Reliability Analysis of Pylon for Yi Sun-sin Bridge

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Summary

This paper presents the reliability analysis of the pylon for Yi Sun-sin Bridge. In order to evaluate the reliability index and most probable failure point(MPFP), the advanced first-order second-moment method with the double iteration loops is adopted. Random variables are load and strength parameters which are associated with the load effects and the pylon strength, respectively. The limit state function is defined by the P-M interaction diagram. The sensitivities of the limit state function are calculated by the direct differentiation of P-M interaction diagram. To construct the continuous and differentiable function, the discrete points of P-M interaction diagram are interpolated using cubic spline method. The reliability analyses of the pylon for Yi Sun-sin Bridge are conducted for the design wind load and service wind load.

Keywords: P-M interaction diagram; reinforced concrete column; reliability index; most probable failure point; first-order second-moment reliability method; cubic spline; sensitivity; direct differentiation; modified Newton-Raphson method.

1. Introduction

This paper presents the reliability assessment of the pylon for a real suspension bridge in Korea using the advanced first-order second-moment method(AFOSM)[1]. The P-M interaction diagram (PMID)[2] presenting the strength of the pylon is defined as a limit state function. Random variables consist of load and strength parameters. Instead of internal forces, each individual load components such as dead load, live load and wind load are considered as the load parameters. The geometric and material properties of the cross section compose the strength parameters. Because the PMID is nonlinear with respect to the random variables, the iterative procedure is needed to solve the AFOSM . In this paper, double iteration loops based on the modified Newton-Raphson method [3] are adopted to estimate the MPFP and reliability index. The sensitivities of the PMID with respect to the random variables are obtained by direct differentiation. Cubic spline interpolation [4] is utilized to construct the continuous and differentiable PMID.

2. Formulations of the AFOSM for PMID

The PMID of the pylon is defined as an implicit function,

$$\Phi = \Phi(\mathbf{F}, \mathbf{A}) = 0 \qquad (1)$$

where $\mathbf{F} = (P, M)^T$ and $\mathbf{A}$ is the curve parameter vector determined by the geometric and material properties of the cross section of the pylon. The material properties involve the compressive

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