A Natural Frequency Identification Method for Cable-stayed Bridge Tension Monitoring Based on SCILAB

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Abstract

Cable tension monitoring is an important work of the cable-stayed bridge health monitoring. Natural frequency method is simple and efficient for cable tension measurement. But its application is limited in offline and manual monitoring because noise signal mixed. In order to monitor the cable tension automatically, a new method (natural frequency method by multiple auto-correlation, NFMAC) is introduced and implementation is based on SCILAB.

Cable tension monitoring is an important part of the cable-stayed bridge health monitoring. Because of convenient, fast, low cost and no affect on the vehicles, natural frequency method has been widely used in cable-stayed bridge cable tension measurement. The critical work is to identify the natural frequency of the cable. The traditional method is employ the average of the spectrum only and is poor accuracy and robust less. Based on the auto-correlation, this work introduces an improved method to identify the natural frequency, namely, natural frequency method by multiple auto-correlations, NFMAC.

Natural frequency method is based on the relationship between the cable tension and its natural frequency. Without bending stiffness of the cable, the natural frequency of every order in the spectrum is such as pitch. Their interval is equal to cable's first-order natural frequency. The traditional method is to find the spectrum peaks of every order and get the average interval frequency of these peaks. The average interval frequency is considered as the natural frequency and is used to calculate the cable tension.

Bridge health monitoring system should not affect the normal condition and normal traffic, so that, environment random excitation is usually used as input signal for cable vibration. In this case, the power spectrum is not ideal and the true peak is not easy to be identified. The field data show that the traditional method should be improved.

Essentially, the auto-correlation function of the real signal is the degree of similarity between itself and its delay some period. Now that cable signal power spectral acceleration are comb-like spectrum and having the same peak interval, then the auto-correlation function will be maximum that be close to 1.0 when the delay is the natural frequency. This property can be used to identify the cable natural frequency. When the power spectrum is not fine enough to pick peaks, the auto-correlation and baseline eliminated can be done many times.

Experiences show that NFMAC is more robust than traditional one and can be used for inline cable tension monitoring under the noise condition.

Key words: Cable-stayed Bridge, Cable Tension, Auto-correlation, Scilab.