Robustness of bridge structures under extreme hydraulic actions

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Extreme weather events can impose hydraulic actions on bridge structures which can lead to structural damage or even total collapse (see Fig. 1). Examples of such hydraulic actions include forces acting on bridge elements from river flows, ocean storm surges and coastal wave actions (see Fig. 2). Hydraulic action is the most common cause of bridge failure in the UK and worldwide. With storms in the UK expected to become both more severe and more frequent as a consequence of climate change, great importance should be attached towards improving the guidance available to infrastructure owners, managers and operators, so that there is an enhanced understanding of the potentially increased structural risks to bridge structures, due to severe weather events.

In this PhD project, you will develop an advanced understanding of bridge vulnerability against hydraulic action by numerically modelling different types of bridges through finite element analysis software. Through advanced modelling of a bridge as a structural system of interconnected and interacting structural members, the extent of damage (partial damage or total collapse) on different typical bridge configurations will be investigated under varying hydraulic actions. Such actions will include bridge scour and pier forces arising from river flows, bridge deck uplifting forces, ocean storm surges and extreme wave actions at coastal structures and estuaries. By carrying out this work, you will develop a step change from existing UK risk assessment methods for bridge structures with respect to hydraulic actions, offering better understanding of the implications of potential structural damage on transport network functionality and resilience. You will contribute towards improved understanding of the susceptibility of different bridge types to climate change effects and extreme weather conditions, which is crucial for the safe operation of transportation networks and long-term planning.

As part of this PhD project, you will interact directly with Highways England, infrastructure owner, manager and operator in the UK, who will assist in guiding you towards the achievement of the project goals. Your research will contribute towards their updating of existing design and assessment guideline documents that is currently in process, aiming at improving their quality and significance.

Fig. 1: Bridge collapse due to hydraulic action.

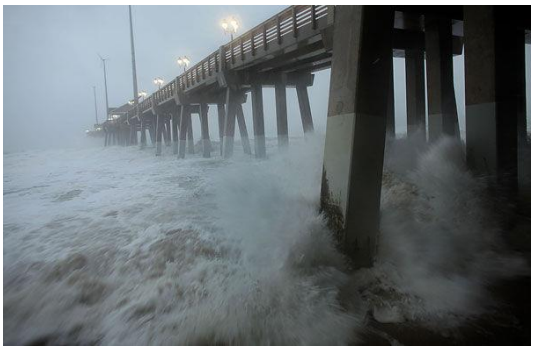

Fig.2: Ocean storm surge on a bridge.

Training opportunities:
You will gain experience in advanced numerical modelling of bridge structures and apply environmental sciences for the purposes of infrastructure risk management. You will spend time in the Highways England's offices and gain knowledge in the assessment and management procedures used for bridge infrastructure, including long-term planning and risk prioritisation. In addition, you will be able to attend advanced postgraduate modules at University of Surrey related to the PhD topic, Keynote Lectures carried out by infrastructure professionals and you will have regular contact with academics and industrial advisors.

Student profile:
This project is suitable for students with an engineering-related degree (either undergraduate or postgraduate) or professional experience in engineering. Motivation and enthusiasm for studying a multi-disciplinary problem that combines environmental sciences with engineering analysis will be desired.

Funding particulars:
Eligible students will receive the usual NERC award including stipend and university fees.