Unified Explanation of Cracks for Long-Span Prestressed Concrete Box Girder Bridge Using Spatial Lattice Grid Model

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Abstract

Sustained excessive deflection is a widespread problem of long-span prestressed concrete box girder bridges. Meanwhile, various cracks are widely present in such bridges. However, some cracks are not interpretable according to traditional beam element model. In this paper, a refined finite element model called the spatial lattice grid model (SLGM), developed by the authors, which fully considers the three-dimensional effects of the box girder, is used to conduct a comprehensive analysis of the cracking causes of a long-span bridge having detailed inspection data. The analysis includes cracks that cannot be accurately or even cannot be explained by traditional beam element model. For this research, a unified identification and explanation of all structural cracks discovered during bridge inspection is achieved only using one model. The methodology presented in this paper will lay the foundation for subsequent research on the sustained excessive deflection problem.

Keywords: Concrete box girder bridge; Excessive deflection; Crack identification; Spatial lattice grid model.

1 Introduction

Due to excellent mechanical properties and economic efficiency, long-span prestressed concrete box girder bridges are widely used in bridges with spans ranging from 100 to 300 meters. However, the sustained excessive deflection phenomenon is the main problem faced by such bridges. A typical case is the Koror-Babeldaob Bridge [1] located in the Republic of Palau, which has a 240m main span and experienced 1.54m of deflection during the 18-year period from 1978 to 1996 and collapsed after only 3 months of strengthening. In recent years, due to the lag in construction time, China has also begun to encounter many similar deflection problems [2-4]. Unfortunately, despite the numerous research efforts [5-8] that have been made on this issue, no definitive conclusions have yet been reached.

A noteworthy observation is that cracking issues often coincide with excessive deflection in bridges, and the forms of cracks exhibit a diverse range. The impact of cracking on structural performance encompasses two main aspects: 1) diminishing structural stiffness, including flexural and shear stiffness; 2) compromising the structural durability, leading to material degradation. This can result in

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