Reinforcement Design for Abutment-Beam Joint of an Integral Abutment Bridge Based on "Tensile Stress Region" Theory

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Abstract

An integral abutment bridge (IAB) is a type of bridge in which bearings and expansion joints are eliminated at the abutment. Its superstructure is usually connected to its substructure by casting the abutment-beam joint in-situ, which is responsible for transferring loads and reaction forces. Like the knee joint of the frame, the joint is in stress disturbed region and the reinforcement is more complicated. In this paper, based on the principle of equal stiffness, the whole structure is simplified to a "single girder + single pile" structure equivalently. Then combined with the "tensile stress region" theory, by calculating the element stresses of an engineering example under four load combinations, a simpler design method is proposed for the reinforcement of the joint of an IAB.

Keywords: integral abutment bridge (IAB); abutment-beam joint; "single girder + single pile" model; tensile stress region; reinforcement.

1 Introduction

An IAB is a kind of bridge which eliminates the bearings and expansion joints at the abutment, that is, its superstructure and substructure are poured together. As a result, its substructure restrains the rotation and translation of the superstructure at the beam end, while the bending moment and axial force are transmitted from the superstructure to the substructure. However, the IAB also avoids the diseases of the weak parts such as expansion joints and bearings, improves the durability of the whole structure and reduces the maintenance cost. Hence, IABs have been widely used in small and medium span bridges.

Under various loads, the force of an IAB not only depends on the stiffness of the structure itself, but also on the structure-soil interaction. Therefore, two equally dominant issues in the structural analysis of an IAB are: how to simulate the structure itself and how to simulate the structure-soil interaction.

Regarding the calculation of the internal force and displacement of the pile under lateral load, the early method adopted was to treat the pile as a beam on the Winkler elastic foundation, i.e., the soil around pile is simulated as a series of discrete Winkler springs. While a pile within a unit length produces a unit deflection, the lateral reaction force provided by the spring is defined as the subgrade reaction coefficient k . When k is a

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