Challenges in seismic design of incrementally launched bridges of Northern Marmara Motorway

Etienne COMBESCURE, Charles de COURCELLES

Freyssinet Technical Department, Rueil-Malmaison, France

Shahrokh GHAVAMIAN

NECS, Sceaux, France

Contact: etienne.combescure@freyssinet.com

Abstract

This paper presents the challenges in the seismic design of the incrementally launched bridges of the Northern Marmara Motorway project in Istanbul Turkey. First it describes the initial design for these viaducts, then it presents the alternative design based on incremental launching method (ILM) and finally does a comparison of their performances. Regarding the earthquake resistance studies, traditional multimodal response spectrum analysis was carried out. This was then completed by a nonlinear time history analysis considering the behaviour the fluid viscous dampers, the cracking of concrete and steel rebar yielding at the plastic hinges. The results of these two analyses are compared in terms of forces and displacements, indicating the conservatism of the modal spectral analysis.

Keywords: bridge, launching, damper, plastic hinge, nonlinear time history analysis

1 Introduction

The Northern Marmara Motorway is a 115 km long ring road around Istanbul. It includes the iconic 3rd Bosphorus Bridge designed to be the symbol of modern Turkey, but also not less than 37 bridges spread over both the European and the Asian sides. Most of these bridges are made of precast I-girders, however three of these bridges are constructed using the incremental launching method (ILM). The three ILM bridges of Northern Marmara Motorway project, also designated as the 3rd Istanbul Ring Road project, are viaducts V6 Left and Right which are 445 m long, viaducts V14 Left and Right which are 427 m and 280 m long respectively, then viaducts V17 Left and Right which are 640 m long. At the time of writing this paper, the launching of viaducts V6 and V17 is completed, while for viaduct V14 the work is in progress. We will focus on viaduct V6 in the following, all three viaducts being similar.

2 Presentation of the original design based on precast I girder

Conforming design was based on precast I girder, length 41 m maximum for span length of 40 m from bearing centreline to bearing centreline and 43,5 m maximum from pier centreline to pier centreline. The precast I girders are placed on laminated elastomeric bearings (300 x 400 x 85. mm). The simply supported spans are connected through link slab, to form 3 to 4 spans modules, an expansion joint being placed in between each module. The total cross section of each deck is 17,52 m² that is 0,8 m equivalent thickness. Each individual girder has a depth of 1,8 m without the top slab, and 2,05 m with the top slab. The slenderness ratio is 1/19,5 considering the total

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