# Challenges Faced In Design of Most Unbalanced Cantilever Continuous P.S.C. Bridge Over River Munawar at Beripattan, in J&K, India

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## Summary

The paper highlights the challenges faced in planning & design of an unique bridge in Jammu & Kashmir, which has been completed recently. This highly unbalanced two lane bridge with footpath is having a total length of 124m between face to face of dirt wall with span arrangement of 14m+96m+14m. The span arrangement was dictated by the site constraints. The central span of this variable depth PSC box girder Superstructure is being constructed by cast-in-situ cantilever method of construction. 14m end Spans are anchored firmly with the abutment at both the ends by using prestressed vertical cables. 18 cables with 288 strands of 12.7mm diameter have been used to anchor the superstructure with each abutment. The reaction from Superstructure to the Abutment is 'upward' unlike the conventional bridges, where the load transferred is 'downward'. The upward load transfer from Superstructure to the abutment is achieved by using a portal frame with inverted free bearing. Overall stability of the system is achieved by provising adequate counter weight on the box type abutment. Foundation for both the piers and abutments are on open foundation, resting on hard rocky strata. **Fig. 1** shows the completed bridge. **Fig.2** shows the General Arrangement of the bridge.

The superstructure of the bridge comprises of single cell PSC cast-in-situ segmental box girder of variable depth (Depth 6m uniform for end spans and 3m at mid span for central span). The end spans on either side are constructed cast-in-situ, on staging first. The central 96 m span of the bridge is constructed next by cantilever method, from either side, using CCE. The superstructure is supported on metallic bearings at the piers as well as at the abutments. A pair of Free Pot cum PTFE bearings are provided at each of the abutments and Piers, to take care of the vertical loads transferred from the superstructure. Additional metallic guided bearings are provided at Pier P1, to take care of transverse horizontal seismic forces. At Pier P2, PIN bearing is provided to take care of horizontal seismic forces in the longitudinal as well as transverse direction. The bearings at abutments are provided up-side down, since at the abutments, the reaction from superstructure is 'negative' (i,e. upward load). A special concrete portal frame has been provided at the abutments to realize the negative reaction.

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*Fig. 1 : Elevation of the Completed Bridge.*

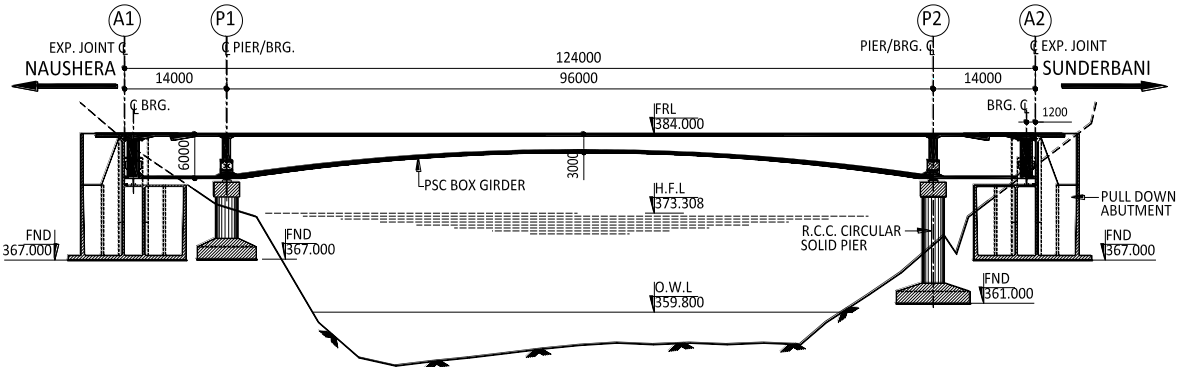


*Fig. 2 : General Arrangement Drawing*

Circular piers of diameter 3.0m resting on open foundation with sloping top have been provided. The pier cap provided is of cantilever type. The foundation size is 8m (L) x 10.8m(T) for P1 and 10.25m SQ for P2. The bridge is longitudinally fixed at pier P2, since increased height of pier will make the structure flexible and will help increase the time period of the structure and thus reduce the seismic forces. The piers are resting on weathered rock with SBC of 90 t/sq.m. Abutments are provided as multi-cellular box type on open foundation. Unlike conventional abutments, which are subjected to vertical downward load from the Superstructure, the abutments in this bridge is subjected to upward load from the deck. Hence massive multi-cellular box type abutment with inverted bearings are provided. The upward load is countered by the dead load of abutment, including the fill inside. In order to overcome the tensile stresses generated in the abutment section, vertical prestressing of the abutment walls using HT cables has been resorted to

The design of superstructure for this bridge is highly construction driven. The statical system of the superstructure keeps changing as the construction progresses. Due account has been taken of the change in nature of the structural system and in material properties that occur during the construction sequence of a continuous bridge. The behavior at any stage of the construction sequence has been analyzed, duly taking into account the effect of creep redistribution.

The 17m high multi-cellular abutment, which anchors the superstructure, is designed with adequate dead weight, to ensure external stability of the system against sliding, base pressure & overturning. The portals on either side of the Box Girder, through which the anchor reaction from Superstructure is transferred to the abutment, are prestressed by vertical prestressing cables. 4 Cables of 18T13 are provided for each portal leg. Prestressing helps in taking care of the tensile stresses in the abutment sections that is caused by anchor pull force from the superstructure.

## Conclusion

Design and Construction of this unique bridge at Beripattan was a daunting task, which was accomplished with good team effort. The challenges posed by the extreme site constraints, brought out a number of innovative solutions, both in design as well as in execution. Credit for successful completion of this project goes to the excellent team work and understanding between the Client (DGBR), Executing Agency, (**D2S Infrastructure Pvt. Ltd.**), Consultant (**Skyline Developers**) and the Proof Consultant (**B&S Engineering Consultants Pvt. Ltd.**).