

An Indian-Australian research partnership

**Project Title:** Mitigation of wave forces on coastal bridges

**Project Number** IMURA0428



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## Research Academy Themes:

**Highlight which of the Academy's Theme(s) this project will address?**

*(Feel free to nominate more than one. For more information, see [www.iitbmonash.org](http://www.iitbmonash.org))*

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

## The research problem

*Define the problem*

Cyclones, tsunamis and earthquakes are examples of critical events for infrastructure performance. Around the world an increasing number of people live near coasts, and rely on transport infrastructure to sustain their lives. For example, in the United States a majority live within 80 km of the coast, and almost 100,000 km of coastal highways are exposed to coastal hazards. Bridges are a key component of the highway network and they are by definition located at otherwise unsurmountable obstacles. Their safe performance in extreme events is therefore highly desirable. However, coastal bridges are particularly

susceptible to wave impacts caused by high winds and/or sea level rise. For example, 44 bridges were damaged in Hurricane Katrina when it struck the gulf coast of the United States, severely hampering disaster relief and recovery efforts. Many bridges fail during such events by bridge deck unseating. This occurs because the hydrodynamic forces overcome the self-weight and connection strengths of the bridge.

## Project aims

*Define the aims of the project*

This project aims to better understand the hydrodynamic forces that are applied to a bridge deck during an inundation event. For a range of bridge decks, it will examine ways to mitigate these forces using sacrificial bridge profiles that help reduce the loading. The bluff body shape that is typical of bridge cross sections will be adapted for improved hydrodynamic behaviour. A range of suitable materials and surface treatments will be examined. Design of the system for retrofit to existing bridges will also be considered. A combination of experimental, theoretical, and computational work will be undertaken as part of this project. Finally, the change to the structural reliability of the bridge as a result of the intervention measures will be assessed.

## Expected outcomes

*Highlight the expected outcomes of the project*

This project will result in a PhD graduate with industry-relevant skills in physical and computational modelling. The graduate will have knowledge of two domains: marine and coastal structure loading, and the structural reliability of highway bridges.

The key technical outcomes of the project will include:

- A better wave slamming force model for bridge decks than currently available;
- Hydrodynamic profile designs for retrofit to existing bridges to reduce probability of failure;
- The improved structural reliability and amended fragility surface as a result of the profiles.

## How will the project address the Goals of the above Themes?

*Describe how the project will address the goals of one or more of the 6 Themes listed above.*

This project directly identifies a real problem area and will examine improved measures to determine the life assessment extension of highway bridges that operate in a hazardous environment. Improved disaster resilience is a key output of this project.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.*

Essential:

- A Bachelors Degree in Civil/Mechanical Engineering with a High Distinction or equivalent from a reputable (IIT or equivalent) institute in India or a Masters Degree in Civil/Mechanical/Ocean Engineering from a reputable institute in India.
- Relevant courses in Fluid Mechanics and/or Ocean/coastal Engineering with evidence of performance at the highest level.
- Demonstrable excellent oral/written communication skills in English.
- Relevant skills in programming in a computer language.

Desirable:

- Ability to fluently program in Matlab and Fortran/C/C++ with good debugging skills.
- TOEFL or IELTS scores to demonstrate English language proficiency.
- Previous experience with experimental setup methods for fluid mechanics.
- Conference/journal publications.

## Potential Collaborators

Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) OR Monash Website [www.monash.edu](http://www.monash.edu) to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

This project will be assisted by CSIRO. Dr Ivan Cole is Chief Research Scientist for CSIRO Materials Science and Engineering Division (CMSE) with a detailed knowledge of materials science and mathematical modelling. He and Mr Wayne Ganther have considerable experience with CFD modelling of airflow and bridge decks as part of a recent CRC project, and bring this experience to the present project.

Please provide a few key words relating to this project to make it easier for the students to apply.

Bridges, Waves, Storm, deck unseating