MASTER OF SCIENCE
IN
MECHANICAL ENGINEERING

A METHODOLOGY FOR DESIGN OF PASSIVE ISOLATION FOR SHIP/BARGE CONNECTION
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Current ramp designs used in Roll-On/Roll-Off (RORO) operations have been determined to be structurally inadequate in Sea-State 3. The main reason for this is that when the ramp is loaded with two vehicles, the relative motions between the ship and the discharge facility induce stresses above yield. The objective of this thesis is to formulate the problem and present results that will enable the design of proper isolators. The problem is formulated in terms of the hydrodynamic interaction between adjacent bodies along with structural coupling. The applicability and limitations of strip theory approaches are established through comparisons with three dimensional hydrodynamic analysis data. An analytic model of the ship-ramp-barge system is developed and tested. The results indicate the validity of the approach and establish a procedure that may be utilized for the design of passively controlled isolators.

DoD KEY TECHNOLOGY AREAS: Materials, Processes, and Structures, Modeling and Simulation, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Hydrodynamic Modeling, Roll-On, Roll-Off, Hydrodynamic Interactions, Strip Theory

BIOMECHANICAL MODEL OF THE HUMAN THORAX FOR IMPACT ANALYSIS
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The Biomechanical response of the human thorax was studied using the finite element method by the classic stiffness method. The main focus was on validation of the model. The model was subjected to static and dynamic forces applied at the sternum. A plate was adhered to the sternum area and the model was subjected to a dynamic load to simulate an impact load similar to a projectile or bullet impact. The projectile characterized a 7.62 NATO M80 ball round. The bulletproof vest was similar in material properties to boron carbon composite. The results included the static analysis and transient analysis and the subsequent displacement due to the external loading. Stress was calculated from the displacements. The results were compared to earlier research and “live fire” tests conducted on cadavers.

DoD KEY TECHNOLOGY AREA: Conventional Weapons, Other (Biomechanics, Body Armor)

KEYWORDS: Body Armor, Biomechanics, Thorax

SPRAY GENERATION
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This is an experimental investigation of the ligaments and drops generated at the free surface of liquid wall jets and liquid axisymmetric jets flowing over sand and polystyrene (beads) roughed surfaces. Experiments were conducted with freshwater and Eulerian and Lagrangian methods of description were used in the analysis. Measurements were made with three different high-speed imagers and two different pulsating laser systems and analyzed with appropriate image analysis software. The liquid jet Reynolds number ranged from $3.5x10^4$ to $8.5x10^4$, the Froude number from 8 to 30, and the Weber number from 2,000 to 7,500. The vertical positions, velocities and accelerations of several ligaments from inception to drop formation as well as the characteristics of the droplets were determined from the digitized images. These are expected to lead to a better understanding of the formation and the ejection of the eddies from the turbulent jet beneath the free surface.

DoD KEY TECHNOLOGY AREAS: Surface/Under Surface Vehicles – Ships and Watercraft, Other (Experimental Fluid Mechanics)

KEYWORDS: Spray, Drops, Jets, Bow Sheets, Liquid Sheets, Turbulent Layers, Ligament Positions, Ligament Velocities, Ligament Accelerations

EFFECT OF FLUID MESH TRUNCATION ON THE RESPONSE OF A FLOATING SHOCK PLATFORM (FSP) SUBJECTED TO AN UNDERWATER EXPLOSION (UNDEX)
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Shock trials are required for the lead ship of each new construction shock hardened ship class. The Navy's Floating Shock Platform (FSP) is used in the acceptance of mission-essential items for installation aboard shock hardened ships if the size and weight of the item permits such testing. Live fire shock trials and underwater explosion testing are both complex and expensive. Finite element modeling and simulation provides a viable, cost effective alternative to these tests. This thesis investigates the effects of reducing the amount of fluid mesh required to accurately capture the structural response of a finite element model of the FSP subjected to an underwater explosion. This same approach can be applied to a finite element model of each shock hardened ship class. With reliable results, computer simulation of ship shock trials and underwater explosion testing could become a dependable, cost effective, and time efficient manner for validating surface ship shock hardening requirements.

DoD KEY TECHNOLOGY AREAS: Surface/Under Surface Vehicles - Ships and Watercraft, Modeling and Simulation

KEYWORDS: Underwater Explosion, Floating Shock Platform

SENSITIVITY ANALYSIS OF TRANSIENT AND STEADY STATE CHARACTERISTICS OF SURFACE SHIP PROGRESSIVE FLOODING

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The Navy's primary analysis of damage control and stability to date has been under static conditions. Dynamic effects, such as progressive flooding, and the dynamic damage control procedures, such as hole patching and dewatering, have not been included in present design requirements. The goal of this thesis is to develop and test a stand-alone progressive flooding model. This model can be used to evaluate the transient and steady state characteristics of shipboard progressive flooding. Several improvements over previous studies are introduced and their effects are assessed. A sensitivity analysis study is performed through a systematic series of runs for a variety of hull forms. These results can be used to aid engineers of future ship designs in the use of damage control techniques and parameters.

DoD KEY TECHNOLOGY AREAS: Surface/Under Surface Vehicles – Ships and Watercraft, Modeling and Simulation

KEYWORDS: Progressive Flooding Design Tool, Transient and Steady State Analysis, Damage Control