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Structural Health Monitoring System for the Honshu-Shikoku Bridges

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Abstract

The health monitoring systems are introduced on long-span suspension bridges and cable-stayed bridges, which are operated by the Honshu-Shikoku Bridge Expressway Company Limited, for the design verification and the maintenance purpose. The equipments for the health monitoring systems are the seismometers, accelerometers, velocity gauges, anemometers, thermometers, GPS sensors, etc.

After completion, the Honshu-Shikoku Bridges were attacked by several earthquakes and typhoons. The external force (earthquake motions or wind velocity) and the response of the bridge structure were recorded during earthquakes and typhoons. Utilizing the recoded data, the structural model of the bridges was analyzed and the structural response was compared with the recorded response.

In this paper, the following typical analytical examples are described.

1) Behavior of the Kurushima Kaikyo Bridge and the Tatara Bridge against the Geiyo Earthquake

In 2001 the Geiyo Earthquake attacked the Kurushima Kaikyo Bridges, which are three consecutive suspension bridges, resulting in the breakage of the center stay rod of the 1st Kurushima Kaikyo Bridge. The Kurushima Kaikyo Bridges were analyzed afterwards, using the recorded earthquake motions, which verified the fact that the rod of the first bridge was broken in a same manner as design calculation. The Geiyo Earthquake also attacked the Tatara Bridge, which is the world's longest cable-stayed bridge with a main span of 890 meters. Earthquake motions were obtained during the earthquake by the monitoring systems. Seismic behavior of the Bridge was studied by simulation analysis, using observed earthquake waves and the analyzed responses can be nearly agreed with the recorded responses.

2) Behavior of the Akashi Kaikyo Bridge against strong typhoons

The Akashi Kaikyo Bridge, which is the world's longest suspension bridge with the main span of 1991 meters, was attacked by several typhoons. Utilizing strong wind data and the structural model, the static and dynamic responses of the Akashi Kaikyo Bridge are analyzed and compared with the design calculation. Based on the analytical results, the observed static displacement by the mean wind velocity agrees well with the design calculation, whereas the observed dynamic response is smaller than the design calculation. When a typhoon passed near the Akashi Kaikyo Bridge, the wind velocity varied in a short time. The analysis concluded that the observed bridge response did not agree with the calculated bridge response due to the 10-minute-average wind, based on the wind-resistant design standard, and that the observed response agreed with the calculated response due to a several-minute-average wind.

Consequently, the design assumptions were verified by the observation results and the analytical results in the past nine years. Additionally, the further plans for utilization of the health monitoring system, including the identification of dynamic characteristics of bridge, are also described.

Keyword: *Health monitoring system, Long-span Bridges, Earthquake, Typhoon*

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