Structural Assessment of the M6 Bromford Viaduct Against Ground Movements

Thomas Wood, Christos Mitsarakis, Stuart Moore

Mott MacDonald, London, UK

Contact: Tom.Wood@mottmac.com

Abstract

As part of the HS2 Phase One project, geotechnical and structural assessments were performed by Balfour Beatty VINCI and their designers Mott MacDonald – Systra DJV in engagement with National Highways to demonstrate that the existing M6 Bromford Viaduct can withstand the effects of ground movement from the HS2 Bromford Tunnel. Initially, a linear elastic analysis indicated the need for extensive strengthening. After an in-situ concrete compressive strength testing scheme, a refined assessment was performed employing advanced non-linear analysis and structural verifications, including consideration of progressive development of cracking, non-linear soil structure interaction, and a hybrid methodology for assessing the capacity of reinforced concrete pile caps. This paper discusses how the refined assessment methodology exploited the existing structure's available capacity reserves and eliminated the need for extensive strengthening works.

Keywords: Structural assessment; reinforced concrete; non-linear analysis; settlement; pile caps; concrete cracking; bridge strengthening

1 Introduction

1.1 Background

As part of the HS2 Phase One project, Balfour Beatty VINCI and their designers, Mott MacDonald – Systra DJV, were instructed by HS2 to perform a Phase 3 Potential Impact Assessment (PIA) of the National Highway's (NH) M6 Bromford Viaduct. The purpose of this assessment was to assess the effects of ground movements on the viaduct due to the construction of the proposed twin-bore HS2 Bromford Tunnel, which crosses under the viaduct at skew as it approaches Birmingham.

The geotechnical assessment estimated the ground movements resulting from the completion of the first and second tunnel bores. Following an optimisation of the tunnel alignment and application of modern tunnelling techniques, the maximum greenfield foundation settlements were estimated to range between zero and 14mm. Preliminary analysis concluded that settlements less than 5mm had negligible effects on the viaduct and therefore further structural assessment was required only for settlements between 5mm and 14mm. The portion of the viaduct experiencing this range of settlements comprised of 34 piers along a length of approximately 550m, which is hereinafter referred to as the zone of influence (ZOI).

1.2 Description of structure

M6 Bromford Viaduct is a 4.4km long bridge constructed circa 1968-1972 with the typical span (between expansion joints) of 15,164m within the ZOI. The steel-concrete composite superstructure comprises longitudinal universal steel girders with an in-situ reinforced concrete deck slab. The longitudinal steel girders are simply supported on sliding steel bearings, which are supported on reinforced concrete piers (bents) comprised of a reinforced concrete crossbeam supported on two, three or four reinforced concrete columns. As the bearings are 'free sliding', the longitudinal and transverse restraint of the deck is achieved by the

https://doi.org/10.2749/manchester.2024.0173
Distributed by structurae