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Overseas Application of RIVER BRIDGE™

1. Introduction

RIVER BRIDGE™ "JFE Steel-Concrete Composite Deck Bridge" is a type of bridge that was developed to have a reduced structural height while maintaining economic efficiency. This is achieved through the use of T-section steel beams with deformations on the top of the flange. RIVER BRIDGE is suitable for small and medium spans.

Other features of RIVER BRIDGE include a high fatigue limit (equal or superior to that of Prestressed Concrete Floor Slab bridges) for its low structural height and a simple structural configuration.

In recent years, extreme weather events caused by climate change have become frequent in countries around the world. In other countries (especially tropical countries), there is an increasing need for high-quality bridges with a low structural height to prevent river flooding caused by typhoons and hurricanes. This article explains the performance requirements for bridges over rivers in tropical countries and the reasons why RIVER BRIDGE is the superior option for meeting those performance requirements.

2. Performance Requirements

2.1 Resistance to Damage Caused by Floods

The greatest advantage of RIVER BRIDGE is its low structural height. The span length to structural height ratio at the center of the span is about 1/30 to 1/42, and the structural height at the girder ends can be lowered to a minimum of about 30 cm. When compared to PC bridges (which are becoming the mainstream in developing countries), this difference is remarkable (**Fig. 1**[1]).

In tropical countries, the upper reaches of a river system are usually a forested area filled with evergreen trees. During heavy rainfall, a large amount of driftwood is washed downstream together with soil. This driftwood can be deposited and accumulate at the bottom of a bridge crossing the river, and can eventually damage the bridge itself. Because RIVER BRIDGE can accommodate a higher vertical clearance under the main girder, it has a clear advantage over typical PC bridges in terms of resistance to damage caused by floods.

2.2 Construction Period

In developing countries where social infrastructure is weak, it is difficult to allocate a sufficient budget for disaster prevention, which results in extensive damage when a disaster occurs. Consequently, the usual situation after a disaster is that developing countries request that other countries provide an emergency response and support for rebuilding/restoration of damaged structures. In cases where bridges are damaged by flooding, detour routes in neighboring areas are usually not established, which results in a huge negative impact on the affected communities. In addition to the urgency of construction, construction periods are often limited by environmental and weather changes during the rainy and dry seasons peculiar to tropical countries, and

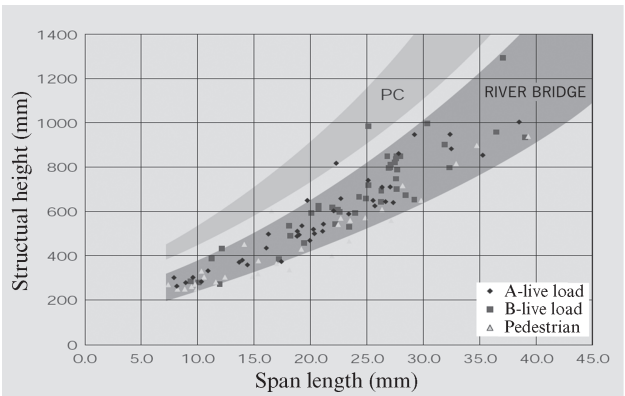

Fig. 1 Span length/structure height ratio of PC bridges and RIVER BRIDGE™s

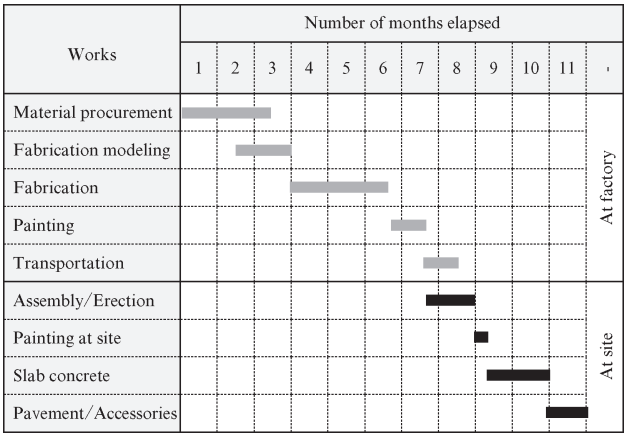

Fig. 2 Typical construction schedule of RIVER BRIDGE™ (200-ton class)

Photo 1 Girder erection by crane (Lao P.D.R)

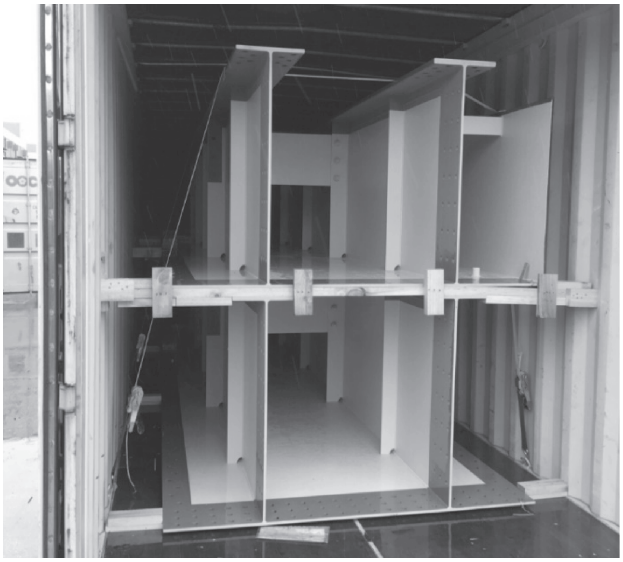

Photo 2 Two-tier stacking of girder blocks in containers

completing the construction work in a short period of time is a challenge. RIVER BRIDGE is significantly lighter than concrete bridges, allowing for downsizing of the heavy equipment required for construction. In addition, the bottom plate of the composite slab serves as the formwork for the concrete slab itself, eliminating the need for formwork and scaffolding except for the coping. For these reasons, RIVER BRIDGE can be constructed safely in a short period of time and has a significant advantage in terms of the construction process (**Fig. 2**[1)]).

2.3 Workability

In developing countries in Asia, which are mostly tropical countries, concrete bridges are more common, and only a few locally based engineers and workers have steel bridge experience. These conditions are an obstacle to the adoption of steel bridges in those countries. it is thought that RIVER BRIDGE can contribute to easier acceptance in such countries, since it is a simple composite structure in which shape steel is used for the main members and familiar concrete is used in the slab. The following features should also be emphasized: Simple connection between shape steel members, use of concrete for the slab instead of steel, and a simple standard construction method using all-terrain cranes for preassembly and erection on-site. While RIVER BRIDGE is a steel bridge, it also more "acceptable" because it is not unusual or unorthodox, and the technical knowledge required in construction is not far from the current capabilities of the local engineers in the countries concerned (**Photo 1**).

Recently, JFE Engineering completed the construction of three RIVER BRIDGEs in the Lao People's Democratic Republic (Laos) and the Republic of the Union of Myanmar. Based on these accomplishments, it is clear that the RIVER BRIDGE is workable in countries where engineers and workers have little experience in steel bridge construction.

2.4 Transportability

The low structural height of RIVER BRIDGE makes it possible to transport members in shipping containers. The weight of each block is also mostly less than 10 tons, which means that 2 layers can be stacked in a single container. The advantages of using shipping containers instead of bulk transportation are as follows:

1. Reduced damage to cargo during transportation.
2. Reduced salt adhesion to steel materials.
3. Improved accuracy of transportation cost estimation.
4. Advantages in terms of cost and logistics due to the large number of shippers that regularly transport containers.
5. Reduced possibility of theft or other malicious mischief.

In addition, the unit price of small-scale transportation using shipping containers is small, and the cost advantage is even greater for small-scale projects (**Photo 2**).

2.5 Life Cycle Cost

The steel members and concrete slab sections have a high fatigue limit, and maintenance-free performance for 100 years is possible if weathering steel is used. Long-term maintenance-free performance is very important in developing countries, where it is difficult to conduct regular bridge inspections due to the lack of budget and/or shortage of steel bridge engineers. Moreover, knowledge of steel bridges as such has yet to become the mainstream among engineers, and the neg-

ative stereotype that "steel bridges deteriorate faster than concrete bridges due to rusting and other factors" still exists, further limiting the possible application of steel bridges.

From this viewpoint as well, it is thought that including the use of weathering steel and education in steel bridge maintenance in the construction project may contribute to the adoption of RIVER BRIDGE in developing countries, and thus lead to wider adoption of steel bridges in general.

3. Conclusion

This article explained some of the advantages of using RIVER BRIDGE™ in developing countries, especially tropical countries. In the future, JFE Engineering will continue to promote the application of RIVER BRIDGE overseas through the use of high-performance lightweight concrete together with weathering steel in order to make these bridges maintenance-free.

References

1) JFE Engineering Catalogue
(Steel-Concrete Composite Deck Bridge "RIVER BRIDGE™")

For Further Information, Please Contact:

Overseas Business Division, Infrastructure Engineering Sector, JFE Engineering
Phone: (81)45–505–7385
Home Page: https://www.jfe-eng.co.jp/products/bridge/br07.html