EVOLUTION OF HYBRID PRESTRESSED CONCRETE BRIDGES WITH CORRUGATED STEEL WEBS

New Challenges in the Evolution of Corrugated Steel Web Technology

1 Summary

A hybrid prestressed concrete bridge with corrugated steel webs (CSW bridge) was realized for the first time in the case of the Cognac Bridge in France (1986). The most important characteristic of this design is the reduced weight, which is about 25% less than a conventional prestressed concrete bridge, achieved by replacing the reinforced concrete webs with corrugated steel webs (Fig. 1). CSW bridge technology was introduced to Japan from France and was used for the first time for the Shinkai Bridge (1993). Since then, research and development has led to evolution of the technology and it has become widespread in a short period. Owing to these efforts, the number of CSW bridges constructed in Japan exceeded 150 by 2012, by far the greatest number in the world (Fig. 2).

2 Technical Developments Unique to Japan

Many construction methods are suitable for the erection of CSW bridges, just as in the case of conventional concrete web bridges. Many challenges have been met in Japan, leading to rationalized construction and a greater range of application. Typical of these new developments are those outlined below.

2.1 Construction rationalization through use of precast members

The work cycle for a cantilevered slab CSW bridge takes the same number of days as in the case of a normal concrete web bridge. However, a newly developed construction method shortens the cycle and also reduces the weight of the cantilevering traveler. The procedure is that precast concrete ribs are fixed to the corrugated steel webs and precast panels are placed on the ribs. Slab concrete is then cast in situ. This process is shown in Figs. 3 and 4. A further labor-saving innovation, which also saves cantilevering traveler weight, is the use of precast panels for the bottom slab (Fig. 5).
2.2 Longer span bridges

Since a CSW bridge is lighter than a conventional concrete web bridge, it is essentially suited to longer spans. Research and development in Japan, allied with experience gained through constructing many CSW bridges, led to the technology being combined with a cable-stayed structure for longer span bridges that were in planning or design at the time. A new problem here is the reinforcement at the stay cable anchorage zone. For these bridges, steel diaphragms or steel cross beams were adopted from the viewpoint of weight saving (Fig. 6). Three dimensional FEM analysis as well as experiments using large-scale models were conducted to ensure the safety of each bridge.

3 Practical Application

Actual examples that made use of rationalized construction with precast members are the Shigaraki-Dainana Bridge, Tsukumigawa Bridge and Kinugawa Bridge. The use of precast panels for the bottom slab is exemplified by the Sugitani Bridge and Nishida Bridge. On the other hand, examples of very long span bridges combining the use of corrugated steel webs and a cable-stayed structure are the extradosed Himi Bridge[1] and Ohmi-Ohtori Bridge[2] (Fig. 7) and the Toyota-Arrow Bridge (Fig. 8).
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