Popular science summary of the PhD thesis

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Title of the PhD thesis	Short-term model-based damping prediction for fluid-loaded structures
PhD school/Department	DTU Construct

Science summary

Physical structures vibrate when they are excited. Some structures are excited by wind and waves, some by moving traffic, and some by something else. The resulting structural vibrations are called the dynamic response, governed by the structure's modal parameters, comprising natural frequencies, damping ratios, and mode shapes. Characterizing the dynamic response is essential for ensuring the structural integrity of engineering structures such as bridges, aircraft, and wind turbines. Some engineering structures exhibit time-varying modal properties driven by variations in environmental and operational conditions, which can, in particular, cause considerable short-term modal damping variations. This thesis develops and tests methods for estimating short-term damping ratios and natural frequencies from vibration measurements.

Conventional methods for estimating modal parameters for structures in operation based on vibration response measurements assume time-invariant modal properties and require long measurements, limiting their capabilities to track short-term damping variations.

This work consists of two main parts. The first and second parts consider damping estimation from free and forced response measurements, respectively. First part compares three methods for short-term and one for time-invariant damping estimation. The performance of the methods is assessed using simple simulated responses, and their practical applicability is tested using wind turbine impulse response tests. Second part introduces a novel method for short-term damping estimation for structures influenced by environmental and operational variability. The method combines physics- and data-driven system identification, leveraging prior domain knowledge to obtain short-term damping ratio and natural frequency estimates. The methods are tested on four application examples of different complexity – two simulated and two experimental. It appears promising for short-term damping estimation, given sufficient data and a suitable model structure.

Please email the summary to the PhD secretary at the department