T.I.M.E. Projects 2019-2020

Application Form

Deadline for submission: ***January 15th 2020***

Please submit the completed form to: ***gwenaelle.guillerme@time-association.org***

Applications must be submitted by e-mail only. You are required to attach a scanned copy of a Letter of Support signed by the Head of your Institution.

Please remember that T.I.M.E. promotes international cooperation and therefore only applications from consortia of at least three T.I.M.E. members in three different countries can be accepted.

You will be notified of the results of the selection after the Advisory Committee meeting on ***February 7th 2020****. Projects run from February 2020 to January 2021.*

Title of Project	
Flood loads on bridge structures	
Acronym (if any)	
Details of the Applicant	
Name of Institution(s)	The University of Queensland, Technical University of Munich, Polytechnic University of Catalonia, University of Padua, University College London, ARUP Pvt Ltd
Faculty/Department/Office	EAIT, University of Queensland
Contact Person/s and Details	Melinda Knox International Mobility Coordinator Faculty of Engineering, Architecture and Information Technology The University of Queensland Brisbane Qld 4072 Australia **T** +61 7 3365 3934 **E** m.knox@uq.edu.au
Summary of the Project (max. 2000 characters)	
Aim of this project is to develop a numerical tool to accurately estimate the flood loads on bridge structures and to experimentally validate the numerical modelling approach. Bridges are a major part of a transportation infrastructure of a country. Therefore, design and maintenance of bridge structures have received much attention by governments and infrastructure agencies. Floods greatly affect the performance of bridges, incurring significant cost to bridge agencies all around the world. In Australia alone, annual spending on bridges arising from flood events is estimated at AUD $ 377 Million (Setunge 2018). With ongoing climate change, the occurrence of floods as extreme events will become more frequent leading to a significant increase in maintenance cost for damaged bridges. While consideration is given to floods as a load in bridge design, the estimation of such flood loads is usually based on earlier investigations. However, more recent studies (Jempson and Apelt 2002) have shown that estimated flood loads on bridges based on codes, such as AS 5100.2 (2017), are insufficient and that real loads can be significantly higher. Detailed investigations providing accurate flood loads on bridges are yet to be carried out. Recent advances in numerical modelling, especially in fluid structure interaction (FSI) and monitoring methods, have provided tools for investigating the behavior of bridges	

subjected to flooding to a significantly higher accuracy.

Multi-physics modelling platforms, such as *Kratos Multiphysics*, provide the ideal solution for the accurately modelling of fluid structure interactions. *Kratos* has already been successfully used in modelling the performance of wind and under-water turbines, membrane roof structures and other FSI problems. Within this project, *Kratos* will be further developed allowing accurate small and large deformation problems related to flood loaded bridges by combining different numerical simulation techniques that will be accurately validated using physical experiments.

Reason for applying for T.I.M.E. funding (max. 2000 characters)

The investigation of flood loads on bridges not only requires expert knowledge, including structural mechanics, fluid mechanics, bridge design as well as risk & safety, calling for the involvement of experts from multiple engineering disciplines. At the same time, it is inevitable that all experts have a common simulation platform and a common interest to further develop this simulation tool as a benefit for the whole engineering community.

Kratos Multiphysics as an open-source simulation platform is the key in this investigation and forms the basis for this collaboration. *Kratos Multiphysics* is currently being developed by collaborators between the Polytechnic University of Catalonia (UPC), the Technical University of Munich (TUM) and the University of Padua (UniPD). Experts from TUM, UPC and UniPD have developed coupled simulation techniques in Kratos to investigate the behavior of specific FSI problems.

The University of Queensland (UQ), the University College London (UCL) and the industry partner ARUP Pty Ltd strongly focus in research projects within bridge engineering as well as risk & safety. They provide extensive expertise on bridge structures to this project and have started to engage in using *Kratos* for solving their engineering problems. Furthermore, with the involvement of ARUP, an early introduction of the outcomes of the project in common practice is ensured.

The project will strongly benefit from the capabilities and expertise provided by the investigators ensuring the best possible outcome for solving the problem of flood loads on bridges. We believe that T.I.M.E. provides the ideal platform for funding this project because:

1. The addressed problem is of significance to Australia, Europe and almost all the countries in the world affected by flooding;
2. This project promotes a unique collaboration between world leading universities and experts in delivering high impact research;
3. The expert knowledge of the research team ensures the project to be finalized within the funding period, thus yielding in a short-term high impact through the industry partner ARUP;
4. This project will promote academic-industry collaborations through the partnership between the participating universities and ARUP, a global engineering design and construction company;

Expected outputs of the project

- A numerical model to accurately predict the behavior of bridges under flood loading
- A validation procedure of the numerical model using scaled experiments
- Load factors for extreme flood events on bridges to be used in design codes

Target group/s and expected impact

1. The civil engineering community as a whole by providing a validated numerical tool for simulating FSI problems of flood loaded structures (e.g. flood protecting structures)
2. Civil engineering practitioners by providing improved load factors for designing bridges
3. Road authorities by providing a validated numerical tool to improve safety and maintenance of bridges
4. The *Kratos* community by extending the capabilities of the numerical platform

Sustainability of the programme

1. Developed methods and procedures will be published in a way that they can be evaluated, discussed and further developed by the scientific computational community.
2. Developed methods and procedures will be implemented in the open source platform *Kratos Multiphysics* making them accessible and useable for the Kratos community beyond the funding period of this project.

3. Establishment of new and strengthening of existing collaborations between project partners in research and teaching brings the collaboration of this project to a new level.
Specific deliverables
• Project report detailing the investigation and outcomes • Series of scientific publications • Submission to revise the flood loads on bridges

Total duration of the project

The expected duration of this project is 1 year:

- Kick-off meeting
- One scientific assistant will dedicate time to investigate the methods coming from all partners. (2 months)
- Expertise is brought together and elaborated in the platform *Kratos Multiphysics*. (3 months)
- Developed methods are verified using scaled laboratory tests (3 months)
- Developed and verified methods are used to simulate an existing large scale bridge and compared against the existing data (2 months)
- Modeling techniques will be elaborated and published to open platforms (1 months)
- Results will be published to preserve the knowledge and discuss it with the scientific community. (1 month)

Planned budget

- AUD $ 12,000 for scaled experiments
- AUD $10,000 for travel expenses and meeting costs
- 1 year scientific assistant at the University of Queensland AUD$27,000

Requested financial support from T.I.M.E.

A total of EUR 15,000 (AUD $24,185) is requested from T.I.M.E to be used for:

- Travel expenses for meetings and exchange (AUD $10,000)
- Coverage of experimental cost (AUD $10,000)
- Partial support of the salary for a scientific assistant (AUD$4,000, approx. 15% of AUD$27,000)

Other sources of funding

- AUD $5,000 funding support by ARUP Pty Ltd
- AUD $8,000 funding support by UQ
- AUD $6,000 as part of the Global Strategy and Partnerships Seed Funding Scheme – awarded in 2019 with AUD $24,500 by the UQ and TUM to establish a partnership between both partners for the further development of *Kratos Multiphysics*
- AUD $6,000 granted by TUM for the exchange of one scientific assistant supporting UQ in the establishment of *Kratos Multiphysics*

Members of the consortium

University of Queensland, Australia; Technical University of Munich, Germany; Polytechnic University of Catalonia, Spain; University of Padua, Italy; University College London, UK; ARUP Pvt Ltd, Australia and UK.

1. UQ –Associate Professor Dilum Fernando, Professor Alexander Scheuermann
2. TUM – Professor Roland Wüchner
3. UPC – Professor Riccardo Rossi
4. UniPD – Professor Antonia Larese
5. UCL- Professor Jose Torero
6. ARUP- Mr. Peter Burnton

Key Staff (Name, Position, E-mail)

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References

AS 5100.2, "Bridge design part 2: design loads", Standards Australia, Sydney NSW, Australia 2017.

Jempson, M. A., C. J. Apelt, T.E. Fenske and A. C. Parola "Flood Loads on Submerged and Semi-Submerged Bridge Superstructures" Austroads Bridge Conference. Sydney 2002.

Setunge, S. "Failure mechanism of bridge structures under natural hazards", Report 446.2018, Bush Fire and Natural Hazards CRC, Melbourne, Australia 2018.

Check List

- ***Attach a signed Letter of Support from the Head of the Applicant Institution***

Send this form and supporting documents by e-mail only to:

gwenaelle.guillerme@time-association.org

THE DEADLINE* FOR *THE SUBMISSION OF APPLICATIONS IS JANUARY 15th 2020