Joint Transportation Research Program

Principal Investigator: Robert J. Connor, Purdue University, rconnor@purdue.edu, 765.496.8272

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-4535 2024

Development of a Formalized Program for In-Service Inspection of Pedestrian Bridges

Introduction

In recent years (circa 2023), the purpose of pedestrian bridges has extended beyond simply providing a safe route for pedestrians to cross an obstacle. Pedestrian bridges are also becoming works of art integrated into the design plan for the whole city. As a result, the pleasant appearance of these bridges often comes at the cost of complex structural analysis and design, unique fabrication requirements, and construction challenges. Furthermore, most of the pedestrian bridges in the U.S. are classified as nonredundant bridges. In the AASHTO LRFD design specification, a nonredundant bridge is defined as a type of bridge in which the failure of one component in wthe bridge will likely lead to an overall catastrophic failure of the entire bridge (AASHTO, 2018).

Like any in-service bridge, long-term inspection is critical for ensuring safe and reliable operation; therefore, inspecting different types of pedestrian bridges efficiently and adequately is crucial to avoid unexpected failure during their service life. While National Bridge Inspection Standards (NBIS) regulations apply to all publicly owned *highway* bridges longer than 20 ft., there is no standardized inspection criteria applicable for any type of pedestrian bridge (NBIS, 2022). The current criteria, implemented ad-hoc by many owners, is to inspect pedestrian bridges using the traditional calendar-based inspection approach. This method assigns an inspection interval within a time frame (typically 24 months) for all bridges except those receiving special inspections. Although this method may provide an adequate level of safety for some bridges, it does not explicitly account for the current condition and characteristics of the bridge. For example, a bridge in severe condition is inspected at the same interval as a newly constructed bridge that was built according to current design specification.

Furthermore, the current inspection practice of pedestrian bridges considers only the *structural conditions*, while some unique safety and serviceability criteria, such as railing, lighting, and walking surface, should also be considered to maintain an optimum level of safety and serviceability for pedestrians and cyclists.

Findings

This project aims to develop an inspection methodology specifically designed for pedestrian bridges that will ensure the best allocation of bridge inspection resources and a high level of safety and serviceability. In its final form, a Risk Based Inspection (RBI) methodology was utilized in conjunction with reliability theory and expert elicitation from the Indiana Department of Transportation Risk Assessment Panel to rationally determine the inspection interval. The proposed methodology was based on the reliability-based inspection procedures presented in NCHRP 782 report (Washer et al., 2014). In this method, the inspection interval was determined based on the risk assessment, which was the product of a combination of occurrence and consequence factors.

The occurrence factor was calculated based on design, loading (mechanical and environmental), and condition attributes for each damage mode. The consequence factor measured the outcomes of the occurrence of the damage mode. The consequence factor was evaluated in two stages: (1) an immediate consequence in which outcomes impact the safety of the service on and under the bridge, and (2) a short-term consequence, in which effects influence the service under the bridge.

A new factor, referred to as the inspection effectiveness factor, was also included in the risk assessment. This factor attempted to account for the inspection technique's reliability in identifying and quantifying a specific defect for each element of the bridge. This factor was evaluated based on different inspection techniques, with consideration for their inherit uncertainty, the type of defect, and the accessibility to the component. Finally, the Risk Priority Number (RPN) was obtained by combining the occurrence, consequence, and inspection effectiveness factors. The inspection interval was identified by using risk bar diagram that was based on the RPN (in which the bridge with high RPN number receive a shorter inspection interval).

Recommended Citation for Report

Alharthi, A. A., & Connor, R. J. (2024). *Development of a formalized program for in-service inspection of pedestrian bridges* (Joint Transportation Research Program Publication No. FHWA/IN/JTRP-2024/17). West Lafayette, IN: Purdue University. https://doi.org/10.5703/1288284317750

View the full text of this technical report here: https://doi.org/10.5703/1288284317750

Published reports of the Joint Transportation Research Program are available at http://docs.lib.purdue.edu/jtrp/.