Replacement of the Cable Stays at Ewijk Bridge, the Netherlands

Conor LAVERY
Associate Director
Managing Contractor / Arup
Dublin, Ireland
conor.lavery@arup.com

Pat MOORE
Senior Engineer
Managing Contractor / Arup
Amsterdam, Netherlands
pat.moore@arup.com

Edo VONK
Associate
Managing Contractor / Arup
Amsterdam, Netherlands
edo.vonk@arup.com

Gerland NAGTEGAAL
Technical Manager
Rijkswaterstaat
Utrecht, Netherlands
gerland.nagtegaal@rws.nl

Summary

Managing Contractor has carried out the design of the replacement of the existing cables stays at Ewijk Bridge. Replacement of the existing cables is one component of the renovation works necessary to extend the design life of this large steel bridge by at least 30 years.

Keywords: Steel bridges, assessment, refurbishment, strengthening, cable stay, steel box girder, orthotropic bridge deck, locked coil cables, jacking.

1. Introduction

Ewijk Bridge is a landmark crossing of the River Waal, in the Netherlands. The bridge requires renovation. After renovation, the bridge is subject to additional design loads which increases the design forces in the locked coil cables by approximately 15%. The existing cables have defects, principally the presence of microfissures. These defects have resulted in a number of wire fractures along the length of the cables. An assessment of the design capacity of the existing cables concluded that a 30 year remaining life of the cables could not be guaranteed. Hence, due to the increasing loads on the cables and concerns with respect to the remaining life of the existing cables, all of the existing locked coil cables are to be replaced.

The overall length of the bridge is 1055m, consisting of 10 spans. The main river crossing consists of a 480m long cable-stayed portion, with a main span of 270m and back spans of 105m each. All cables are located along the central longitudinal axis of the bridge. The cables run uninterrupted over the cable saddles located in the pylon. The long cable stay consists of two bundles of 5 cables, while the lower cable stay consists of two bundles of 3 cables. Each cable has an external diameter of 101mm and a minimum breaking force of 903tonnes per cable.

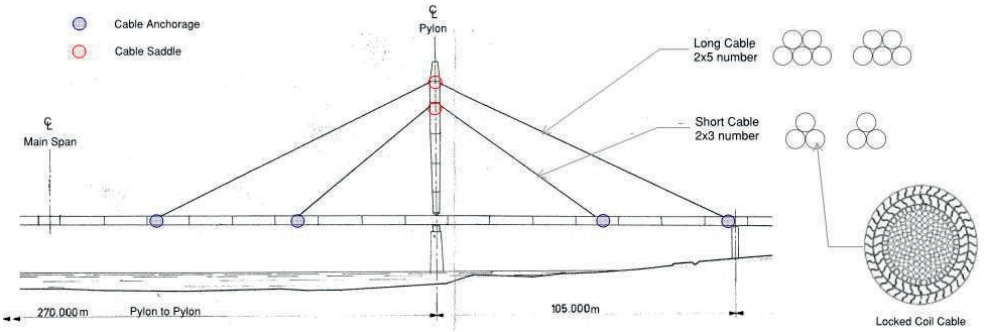
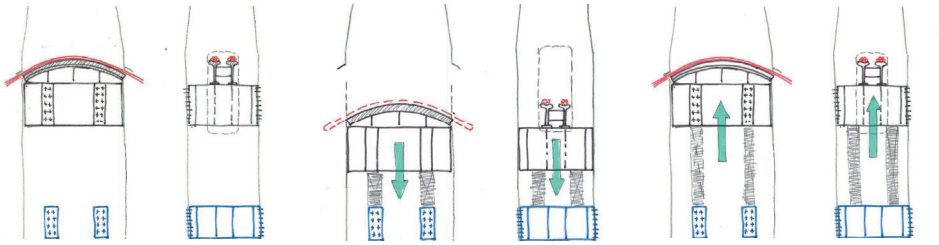


Figure 1: Half Elevation of Main Span at Ewijk and Cable Details

https://doi.org/10.2749/222137813806548433

2. Description of the cable replacement design

The original design of the Ewijk Bridge did not consider the replacement of cables. The configuration at the existing cable saddles and cable anchorages do not allow the possibility to replace the cables one by one, or even bundle by bundle. The selected cable replacement method, which effectively reverses part of the original construction process, is to jack down the cable saddles in the pylon, and then jack up the saddles when the new cables are in place, in order to apply the required force (preload) in the new cable. The tuning of the cable forces is controlled and monitored by measuring cable forces and monitoring deck displacements during the cable replacement works.



A: Initial configuration at Upper Saddle in Pylon

B: Jacking down of Saddle – de-tensioning existing cables

C: Jacking up of saddle – tensioning new cables

Figure 2: Schematic showing replacement of cables at upper saddle location.

A "like-for-like" cable replacement system was selected. The new cables proposed are 100mm diameter, fixed-length locked coil cables with the same structural characteristics as the existing cables, in terms of strength and stiffness. The like-for-like system allows the re-use of the existing saddles located in the pylon and the existing anchorage configuration in the box girder.

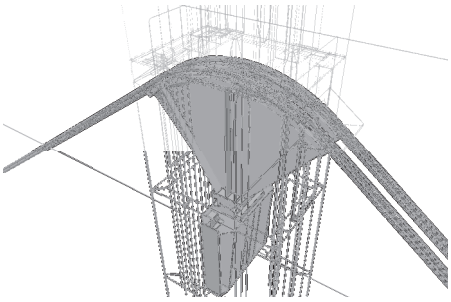


Figure 3: Lower Cable Saddle

The indicative cable replacement sequence adopts a cable stay by cable stay approach whereby one cable stay is removed and replaced with a new cable stay, before commencing on the next existing cable stay. Incorporating cable replacement with the overall renovation works has provided significant benefits. It allowed the possibility to minimise the load effects by removing existing asphalt and removing traffic from the bridge during the replacement works. In addition, phasing of deck strengthening and deck jacking, provide some advantages. Without these opportunities, cable replacement without a system of temporary supports, would not be feasible. The governing criteria during cable replacement was found to be deflections in the main span over the navigational channel, the loads in the existing cables, and the effects of the redistributed forces in the box girder.

The contract to undertake the renovation works at Ewijk Bridge has been awarded. The Contractor has proposed an alternative cable type, namely a parallel strand system which utilises a multi-tube saddle element.

The cable replacement will result in minimal hindrance to highway and waterway traffic during construction, and will help prolong the useful life of this landmark bridge.