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PERFORMANCE OF KALIABHOMORA BRIDGE ON RIVER BRAHMAPUTRA DURING BURMA-INDIA BORDER REGION EARTHQUAKE OF AUGUST 6, 1988

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ABSTRACT

The Kaliabhomora bridge, named after the illustrious Ahom General of Assam, connects the National Highway 52 on north bank and the National Highway 37 on south bank of the river Brahmaputra near Tezpur, Assam. This bridge is 3015 m long. It was opened for the public use in the year 1987. This bridge was subjected to earthquake motions on April 16, 1988 and again on August 6, 1988. This study describes the performance of the bridge during the Burma-India Border Region earthquake of August 6, 1988 which was felt in the entire northeastern India, Calcutta, entire Bangladesh and in the part of northwestern Burma. It also describes the various types of damage caused to this bridge by this earthquake.

INTRODUCTION

The Burma-India Border Region Earthquake of the magnitude 6.8 shook the entire northeastern India, including Calcutta, entire Bangladesh and the parts of northwestern Burma in the morning of August 6, 1988. The origin time of this earthquake was 6 hours, 36 minutes and 24.6 seconds (IST). The epicentre was located in Burma near Burma-India Border Region and its coordinates were latitude 25.142° north and longitude 95.121° east. The depth of the focus was 92 km [1].

This earthquake caused damage to National Highway 37 near Guwahati. The buildings in Guwahati, Jorhat, Sibsagar, Silchar in Assam and in other parts of northeastern India also suffered damage. It caused landslides at several places including in Lumding -Diphu section of meter gauge railway in Assam. The Kaliabhomara bridge, the second bridge on the river Brahamputra (the first rail cum road bridge was constructed at Guwahati in the year 1962 and it did not suffer any damage) near Tezpur, the single span Metong bridge on the National Highway 37 between Jorhat and Sibsagar and the prestressed concrete box girder bridge on the river Barak, Silchar [2], all in Assam, suffered damage due to this earthquake. This study describes the damage suffered by the Kaliabhomara bridge. The author carried out the earthquake damage survey of this bridge on August 11, 1988 during his field visit from August 10 to August 18, 1988 in the northeastern region.

SEISMIC ACTIVITY

The northern and central parts of Burma lie at the junction of the Alpide Himalayan seismic belt to the north and the Indonesian arc to the south. This region is characterised by very high seismicity which is attributed to the convergence of Indian plate with the Burmese or Eurasian plate. The distribution of epicentres for the period during 1900-1970 exhibits a narrow north-south trending seismicity zone which spreads over the Burmese plains. This zone is being bordered by the Arkan Yoma ranges to the west and Shan plateau to the east [3]. The region is characterised by the occurrence of both shallow and intermediate focus earthquakes forming roughly a V shaped seismicity zone. The fault plane solutions indicate that at shallower

depths (<70 km) and depths above 105 km, the strains are released by normal faulting whereas in the intermediate depth range (72-107 km), the predominant mode of the strain release is by thrust faulting [3]. Further studies are required to permit a proper understanding of the seismic activity of the region as only broad features of the activity alone have been identified and explained.

DESCRIPTION OF THE BRIDGE

The feasibility study of the project Kaliabhomora Road Bridge on the river Brahmaputra near Tezpur, Assam, was entrusted to Rail India Technical and Economic Services Limited by the North Eastern Council in 1975. This bridge was designed by the Northeast Frontier Railway Construction and was constructed by the Hindustan Construction Company Limited, Bombay. It was opened for public use since 1987. The salient features of this 3015 m long bridge (Fig. 1) having 24 spans of 120 m and two shore spans of 67.5 m, are given as under [4]:

Super Structure

The centre to centre distance of 120 m between two consecutive piers is spanned by i) two balanced cantilevers projecting out from the piers; each cantilever is 52.5 m long and ii) the suspended span of 15 m consisting of two R.C.C. girders supporting cast-in-situ R.C.C. deck. The suspended span is resting on the free ends of the cantilevers. The cantilever arm is a single cell prestressed concrete (grade M-425) box girder consisting of eleven segments of different lengths. The diaphragms have been provided at the pier head and near the free end to increase the torsional rigidity of the cantilever arm. The suspended span has been provided to isolate the piers structurally for minimising the damage to piers during the earthquake. The bridge is provided with 25 mm thick coating of Mastic Asphalt. The clear width of the road is 7.5 m and the footpath of width 1.5 m has been provided on the either side of the road. The details of a typical cantilever span is shown in Fig. 2.

Bearings

The free end of the cantilever and the north end of the suspended span are connected by the fixed bearings. The hemispherical knuckle cum elastomeric bearings have been specially designed to undergo longitudinal and lateral displacements of ± 16 mm and ± 3 mm, respectively. The bottom square steel plate of the size 425 mm and thickness 20 mm is fixed on the top of the free end of the cantilever with four threaded bolts embedded in concrete near the corners of the plate and the bolts are tightened. The elastomeric pad having thickness 45 mm is placed over this plate and is connected through steel pin at the centre. Similarly, another steel plate is fixed at the bottom of the suspended span which forms the upper part of the bearing connected with the hemispherical knuckle device. Thus, elastomeric pad is sandwiched between the upper and lower parts of the bearing as shown in Fig. 3. The expansion joint has been designed to permit the longitudinal displacement of ± 25 mm.

The south end of the suspended span and free end of the cantilever are connected by free bearings. It consists of spherical knuckle and P.T.F.E. (Polytetra Fluoro Ethylene) - stainless steel sliding surface designed to undergo longitudinal and lateral displacements of ± 100 mm and ± 1.5 mm, respectively. The free bearing is shown in Fig. 4. The expansion joint has been designed for the longitudinal displacement of ± 62.5 mm. In addition to these bearings, stoppers connecting the suspended span end and the free cantilever end have been provided to prevent falling down of the suspended span in case of excessive displacements. One such stopper is shown in Fig. 5.

Substructure and Foundation

It consists of the hollow circular R.C.C. piers of 12.5 m height and a square pier cap of 6.5 m constructed with M-300 grade concrete. The height of the pier has been determined on the basis of navigational clearance. The R.C.C. fenders have been provided to protect the piers from damage due to the collision by a stray vessel. The well foundation having depth and diameter of 56 m and 12 m, respectively, have been provided.

PERFORMANCE OF THE BRIDGE DURING EARTHQUAKE

The bridge was subjected to earthquake motion on April 16, 1988, however, the details of this earthquake are not available so far. The earthquake of the magnitude 6.8, which occurred on August 6, 1988 shook the bridge and caused damage to the rail posts, elastomeric pad of the bearings, anchor bolts of the bearings, footpath and expansion joints. The bridge had remained open to the traffic during and after the earthquake and is currently in use. The following earthquakes (Table 1) which are aftershocks, also occurred [5] and some of these might have shaken this bridge.

TABLE 1

LIST OF AFTERSHOCKS FROM 6-8-1988 to 9-10-1988

Sr. No.	Origin Time hh : mm : ss (UTC) Date	Epicentre Lat °N Long °E	Magnitude
1	06 : 21 : 42.3 06-08-1988	25.391 94.97	4.6
2	13 : 04 : 12.3 07-08-1988	25.704 95.218	4.7
3	16 : 14 : 23.1 08-08-1988	25.356 94.963	4.9
4	19 : 59 : 50 13-08-1988	25.332 94.963	5.0
5	13 : 16 : 28.8 21-08-1988	25.306 95.136	5.0
6	16 : 45 : 06.6 17-09-1988	25.148 95.127	4.6
7	22 : 05 : 3.6 09-10-1988	24.644 94.887	4.5

DAMAGE TO THE BRIDGE

The damage caused to the pier, expansion joints, footpath, rail posts, elastomeric pads of the bearings and anchor bolts of the bearings is described in this section.

The piers of this bridge are numbered in ascending order from north to south, i.e., the pier 1 is at the extreme north and the pier 25 is at extreme south. In

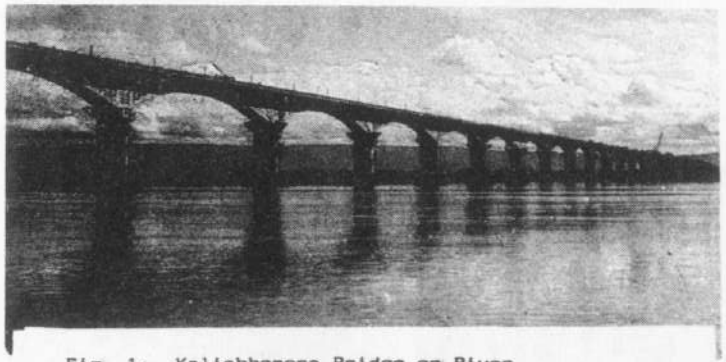

Fig. 1: Kaliabhomora Bridge on River Brahmaputra near Tezpur, Assam

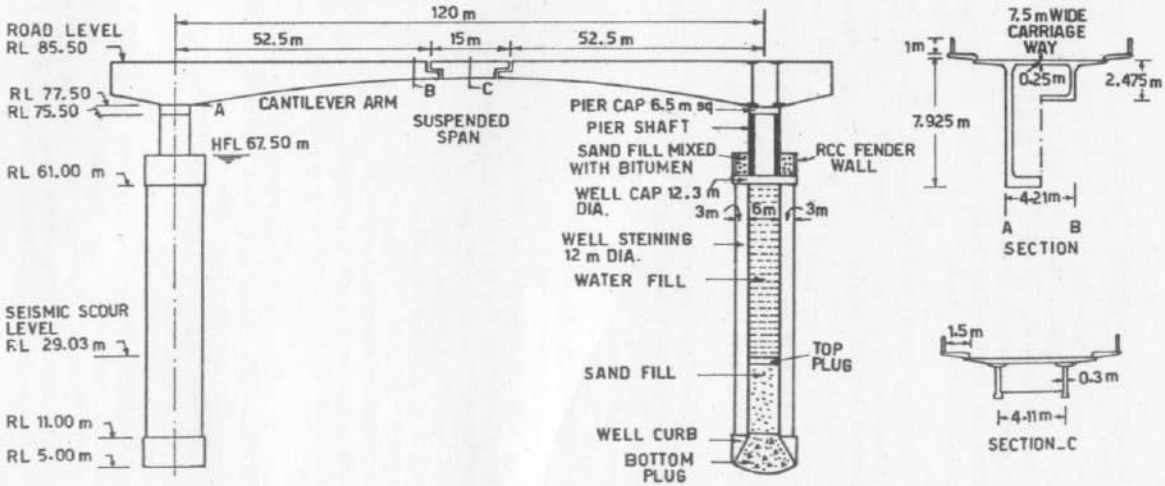

Fig. 2: Elevation and Section of Typical Cantilever Span of Kaliabhomora Bridge.

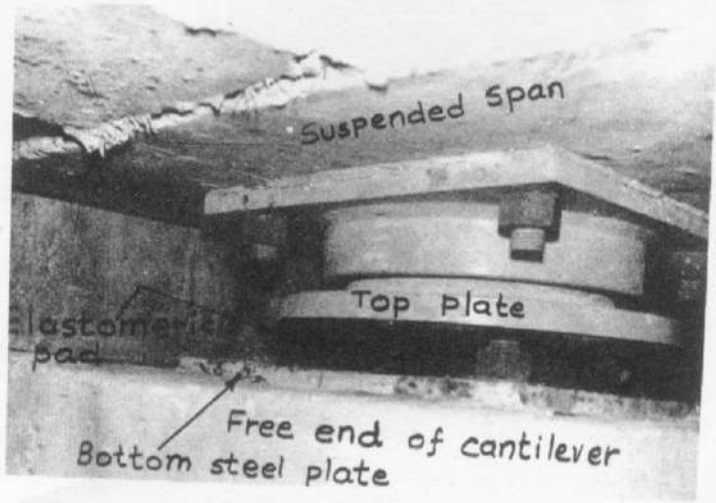

Fig. 3: Hemispherical Knuckle cum Elastomeric Fixed Bearing at North End of Suspended Span

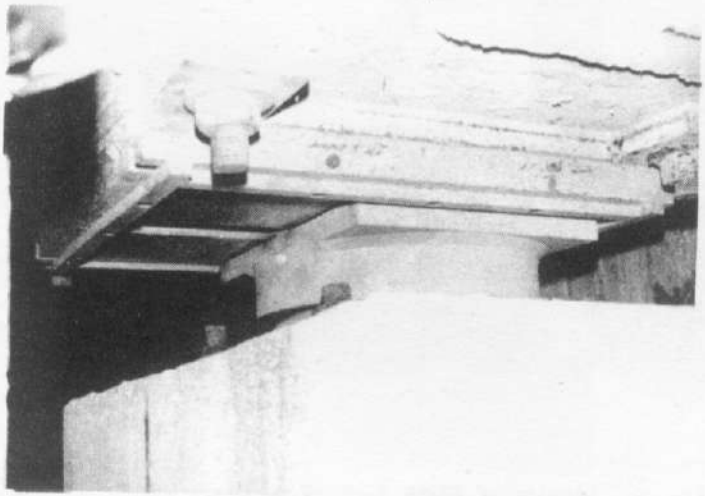

Fig. 4: Free Bearing at South End of Suspended Span

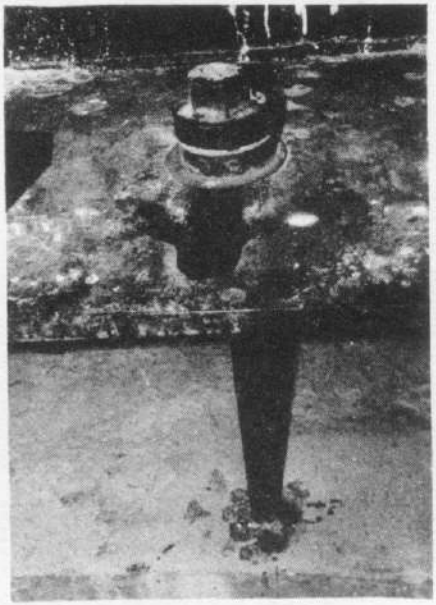

Fig. 5: Arrangement of Stopper Connecting Suspended Span and Free End of Cantilever

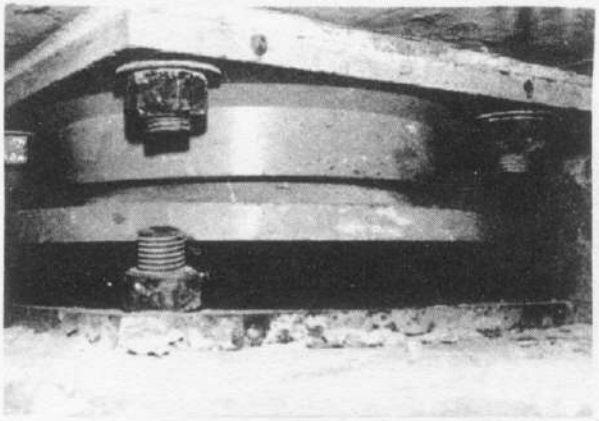

Fig. 6: Bending of Bolts Holding Bottom Steel Plate of Fixed Bearing

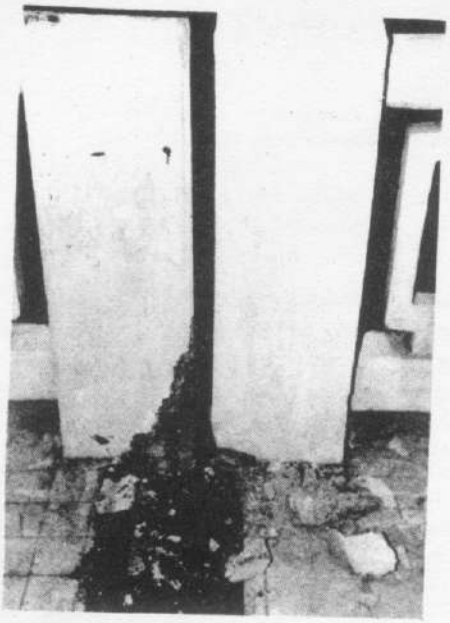

Fig. 7: Damage to Rail Post at Fixed End of Suspended Span

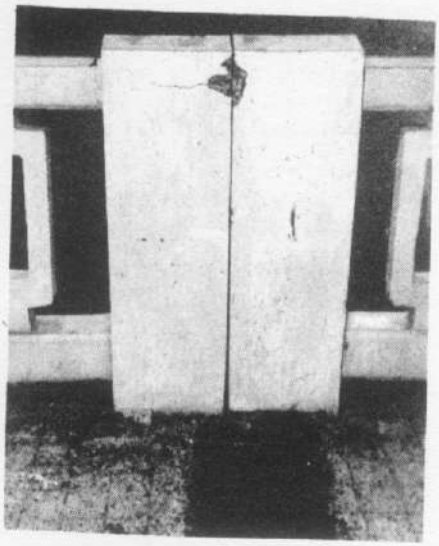

Fig. 8: Closure of Gap between Two Rail Posts at Fixed End of Suspended Span between Piers 14 and 15