Engineering Structures 33 (2011) 502–515

Contents lists available at ScienceDirect

Engineering Structures

journal homepage: www.elsevier.com/locate/engstruct

Parametric and pushover analyses on integral abutment bridge

Tobia Zordan [a,*], Bruno Briseghella [b], Cheng Lan [c]

[a] *College of Civil Engineering, Tongji University, PR China*
[b] *College of Civil Engineering, Fuzhou University, PR China*
[c] *University IUAV of Venice, Italy*

ARTICLE INFO

Article history:
Received 22 February 2010
Received in revised form
24 May 2010
Accepted 2 November 2010
Available online 27 November 2010

Keywords:
Integral abutment bridge (IAB)
Soil-structure interaction
Nonlinear parametric analysis
Temperature load
Pushover analysis

ABSTRACT

Integral abutment bridges (IABs) are jointless bridges where the girder or the deck is continuous and monolithically connected to the abutments. A usual and important problem in the design of IABs is how to deal with the soil–structure interaction behind the abutments and next to the foundation piles: this can be considered as a fundamental aspect to reach a thorough understanding of this type of structure, which requires iterative and nonlinear analysis. In this paper, a 2D simplified finite-element model of a real 400-metre-long IAB, built in the Province of Verona-Italy, is implemented and used to perform non-linear analyses on the bridge, the structural response of which is then examined in detail. A parametric study based on the variation of the soil properties behind the back-walls and around the piles is then performed. Furthermore, a temperature pushover analysis (non linear static analysis for positive and negative temperature variations) is carried out to assess the failure pattern of the bridge caused by a temperature change, considered as one of the key parameters in IAB design. Lastly, the effect of abutment stiffness is also discussed.

1. Introduction

In recent years the integral abutment bridge (IAB) concept has become quite common. It is, incidentally, not a newly developed concept as its formulation dates back at least to the 1930s and was introduced to deal with long-term structural problems frequently occurring with conventional bridge design. The original IAB concept was not well managed at that time and it turned out to cause numerous problems relating to the post-construction life of the structure due to the specific type of design and to the soil–structure interaction problems that still represent a challenging issue that requires a close cooperation between structural and geotechnical engineers. The IAB concept is currently generating much interest among bridge engineers because of the enormous benefits deriving from the elimination of expansion joints and the reduced installation and maintenance costs accruing. The superstructure of integral abutment bridges is made continuous through a composite cast-in-place concrete slab over prestressed concrete or steel girders and rigid transverse diaphragms: the system, made up of the sub- and the super-structure, acts as a single structural unit [1,2].

The connection between the super-structure and the sub-structure makes IABs different from other conventional bridges and allows for a remarkably increased redundancy, with improved response during seismic and other extreme events. Furthermore, the IAB concept has proved to be successful in eliminating a number of problems related to the management of conventional bridges during their service life, thus resulting as a more financially viable solution in terms of both construction and maintenance costs [2]. It would be rather naïve, though, to consider this kind of structure as “maintenance-free” as the IAB concept indeed suffers from an intrinsic and fundamental flaw deriving from the need to accommodate the different displacements between superstructure and soil, mainly by seasonal fluctuations of air temperatures. Also, as is usual for statically undetermined structures, the effects of temperature changes have to be carefully evaluated. The large number of uncertainties involved in the analysis — such as on-site real temperature conditions and soil mechanical characteristics — for IABs, parametric analyses is particularly useful in assessing the expected structural response.

2. Engineering background—the *Isola della Scala* bridge

The case study presented concerns a flyover (Fig. 1), completed in 2007 and located at *Isola della Scala* in Verona, Italy. The total length of the structure, arranged on 13 spans, is approximately 400 m. To the authors’ knowledge, this is currently the longest IAB ever built. The construction of the bridge, which began in 2001 as a simple supported flyover, was halted after 2 years because of

* Corresponding address: P.tta Maestri del Lavoro 3, I-30173 Venezia-Mestre, Italy. Tel.: +39 3939870385; fax: +39 0412621945.
E-mail address: tobia.zordan@gmail.com (T. Zordan).

0141-0296/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engstruct.2010.11.009