Development of a 3D Finite-Element Modelling Generation System Based on Data Processing Platform and Fatigue Analysis of Full-Scale Reinforced-Concrete Bridge

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Abstract

This study presents a technology development for creating 3D finite-element full-scale bridge models based on a data processing platform (DPP) and explores the trial fatigue analysis to serve as an important reference for future practical applications. Until now, the model generation, validation and calculation for a large-scale model of conventional method consume huge time and money. Currently, developments in High-Performance Computing (HPC) and preparation for large parallel computers make numerical simulation operation more efficient. Moreover, through the grouping structure technique, different types of data can be linked together. In this research, a 3D finite-element full-scale bridge superstructure model was created using the DPP. A trial fatigue analysis was performed using a high-performance computer. By considering the details such as the position of each reinforcing bar, prestressed tendon, the slope, etc., the DPP model more closely captures the real structure. Therefore, it could be said that the model made by the DPP has higher analytical accuracy. This research paved the way for the implementation of large-scale fatigue analysis, which has significant engineering applications prospects.

Keywords: data processing platform (DPP), full-scale bridge model, HPC, fatigue analysis

1 Introduction

A large number of infrastructures were constructed during the period of high economic growth in Japan. After almost 50 years' usage, the reduction of performance and safety of these aging structures has become a serious problem, especially for the structures like bridge slabs that directly bear the load of vehicles in a variety of environments. According to the report from the Ministry of Land, Infrastructure, Transport and Tourism, more than 60% of the 700,000 bridges are expected to be more than 50 years old in 2033 [1]. In order to be able to ensure safety, grasp the deterioration characteristics, numerical analysis is the most direct method. However, there are still some issues that need to be solved. Firstly, the efficiency of generating numerical finite element models for large-scale complex bridge structures is relatively low. Secondly, based on the limited performance of the computer, the calculation time is significantly long. Especially for the fatigue analysis, a large-scale bridge simulation usually requires more than several terabytes of computer memory and at least a few weeks of calculation time. Therefore, simple plates or simplified bridge models are usually used to reduce the time cost for model generation and calculation [2]. However, comparing with the full-scale actual bridge, since the simple plate models give different shapes, sizes and boundary conditions, the analysis results will also be different. Even if the simplified one span