Design Tool for Practical Design of Integral Bridges

Jaromir KRIZEK
Civil Engineer
Ing. Software DLUBAL
Prague, CZECH REPUBLIC
Jarek.Krizek@seznam.cz

Jaromir Krizek, born 1980, received his civil engineering and doctoral degree from the Czech Technical University in Prague. His main area of research is related to integral bridges.

Jiri STUDNICKA
Professor
CTU in Prague
Prague, CZECH REPUBLIC
Studnicka@fsv.cvut.cz

Jiri Studnicka, Professor at the Department of Steel and Timber Structures of FCE CTU in Prague, head of IABSE National Group, member of ECCS. His research is focused on composite steel and concrete structures and bridges.

Summary

This paper describes a method useful as a design tool for the practical planning of integral bridges. The application of integral bridge brings some specific problems, especially the interaction between the superstructure, the substructure and the surrounding soil. One of the main problems of the practical design is to take into account the influence of the surrounding soil in a proper way. The paper suggests the original way solving this practical engineering problem. The developed method gives a design tool to simulate the soil-structure interaction using elastic supports introduced into the static system of the integral bridge and how to determine stiffness of these supports.

Keywords: Integral bridge; soil-structure interaction; modules of subgrade reaction; design manual.

1. Introduction

Traditional girder bridges comprise two essential components: a superstructure and a substructure. The connection between the superstructure and the substructure is provided by the combination of fixed and mobile bearings accommodating thermal movements of the superstructure. It is customary to use separation joints to span the gap between the ends of the deck and the abutments. These joints and the bearings are supposed to enable the thermal movements of the superstructure.

However, both bearings and joints are not durable enough to fulfill their function for the whole life of the bridge. Changing these components is expensive and disables or reduces the traffic on the bridge. That is why these traditional girder bridges are becoming a little obsolete in some countries when used for a relatively short span. It is intended to exclude joints and bearings from the structure and to provide structural continuity between the superstructure and the substructure. It reduces construction and whole life costs. Restrictions or closures of traffic due to changing of bearings and joints are eliminated. The bridges without bearings and joints are termed “integral” [1]. Integral bridges became very popular in many countries. They are very efficient when used for bridges with one or more short and middle spans.

The design of integral bridges brings some specific problems. The connection between the superstructure and abutments is usually framed. The thermal movements of the superstructure are transferred to the abutments, because there is no relative movement between them. As the abutment is partially restrained by the soil, passive earth pressures acting on the abutments occur, which brings additional axial forces and bending moments into the superstructure. This arrangement leads to complexity of the design, because the interaction between the superstructure, the substructure and the surrounding soil has to be taken into account.

Thus, the model of integral bridges comprises the superstructure, the substructure and the surrounding soil. The effect of the surrounding soil is simulated by the distributed elastic supports introduced into the static system (see Fig. 1). The crucial problem by the practical design of an integral bridge is to determine stiffness of particular elastic supports of the substructure. The stiffness of the elastic supports can be determined using the method described in this paper. This method can be used as a manual for the practical design of integral bridges.

https://doi.org/10.2749/venice.2010.0096