Exploration of super-large-span prestressed steel truss-concrete composite continuous rigid frame bridges

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Summary

To succeed to major advantages while overcome demerits of the existing prestressed concrete (PC) continuous rigid frame bridge, a new type of prestressed steel truss-concrete composite continuous rigid frame bridge (PTCB) is put forward in this paper. The PTCB is schemed with a composite main beam combining steel truss with concrete prestressed in batches to fully exert the respective superiorities of shape steel, prestress tendons and high-strength concrete, which can greatly cut down the superstructure self weight and in turn enable a slimmer substructure shape compared with the PC correspondents. Therefore, the PTCB is especially suitable for design of super-large-span continuous rigid frame bridges. A preliminary analysis of a rigid frame bridge with a 400m span indicates: a PTCB design could effectively simplify the construction process, save the building time and result in a bridge structure with more concise mechanics and more reliable performances. In addition, the PTCB could basically avoid the latent distresses of uncontrollable long-term main-beam deflection and concrete cracking that often haunt the PC continuous rigid frame bridges.

Keywords: continuous rigid frame bridge; steel truss-concrete composite beam; concept design; construction technique.

1. Introduction

With the rapid development of economy as well as transportation, large-span bridges are constructed more and more under higher requirements of driving pleasure. The traditional PC continuous rigid frame bridge, in line with the design principles of ‘Safety, Utility, Economy and Aesthetics’, is suitable for service in various landforms such as plains, mountains or valleys and therefore a widely welcome structural form for large-span bridges[1]. It has a continuous main beam rigidly supported by piers without intermediate expansion joints and large bearings, providing smooth driving experience; its main beam boasts high stiffness in longitudinal bending as well as transverse torsion to insure reliable structural integrity and aseismic performance; it can be conveniently constructed with relatively mature and safe cantilever method in most sites.

Whereas the PC continuous rigid frame bridge has some intractable 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 truss-concrete composite continuous beam bridge, developed and practiced in recent years, can comparatively overcome some defects of the PC continuous rigid frame bridge and work well

https://doi.org/10.2749/222137810796063418