Influence of substructure height on fully integral abutment bridge in sand

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Summary

Nowadays, many simply supported bridges constructed all over the world have been affected by the durability problems, especially broken expansion joints and damaged bearings. In order to resolve fundamentally the durability problems of existing bridges during their service life, the concept of integral abutment bridge came out. In this paper, the retrofit technology with the concept of integral abutment bridge was analyzed, based on a simply supported bridge “Viadotto Serrone” in Italy. The corresponding finite element models of the existing jointed bridge and four types of fully integral abutment bridges after retrofit were built by Sap2000. Using the finite element model, the sensitive analysis choosing the substructure height as the critical influential factor was carried out. Some regulations obtained can be adopted as the guideline of this retrofit technology.

Keywords: Integral abutment bridge; Retrofit; Sensitive analysis; Substructure height; Sand.

1. Introduction

Many conventional jointed bridges have been constructed all over the world, in which expansion joints and bearings are installed to absorb cyclic thermal expansion and contraction, creep and shrinkage, and differential settlement. Some statistics indicated that many existing jointed bridges have durability problems during their service life, especially broken expansion joints and damaged bearings, which can be considered as the most common durability problem [1]. Furthermore, damaged expansion joints and bearings can produce some other bridge diseases, such as the corrosion in girder ends and bearings due to de-icing salt water passing through damaged expansion joints, unexpected supernumerary forces caused by debris accumulation, discomfort driving sense and so on. Moreover, frequent retrofit or replacements will cost a lot of money and time, and lead to serious environmental and social impacts [2, 3]. In order to resolve the problems of broken expansion joints and damaged bearings, some methods can be used by improving their inherent mechanical properties and adopting some other auxiliary techniques. However, these approaches can not resolve the problems fundamentally. According to the idea of ‘The only good joint is no joint’, the retrofit method of eliminating expansion joints and bearings is proposed [4].

Many retrofit methods can be used to eliminate or reduce the expansion joints and bearings in superstructure-pier connections, such as the continuous slab method, continuous diaphragm method, integral pier method and so on. Therefore, the key issue of transforming the existing jointed bridges into the jointless bridges is to carry out the jointless retrofit on superstructure-abutment connections [5]. In the last few years, one type of single- or multi-span jointless bridge, so-called as integral abutment bridge (IAB), has attracted more and more attention. The concept of IAB could be advantageously used in many situations, not only for the construction of new bridges, but also for the retrofit of existing bridges [6, 7]. Due to the statistics on the retrofit method of existing bridges in 2005 [8], it is found that 49% of the American States have a policy of transforming jointed bridges to jointless bridges during retrofit. From 2005, the IAB consisted of fully integral abutment bridge (FIAB) and semi-integral abutment bridges (SIAB) is becoming more popular in Europe [9].

In this paper, the research on the retrofit technology with IAB concept was conducted. The

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