

UNIVERSITI TEKNOLOGI MARA

**SERVICEABILITY
PREDICTIVE MODEL OF
ULTRA-HIGH PERFORMANCE
CONCRETE BRIDGE USING
VIBRATION ASSESSMENT**

SITI SHAHIRAH BINTI SAIDIN

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ABSTRACT

The bridge structures are important component in highway, railway, and urban road which contribute to the economy, politics and culture. Bridge are designed to carry and transfer loading from the traffic during its service lives where the load actions are in the form of forces, deformation, acceleration that applied. Many existing old bridges have exceeded their design life, the average age of bridges being more than 50 years old and have failed due to structural deficiencies, unexpected events, excessive load, and ineffective monitoring. Thus, the proper maintenance and monitoring by conducting structural health monitoring (SHM) can be done to reduce the number of bridges from collapse is needed. SHM aims to provide quantitative and reliable data on the real conditions of a bridge, observe its evolution and detect the appearance of degradation. Therefore, this study is using the dynamic modal parameters such as natural frequencies and mode shapes as indicator to determine the slenderer and lightweight UHPC bridge structure serviceability state. The modal parameters were obtained from: experimental and analysis method. 1) The Ambient Vibration Test (AVT) was conducted on the Ultra High-Performance Concrete (UHPC) bridge to obtain the experimental modal parameter using accelerometers. The vibration responses obtain were post processing using Operational Modal Analysis (OMA) to extracted the natural frequencies and mode shapes. These modal parameters accuracy was verified using different algorithms which are Frequency Domain Decomposition (FDD), Enhanced Frequency Domain Decomposition (EFDD), and Stochastic Subspace Identification (SSI). The experimental modal parameters obtained from AVT were validated and updated the finite element analysis (FEA) modal parameters. The dynamic parameters obtained such as the natural frequency (3.223 Hz) were utilised to evaluate the structure's serviceability vibration limit state in accordance with EN1991-2; the value obtained was within the range indicating that the bridge was safe to use. Modal parameters, natural frequencies obtained from the Frequency Domain Decomposition modal identification and FEM model updated were then used to produce a UHPC bridge serviceability predictive model using Simple Linear Regression (SLR) model. From the result, the changes in natural frequencies for different conditions of structure deterioration can be linearly represented by stiffness degradation. The results show that as the bridge's operation year increases, the natural frequency and stiffness of the structure decreases significantly. In conclusion, this research provides important fundamentals information for developing a predictive model to predict the serviceability of UHPC bridges for risk assessment using experimental modal analysis and dynamic measurements. It is beneficial to the structural owners and government where by having appropriate guidelines to ensure their structural safety, predict early structural failure, and provide information for immediate maintenance, thus would reducing structural maintenance costs.

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