M5 Exe and Exminster Viaducts - Strengthening and Safeguarding

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Abstract

Exe (692m long) and Exminster (302m long) Viaducts were built in 1977 and carry the M5 motorway across the Exe Valley in the UK. The deck of both bridges consists of a pair of constant-depth twin-cell post-tensioned box girders with fully external prestressing tendons. In 2016, corrosion was observed in the end-span tendons of Exe Viaduct. A safeguarding solution was proposed comprising additional external post-tensioning. In addition, an assessment revealed that the superstructure did not have sufficient ultimate capacity in the mid-span regions. The assessment of Exminster Viaduct found a similar shortfall in resistance. This resulted in a scheme comprising of external unbonded tendon safeguarding in the end spans of Exe Viaduct and internal bonded tendon strengthening in all midspan regions for both bridges. The solution offered a positive environmental impact avoiding the need for demolition and deck replacement for these two significant motorway bridges.

Keywords: bridge; post-tensioning; box-girders; assessment; strengthening; rehabilitation.

1 Introduction

The two viaducts discussed in this paper are situated just southeast of Exeter between junctions 30 and 31 of the M5 motorway, which links Birmingham in the Midlands to Plymouth in the south.

The structures are separated by a 400m long embankment. Exe Viaduct comprises 11 spans (53.50m – 9 x 65.00m – 53.50m) over the Rive Exe and the Exeter Canal. Exminster Viaduct has 5 spans (53.50m – 3 x 65.00m – 53.50m) carrying the motorway across a double-track railway line.

The 2.80m deep twin cell concrete box girders (see Figure 1) were designed with only external, unbonded prestressing. Tendons are up to 170m long and pass through saddles cast within internal diaphragms spaced regularly within each span.

Each span contains 16 to 24 tendons (type 6-19 Dyform) formed from bundled sheathed monostrands and with stressing anchorages at each end as shown in Figure 2.

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