UNIVERSITI TEKNOLOGI MARA

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

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Thesis submitted in fulfillment
of the requirements for the degree of
**Doctor of Philosophy**
**(Civil Engineering)**

**College of Engineering**

**July 2022**

# 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.

# ACKNOWLEDGEMENT

Praised to Allah, the Most Gracious and the Most Merciful who have created the mankind with knowledge, wisdom and power.

Firstly, I wish to thank God for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully.

Foremost, I would like to express my sincere gratitude to my supervisor (**Dr. Sakhiah Abdul Kudus**) for the continuous support of my PhD study and research, for her patience, motivation, enthusiasm, and immense knowledge. Her guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my PhD study.

I would like to acknowledge my co-supervisor **(Ts. Dr. Adiza Jamadin, Ass. Prof. Ts. Dr. Norliyati and Ts. Dr. Muhamad Azhan Anuar)** who made this work possible. Their guidance and advice carried me through all the stages of writing my project. I would also like to thank my committee members for letting my defense be an enjoyable moment, and for your brilliant comments and suggestions, thanks to you.

My appreciation goes to the staff and lab members at Universiti Teknologi MARA Shah Alam (UiTM). They provided the facilities and assistance while working with them. Special thanks to my colleagues and friends for helping me with this project.

I would also like to give special thanks to my husband (**Mohd Fazli bin Mohd Idris**), both of my parents (**Saidin bin Zakaria** and **Norsham binti Ahmad**) and other family members as a whole for their continuous support and understanding when undertaking my research and writing my project. Your prayer for me was what sustained me this far.

Last but not least, I would like to thank all my colleagues and friends for helping me with this project. All of you have helped me to focus on what has been a hugely rewarding and enriching process. Alhamdulillah.

Finally, thank you to everyone who has contributed directly or indirectly in completing this work.

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