FAILURE MECHANISM OF A TYPICAL GIRDER BRIDGE IN AUSTRALIA DUE TO SEISMIC LOADS

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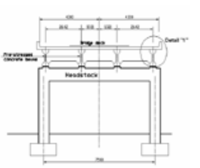
THERE IS A SIGNIFICANT NEED TO PERFORM ADEQUATE ASSESSMENT OF THE VULNERABILITY OF BRIDGES AND BRIDGE NETWORKS PRIOR TO FUTURE SEISMIC EVENTS IN AUSTRALIA. THIS STUDY AIMS TO IDENTIFY THE FAILURE MECHANISM OF A TYPICAL GIRDER BRIDGE IN AUSTRALIA DUE TO A SEISMIC EVENT AND DEVELOP A EARTHQUAKE MANAGEMENT METHODOLOGY BASED ON A PROBABILISTIC BASED APPROACH

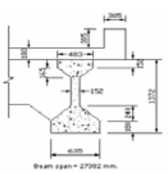
Bridges are the main structural system of transportation systems. Although new bridges are designed with improved seismic design guidelines, existing bridges are more vulnerable for failures due to earthquakes. This study aims to find out:

- The failure mechanism and critical structural components of a typical girder bridge types due to Australian earthquakes
- Probabilistic seismic risk assessment is carried out using fragility curve method, as behaviour of bridges due to earthquake excitation is probabilistic
- Generation of fragility curve methodology is developed using full non-linear time history analyses with particular damage states of critical components in the bridge. The vulnerability of the bridge is expressed in terms of predefined damage states based on capacity and demand ratios of the significant structural components

BRIDGE CHARACTERISTICS

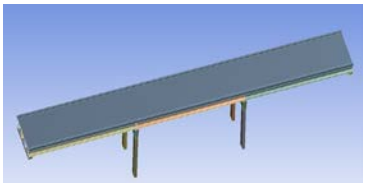
The most common bridge type in Australia is precast concrete girder bridges. The Tenthill creek bridge is selected for the study. The Tenthill creek bridge is a simple span reinforced concrete bridge in Queensland. The bridge is 82.15m long and about 8.6m wide. It is supported by a total of 12 pre-stressed 27.38m long beams over three spans. Both ends are supported by two abutments and two headstocks

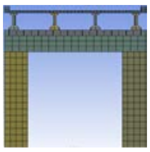


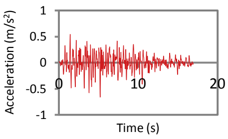


NUMERICAL MODELLING AND NON LINEAR TIME HISTORY ANALYSES

Three dimensional analytical models are developed using ANSYS 14.5 software. All the structural components are modelled as per the structural drawings except the abutments at the two end. Non linear time history analyses were conducted based on 24 different artificially generated earthquake time histories compatible with Australian conditions.

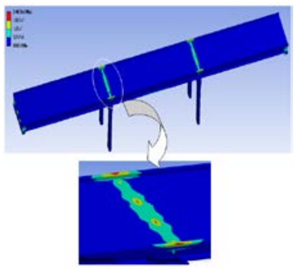






FAILURE MECHANISM

Maximum stresses are observed at the deck joint and separation of deck joints due to these type of earthquakes are possible as per the results. The gap between the two girders at the pier make a week connection to the deck. This has created higher stresses at the joint



Since earthquakes occur in Australia is not very severe in magnitude, these types of repairable damages are anticipated. Therefore strengthening of deck joints and retrofitting of these joints are important in typical girder concrete bridges

DEVELOPMENT OF FRAGILITY CURVES

Fragility analysis was developed as a probabilistic methodology which addresses the uncertainties and demonstrates the reliability of structures achieving certain performance level.

Damage state	Description	C/D Ratios
No Damage	Minor inelastic response may occur post-earthquake damage is limited to narrow cracking in concrete. Permanent deformations are not apparent	C/D≥ 0.5
Repairable damage	Inelastic response may occur, resulting in concrete cracking, reinforcement yield and minor spalling of cover concrete. Extent of damage should be sufficiently limited so that the structure can be restored essentially to its pre-earthquake condition without replacement of reinforcement or replacement if structural members. Repair should not require closure. Permanent offsets should be avoided.	0.5>C/D≥ 0.33
Significant damage	Although there is minimum risk of collapse, permanent offsets may occur, and damage consisting of cracking, reinforcement yielding, and major spalling of concrete may require closure to repair. Partial or complete replacement may be required in some cases.	C/D<0.33

The damage due to all the earthquake accelerations shows minor damages in the bride at the deck joint and the capacity and demand ratios of the slab deck was used to obtain the fragility curves