IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Retrofit assessment for deteriorating highway bridges and impact on seismic fragility:**	
Project Number	**IMURA0654**	
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IITB Department:	Civil Engineering	

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)

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

The research problem

Define the problem

Extreme events such as earthquakes continue to threaten the security of highway bridge infrastructure systems. However, current approaches for seismic protection do not explicitly consider critical and continuous threats such as aging and corrosion deterioration of the structure. Presently, a significant percentage of bridges across the globe are estimated to be structurally deficient and a careful literature review reveals that aging bridges are more vulnerable to seismic threats. Hence, it is important to identify

retrofit strategies that simultaneously target both aging, such as corrosion protection, as well as reduction of seismic vulnerability of aging highway bridge components, as well as overall bridge system.

This project will investigate feasible retrofit techniques for protection of bridge structures against joint seismic and aging threats. Multiple retrofit techniques will be assessed to develop a probabilistic framework to assess the decrease in likelihood of bridge failure during earthquake events. The project would involve development of high-fidelity finite element bridge models to numerically investigate the impact of effectiveness of retrofit measures. Numerical results will be validated against experimental tests in the laboratory, for instance, cyclic pushover test of reinforced concrete columns wrapped with fiber reinforced polymers. Cost-benefit ratio analysis of multiple retrofit strategies across different bride types will help to identify most economically viable and structurally effective retrofit strategies for deteriorating bridge structures in seismic zones.

Project aims

Define the aims of the project

To investigate viable retrofitting techniques (such as fiber reinforced polymers) for corrosion protection, strength recovery and enhancement in ductility of highway bridges components in moderate to high seismic zones

The primary objectives of this project includes the following:

- Investigation of multiple corrosion protection techniques for highway bridges under chloride attacks
- Impact assessment of retrofit strategies on the seismic behaviour and response of critical bridge components, such as bridge columns
- Identification of critical locations within bridge components for optimum performance of retrofit measures
- Cost benefit analysis of corrosion protection techniques and impact on seismic lifecycle cost

Expected outcomes

Highlight the expected outcomes of the project

The expected outcomes of this research are given below:

- A probabilistic framework for seismic fragility analysis of highway bridge structures retrofitted against seismic and aging threats
- Identification of the retrofit strategies for corrosion protection of aging highway bridge structures after a thorough analysis of viable retrofit methods
- Quantify the reduction in seismic fragility estimates and life-cycle cost along the useful service life for multiple bridge classes
- Cost-benefit ratio analysis of different retrofit techniques and selection of most economical and effective retrofit strategy for seismic protection of aging bridge structures

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.

Highway bridge constitute key elements of the transportation infrastructure system. This projects focuses on the protection of these systems against joint seismic and aging threats. The workflow involved for the

project would involve the implementation of retrofit strategies in high fidelity finite element bridge models. Following a series of nonlinear time-history analysis of bridge models, the effectiveness of the retrofit strategies will be tested using seismic fragility curves. Component level tests of the protection devices would be conducted experimentally in the laboratory, for example of carbon fiber wrapped columns under cyclic loading. Comparisons will be drawn between the experimentally obtained performance of test columns and analytically developed computer models.

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 Bachelor Degree in Civil Engineering with a High Distinction or equivalent from a reputable (IIT or equivalent) institute in India or a Master Degree in Civil from a reputable institute in India.
- Relevant courses in structural engineering, probability and statistics.
- Demonstrable excellent oral/written communication skills in English.
- Relevant skills in programming in MATLAB.

Desirable:

- TOEFL or IELTS scores to demonstrate English language proficiency.
- Conference/journal publications.
- Experience of working in a structural engineering laboratory.

Potential Collaborators

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

Dr. Yu Bai

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

Seismic protection of bridges; Fiber reinforced polymer wraps; Aging and deterioration; Corrosion protection and monitoring