Segmental hollow box girder bridges with bow shaped precast elements

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Summary

Segmental bridges made of small precast elements have become a standard construction method for many bridges and elevated expressways in the world. Nevertheless some important aspects need still further investigation. One is the unavoidable gap between two adjacent elements caused by the heat of hydration during segment production ('bowing effect'). This imperfection may significantly influence the bearing capacity of the structure and it's serviceability.

A thermo-mechanical finite element model has been developed and verified by full-scale test data to study systematically the match casting process for different boundary conditions. A simple model for practical purposes is presented to estimate the bowing. Next 2 typical real segmental bridges with perfect and imperfect segments had been modeled to analyze the behavior of bridges with imperfect segments. The various analysis showed that compressive stresses in the deck slab and thus the load bearing capacity of the structure as well as the durability are highly reduced by the bowing effect.

Keywords: Segmental bridge; durability; match-casting; bowing effect; finite element analysis

1. Introduction

The need for economical and safe design and fast versatile construction without a disruption in traffic resulted in segmental construction in the field of prestressed hollow box girders concrete bridges (Fig. 1). Segmental bridges can be more economical by reducing the mild reinforcement and improving the construction speed [1- 3]. A higher concrete quality can be achieved which improves the durability of the structure.

A perfect fitting of adjacent segments is of great importance with regard to the durability of precast bridges. Therefore the segments must be made by match-casting to avoid imperfections from the formwork. The short line match-casting is mostly used as a segments production technique for bridges due to it's great flexibility. Hereby the end face of the finished 'old' segment is used as formwork for the new element (Fig. 2). But even with this method, a perfect fitting of the precast elements is not possible. The hydration of the fresh concrete causes a heat flux from the new to the old segment (Fig 3c). The resultant temperature gradient leads to a bowing of the old segment. The fresh concrete follows this deformation and gets hardened under the bowed shape whereas the old segment goes back in its initial shape after cooling down to ambient temperature. This results in a gap between two adjacent segments (Fig. 3d).

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