

EVALUATION OF CRACKS OF HATHAWAY PRECAST CONCRETE SEGMENTAL BOX GIRDER BRIDGE

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Summary

The Hathaway Bridge, an eastbound and westbound bridge pair, is located in Panama City, Florida, USA. Each of the pair consists of a single box precast concrete segmental girder with a deck width of 24,4 m (80 ft). The lengths of the eastbound and westbound bridges are 1031,43 m (3384 ft) and 1162,93 m (3815 ft) respectively. To date, these are the largest single-cell precast segments without internal struts fabricated in the USA. Unfortunately, during construction many web cracks developed in the external anchorage areas. The purpose of this investigation is to identify the main causes of the cracks and to provide some design recommendations for large precast concrete segmental box girders. First, a brief description of the bridge is given. Then, analytical models for the bridge, post-tension forces, and construction forces are presented. The analytical results show that the external longitudinal post-tension forces can cause a significant high tensile stress in the inside face of the web around the anchorages. The information presented in this paper can assist bridge engineers in the design of concrete segmental box girder bridges.

Keywords: concrete segmental bridge; box girder; cracking analysis; finite element method; bridge model; prestressing force model; anchorage zone design.

1. Introduction

Due to initial cost and life cycle cost advantages, speed of construction, appealing aesthetics, and adaptability to curved roadway alignment, segmental concrete bridge construction has become a preferred bridge alternative for major transportation projects worldwide. The Hathaway Bridge, completed 2004, is a pair of concrete segmental single box girder bridges each consisting of 544 variable-depth segments weighing from 140 to 182 metric tons with deck widths of 24,4 m (80 ft). These are the largest single-cell precast segments without internal struts fabricated in the USA to date. During construction, many web cracks developed in the external anchorage areas.

Concrete cracking has always been an intriguing design and research topic of bridge engineering: Marshall and Mattock (1962) performed experimental research on cracks in precast prestressed concrete I-girders. Huang and Shahawy (2005) investigated the end zone cracks in precast prestressed U-beams. Huang et al (2011) investigated the horizontal cracks in spliced I-girder bridges. However, little has been written on the cracking analysis of segmental box girder bridges. The purposes of this investigation are to identify the main causes of cracking in precast concrete segmental box girders and to propose a practical design method for limiting such cracking. First, a brief description of the bridge is given. Then, analytical models for the bridge, post-tension forces, and construction forces are presented. Finally, the analytical results and some recommendations are given.

2. Description of bridge

The Hathaway Bridge (Fig. 1) in Panama City, Florida, USA, consists of an eastbound and a westbound pair with 12 and 14 continuous spans respectively having a maximum span length of 100,58m (330 ft). The cumulative span lengths of the eastbound and westbound bridges are 1031,43 m (3384 ft) and 1162,93 m (3815 ft) individually. The elevation view of the Eastbound Bridge is shown in Fig. 2. Each of the eastbound and westbound bridges consists of a single box precast concrete segmental girder with a total deck width of 24,4 m (80 ft), accommodating 4 travel