The University of Queensland - IIT Delhi Academy of Research (UQIDAR) Joint PhD Project Proposal Template

1. Project details

Project title

Life-Cycle Risk Assessment of RC Structures under Earthquake and Fire

Project ID

UQIDAR-00116

2. Supervision team

Please visit the IITD website www.iitd.ac.in and UQ website http://researchers.uq.edu.au/ to highlight potential collaborators that would be best suited for the proposed project. Complete where possible – advise if you'd like assistance establishing contacts.

	University of Queensland	IIT Delhi	External/Industry (if applicable)
Supervisor name and title	*Dr. David Lange*	*Prof. Vasant Matsagar*	
School or department (or company, if applicable)	*School of Civil Engineering*	*Department of Civil Engineering*	
Phone number	*+61 7 336 56646*	*+91 (11) 2659-1225*	
Email-ID	*d.lange@uq.edu.au*	*matsagar@civil.iitd.ac.in*	
URL for more info	*https://researchers.uq.edu.au/researcher/20572*	*http://web.iitd.ac.in/~matsagar*	

3. Other supervisors

Please provide information about other associate supervisors below.

Full Name and Title(s): Dr. Cristian Maluk
School/Department/Company details: UQ School of Civil Engineering
Phone/Email/URL: +61 7 336 53518 / c.maluk@uq.edu.au / https://researchers.uq.edu.au/researcher/12949

2. Field Of Research (FOR) codes

Specify up to four four-digit FOR codes for your project – see **here** for more detail on FOR codes.

1. **0905**	3.
2. **1204**	4.

3. Keywords

Please choose up to 4 keywords for your project. E.g. Nanotechnology, data science, novel batteries, etc. Keywords will assist in classifying project and presenting projects to students on the applications portal.

1. Structural Engineering	3. Earthquake response
2. Fire response	4. Risk assessment

4. Discipline background of candidate

Please outline the preferred background of your student. E.g. Organic chemistry, physiology, topology, CFD, etc. This will assist in presenting projects to applicants on the apps portal.

1. Civil Engineering	3.

UQ IITD Academy of Research

The University Of Queensland AUSTRALIA

Indian Institute of Technology Delhi

2. Structural Engineering	4.

5. Project description

Fragility and risk assessments of reinforced concrete (RC) structures against various design loads and their combinations is required to be conducted for evaluating structural vulnerability. This is typically done at the design stage. However, during the service (design) life of a civil engineering structure, it is important to investigate the change (increase) in the risk posed to a RC structure on account of multiple hazards such as, the two uncorrelated (non-cascading) independent hazards: earthquake and fire. That is to say, that the risk to the structure as a result of fire may increase if the structure has already been damaged by, e.g. an earthquake; and vice versa.

With an aim to evaluate reduction in the desirable design factor of safety due to deterioration of the RC elements (with and without strengthening) over the service-life of a building by using a suitable well-established degradation model, this research proposal plans to investigate the life-cycle risk assessment of RC structures exposed to earthquake and then fire. A series of high repeatability tests will be conducted, by applying cyclic loading (to simulate earthquake damage) to scaled-down RC elements in the Structures Laboratory at the University of Queensland (UQ) and then testing them under heating using the H-TRIS apparatus (to simulate the subsequent fire exposure) in UQ's fire laboratory. Numerical models of the RC elements will be developed at the Multi-Hazard Protective Structures (MHPS) Laboratory at IIT Delhi and validated using these test results. The validated numerical models will then be used for conducting multi-hazard vulnerability assessment of the RC elements under earthquake and fire. Subsequently, risk posed to the structures during its service-life, with degradation of the RC elements due to life-cycle deterioration, earthquake and fire, will be evaluated.

6. Project deliverables/outcomes

1. Three dimensional (3-D) finite element (FE) models for conducting non-linear earthquake and fire analyses of the reinforced concrete (RC) structures in multiple stages will be developed and validated by comparing with the data obtained experimentally.
2. Fragility assessment method under the multi-hazard uncorrelated (non-cascading) hazard scenarios anticipated for a RC structure will be developed.
3. An analysis framework for life-cycle risk assessment of the RC structures under earthquake and fire will be developed.
4. A realistic factor of safety will be evaluated in different possible failure modes of the RC structures, not only at the design stage but also during its service-life.
5. This methodology, once developed, could in the future be applied to other uncorrelated accidental loads.

7. Research impact themes

Highlight the research impact theme(s) this project will address. Feel free to nominate more than one. For more information, see http://www.uq.edu.au/research/impact

1. Healthy Ageing
2. Feeding the World
3. **Resilient Environment** ✓
4. Technology for Tomorrow
5. Transforming Societies

8. Type of student

This project is best suited for an:

i-student	
a-student	

i- or a-student	✓

Please note that:

- an i-student will be expected to spend year-1 at IIT-D, year-2 at UQ and the remaining time at IIT-D.
- an a-student will spend year-1 at UQ, year-2 at IIT-D and the remaining time at UQ.
- All students will be required to complete some amount of coursework in their first year.

9. Student capabilities and qualifications

Essential Capabilities:

Knowledge in structural engineering with high grades in academics.

Desirable Capabilities:

Experience in experimental and/or numerical simulations.

Knowledge in fire engineering, in particular structural fire engineering. In case the student does not have the relevant experience the student will be encouraged to undertake additional study in this field at UQ.

Expected qualifications (Courses/Degrees etc):

Masters Degree in Structural Engineering.