Scaled Fluid-Structure Interaction Experiments

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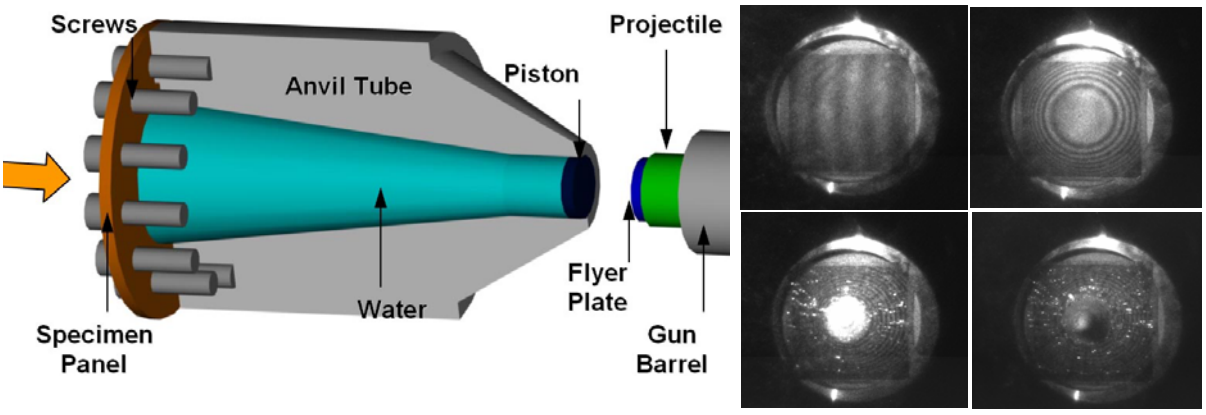
We have developed a novel fluid-structure interaction (FSI) experimental setup to investigate the performance of naval material/structure systems. The set-up is a highly instrumented scaled model designed to characterize the underwater blast impulsive loading of structures, and to identify their failure by means of real time measurements of deflection profiles, deformation histories, and fracture. In the FSI setup, a water chamber made of a steel tube is incorporated into a gas gun apparatus. A scaled structure is fixed at one end of the steel tube and a water piston seals the other end. A flyer plate impacts the water piston and produces an exponentially-decaying pressure history in lieu of explosive detonation. The pressure induced by the flyer plate propagates and imposes an impulse to the structure (panel specimen), which response elicits bubble formation and water cavitations.

The performance of the set-up was assessed by performing calibration experiments and by subjecting stainless steel solid and sandwich panels with honeycomb and pyramidal cores to impulsive water loading. Pressure sensors were employed to record pressure histories. Shadow Moiré and high speed photography were used to record real time full field out-of-plane deformation profile of the structure. Using the deformation field as a metric, various structural concepts were compared and ranked. Features associated to their failure modes and kinetics were also identified.



a) Configuration of Fluid-Structure Interaction (FSI) experimental setup. b) Sequence of high-speed images obtained by Shadow Moiré.