STEVENS INSTITUTE OF TECHNOLOGY 1870

Ph.D. DISSERTATION DEFENSE

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Date:	Thursday, June 18th, 2026
Time/Location:	9:00 am – 11:00 am, ABS 301
Title:	Experimental Investigation of Plunging-Breaker Impact on a Finite-Draft Structure
Chairperson:	Dr. Raju Datla, Department of Civil, Environmental and Ocean Engineering, Charles V. Schaefer, Jr. School of Engineering and Science
Committee Members:	Dr. An Wang, Co-Chairperson, College of Water Resources and Hydropower, Sichuan University Dr. Muhammad Hajj, Department of Civil, Environmental and Ocean Engineering, Charles V. Schaefer, Jr. School of Engineering and Science Dr. Gizem Acar, SES/Department of Mechanical Engineering, Charles V. Schaefer, Jr. School of Engineering and Science

ABSTRACT

The impact of a deep-water plunging breaker on a partially submerged vertical structure can generate highly unsteady pressure fields and impulsive loads that affect marine vessels and offshore structures. Most laboratory studies of this problem have employed walls extending to the bed, leaving the mechanics of impacts on structures with shallow draft relative to the wavelength only partially understood. The measurements used in this dissertation were obtained from a separate experimental campaign conducted at the University of Maryland, while the dissertation develops the analysis and physical interpretation of plunging-breaker impacts on the finite-draft vertical face of a cube. Across eight streamwise positions, the interaction is shown to fall into three distinct regimes that depend sensitively on the stage of breaker development at the moment of contact. In the no-aeration regime, the underdeveloped crest converges onto a rising water column on the cube face and produces a single, moderate pressure peak with a gradual rise time. In the low-aeration regime, the steepened crest impinges on the cube face and entraps a small air pocket, producing the highest measured pressures accompanied by strong post-impact oscillations consistent with air-cushion compression and rebound. In the broken-wave regime, the crest overturns upstream of the structure and a turbulent air–water mixture impinges on the face, producing reduced peak pressures

but persistent low-frequency oscillations associated with an extended bubbly layer. The force and impulse derived from the pressure measurements further show that the spatial distribution of pressure, not the local peak magnitude alone, controls the integrated loading on the structure. The analysis further identifies a flip-through-like focusing process in which the rising contact-point column and the approaching crest converge to a single point, exhibiting the characteristics of a finite-time, self-similar focusing process, in which geometric confinement and inertial amplification together generate extreme localized pressures. Near the boundaries between regimes, nominally identical wave conditions can lead to stochastic transitions governed by the fine-scale geometry of the merging free surface rather than by the bulk wave kinematics. Together, these results provide a unified experimental and physical account of plunging-breaker impacts on finite-draft structures and establish benchmark results relevant to the design of vessels, floating platforms, and offshore structures exposed to deep-water breaking waves.