RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

<u>News Article for RISUD Emerging Frontier Area (EFA) Scheme</u>

		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***)**

After one year of research, this project has achieved varying degrees of progress in the following aspects: compound hazard events (**Task 1**), coastal infrastructure failure mechanisms (**Task 2**), and physics-guided deep/transfer learning (**Task 3**). Promising results can be achieved in the future stages of this project.

For **Task 1** (**modeling compound climate events and extremes**), it is estimated that around **80%** of this task has been finished. Based on previous post-hazard reports and field survey results, the team has successfully established models to investigate the effects of climate events on coastal infrastructures, as shown in **Fig. 1(a)**. The occurrence rate, time interval, and hazard intensities of these extreme natural hazards are predicted by a nonhomogeneous mathematics model. Potential damages to coastal infrastructures induced by different intensities of hazards are investigated. Taking the successive earthquake-tsunami hazard as an example, the team reproduced the extreme process with the established model, calculated the maximum loads on a coastal bridge, and evaluated the structural performance. Through comparisons with the results of a single hazard, it is found that compound events could lead to 20% larger loads on the structure and lead to much worse results. There is one manuscript under review for this part of the research. The team will use copula models to accurately quantify compound event effects in future work.

Task 2 aims to investigate **the vulnerability of infrastructure under compound events**. The team has finished a series of experiments at the hydraulic laboratory of the HK PolyU (as shown in **Fig. 1(b)**) and established advanced numerical models to investigate infrastructure vulnerability. The team measured the hazard loads on a bridge model in the laboratory test and established Computational Dynamic Fluid (CFD) and Finite Element (FE) models to compute structural responses. The experimental measurements not only provide intuitive results but also ensure the reliability of the established models. Compared with existing models, these novel three-dimensional models have superior performance in computing load distributions, the performance of fragile structural components, and complex wave-air-bridge interactions. This part of the work has led to one published journal paper. About **50%** of this task has been finished. The project team will assess the structural vulnerability based on the experimental and numerical results in the following work. A systematic fragility model of the coastal infrastructure will be proposed.

In addition, the project team has performed some preliminary investigations in the Artificial Intelligence (AI) and adaptation fields, which are related to the objectives of **Tasks 3** and **4**. Around **15%** of these two tasks have been finished. The team collected structural health monitoring (SHM) data of typical coastal infrastructures under hazard scenarios and established reliable and high-efficiency deep neural networks for structural response modeling (as shown in **Fig. 1(c))**. These models can reflect the inner mechanism of the practical physical model and thus provide more accurate results. We also tested several adaptation measures (e.g., inserting air venting holes, and settling wave attenuation devices) and proposed a long-term loss model over the life cycle of coastal infrastructures (as shown in **Fig. 1(d)**). In future studies, the team will combine the adaptation measures, long-term loss models, and climate change uncertainties, to formulate robust adaptation strategies for existing coastal infrastructures and advise on future bridges.

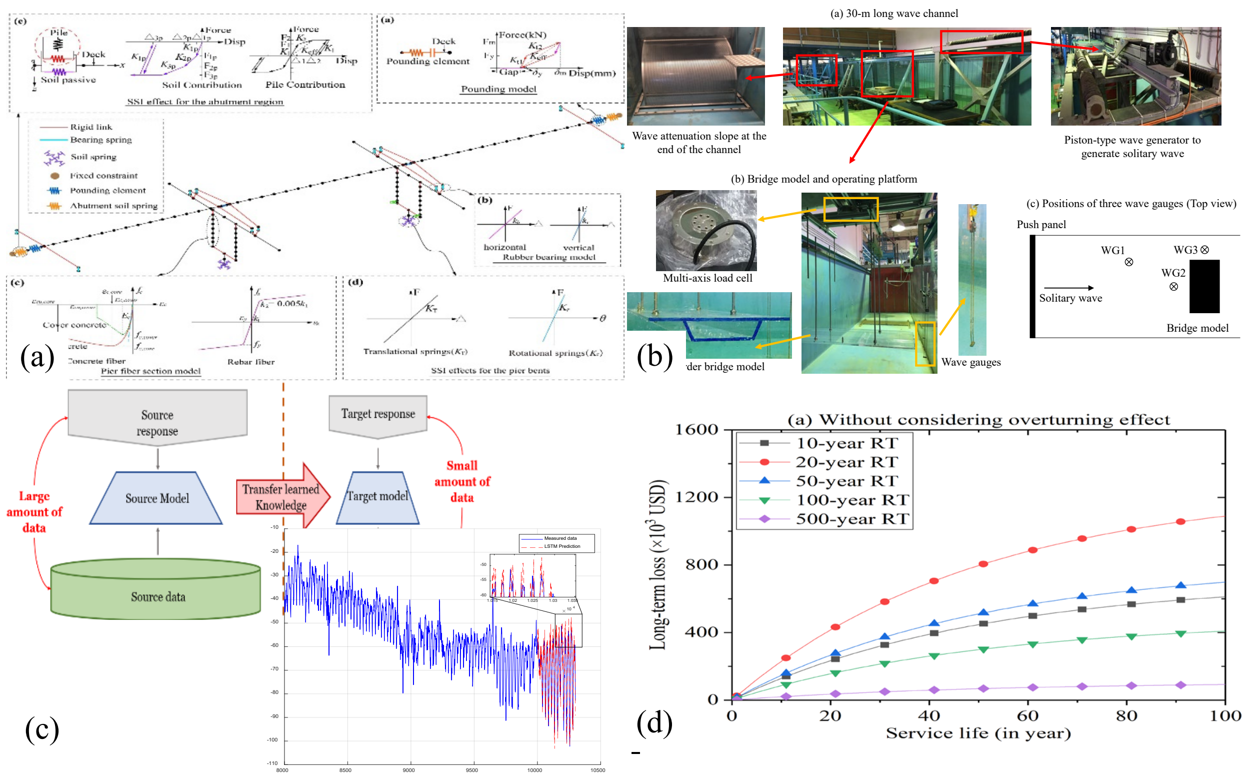

Fig. 1 (a) Finite element model to investigate compound hazard effects on coastal bridges; (b) photos of experimental works in PolyU's hydraulic laboratory; (c) deep/transfer learning models; and (d) long-term loss model during the bridge service life