CONDITION ASSESSMENT AND EVALUATION OF THE NARAHENPITA RAILWAY BRIDGE

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INTRODUCTION

In Sri Lanka, railway bridges with spans less than 3 m are considered as culverts. In the very beginning, rolled I sections were not available for construction work of bridges. Hence, Rolled Steel Joists (RSJ) were used to construct culverts and bridges. The maximum available depth of these joists was 400 mm. In railway bridges of spans from 3.0 - 7.6 m, the RSJs have successfully been used. When the span is more than 7.6 m and up to 18.25 m, built up plate girders were used. In this period, rolled girders have not been produced. Hence, built - up plate girders have been used to construct main girders and other components. For these spans, depth of the girder used was around 1.6 – 2.1 m. In plate girder bridges, when the girder depth is very high, it becomes a crucial factor. For a deck type bridge, when the depth of plate girder is more, it may disturb navigation in the river. It also disturbs the water flow at flood levels. Deck type bridges are more suitable when approaches are at a higher altitude than the average flow level of the river or stream. The other factor that needs to be considered in selecting different types of structures for bridges is the wind force. Most of the bridges in the up-country are deck type bridges. To overcome the effect of the wind force, semi through or half through bridges came in to practice. Semi through bridges are designed mainly to increase the space between the bottom frame and flood level of the river and to make the river navigable. Both truss and plate girder bridges are considered as semi through bridges. Whe1n the span is more than 20 m plate girders cannot be used economically. Therefore, when the span is more than 20 m suspended or truss girder bridges have to be used by the Sri Lanka Railways (SLR).

As per the bridge register of SLR, there are 386 bridges in the railway network. Out of these, 384 bridges are steel and only 2 are concrete bridges. Among the different railway lines, the Kelani Valley (KV) line is one of the oldest tracks constructed for the Ceylon Government Railway dating back to 1902. The main objective of this track was to haul estate products to Colombo city and Fort from Kelani Valley area. Over the years after Independence in 1948, the purpose of the KV line was transformed purely to passenger transport. A majority of the passenger transportation is being done between Colombo Fort and Homagama. There are four main bridges in the KV line up to Awissawella (Hyatt 2007). The Narahenpita railway bridge is located close to the Open University of Sri Lanka (OUSL) and over the Diyawanna Oya, between Fort and Nugegoda.

At the inception of KV line, the track was designed to carry the load class H1,V2, N1, N2 and etc, (Silva 1991) which were narrow gauge locomotives having the axel loads of 8.5 to 15 imperial tons which were operated at low speeds (20-25 km/hr). About two decades back, it was proposed to convert the track from narrow gauge to broad gauge as a composite track which could operate broad gauge as well as the narrow gauge locomotives. After the removal of obsolete narrow gauge locomotives, the KV line was meant only to carry broad gauge locomotives despite the fact that the track was designed to carry narrow gauge locomotives. In 2012, Chinese built S12 Diesel Multiple Units (DMUs) were introduced in the KV line. However, S12 DMUs have 18.5 Tons axle load which are heavier than the presently operated S6 and S8 DMUs (14.5 Tons).

In the recent past, the number of passengers using the KV line has increased rapidly due to increase of the population density in Colombo suburbs from Nugegoda to Avissawella. Hence, the number of turns of travel and speed were increased to haul more passengers to meet with the current demand. In order to achieve an acceptable solution for the above problem, the relevant authorities have proposed to develop the KV line as a dual track line and also to integrate the same with the proposed Colombo city outer circle highway. Further, there is another proposal to extend the service of the KV line up to Nonagama and interconnect to the proposed Matara Kataragama railway line.

As per the authors' knowledge, there has not been any structural assessment of the bridge. Considering all these factors, it is important to assess the present condition of the bridge to avoid any catastrophic failure of any member or a section of the bridge. Therefore, the objective of this paper is to visually assess the bridge considering present deterioration conditions and to give recommendations for further assessments.

NARAHENPITA RAILWAY BRIDGE

The existing bridge consists of two spans, which are of wrought iron; One is 32.0 m span open deck type truss bridge and the other one is 19.7 m span ballasted deck plate girder bridge shown in Figure 1. All abutments and piers are arch type brick masonry.

At the time of conversion from narrow gauge to broad gauge, a new bridge was not constructed to take the increased loads of heavier engines. Instead, temporary strengthening of the existing bridge was carried out. Due to this, restrictions on heavy engine types and speed limits were imposed as a safety precaution. At the time of conversion, no modification or strengthening was done in pier or in the abutments.

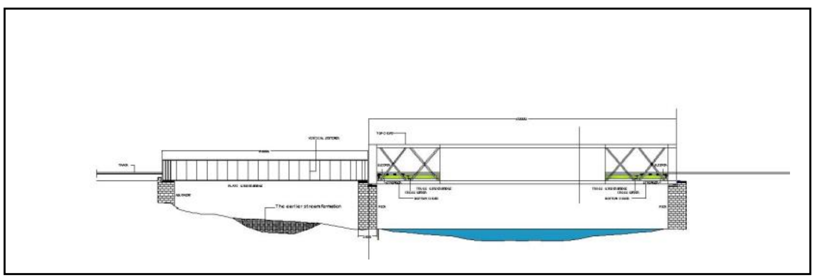

Figure 1: Schematic view of the existing bridge

METHODOLOGY

The present state of the bridge was visually evaluated to identify affected structural members and sections in the super structure and sub structure. Following sections outline the level of damage occurred in specific areas.

PLATE GIRDER BRIDGE

Physical inspection revealed that the end box of the plate girder is highly corroded and deteriorated at the Kirulapone end approach due to a high-level of corrosion. Further, the bottom chord of the girder and the steel troughs are also corroded. All the weep holes are blocked and visible sedimentation is also present. In addition, the box girder in the Narahenpita end approach is also heavily corroded. The present condition is not favorable to carry the loads of heavy engines like "M class" locomotives. Figure 2 shows the current state of the end box at the Kirulapone end.

Figure 2: View of the corroded end box

Figure 3: View of the cross girder-bottom girder connection

TRUSS GIRDER BRIDGE

The truss girder bridge is 32.0 m long Double Warren open deck type semi through bridge. At the time of conversion from narrow gauge to broad gauge, the bridge deck and top chord were strengthened to suit for the S–class loading (14.5 Tons axle load) and to maintain an average speed less than 40 km/hr. As per the visual inspection end box of Narahenpita end approach is heavily corroded and decayed. The provision of the additional stinger beam to cross girders at the strengthening stage has caused additional vibration effects to the bridge. The view of the cross girder-bottom chord connection is shown in Figure 3.

ABUTMENT AND PIER

The centre pier of the present bridge, constructed of brick masonry has distinctive cracks at the top which appear to spread towards the bottom of the pier. Therefore, it is difficult to make a proper judgment on its load carrying capacity since structural details of the bridge pier are not available with SLR. Due to the change of the stream flow path, there is an extensive scouring damage at the Narahenpita end abutment. Soaking of the abutments at the high floods may further damage the brick pier and abutment. This effect has been worsened due to the construction of a gabion wall in the river bank recently. The gabion wall has reduced the width of the water way from 50m to 30m.

Figure 4: View of the centre pier

POSSIBLE REASONS LEADING TO DETERIORATION OF THE BRIDGE

The following possible reasons were identified as the main reasons for bridge deterioration,

1. Non-responsible human behavior of the residents near the bridge.
2. Poor maintenance of the bridge. Since the weep holes provided underneath the ballasted deck are completely blocked, the storm water stagnates over the bridge. The authors are of the view that a close deck type bridge is not suitable for this place.
3. Some of the structural modifications carried out during the strengthening works of the bridge have had a detrimental effect of the bridge.

CONCLUSION

As per the visual inspection and the literature survey carried out on the Narahenpita bridge, it was revealed that no significant documentary evidence is available to make a realistic justification of the life span of the plate girder and truss bridge as well as the substructure. From the visual inspection, it was revealed that the present state of the bridge is not satisfactory. Therefore, in order to make a realistic justification of the balance service life of the bridge, a compressive condition evaluation test needs to be carried out based on the axle loads of new engines that have entered the fleet of the Sri Lanka railway. Thereby, it is possible to justify the application of new heavier DMUs.

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