**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte

**Band:** 82 (1999)

**Artikel:** Rehabilitation of the Luangwa Bridge

**Autor:** Reinholdt, Peter / Veje, Ejgil / Kalvslund, Jimmy

**DOI:** https://doi.org/10.5169/seals-62169

# Rehabilitation of the Luangwa Bridge

**Peter REINHOLDT**
Department Head
COWI AS
Lyngby, Denmark

Peter Reinholdt, born 1953, received his civil engineering degree from the Engineering Academy of Aalborg Denmark in 1976. He is head of Department of Design and Supervision of Bridges.

**Ejgil VEJE**
Department Head
COWI AS
Lyngby, Denmark

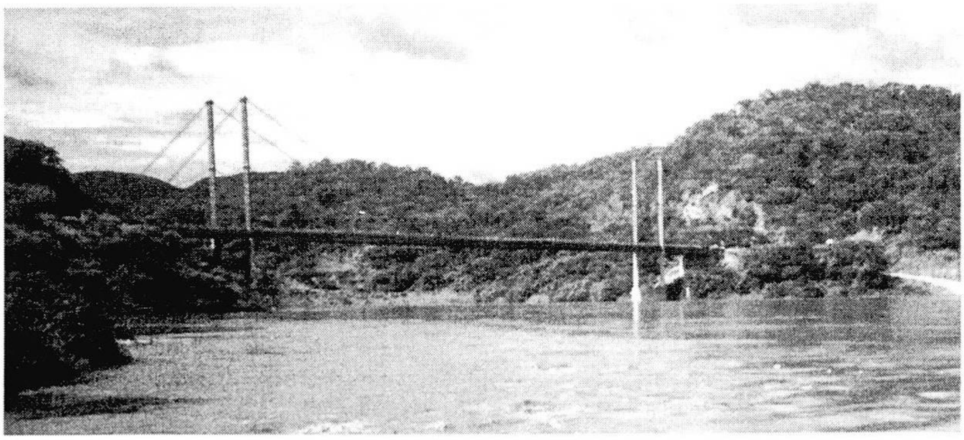
Ejgil Veje, born 1954, received his civil engineering degree from the Technical Univ. of Denmark in 1981. He is head of Department of Maintenance and Rehabilitation of Major Bridges.

**Jimmy KALVSLUND**
Project Lead Engineer
COWI AS
Lyngby, Denmark

Jimmy Kalvslund, born 1963, received his civil engineering degree from the Technical Univ. of Denmark in 1989. He is Project Lead Engineer in the Department of Operation Management and Systems.

## Abstract

The Luangwa Bridge is a cable stayed bridge with a free span of 222.5 metre situated in Zambia. The bridge was built between 1966 and 1968. The bridge girder is made as a composite structure, with two main steel boxes at the sides with a concrete deck between supported on steel cross beams.



Shortly after the opening of the bridge it became evident that it was not behaving as intended. The traffic on the bridge was then restricted to the crossing of one vehicle at a time travelling with a maximum speed of 15 km/h with a maximum gross weight of 50 tonnes.

In 1972-73 remedial works were carried out involving:

- Shortening of stays by applying clamps to improve the vertical alignment of the bridge
- Mounting inside the bridge girder of horizontal compression steel tubes near the towers and horizontal tension cables near the middle of the bridge
- Replacement of failed friction grip bolts in the main steel boxes of the bridge girder.

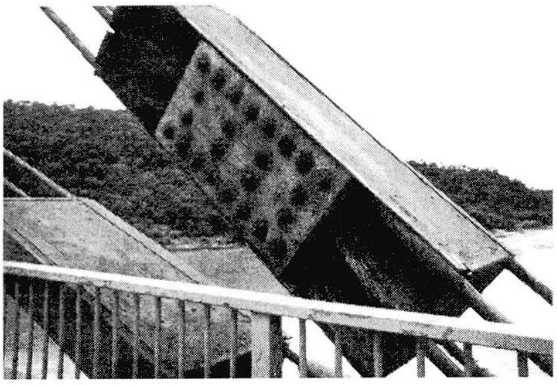


*Fig. 1 Cable Clamps*

An inspection of the bridge was carried out in 1993 covering both visual inspection, non-destructive and destructive testing.

In spite of the remedial works carried out in 1972-73 with the intention of rectifying the longitudinal profile there was still a considerable sag in the main span.

The reason for the failure of high friction grip bolts in the splice connections of the main steel boxes was examined and found to be caused primarily by intergranular cracking in the bolt shaft caused by hydrogen.

Severe pitting corrosion was found on the cable stays. The painting of the cable stays was cracked and there was virtually no adhesion to the cable surface any more.

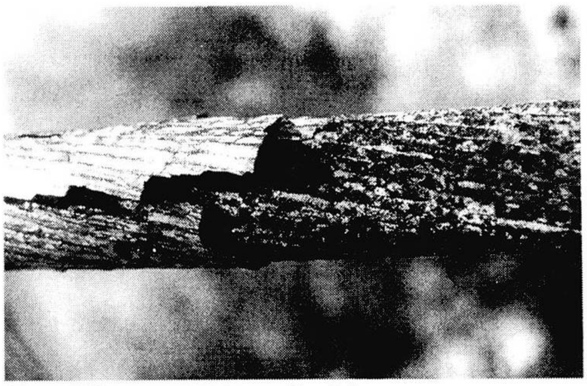
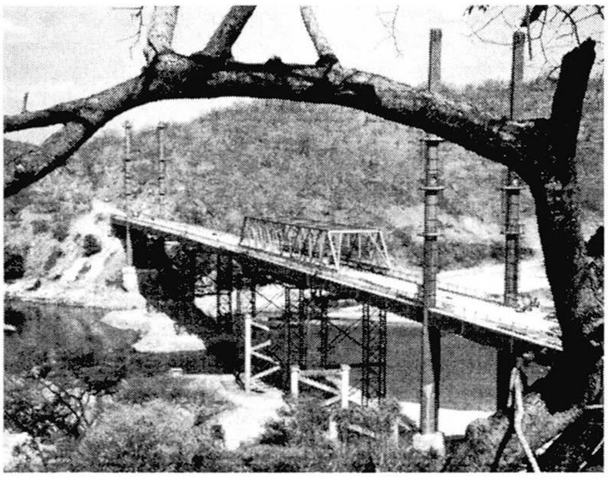


*Fig. 2 Severe pitting of cables*

A rehabilitation of the bridge was carried out in 1997 to strengthen the bridge and enhance its load bearing capacity. The rehabilitation included replacement of all cables and strengthening of the bridge girder. Construction work had to be completed within a time slot between two rainy seasons, which represented a serious constraint on the project.

For the analysis and design of strengthening measures an IBDAS FEM-model was established to take into account the full history of construction of the bridge. This included back tracking the construction phases for the main girders, the casting of the concrete deck in sequences, shortening of the stay cables and other remedial measures carried out in 1972-73.

As the rehabilitation included installation of new bottom plates, splice plates and bolts in the main steel girders of the bridge deck, all bolted connections had to be opened. To do so the connections had to be either in a virtually "stress free" state or had to be temporarily fixed by clamps or equivalent. The chosen method of rehabilitation involved bringing the deck into a "stress free" state. This was achieved by use of temporary towers at the cable anchorage points and a travelling girder.



The travelling girder was designed to span neighbouring support points lifting the deck section undergoing rehabilitation. Spanning a maximum of 56 m and weighing 90 tonnes, it was designed to carry both the weight of 55 m bridge girder and the traffic loads.

The travelling girder was successively moved on top of the bridge deck on temporary rails into positions between two temporary towers. Once in position the weight of the bridge girder underneath was transferred to the travelling girder. The virtual "stress free" condition was achieved in this way and the required opening of bolted joints could be performed to allow fitting of the new splice plates and new bolts.

Thanks to a very intense and close contact during construction between the contractor on site, the supervision team and the design team in Denmark the contractor succeeded in finishing all critical operations and removing the temporary towers from the river bed before the heavy rains made the water level in the Luangwa River rise dramatically by mid December 1997.

With the chosen level of rehabilitation the bridge is now able to carry HA loading and HB loading up to 25 units. The HA loading is a formula loading representing normal traffic and the HB loading is an abnormal vehicle unit loading.