

**Project Title: Investigation on the application of high strength steel H-sections in foundation engineering**

**Principal Investigator: Dr. Y. F. Andy Leung (CEE)**

**Project Outline:**

The proposed study aims to promote effective use of high performance, high strength steel materials in foundation engineering, particularly in steel piles and retaining structure elements. Many existing local and overseas design guidelines for foundations were established based on previous research on steel sections with yield strength between 265 to 460 MPa, and the recommendations do not necessarily scale up linearly when the yield stress of high strength steel may reach 690 MPa or above. Various aspects of pile engineering, including the installation (e.g., pile driving) process and the long term performance in soil-structure interactions involving the high strength materials have not been thoroughly understood.

To facilitate rational recommendations or revisions in local and overseas design guidelines on foundation engineering involving high performance steel, this study investigates its implications on the design and construction aspects of foundations and underground constructions.

The specific objectives of the study are as follows:

- 1) To identify the areas in foundation or geotechnical engineering where the use of high strength steel sections will bring significant impacts in terms of enhanced productivity or improved system performance.
- 2) To examine the key issues associated with installation process of these foundation elements with high strength steel sections adopted. For example, the wave equation analysis for pile driving process will be extended to enhance understanding of the compressive and tensile stresses generated in the high strength steel material during pile installation. The soil models will be modified for more realistic representation of the static and dynamic response, and to enable probabilistic characterization of the relevant soil properties.
- 3) The Bayesian updating approach will be extended and applied to back analyses of geotechnical parameters using piling records. Essentially, the construction records obtained during pile driving or jacking process provide a wealth of observation data to calibrate the analytical model, to provide insights to the performance of foundations under similar site conditions. The enhanced model and calibrated geotechnical parameters also facilitate more realistic estimates for the response of foundations constructed by high strength steel materials.

4) With the extended model calibrated by previous site testing results, recommendations will be made on refinements of current design guidelines associated with pile driving stress and allowable working stress, so that more specific guidance can be applied to foundation designs with high performance steel.

**Expected Deliverables:**

- A user-friendly program that can be readily applied for back analyses of geotechnical parameters using piling records, and wave equation analysis for stress induces during pile driving. Bayesian and/or machine learning approaches can be incorporated into the algorithm to enhance its effectiveness. The numerical tool can be tailored for foundation applications with high strength steel sections.
- A critical review, in the form of publications and recommendations to existing guidelines, on the applicability of high strength steel materials in various aspects of foundation engineering, such as piling or excavation support. The impacts on design/construction process and performance robustness will be reviewed.