Design of the Chenab Bridge in India

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Summary

This paper describes the conceptual design and the main principles of structural design of the Chenab Bridge. The main focus is to explain the exceptional bridge concept in challenging terrain and to give an overall description of design solutions used in one of the highest steel arch railway bridge in the world.

Keywords: bridge design, arch bridges, railway bridges, steel bridges, erection methods

1. Introduction

A new railway line from Udhampur to Baramulla is under construction in the State of Jammu and Kashmir in India. The terrain is mountainous, and the new railway will pass tunnels and bridges constructed in difficult Himalayan geology. The crossing of the Chenab River between Bakkal and Kauri with a bridge (Figure 1) is one of the most challenging parts of the project [1]. The height from the river to the bridge deck is more than 300 metres which leads to the huge span of the main crossing.

Fig. 1: Photomontage of the completed bridge.

Bridge design is done by two engineering companies. WSP Finland has the main responsibility for the planning. The design of the steel arch is done by subconsultant Leonhardt, Andrä und Partner of Germany.

The paper describes the conceptual and structural design of the Chenab Bridge. It also explains the exceptional construction method of the arch portion.

2. Description of the Chenab Bridge

The Chenab Bridge is a steel railway arch bridge with a total length of 1315 metres (Figure 2). It is composed of an approach bridge, which is 530 metres long, and an arch bridge, which is 785 metres long. The main arch spans 467 metres, making it one of the longest arches in the world and probably the longest arch for rail traffic. The deck is 13.5 meters wide and will carry two tracks at final stage. The superstructure will be constructed 320 metres above the surface of the river flowing in the valley.

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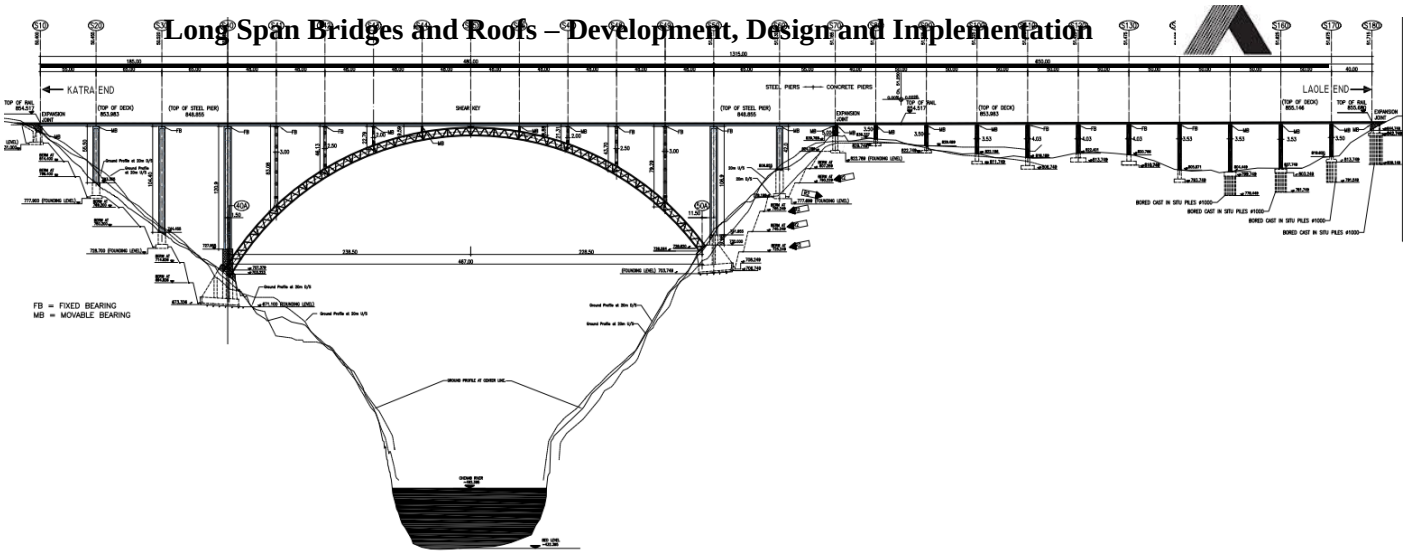

Fig. 1: Elevation of Chenab Bridge.

3. Some exceptional design parameters

The bridge will be designed for seismic loads according to IS 1893, Part 1, 2002, Zone V and site specific spectral studies as carried out by IIT, Roorkee. A challenging 50 % of this seismic loading must be considered in erection stages. .

The bridge will be furnished with warning systems for high wind and seismic activity. Wind loads are based on the wind equivalent static wind load procedure. This procedure involves specialist computation of wind-induced vibration responses and wind-tunnel testing together with vibration mode-shape analysis of the bridge.

An exceptional blast load has to be considered in the design: the bridge will be designed for two scenarios of blast taking place on the deck or in close proximity of the foundations. The arch trusses shall not be damaged and no bridge span shall collapse under the above scenarios. Any damage of the structure has to be repairable so that it can be restored to its original serviceability requirement.

Another exceptional loading case comes from the requirement for robustness. The system will be assessed by removing critical single structural elements one at a time. These elements are:

- one chord of the arch truss (one box out of eight boxes forming the total arch) of a length of max. 8 m between the truss joints
- one diagonal member of the arch truss.

4. Conclusions

Many challenges have to be overcome until this bridge will be finished. To construct one of the biggest railway bridges in the mountains in extremely harsh conditions requires innovative design and experienced and open minded construction organization.

The success in the project will depend mostly on the chosen erection method and the logistics of construction at the site as well as ability to cooperate between all parties involved in the project.

References

[1] PULKKINEN, HOPF and JUTILA, “Conceptual Design of the Chenab Bridge in India”, Steel Structures and Bridges Conference Podbanské, High Tatras, Slovakia 26-28 September 2012.