VULNERABILITY EVALUATION FOR BRIDGES SUBJECTED TO FLOOD LOADINGS

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IT IS IMPORTANT TO ASSESS THE VULNERABILITY OF BRIDGES IN AN EXTREME FLOOD EVENT AS THESE CRITICAL INFRASTRUCTURES CONTRIBUTE TO THE RESILIENCE OF THE COMMUNITY DURING AND IN THE RECOVERY STAGE OF THE EVENT. THIS STUDY AIMS TO ANALYSE THE BEHAVIOUR OF BRIDGES UNDER FLOOD LOADINGS USING FINITE ELEMENT MODELLING APPROACH AND COMPARE PERFORMANCE INDICATORS.

Bridges are critical infrastructures whose resilience in extreme flood events is contributing towards the resilience of the community being served. Therefore it is important to understand the impact that flooding has on bridges so that they can be made less vulnerable to damage from these extreme events. This study aims to find out:

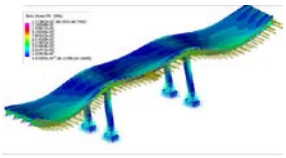
- The failure modes in critical structural components of a case study bridge when subjected to flood loadings
- Incorporate possible damage scenarios in girders and piers and analyse the behaviour of the bridge with different load combinations using finite element modelling
- Use selected performance indicators (probability of failure, reliability, load capacity based vulnerability and probability based vulnerability) to evaluate the vulnerability of the bridge under different damage scenarios

CASE STUDY BRIDGE

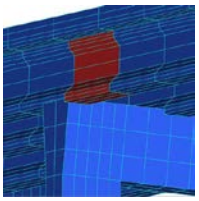
Tenthill bridge is selected as the case study bridge which is located near Gatton, in the Lockyer Valley. The bridge was constructed in 1976 and up until 1989, when the Gatton Bypass was opened; it was part of the Warrego Highway which carried traffic from Brisbane to Toowoomba. It is a simply supported reinforced concrete bridge with three 27.38 m spans and an overall length of 82.15 m and a width of 8.6 m. The depth from the stream bed to the bridge is approximately 15.3 m.

NUMERICAL MODELLING OF BRIDGES UNDER FLOOD LOADING

Three dimensional numerical models are developed using STRAND7 software. All the structural components are modelled as per the structural drawings and the designed compressive strength of concrete was taken as 20 MPa.

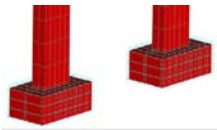


Considered damaged scenarios are a weakened girder to represent damage from debris impact; a longitudinal crack applied to the web of the girder to simulate damage from impact; a pier crack and pier scour.

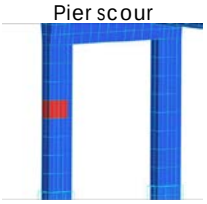


Weakened girder

Longitudinal crack



Pier scour



Pier crack

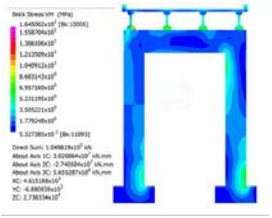
FINDINGS

Numerical results from the finite element modelling were analysed using maximum stress, cross section stress and performance indicators.

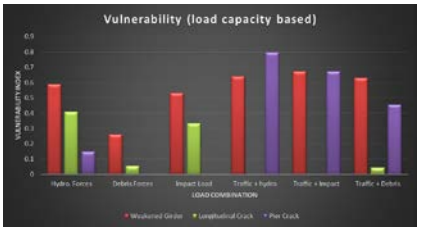
Weakened girder applied above the headstock gives the worst case damage scenario which was followed by the crack applied to the centre of the pier.

The cutting plane feature of Strand 7 was used to analyse various cross sections along the bridge length.

The areas of interest were those where the highest stresses were located and also where the damaged bridge sections were applied. The peak stress occurred with the ultimate impact load being applied directly to the section of weakened girder above the headstock.



Load capacity based vulnerability index depends on the loads that caused the capacity of the bridge to be exceeded for both the damaged and undamaged state. Weakened girder case produces the highest vulnerability for all load combinations except for the traffic and hydrodynamic force load, where the pier crack gave the highest value of approximately 0.8



END USER STATEMENT (For Annual report 2015-2016, Project B8: Enhancing resilience of critical road infrastructure: Bridges, culverts and flood-ways under natural hazards)

This project is filling an important gap in understanding the vulnerability of road infrastructure to natural hazards and the impact to communities. Three interesting utilisation activities to transfer knowledge gained to practice have been developed as a result of a constructive end user workshop.