THESIS INFORMATION

Title: **SPECTRAL CHARACTERISTICS OF BRIDGE VIBRATION UNDER REAL TRAFFIC**

Major: **Engineering Mechanics**

Major Code: 62 52 01 01

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Health Monitoring of structure is one of important areas in engineering mechanics. Current monitoring procedures are mainly inspection by the following methods: Non-Destructive Testing (NDT), Static Load Testing and Dynamic Load Testing (using deterministic loads). However, a common limitation of these procedures is closure of the bridge. One recent trend that many scientists are interested in is Dynamic Load Testing by the ambient load of the structure. For bridges, girders are one of the mainly loaded components and traffic flow is a major ambient load. The objective of the thesis is to analyze the characteristics of the vibration spectrum of the bridge girder, as a basis for developing a method of monitoring bridge conditions continuously on a large scale.

The contributions the thesis might be generalized as following:

Theory

- Set up the analytical formula to calculate the first natural frequency of beams by generalizing variation in Fryba' inertia moment model and simplifying Abdel's elastic modulus reduction model at the most dangerous position of the beam. It shows that the natural frequencies is less sensitive with damage.
- Proposed use of spectrum with random amplitudes to model spectrum of traffic loads with different speeds on the bridge. Then, the effect of the damping in variation of vibration spectrum of structure is also investigated. The results show that the features are extracted from spectrum of the acceleration response are less dependent on the traffic loads and more sensitive to damage than the natural frequency.

Experiment

- A large number of vibration signals of various bridges with different structures over the time are recorded in order to find the general behavior of the bridges through spectrum of the actual vibration response. By the operation time, the appearance of spectra with the greatest number of dominant areas will decrease and more spectra with less number of dominant areas will appear. On the mechanical side, this phenomenon shows that the ability to perform high-level oscillations of the structure will decrease as the structure has damage.
- Experimental investigations of change in the spectral shape of a beam under moving load with different velocities were carried out. The results of the change of spectrum are similar to those of the bridge. The spectral features allows for not only estimate damage, but also locating structural damage. The closer the location of damage, the greater the change in spectral features.

Application

- Proposed cumulative factor of spectral moment (CF) to overall structural health monitoring (SHM). The weaker the structure, the lower this factor. For the same structure, this factor help to compare the degradation of them together.
- Use of ambient vibration source such as traffic loads is only applicable for large bridges with SHM system installed. The methodology of the thesis using the vibration response of the bridge under real traffic will open up the prospect of building a regular monitoring method for small to medium sized bridges, including large bridges that have already installed the SHM system.

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