantity of overall steel use, SBCB can save 75% of the concrete quantity compared to the traditional PC continuous rigid frame bridge.

Keywords: continuous rigid frame bridge; composite structure; cantilever construction; stress analysis.

1. Introduction

The PC continuous rigid frame bridge built by cantilever means bears the biggest advantage of convenient construction for which neither large lifting-transporting equipment nor specific sites is required, therefore suitable for high-pier large-span bridge plans in mountainous areas; in service it boasts neat shape and high structural integrity without intermediate expansion joints, providing smooth driving experience[1].

Nevertheless, the PC continuous rigid frame bridge has some inherent defects[2-6] such as: cumbersome self-weight quickly increasing with while limiting the span length; lengthy construction process with numerous steps, unstable concrete material properties, error-prone locating and tensioning of longitudinal curved prestress tendons and difficult estimation of concrete shrinkage, creep and prestress losses[7-9]. The built bridge may be in a state quite different from required by design and liable to structural cracking and excessive long-term deflection in service.

The steel-concrete continuous bridge, developed and practiced in recent years, can comparatively overcome some defects of the PC continuous rigid frame bridge and prevail within an appropriate span range[10-13], but somewhat hampered by difficult steel-concrete shear connection, complex construction and crack-prone cast-in-situ deck slabs on steel truss upper chords[14-18]. Research on the cantilever-constructed steel truss-concrete composite continuous rigid frame bridge in the large-span area is fading away with a limited span under 200m as the ceiling over its application in the cases of high-pier large-span bridges in mountainous areas.

2 Structural principles for the SBCB

https://doi.org/10.2749/222137810796063382