NEW SARAIGHAT BRIDGE- A VITAL LINK TO GATEWAY OF NORTH EAST

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Abstract
The Brahmaputra River is the major International waterways of the North East. Due to its higher bed slope compared to other major rivers in India, the river has a tendency to roll instead of flowing down as a sheet producing vertical eddies culminating in huge siltation.

The new Saraighat bridge is a three-lane bridge across the river to connect Guwahati city with North Guwahati parallel to 1275m long existing Saraighat Rail cum Road Bridge which was inaugurated by then Prime minister Pandit Jawaharlal Nehru. The bridge consists of continuous spans of 105m + 150m + 8x122.948m + 150m + 105m giving the overall length as 1493.584m between Expansion Joints.

The bridge superstructure was realised by cast-in-situ balanced cantilever method of construction. The deck section has a 9.0m carriageway with 2.0m wide footpath on one side and anti-crash barrier on both sides of carriageway, with the overall deck-width of 13.875m. The deck is supported on POT-fixed and POT/PTFE-sliding bearings, placed on hollow R.C. piers with semicircular cut and ease waters, the latter resting on double-D caissons. The bridge is located in the highest seismic zone V. A line of two Fixed POT bearings is provided on the central pier and the guided POT/PTFE-sliding bearings are provided on all other supports. Shock Transmission Units (STUs) are provided to distribute the horizontal seismic forces among the supports.

Key words : Caissons, Cofferdams, Cantilever Construction, Seismic Transmission units, Expansion joints.

INTRODUCTION
Guwahati’s 'urban form' is somewhat like a starfish. With a core in the central areas, the city has tentacles extending in the form of growth corridors towards south, north, east and west. The most important corridor is along the Guwahati-Shillong (GS) Road towards the south (almost 15 km from the city-center). The GS Road is an important commercial area with retail, wholesale and offices developed along the main road. The city is having notable changes in its morphology with rapid expansion.

The state of Assam particularly Jalukbari junction is known as Gateway to North East (Fig 1) as this junction literally connects other part of India to north eastern states. While towards the south of this junction Assam is connected to Arunachal Pradesh and Bhutan on Northern side Meghalaya and Tripura could be reached.

The Guwahati city is extended towards west while on eastern side of the junction the Airport and North Bengal can be reached.

The old Saraighat bridge is the only bridge over the river Brahmaputra for about 100 km upstream and downstream. Daily huge amount of highway traffic is
is forced to take Saraighat Bridge in order to enter city and northeast States, resulting in slow moving long queues, almost choking the vehicular flow. This traffic jam on the way to city is responsible for the further increment in travel time. It takes about 75-90 min to reach city due to high level of congestion.

The old Saraighat Bridge (Fig 2) was the first rail-cum-road bridge constructed over the Brahmaputra River in Guwahati. This bridge is a vital link and connects North bank of Guwahati city to that of South bank as such has become a very important urban structure over the period catering for ever increasing traffic intensity due to unremitting growth of the city. It was opened to traffic in April 1962 by then Prime Minister Jawaharal Nehru. The Lachit Borphukan Park is situated on the south end and Chilarai Park situated on the north end of the bridge. The bridge was built for the North Frontier Railway.

Guwahati is the largest city in Assam and one of the fastest developing cities in India. With the rapid growth of population in the city and ever-increasing traffic on old bridge which connects rest of India North East, the road traffic problems were also increasing at an alarming rate resulting in perennial traffic jams on the bridge. To ease out this problem, NHAI (National Highway Authority Of India) proposed new Saraighat bridge around 40 metres south of the existing old Saraighat bridge in the year 2006. The bridge, which will connect the city’s south and north banks, is expected to reduce the pressure of traffic on old Saraighat bridge, however the same necessitated later Signal free elevated corridor at Jalukbari junction (Fig 3) as a Gateway North East.

The traffic intersection at Jalukbari touches the approach of the bridge and the existing roads. The flyover is 244 metres long and have six lanes. Each three-lane carriageway has separate foundations, substructure and superstructure.

Three numbers of loops and ramps each, an underpass and approach embankment made up of retaining walls touch the existing roads in all direction providing a signal free intersection to majority of the North eastern states.

2.0 NEW SARAIGHAT BRIDGE

2.1 General

The Brahmaputra, is the longest river in Asia, having a multi-channel river system having a high braiding tendency.

The nature and behaviors of Brahmaputra is quite different than that of other Indian rivers - its Flow concentration, unpredictable shifting of main course, innumerable sand-bars, deflected flow pattern coupled with high bed scour tendency make difficult for successful constructions besides having inconsiderable suitable construction period.

The flood discharge of Brahmaputra (Fig 4) is 90400 M3/sec (4th in world) with an observed average velocity of 5.00 m/sec.

reaction in terms of conservatism leading to huge financial drain on the country's exchequer.

It is one of the largest rivers in Asia with a total length of about 2900 km, originating from China, out of which a stretch of about 920 km lies in the northeast region of Indian Catchment area of about 1.80 lac Sq. Km, keeping
a width of 10-16 km. Its annual sediment load is estimated to be about 397 million ton. Extensive river training works needed to establish works and it has been traditionally considered as extremely difficult for bridging. Seasonal Change in the course of River and Water depth at different locations, result in change in construction methodology and materials, plant & machineries movement/logistics to desired locations. Early onset of monsoon, prolonged monsoon and unprecedented flash floods pose constant disruption in works. The peak working season is practically, reduced to 4 months only i.e, from 15th Nov. to 15th March.

2.2 Salient features of the bridge

The vital urban transportation link new Saraighat bridge is a three-lane bridge across the river Brahmaputra to connect Guwahati city with North Guwahati parallel to 1275m long existing Saraighat Rail cum Road Bridge. The bridge consists of continuous spans of 105m + 150m + 8x122.948m + 150m + 105m giving the

**Fig 5: General arrangement of new Saraighat bridge**

total length as overall length as 1493.584m between Expansion Joints culminating in a longest single continuous girder bridge in India. The bridge superstructure is realised by cast-in-situ balanced cantilever method of construction. The deck section has a 9.0m carriageway with 2.0m wide footpath on one side and anti-crash barrier on both sides of carriageway, with the overall deck-width of 13.875m. The deck is supported on POT-fixed and POT/PTFE-sliding bearings, placed on hollow R.C. piers with semi-circular cut and ease waters, the latter resting on double-D caissons. The bridge is located in the highest seismic zone V. A line of two Fixed POT bearings is provided on the central pier and the guided POT/PTFE-sliding bearings are provided on all other supports. **Shock Transmission Units (STUs)** are provided to better distribute the horizontal seismic forces among the supports.

The main bridge (Fig 5) is flanked by viaducts on either side. The northern end viaduct on Amingaon side has 6 spans of 24m each with total length of 144m. The southern end viaduct has on Guwahati side has 4 spans.
of 27m with total length of 108m.

The main bridge superstructure has around 18500 cum of M50 grade of concrete in combination with 9300 cum of M60 grade of concrete. While the High Tensile strands was around 1500 t, the un tensioned steel accounted for 6631 t in superstructure of main bridge. The foundations and substructure together has around 83600 cum of M35 grade of concrete embedded with 4550 t of reinforcement steel.

This contract was an item rate contract with the complete designs made available during tender stage itself. However, original designer was not available during the execution after the award of the job for any clarifications on the designs and drawings. The contract like this where the final design of the structure is dictated by construction methodology to be used is well suited for lumpsum contracting model where designs are done by contractor himself. As that it may be, during the construction of the viaduct the structural cracks appeared on the piers. It was quite apparent that the reinforcement provided in the piers were inadequate. Therefore the decision was taken to get the entire design rechecked as such the job was almost like a design build contract.

While redesigning superstructure of main bridge it was found that depth of the girder needs to be increased but as viaducts were completed already, increasing the height of Girder was not possible. So for a short length Concrete strength had to be augmented to M60 grade from M50 grade.

All these designing activities have eaten up sufficient working times which lead to the delay in completion of the project. Time cycle for casting of segments by CLC gantries has been increased due to increase in quantity of Reinforcement steel & H.T. Strands for Superstructure while redesigning.

The designed founding level of wells as per the tendered design was found to be inadequate. The depths of the revised founding levels were generally increased by 5 metres and in some cases up to 10m even.

### 3.0 FOUNDATIONS

The main bridge has 11 numbers (P7 to P17) of pier well foundations out of which 7 numbers are constructed by floating steel caissons while rest are constructed by island method. Generally well foundations are 16m by 10m size double D wells being designed.
with the top of 3.0m thick well cap at RL 40.0m and founding levels at RL -11.40m. The design scour is around the RL 7.684m providing the grip of around 19.0m. However, due to redesigning during construction, the final founding levels are varying and for some foundations had to be taken down to the RL-21.10m making the total depth of double D well foundation to

Existing Saraighat Bridge is just 40m (upstream) away from new Bridge & under influence zone of foundation of existing Bridge. Special precaution has been taken while execution of well foundation works of new Bridge under high current of water and sand blow which could be encountered during the sinking of new wells which may jeopardise the old bridge.

At some locations protruded Reinforcement steel were cut due to abrasive action of silt content in water coupled with high water current during the flood.

To sink double D wells of 61m deep & to keep tilts & shifts within a permissible limit, utmost caution has been taken by adopting pre-defined methodology of sinking. Well foundations which were very near to crude oil pipeline at P7 & P17 locations were completed successfully without diverting these pipelines. Special structures were to be designed & constructed for support of these Oil Pipelines.

Brahmaputra river at this location has an annual mean discharge of 46,100m3/sec with the maximum recorded discharge of 72,400m3/sec. On the alluvial soil bed, the river rolls at the maximum mean velocity of 5m/sec. Early Flood / Flash Flood in the river restricts the working season to a very short period of six months from November to April. In the Himalayan rivers, the available working season gets shifted due to flash floods, unexpected rains etc. imposing challenges for planning and resource mobilisation. Due to very short working season available for construction, it demands huge mobilization & meticulous resource planning for execution, transportation of concrete & other construction materials by barge across the river under heavy water current. The short working season warranted additional precautions like, sinking of wells up to safe grip (below scour level), removing obstructions / dredged materials accumulated near the well for clear water passage, if plugging of well was not possible at the end of working season, covering of the at the top etc.

Even in working season, it is very difficult for execution of deep caisson foundations against heavy water current in River Brahmaputra because of the narrow passage way of water at this location. As the bottom of Well cap is at LWL of RL 40.0m additional coffer dam has been constructed to retain the water for executing the Well cap.

When well foundations are chosen where the velocity and depth of the water is low, sand islands or artificial cofferdams (Fig. 8) are constructed, providing sand bags to support the sand in the location of pitching of cuttingedge. The sand island or construction of cofferdam bund is an ingenuous application, which is in practice in India for many years. Here, the island is made to bring the ground level above water level and wells are constructed on the level surface. The four of the foundations near the banks were constructed using this technology.

At the location of the foundations Balli piles (Fig 8) were driven almost to the diameter of 20 m to accommodate 16m X 10m double D well and the Balli piled cofferdam
walls were filled with sand bags to retain the sand island within. After pitching the cutting edge the curb walls of 4.5m height are installed and the reinforcement inside are fixed prior to the commencement of concreting. The material inside is gradually scooped out to facilitate the sinking under its own weight. As the sinking proceeds, the steining is built up in lifts of 2.325 m to further the sinking due to increase in weight. The double D well is divided into two compartments, the drifting, i.e., shift and the tilting, is controlled by dredging the appropriate compartment. Normally, the tilt of 1 in 80 and shift of 150 mm is considered to be tolerance limits and the design caters for the same.

Cranes and grabs were deployed for well sinking. It was ensured that the could bite into the soil and be closed when operated from top. The length and breadth in both opened and closed condition was kept as small as possible, yielding maximum quantum of earth carrying capacity.

The concrete grade of M35 was produced in the batching plant installed on Guwahati side as well as at the crushing plant on Amingaon side was transported by transit mixers. In the river, transit mixers were mounted on the barges and concrete placement (Fig9) was done either by pumping or by cranes. Once the founding levels were reached, the bottom plugging was completed using tremies followed with sand filling up to scour depth.

At depths more than 5.0 m, particularly for foundations P9 to P15 the bottom section of steel caisson (cofferdam)
of 12m x 5m.

In the direction of the water flow on both ends the circular ease waters of radius 3.5m at bottom tapering to 2.5m at top have been provided in piers with in the above size. The thickness of hollow piers were 1.0m uniform from top to bottom.

The reinforcements for the piers were embedded in to 3.0m thick well before being cast and the tapering hollow pier (Fig 12) of 15.0m height was cast in 6 lifts.

Heavy pier cap with 420 cum of concrete & 65 MT of reinforcement steel was cast on cantilever brackets without taking support from bottom. POT/PTFE bearings up to 4410 MT used in this project. Pier head unit of 20.66m length cast on cantilever brackets. Shock Transmission Unit (STU) & Freezing Arrangement is provided due to seismic zone – 5.

In case of multi-span continuous bridges, the horizontal forces due to seismic in longitudinal direction is mainly absorbed by fixed pier as such there is no uniform distribution of horizontal forces among the piers. One way of achieving this is by integral bridge without bearings so that seismic distribution is uniform on all piers. But this gives rise to provision of very large expansion joints which may not be feasible. The shock transmission units designed to connect the superstructure with substructure to form a temporary rigid link provides an opportunity to distribute the sudden loads due to seismic and braking etc. uniformly on all piers apart from allowing the movement for slowly induced loads due to temperature, creep and shrinkage. Within the cylinder provided in STU, viscous fluid passes from one compartment to another through a small designed passage. Under the sudden load like seismic and braking it gets locked as the fluid cannot pass from one compartment to another suddenly as such superstructure and substructure is integrated for structural response. For other slowly applied loads like temperature, creep and shrinkage, there is little resistance for the passage of fluid as such the movement is accommodated in STUs. The STU was first used by Steinman for Carquinez Bridge in California in 1927.

In new Saraighat bridge STUs were very effectively used (Fig14). In this bridge, first time STUs have been adopted in such a large magnitude perhaps in India. The total
length of the main bridge of 1.50 Km is conceptualized by a single girder between piers P6 to P18 having 12 spans (2\*105 + 2\*150 + 4\*129.948). The expansion provision at P6 & P18 locations being 450mm, the construction was done by cast in situ balanced cantilever construction method. Shock Transmission Units (STU) are provided to distribute the horizontal seismic forces among the supports. There are 3 Nos. of STU's installed in each pier having max. capacity of load 4000 Kn. In total 30 Nos. of STU has been installed on all piers except central Pier of the bridge which has fixed bearing. The approx. weight of STU is around 3 MT and it is kept in position with the help of 12 Nos. vertical bolt of dia. 40mm and grade 12.9, the capacity of bolt is 60T. The STU's are fixed to the pier cap with 10 Nos. of horizontal bolt of length 9.2 meter on either side of base plate fixed on the vertical side of the central pier P12 is equipped with fixed and longitudinally guided bearings without STUs, while the other piers are provided with 3 numbers STUs of 4.5 MN capacity and 2 numbers longitudinally guided bearings.

As the structure is idealized to originate expansion and contraction from pier P12, on either side as the piers are moving outwardly, longitudinal movement absorption capacity of STUs as well as bearing keeps on increasing as can be seen from the Fig 15. In the absence of STUs, the central pier would have to be catered for approximately 80 MN instead of 6.3 MN and the expansion provision requirement at P6 and P18 locations would have been unmanageable. Perhaps the largest single girder bridge of 1.5 Km in India would not have been possible without the provision of STUs.

5.0 SUPERSTRUCTURE

5.1 Design aspects

As has been depicted in the Fig 5 the bridge is a continuous bridge from P6 to P18 where the abutment spans P6-P7 & P17-P18 are 105m in length that are flanked towards the river sides by penultimate spans P7-P8 & P17-P16 of 150m lengths each. In the river portion there are 8 spans of 122.948m each. The cross section for both spans (L) 150m and 122.948 m varied from root depth (h) of 8.0m to mid span depth (t) of 3.5m (Fig 15). The charts of parametric studies conducted by
José Diogo Honórioas as a part of master thesis titled “Conceptual design of long-span cantilever constructed concrete bridges” is produced in Fig 16.

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The ratio h/t values remain an average 3 to 4.2 for various span lengths as per the conventional design recommendations. In Brahmaputra bridge the same is on lower side (2.28) compared to that of recommended guidelines and practice for both 150 m and 123 m spans. In fact one of the challenges to designer was to mate 150 m penultimate spans with the adjacent 123 m span and adhering to recommended parametric dimensioning according to relationships depicted in Fig 16.

A closer look at Fig 16 allows us to know that almost all the L/h values are between 15 and 20. From the trend line traced we can also see that the longer the span becomes, the closer L/h is to 20. The L/h values of 15.375 for 123 m span and 18.75 for 150 m span is in line with this trend in new Saraighat bridge.

The greatest variations of values occur in the L/t ratio. Once again, the longer the span, the higher the L/t value, as seen on the Fig 16. From this Fig we can say that for a span between 100 m and 150 m, the preferred L/t value is around 45 and this value keeps on growing until 85 when it reaches the greatest span dimension ever – 301 m.

There seem to be an almost perfect linear relation between L/t and h/t in the parametric study of number of cantilever bridges in the said thesis. For h/t of values around 4, L/t is about 75. When the ratio is between 2.5 and 3 the aesthetically recommended L/t has an average value of 45.

5.1.1 Camber-Correction

There were overall 11 number of pier well foundations from P7 to P17 from where the balanced cantilever construction was to be carried out. As the working season in Brahmaputra river is normally barely 6 months and also all the foundations and later superstructure cannot be tackled simultaneously from all 11 piers due to huge resource requirement, the time gap between the realisation of different spans is large and also erratic depending upon the readiness of pier foundations. Since the structure is continuous from P6 to P18, the balanced cantilever determinate spans during construction are to be mated following a sequence of construction (Fig 17) based on construction stage design rendering the structure to indeterminacy in 7 construction stages. The penultimate spans of 150 m were to be connected to its adjacent spans of 122.948 m (Fig 15), the same posed additional complexities in terms of design and construction for mating these asymmetrical cantilevers.

Taking the above complexities into considerations, the camber corrections had to be carried out for following stages of deformations in Saraighat bridge.

• Deflections caused during cantilever construction
• Deformation of cantilever segment before closure due to dead load of cantilever segments, traveler and closure segment.
• Deformations of the continuous system after closure.
at midspans, the stressing of continuity tendons and placement of superimposed dead load

**During the cantilever construction**, each addition of a new segment contributes to the deflection of cantilever arm as it exists at that time. The contribution may be considered as consisting of deflection of the cantilever tip, rotation of the end section about a horizontal transverse axis. The stressing of tendons anchored in the particular segment will cause opposing deflection.

The subsequent advancement of cantilever gantry will increase the bending moment in cantilever arm due to weight of gantry, and therefore also contribute to the deflection. This contribution, however, will exist only in the construction phase. It is important, therefore, to predict accurately the deflection curve of the various cantilevers so as to provide adequate camber adjustment of the form gantries for cast in situ construction.

![Fig 17: Construction sequence showing seven stages](image)

During cantilever segmental operation, the deflection will occur on a statically determinate system. The factors which effect the deflection can be:

- Dead load of the segment (concrete weight).
- Weight of the gantry or segment placing equipment,
- Cantilever pre stress, considering instantaneous and time dependent losses, and
- The modulus of Elasticity of concrete E, creep, and shrinkage.

**Before the casting of continuity units**, deflections of tip point occur in the time interval that begins immediately after the form gantry has been removed from the tip of the completed cantilever and ends after the stitch segment.
(m) has been cast. They are caused by following actions:

- Loss of prestress during the time interval
- Creep during this time interval
- Self-weight of the closure segment.

**After achieving continuity of cantilever arms**, the structure becomes statically indeterminate and continues to undergo additional deformations for the following reasons:

1. Residual plastic deformation due to self-weight and cantilever prestressing,
2. Residual loss of prestress in cantilever tendons
3. Continuity prestress, including its losses,
4. Removal of cantilever gantry (which is a reverse loading on continuous structure),
5. Release of temporary bearing restraints if any (which too is a reverse loading on continuous structure),
6. Superimposed dead load,
7. Residual foundation settlement and column deformation occurring after closure – if any.

The calculation of items (2) to (7) above is made for final continuous system. Item (1) is calculated for cantilevers, taking into account the redistribution of moment due to change of system.

**5.2 Construction aspects**

The entire superstructure was realised by cast in situ balanced cantilever method of

Irrespective of the span lengths (for both 150m & 122.94), the pier table unit of around 10.83m length were cast on bearings. The pier table had 404 cum of concrete embedded with 105 t of steel reinforcement. After the casting of pier table, the cantilever gantries which are also called form travellers were erected on either side of the pier table. There were around 22 segments having lengths of 2.925m for initial segments and 3.725 m length for later segments of cantilever of 150m span while for 122.948m span cantilever there were 18 segments. The lengths of the cast in situ segments were varied to keep the green concrete weight within 65 cum embedded with steel reinforcement of 15 t.

![Fig 19: Planned movement of Gantries](image)

Depending upon the sequence of construction, 5 numbers of form travellers were deployed for this project. The form travellers' movement (Fig 19) were planned optimally to suit sequence of construction and speedy expedition of the project.

The each form traveller (Fig 20) was indigenously designed and manufactured at site itself and finally load tested before being put in to use. The travellers were designed for the handling load of 160 t, live load of 360kg/m^2 and self-weight of 80 t acting at 1.625m eccentricity from the edge of last cast segment.

Concreting activities in the Brahmaputra River had been achieved with the use of high capacity concrete pump, transit mixer of 6 cum capacity, transit mixer mounted on the barge, tug boats, crawler crane mounted on barge capacity 80T & bucket of capacity 2 cum to 1.2 cum.

In superstructure concreting, two concrete pumps were used, one concrete pump placed at bank loads the concrete in the transit mixer mounted on the barge which are later towed with help of tug at the location. Crawler
crane mounted on the barge with concrete bucket helped in lifting the concrete to the second concrete pump placed on the deck for the further pumping. The whole cycle of concreting in the river for the superstructure came to 8 cum per hour.

On an average following time cycle was achieved for realization of a segment:

1) Gantry Unlocking: 1 Day
2) Gantry Movement: 0.5 Day
3) Gantry Locking: 1 Day
4) Gantry Alignment: 0.5 Day
5) Reinforcement fixing, binding and fixing of shuttering: 5 Days
6) Cable Profiling: 1 Day
7) Stopper Fixing/checking: 1 Day
8) Concreting: 1 Day
9) Cable threading/waiting period of concrete for achieving 70% strength for post tensioning: 5 Days

Total = 16 days.

During the construction as the cantilever progression takes place, the deck had to be stabilised against the overturning and also had to be restrained against translation as most of the piers were supported on longitudinally guided POT/PTFE bearings.

The 14 numbers of 19K15 stabilising (Fig 22) cables were anchored to pier cap from bottom of pier table in addition to 4 numbers of sand jacks. The translation or sliding of the deck during construction was restrained by freezing the bearings through end stoppers anchored by PT bars.

In order to be able to follow the evolution of cantilever deflections towards the goal as indicated above in the camber correction section, two survey points were placed in the top slab concrete of each new segment, one over the axis of each web, say 100mm behind the front edge of the segment. The level of each point represented the level of segment next to the segment joint in subsequent survey checks. The longitudinal profile constituted by the points would be a polygon whose angles determine the final road profile.

When measured deflections were compared to the predetermined ones, further corrections were to be introduced in consideration of circumstances like the following:

- Temperature difference due to solar radiation, heat of hydration, etc,
- Any particular thermo-hygrometric condition e.g. high humidity under bridge deck which passes at low height over a water surface,
• Settlement / rotation of foundation, and
• Any additional load on the bridge, e.g. construction load, furnishing, etc.
• The difference in the theoretical and actual creep and shrinkage losses.

During the cantilever operation, the cantilever is the system in constant evolution as such no fixed level is available. The 'difference' between segment joints was not only in level but also in slope.

In order to achieve the desired longitudinal Deck-profile, the geometry control should focus on the difference of slope as-built between subsequent segments; this could be done graphically e.g. by drawing the longitudinal profile made up by the bolts in each web line. Whenever the discrepancy was detected between the desired curve and as built curve, it had to be corrected over a few following segments.

6.0 CONCLUSIONS

Bridging the mighty river Brahmaputra is one of the major challenges for bridge engineers and could be done only by an experienced and techno savvy bridge builder.

Some of the achievements while overcoming the challenges were:
• Successful completion of 11 numbers of Double D type Well Foundations with 57m avg. depth without any major problems of tilt & shift in the river Brahmaputra.
• Continuous superstructure of Single PSC Box Girder of 1494 m in length having an finger type expansion joints at the ends of capacity 500mm with overall deck width of 13.875.
• Successful completion of shoring to maintain stability of approach road of existing Saraighat Bridge.
• The use of STUs in large magnitude for the first time in the country. Perhaps the adoption of the above STUs helped in withstanding earthquake on 25th April' 2015 in Nepal & North Eastern part of India on 7.3 in Richter Scale. This Bridge structure under construction sustained this massive earthquake without any damage.
• Indigenously designed, manufactured and load tested 5 numbers of gantries in use at a time.
• Specially designed stabilizing and bearing freezing arrangement for peculiar bearing layout provided with in bridge system.
• Special attention to pre camber monitoring during superstructure construction.

7.0 REFERENCES
