Effect of Cable Loss in Cable Stayed Bridges – Focus on Dynamic Amplification

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Summary

This paper investigates the dynamic response in case of cable loss with focus on dynamic amplification through case studies on an actual cable-stayed bridge. Cable-stayed bridges are designed to accommodate cable replacement as well as the abrupt loss of a stay cable and design recommendations are providing simplified method of the cable loss verification, which replaces the dynamic effect by factored static load. It is not unusual for cable loss to govern the design of the superstructure due to inadequate or overestimated dynamic amplification factors. This paper intends to derive proper load factor for cable-stayed bridges through adequate simulation of the instantaneous or progressive rupture of a stay cable as well as the use of appropriate model in the time history analysis. Accordingly, a process by which reasonable values of DAF can be derived for cable stayed bridges according to the stress of considered structural element or section is proposed. The proposed process applied to Seohae Bridge is seen to produce reasonable values of the DAFs according to the structural element with values below 1.5 for the critical sections.

Keywords: Loss of cable; cable-stayed bridge; dynamic amplification factor; progressive rupture; instantaneous rupture; dynamic analysis.

1. Introduction

The consideration of the eventual occurrence of extreme events is critical during design to achieve safer and reliable bridge in a lifetime perspective. Major codes are considering such extreme events, which include ship collision, car accidents, fire, loss or change of structural elements, and are prescribing evaluation of the corresponding structural behaviours. Among these events, the loss of cable constitutes a particular feature of cable-supported bridges. In spite of their structural importance, the cables of cable supported bridges may be subject to events that can cause their rupture such as car accident, fire or seismic event like the Ji-lu Bridge in Taiwan in 1999 [1]. Besides, fatigue or aging requiring the replacement of the cables should also be considered.

Several scenarios of cable rupture can be drawn that are sudden or gradual rupture of cable, or local failure of the deck or progressive failure of one or multiple cables. Accordingly, major codes related to cable-supported bridges prescribe to assess the safety of the bridge fully loaded by the sum of factored dead load, live load and vehicular live load combined with the effect of the loss of cable multiplied by a dynamic amplification factor (DAF) under the assumption of quasi static behaviour of the bridge. Note that the PTI recommendations for cable-stayed bridges mentioned that the recommendations apply only for stay cables used in redundant cable-stayed bridges [2-4].

Despite the importance accorded to the loss of cable, the value for the DAF specified in the design guidelines seems to have been established without thorough research [5] or simply based on single-degree-of-freedom analysis. The application of such formerly proposed values of the DAF is likely

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