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Investigation Of Critical Port Infrastructure Subjected To UNDEX: Suspension Bridge

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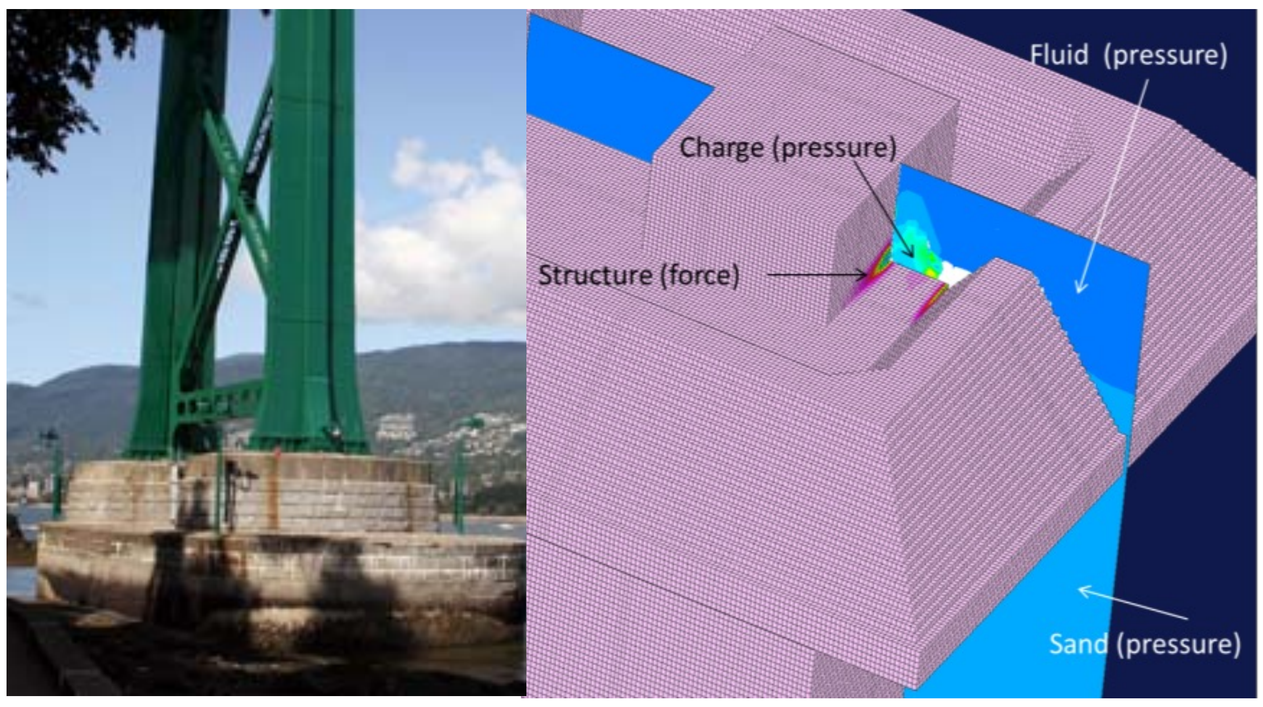
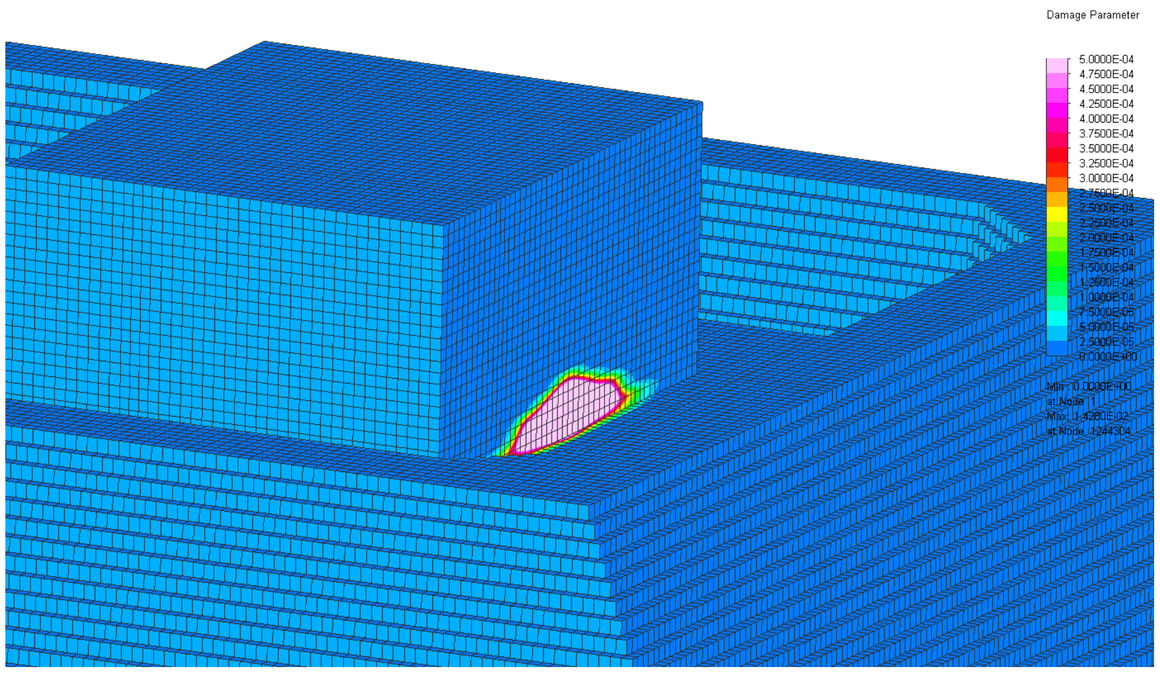
Vulnerable to Waterborne-IED Attack

- Port infrastructure is especially vulnerable to waterborne improvised explosive devices (IED) and underwater explosions (UNDEX).
- Massive engineering structures such as bridges, tunnels and piers serve the public day in and day out providing transportation, commerce and connectivity throughout waterfront areas.
- Accessibility to these critical elements makes them particularly exposed to the powerful effects of UNDEX.



Bridge Foundation (left), Fully coupled fluid-structure simulation with underwater explosion shock loading and resulting structural response (right)



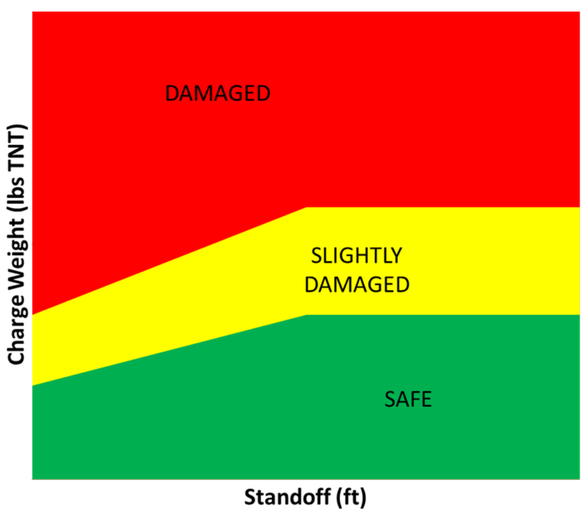
Bridge structural model depicting the damage parameter in reinforced concrete foundation as a result of an underwater explosion

Research Objectives

- Produce a physics-based Modeling and Simulation approach to investigate the vulnerability of port infrastructure; specifically, the suspension type bridge, subjected to UNDEX.
- Provide engineering guidance regarding potential damage to the port commander in making a decision on the damage severity of waterborne IED or other high explosives located in and around the pedestal and pier base of the bridge structure in contact with the surrounding water.

Prediction of Damage Potential in the Bridge Structure

- Fluid surrounding the bridge foundation complicates the explosive blast loading through the introduction of multiple phenomena (e.g. shockwave, bottom reflection, surface reflection, bubble oscillation, headwave, etc.).
- The damage parameter used in the finite element analysis of the bridge abutment provides insight into the areas where failure of the concrete is likely to occur based on previous experimental of the construction materials.
- The criteria in setting the damage potential consists of damage parameter and plastic strain found in the rebar, and results in a plot of damage levels as a function of charge weight and standoff distance between the explosive and the structure. Other standard engineering characteristics were also reviewed in order to create the basis of the damage potential levels.



Damage Potential as a function of Charge Weight and Standoff

Physics-Based Modeling and Simulation Aids in …

- Giving the on-scene mine warfare commander potential risk of failure in critical port structures
- Planning for mitigation of high explosive charge
- Informing port authority in budgeting of ongoing security and structural improvement as well as planning for future threats and training responders

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