Long-Term Damping Characteristics of a Cable-Stayed Bridge

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Abstract

Damping ratio is a crucial factor in assessing the vibrational serviceability of flexible large-scale structures such as cable-supported bridges. While the natural frequencies of structures have been estimated from operational modal analysis (OMA) with relatively minimal scattering, damping ratios have shown a high degree of scattering due to analytical uncertainty and in environmental and operational variations (EOV). To examine the damping ratio in context of EOVs, an automated damping estimation framework is applied with minimal user intervention to 2,5 years of long-term data acquired from a sparse continuous monitoring system. Daily and long-term fluctuations of damping ratios are examined. Environmental and operational factors such as temperature, wind environment and level of excitation are examined in context with damping ratios. The probability distribution of the damping ratio is also suggested based on statistical methods.

Keywords: damping; cable-supported bridges; system identification; operational modal analysis; long-term monitoring; environmental and operational variations

1 Introduction

In wind-resistant design and dynamic analysis, damping ratio is one of the most important parameters in assessing safety and serviceability for lightweight structures. Phenomena such as vortex-induced vibrations and vehicle-bridge interaction are some of the examples in which damping ratio are used to estimate the dynamic response of a structure. In particular, vortex-induced vibration has been a recurring problem for cable-supported long-span bridges around the world. Miniscule differences in modal damping ratios can make the difference between satisfactory serviceability and harmful vibrations. Thus, it is imperative that damping ratios of such sensitive structures be understood well. While past research on predictive damping models have relied on damping models derived from limited real-world data, recent advances in the field (cite

https://doi.org/10.2749/nanjing.2022.1273
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