Development of a Web-based Distributed Computing Platform and Its Application in Evaluating Flutter Onset Velocity

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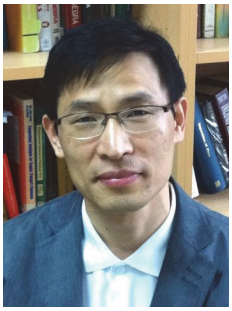

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Summary

The purpose of this paper is the evaluation of the flutter onset velocity acting on a moving bridge deck section using a web-based distributed computing environment, namely e-WINDS. e-WINDS, an abbreviation of 'e-Wind flow Investigation & Design Systems', is a virtual organization supporting CFD (Computational Fluid Dynamics) simulations for the users who have a lack of knowledge on CFD. The e-WINDS supports CFD service which is composed of pre-process (mesh generation), simulation-process (CFD analysis) and post-process (result visualization), and enables users to conduct the full CFD simulation process on the web. This system also provides the function of automatic parameter sweeping and job submission using the resources of the HTC (High Throughput Computing) environments. This characteristic makes e-WINDS to be an efficient computing system for evaluating flutter onset velocity.

Keywords: CFD, e-WINDS, flutter derivatives, flutter onset velocity

1. Introduction

Long span bridges are often turned out to be sensitive to wind effects; hence, wind loading and aerodynamic instability have to be considered during the design of bridge deck. Flutter is a typical instability phenomenon that occurs due to interactions between wind and structural motion. Since it may lead to a collapse of bridge, a flutter critical wind speed is one of the most important design factors for the long span bridges. The evaluation of flutter velocity was traditionally based on the direct wind tunnel test [1, 2] and the combination method of theoretical models and experimentally identified parameters [3, 4].

With the growth of computing power and technologies, CFD (Computational Fluid Dynamics) has become a powerful alternative in analysing aerodynamic flutter of long-span bridges. Recently, computational studies have had some successful results in wind–bridge interaction problems. Larsen *et al.*[5] investigated two-dimensional viscous incompressible flow past typical bridge deck sections using discrete vortex method. Jeong *et al.*[6] evaluated the motion-dependent aerodynamic forces by the finite element-based fluid analyses and obtained the flutter onset velocity from aero-elastic analyses. Watanabe *et al.*[7] simulated the slotted box girder to ensure wind-resistance characteristics for the super long bridge. They carried out three-dimensional unsteady flow simulation by finite element technique with LES (Large Eddy Simulation) turbulence model. Sun *et al.*[8] considered appropriate turbulence models for the computational modelling of bridge deck aero-elasticity.

However, computational approach is extremely constrictive to the researchers who do not have a sufficient background in CFD. Thus, many researchers, especially in civil engineering fields, need to the integrated system which enables them to conduct the full CFD simulations for evaluating the flutter onset velocity.

The e-WINDS (e-Science Wind flow Investigation & resistant Design System) is a virtual

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