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Decision-making of alternative pylon shapes of a benchmark cable-stayed bridge using seismic risk assessment

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Abstract. One of the main applications of seismic risk assessment is that an specific design could be selected for a bridge from different alternatives by considering damage losses alongside primary construction costs. Therefore, in this paper, the focus is on selecting the shape of pylon, which is a changeable component in the design of a cable-stayed bridge, as a double criterion decision-making problem. Different shapes of pylons include H, A, Y, and diamond shape, and the two criterion are construction costs and probable earthquake losses. In this research, decision-making is performed by using developed seismic risk assessment process as a powerful method. Considering the existing uncertainties in seismic risk assessment process, the combined incremental dynamic analysis (IDA) and uniform design (UD) based fragility assessment method is proposed, in which the UD method is utilized to provide the logical capacity models of the structure, and the IDA method is employed to give the probabilistic seismic demand model of structure. Using the aforementioned models and by defining damage states, the fragility curves of the bridge system are obtained for the different pylon shapes usage. Finally, by combining the fragility curves with damage losses and implementing the proposed cost-loss-benefit (CLB) method, the seismic risk assessment process is developed with financial-comparative approach. Thus, the optimal shape of the pylon can be determined using double criterion decision-making. The final results of decision-making study indicate that the optimal pylon shapes for the studied span of cable-stayed bridge are, respectively, H shape, diamond shape, Y shape, and A shape.

Keywords: cable-stayed bridge; pylon shape; seismic risk assessment; double criterion decision-making; financial - comparative approach; Cost-Loss-Benefit (CLB) method

1. Introduction

There are several reports of damaged bridges in the earthquakes such as 2008 Wenchuan earthquake or 1999 Taiwan Chi-Chi earthquake. It goes without saying that bridges, as one the most important facilities of transportation, must remain serviceable for the purpose of emergency disaster relief. Therefore, in addition to design according to code requirements, methods for the seismic risk assessment of the existing bridges are needed to be presented. Seismic risk assessment could help engineers select an economically justified structural design from various structural

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