RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

News Article for RISUD Emerging Frontier Area (EFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Dr. You DONG	CEE
2.	**Name of EFA:**	Climate-Resilient Development	
3.	**Project Title:**	Artificial Intelligence-Enhanced Climate-Resilient Infrastructure	

4. **Annual Progress/Achievement (***in layman's language, no more than two A4 pages, pls attach photos***)**

During the reporting period, the team mainly investigated compound climate events and extremes. The infrastructure vulnerability model under compound hazards has been established based on the numerical simulation results obtained during the last reporting period. The structure component failure mechanisms have been investigated and a system-level vulnerability model has been developed accordingly. Besides, advanced machine learning techniques, including Artificial Neural Network (ANN), Convolutional Neural Network (CNN), and LSTM models, etc., have been trained for different types of structural responses. These results will be further utilized in investigations on the decision-making of robust adaptation of coastal infrastructures in the next reporting period.

Specifically, the research team collected experimental-measured data from the lab tests of the wave-bridge interaction. Photos of the hydraulics laboratory and schematic diagrams of facilities are shown in Fig. 1. We also performed numerical simulations using Computational Fluid Dynamics (CFD) and Finite Element (FE) model simulations. A typical figure showing the numerical modelling details of the investigated bridge under compound earthquake-tsunami hazards are shown in Fig. 2. Based on these structural analysis results, the failure mechanisms of different bridge components were investigated, multi-level damage states were defined, and their corresponding limiting values were calculated. On this basis, the stochastic vulnerability model has been developed for the investigation of coastal infrastructures. Life-cycle-based structural vulnerability, risk, and resilience were quantified considering both the quantifiable uncertainties associated with hazard parameters and deep uncertainties associated with future climate and economy scenarios. These models will be further utilized for the investigations on robust adaptation for the coastal bridges in the following reporting period. Besides, the research team utilized different machine learning techniques to coordinate and facilitate the performance analysis. We established high-performance LSTM models for structural response predictions. Regular neural networks possess limited memory and are not suitable for modeling data sequencing or time-dependent data. To overcome this limitation, Recurrent Neural Networks (RNNs) have been developed to learn the time histories of wave-induced loads and structural responses. After training and comparisons, the LSTM model has proven to be the most efficient variant of RNNs due to its gated memory unit that mitigates the effects of vanishing gradients. Moreover, Our team has conducted some preliminary research on the robust decision-making on adaptation measures of coastal infrastructures against damage from compound hazards. For instance, we investigated previous hazard reports, the climate change report from the Intergovernmental Panel on Climate Change (IPCC) panel, and existing infrastructure data. With the above-mentioned techniques and those reported in the 1st year, we will evaluate different retrofit actions and plans from both engineering and economic aspects.

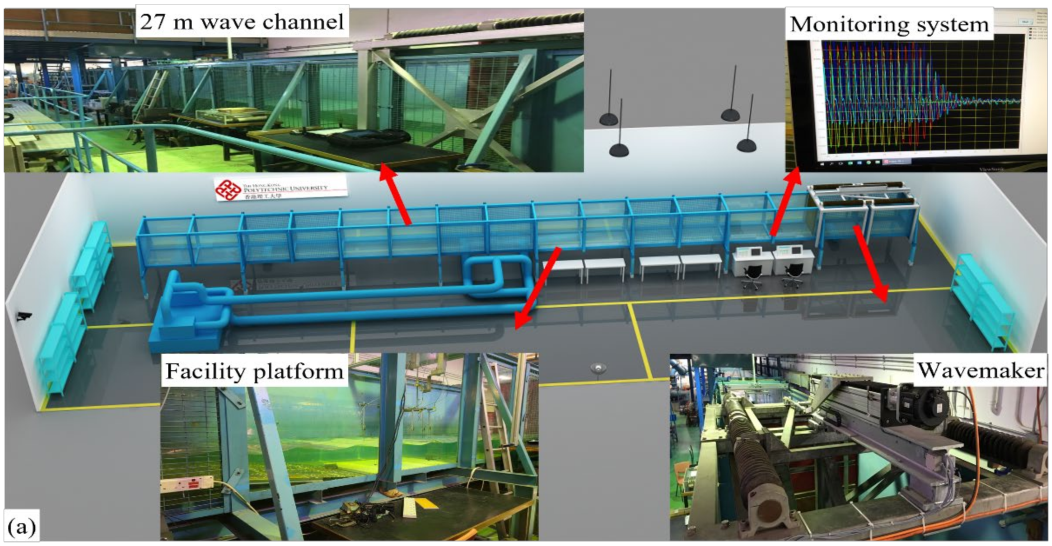

Fig. 1 Laboratory tests of hurricane wave impacts on coastal bridges

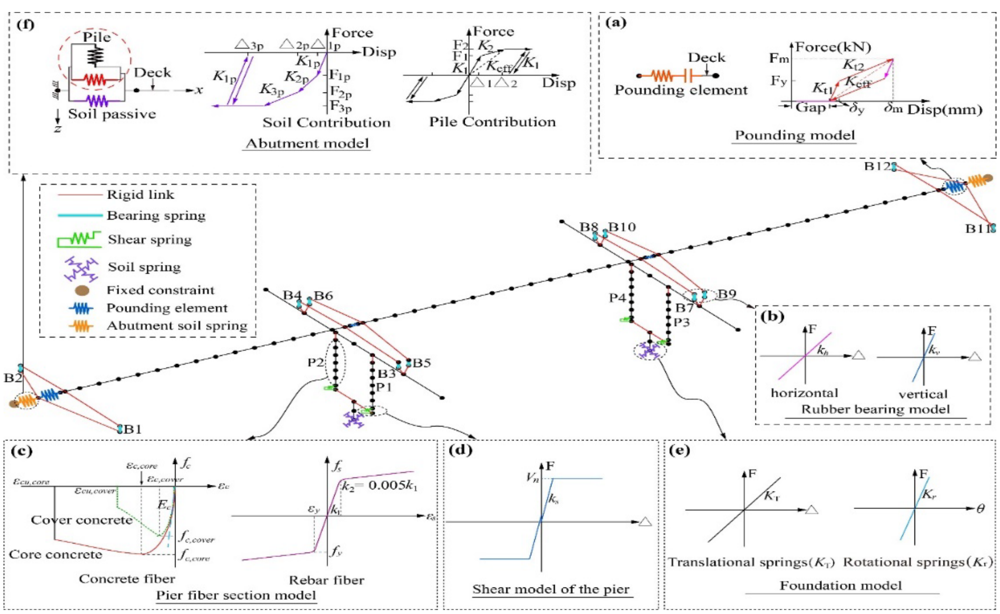

Fig. 2 Numerical modelling details of the investigated bridge under compound earthquake-tsunami hazards