

Evaluation of time history of design wind speeds using typhoon model and empirical wind characteristics

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Summary

A method is proposed for calculating the temporal variation of wind speeds during a typhoon to estimate wind load effects on energy-consuming structural devices and cumulative fatigue damage under an extreme typhoon event. This method is based on the concept of scenario-based design wind speed. It utilizes parameter scaling, and consists of selecting a seed typhoon that has affected the target site, identifying its parameters, modifying them and calculating the temporal change of wind speeds of a virtual typhoon. Some calculation examples are shown. The calculated temporal wind speeds give the same wind speeds as the design wind speeds and realistic temporal variations based on meteorological considerations.

Keywords: scenario-based design wind, typhoon model, empirical wind characteristics

1. Introduction

Conventional wind resistant design consists of setting the design wind speed, calculating the maximum response under that wind speed, evaluating the wind load effects, and checking that they are within required criteria or allowable limits. The design wind speeds are prescribed in regulations or recommendations, and have been estimated from extreme value statistics obtained from historical observed records and special considerations of local wind climates. For example, in Japan, the recommendations for loadings on buildings take typhoon effects into account (AIJ, 2004). The estimated design wind speeds are annual maximum wind speeds under standard observed conditions. The standard conditions are 10-minute mean at 10m above flat and open terrain.

Maximum load effects, e.g. maximum stresses, maximum deformations and maximum accelerations, can be evaluated from maximum wind speeds only. However, for some structural devices these effects need to be evaluated from the viewpoint of energy consumption or cumulative damage. To evaluate these types of devices, the total wind application time or temporal variation of one extreme wind event is required. Existing references, recommendations and regulations do not provide this kind of information.

This paper discusses the problem of how to estimate temporal variations of wind speeds whose maximum values are the same as the design wind speeds under extreme wind events by applying a typhoon model and scaling parameters. This is especially important because typhoons are the most predominant events in the north-west pacific area.

The proposed method is based on the concept of a scenario-based design wind speed, so to speak.

2. Evaluation of Methodology

2.1 Outline of Procedure

The proposed method follows a set procedure: selecting a seed typhoon that has affected the target site, identifying its parameters, modifying them, and calculating the temporal change of wind speeds of a virtual typhoon. The calculation utilizes parameter scaling.