Design Features of Bardhaman Cable Stayed Road Over Bridge

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Summary

These paper is dealing with design of Cable stayed ROB at Bardhaman Railway yard. This 4 lane ROB will replace the existing 2 lane ROB across one of the busiest railway routes of the country.

Keywords: Cable Stayed Bridge, Construction stages, aerodynamics, Modal analysis.

1. Introduction

Bardhaman is an old city and its railway station was designed and constructed in the waning decades of the 19th century. As the network of the Indian Railways grew, so did the demands on the station and along with it, the neighbourhood surrounding it. Now, most of approaches and facilities are overstrained and are due for a major upgrade. For example, the existing Road Over Bridge (ROB) was found inadequate for the current traffic and it is planned to be replaced with a new bridge. At the location, the ROB is to cross eight numbers of lines and no support can be provided from between the lines, making the mandatory span 124.163 m long.

2. Geometry of the bridge and alternatives

The bridge as proposed is an asymmetrical cable stayed bridge with the main span measuring124.163m and the back span, 64.266m.. The constraints of clearances and maximum slope of approaches, limited the main girder depth and also the depth of the cross girders.

A cable stayed system with two planes of cables was found unsuitable because the depth of the girders between the cable planes breached the clearance requirements during live load condition. Therefore, one of the two approaches where the slope could be steepened was raised with three planes of cable stays. The harp type cable stay configuration was adopted to add to the aesthetics.

3. Details of the superstructure

The main 124.163 m span has been designed as steel box girders with 250mm thick concrete deck. The steel-concrete composite offers a lighter superstructure, conferring constructability advantage: during execution with minimum interference the front portion can be built over the railway tracks. From deflection considerations, however, the 64.266 m long backspan is a concrete slab 750mm thick, spanning between concrete beams of 2.5mx2m beam at center and 2.5mx1.8m beam at edges. The backspan is monolithic with the central concrete pylon and the pier at the other end. The heavier concrete slab backspan balances the load on either side of steel pylon, which in turn reduces lateral load and bending moments of pylon and helps in the economics of the bridge.

4. The pylons and cables

The three pylons have a constant box cross section made of steel, 2.5mx2m formed with 50mm thick plate and rise up to 55.8 m above deck level. The cable inclination more than 24 degrees, increased their efficiency.

The spacing between cables along the main span has been kept 12m and at backspan it has a spacing of 6.881m. Thus, the panel length for fabrication and erection is fixed as 12m as optimum.

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The concrete backspan has been planned as cast-in situ concrete section supported continuously on temporary supports.

5. Analysis and design

The analysis of the structure has been carried out by Larsa4D software. This has been used to analyse construction stages (with geometric non-linearity), final stage, live load, thermal load, seismic (response spectrum) and wind load. Cable forces are optimized such that for the dead load and superimposed dead load of the finished bridge, the bending moment distribution will be similar to that of a continuous beam on rigid supports, thereby significantly reducing the influence of creep and redistribution of forces.

6. Construction stage analysis and sequence

Majorly construction stages were divided in 9 stages, starting from pile foundation and ending with laying of wearing course.

Other than construction stage analysis the bridge has also been analysed for seismic loads based on modal analysis. In this case stressed Eigen value analysis has been carried out in which permanent stresses in cables are also considered for calculating the stiffness of the system. Separate aerodynamic studies were made to ascertain its stability during wind. The structural elements and cables were checked for fatigue load.

As the structure is very sensitive to any changes it was decided that the whole model should be studied for its sensitivity to foundation system. As the stiffness assumed for piles in model may vary in actual, it was decided to carry out whole set of analysis by changing the springs stiffness to both positive and negative direction by total 50%. It was ensured that in all these cases all members remain within the permissible capacity.

7. Concluding Remark

Construction of this bridge has already started in Bardhaman and Piling and substructure work substructure work is complete. Contractor is carrying out fabrication of steel pylon and planning for construction of back span. Minor modifications in the structural detailing are still taking place to suite the construction at site keeping in mind the global requirement of the bridge.