Salient construction features of superstructure

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This paper briefly covers the fabrication of the bridge components and preparation of erection scheme of the superstructure of Jogighopa bridge.

The rail-cum-road bridge over the Brahmaputra river at Jogighopa is one of the longest and heaviest rail-cum-road bridges in the country, connecting Jogighopa and Gaolpara in Assam. The Braithwaite, Burn & Jessop Construction Co. Ltd. (BBJ), a subsidiary of Bharat Bhari Udyog Nigam Ltd (BBUNL), was entrusted with the superstructure construction of this bridge. This bridge is 11.5 m wide, designed to carry twin lane road traffic to class A or 70R loading and twin track railway MBG loading. The total weight of the bridge including deck concrete is about 50,000 t out of which the weight of steel is 30,000 t [20,000 t High tensile (HT) and 10,000 t mild steel]. The weight of the 1 / 120 m span is 1600 t, while the weight of top and bottom chord members is about 22 t each.

The order was placed on BBJ in two phases. The first phase was for the construction of two 32.5 m spans, one each at Jogighopa end and Gaolpara end and 13 spans of 125 m from the Jogighopa end. In phase II, the bridge was originally intended to be a cable-stayed bridge of 675 m span but was finally converted by railways to one no. 90 m span and four nos. 125 m spans.

Configuration of the bridge

The centre to centre distance between top and bottom chord is 18.5 m. The diamond truss system is of rivetted construction and the truss members are connected by 17 nos. cross girders and stringers.

All cross girders and stringers are of welded construction. The roadway cross girders and stringers were made composite with concrete deck by welding channel shear connectors.

At the road level, transflex expansion joints were provided to cater for a total movement of ± 160 mm due to variation of temperature, live load expansion and seismic effect. Intermediate expansion joints were provided at alternate panels in the deck by using copper strip with resilent filler.

In order to arrest the bridge against seismic oscillation, an aseismic structure was designed. This structure was connected underneath the railway end cross girders and encased 1m deep inside the pier chamber. Adequate drainage system has been provided in the road deck having two percent cross slope.

The width of the bridge is 11.5 m which accommodates a 7.5-m carriageway with two nos. of 1.5 m wide footways on either side of the bridge. Both handrails and crash barriers have been provided on the bridge. Underneath the footways, provision has been made to carry service lines like electric and telephone cables etc.

The roadway comprises of 200 mm thick M30 reinforced concrete (RC) deck with varying wearing coat thickness from 50 mm at the end to 75 mm at centre. 25 mm thick mastic asphalt has been provided on top of the wearing coat.

Scope of the work

The scope of the work entrusted to BBJ included preparation of shop drawings and fabrication of the bridge superstructure components, preparation of erection scheme and erection of complete superstructure. Checking the adequacy of the superstructure was also a part of the scope of work.

The preparation of shop drawings was based on the design drawing given by Railways. But it was found that no braking truss members was suggested. Therefore the adequacy of the cross girders and bottom laterals without the provision of braking truss was checked and found to be unsafe.

Further, it was found that no jacking arrangement had been provided at the end cross girders for final jacking of the bridge, weighing 2500 t inclusive of concrete road deck. Against this load the end cross girders were found to be unsafe.

These discrepancies were pointed out to the railways and changes were made accordingly.

Fabrication

The work of fabrication of primary bridge deck components, which were of H.T. steel was executed by Jessop, Braithwaite and Burn Standard. The secondary MS members like roadway cross girders, railway cross girders, stringers, top and bottom lateral bracings handrails, aseismic structure etc. were fabricated by Bharat Wagon, BPMEL, RIC and Buildworth Pvt. Ltd.

As the fabrication was done in different houses, master jigs were fabricated after control assembly of half truss was laid in horizontal position at Jessop's workshop. Camber was checked by RITES.

The copies of master plates were made and distributed amongst the fabricators for achieving the interchangeability of the spans.

Erection of the bridge

Various methods of erection was thought of and it was found that the cantilever method of erection would be technically more sound and faster.

A complete three dimensional erection design and analysis was done by using Ansis programme. The link pin, buffer and bearing slab were made of special quality carbon alloy steel having tensile strength 5000 kg / cm^2 with elongation 20 percent. These items were produced by Bharat Heavy Electricals Limited (BHEL) by forging. The pin diameter was 375 mm and thickness of buffer slab was 250 mm.

The first span was erected on trestle supports, At each trestle point, load was 60 t . As the area was in the high scour zone of about 12 to 15 m, four 500 mm diameter bored piles of about 30 m depth were used under the trestle foundation.

Infrastructure development

Near the bridge head a large area was developed with fencing all round, inside which labour camp, staff and officers quarters, office building, workshops and a nicely planned yard were constructed. Two Goliath cranes, of 50 t and 15 t capacities, were installed. The yard was connected to railway lines to unload the materials carried by railway wagons. In addition to the Goliath cranes, two mobile cranes of 20 t capacity were also installed to unload and stack the materials carried by trailer. Raw materials, fabricated girders and consumables were stacked to suit the erection sequence.

A track connecting the bridge head with the yard was laid. The fabricated materials were stacked properly at the yard which was carried by 50 t bogie and locomotive to the bridge head. A Scotch Derrick crane having 30 t capacity with 20 m radius was placed near Pier 1.

This massive crane fed through top chord (top laterals were dismantled to make room for feeding) on the bogie, which carried the bridge components at the erection front.

As the maximum weight of the heaviest component was 22 t, an erection crane of 22 t at 22 m radius was manufactured by Jessop & Co. The weight of this crane was 80 t. This crane was installed over the track placed on top chord of the bridge.

The first span was erected over trestle support by Scotch Derrick crane. The erection crane was installed over first span. Using the first span as anchor span, the second span weighing 1600 t was cantilevered.

The most critical activity in cantilever erection is the setting of bearing rollers. At the rear end of the anchor span the rollers are kept inclined towards the preceding span and at the buffer end the rollers are kept inclined towards the river. The front end of the anchor span rests on fixed bearing.

Designing of proper curvature of the buffer slab is equally important in the design of cantilever erection. For the Brahmaputra bridge, the amount of tension and compression in the link and buffer were of the order of 2600 t. Hence, proper centering of the buffer and bearing slab with the bottom chord member played a vital role in cantilever erection. At every stage of the erection, proper checking of all joints, the deflection of span, and the alignment of the span were monitored. For proper fitment of the chord member, hanging device was used.

In cantilever erection another important factor is the shortening of link members. If the link members are too short, the tip of the cantilever span will be too high to jack up, for releasing tension in the link member and if the link member is bigger the extreme end of the cantilever span will go below pier level. The link member was designed in such a way that after cantilever deflection, the end of the cantilever span was 1200 mm above the pier, that is, 300 mm above the bearing.

After the span was cantilevered, four 500 t jacks with traversing base were placed, two nos. at the rear end of anchor span and two each in the front end of cantilever span. Jacking was done at both ends to release tension in the link members, after which the link pin was dismantled. The span was then jacked down and placed over bearing. The traversing base under the jack was used for alignment of the span.

The setting of bearings was done based on the temperature recorded at the time, the design requirement, protocol distance between the centre of piers and protocol distance of the anchor bolt holes from the centre of the pier. For cantilever erection, receiving brackets were used . The bracket was cantilevered 7.6 m from the pier to receive the cantilever span.

Similar procedure was followed for erection of next span. While the third span was cantilevered, a follow-up crane having 15 t capacity was installed over top chord to do the follow-up erection of the secondary members. The follow-up rivetting was also done. By this process one complete span of 1600 t could be erected in one and half months.

An erection manual was prepared elaborating each and every micro level activities to be followed sequentially during erection.

The complete erection of two 30.5-m spans, 14 nos. 120-m spans and one 90-m span was completed by December '94 leaving three 120 m spans yet to be erected. However due to certain technical difficulties, two piers could not be constructed by the Railways, and therefore work on these three spans was held up for almost two and half years. Work is expected to commence soon and it will possibly take another six months for the completion of the bridge.

Special erection of 125 m cantilever span

Usually for all cantilever erection, anchor span is made heavier by putting adequately designed kentledge at the rear end of the anchor span. But in this bridge 120 m cantilever span weighing 1600 t has been erected with the help of 90 m anchor span weighing 1200 t.

Elaborate anchorage arrangements were made to prevent the rear end of 90 m anchor span from uplift as well as allowing free translation and rotation by securing the end with the end of 120 m cantilever span and using teflon bearings. Three-dimensional computer analysis was made to see the amount of uplift, the translation and rotation required at the end of the span.

Conclusion

Many road-cum-rail bridges have been constructed by BBJ in the past. The first Brahmaputra road-cum-rail bridge was also constructed by the company. This particular bridge at Jogighopa could also have been completed in the stipulated time but for certain technical difficulties in the construction of piers.

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