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Internal force monitoring design of long span bridges based on ultimate bearing capacity ratios of structural components

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Abstract. In order to provide a novel strategy for long-span bridge health monitoring system design, this paper proposes a novel ultimate bearing capacity ratios based bridge internal force monitoring design method. The bridge ultimate bearing capacity analysis theories are briefly described. Then, based on the ultimate bearing capacity of the structural component, the component ultimate bearing capacity ratio, the uniformity of ultimate bearing capacity ratio, and the reference of component ultimate bearing capacity ratio are defined. Based on the defined indices, the high bearing components can then be found, and the internal force monitoring system can be designed. Finally, the proposed method is applied to the bridge health monitoring system design of the second highway bridge of Wuhu Yangtze river. Through the ultimate bearing capacity analysis of the bridge in eight load conditions, the high bearing components are found based on the proposed method. The bridge internal force monitoring system is then preliminary designed. The results show that the proposed method can provide quantitative criteria for sensors layout. The monitoring components based on the proposed method are consistent with the actual failure process of the bridge, and can reduce the monitoring of low bearing components. For the second highway bridge of Wuhu Yangtze river, only 59 components are designed to be monitored their internal forces. Therefore, the bridge internal force monitoring system based on the ultimate bearing capacity ratio can decrease the number of monitored components and the cost of the whole monitoring system.

Keywords: bridge health monitoring; internal force monitoring; ultimate bearing capacity; component ultimate bearing capacity ratio; reference component ultimate bearing capacity ratio

1. Introduction

The concept of structural health monitoring was primarily proposed in the aerospace field. For instances, Housner *et al*.(1997) defined the structural health monitoring system as an effective way to get and process data from the operating state structure and evaluate the main performance indicators of the structure. Boller *et al*. (2009) defined structural health monitoring as a technique for recording, analyzing, locating and predicting structural loads and damage states through a range of sensing devices.

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