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SEISMIC FRAGILITY ASSESSMENT OF BRIDGES: A STATE OF ART REVIEW

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In recent years, one of the ways to investigate the vulnerability of bridges is to use fragility curves, which can have many applications before and after earthquake occurrence. These curves are used to assess seismic hazard, prioritize structural rehabilitation, crisis management planning, and multi-risk approaches for lifeline structures in different natural hazardous zones. Also, to estimate the amount of post-earthquake damage which is a prerequisite to ensure continuous transport facilities, emergency and evacuation routes. This paper investigates the practices and methodologies for assessing seismic vulnerability of bridges in regions exposed to high seismicity. The study involves an extensive collection and review of analytical, empirical, expert-based and hybrid models for assessing fragility curves available in the technical literature and their evaluation according to a set of qualitative criteria. Also, it reveals the most recent the fragility curves, introduces their advantages and describes the relationship between the intensity of the earth's earthquake and the probable seismic hazard level to accurately determine the correct choice for specialists, engineers, and stake holders for specific level of performance.

A vast majority of the highway bridges around the world were not designed according to any seismic design criteria and thus do not meet the seismic detailing requirement imposed by current guidelines (Caltrans, 2013; CSA-S6, 2014; Eurocode 5, 2005; Federal Highway Administration (FHWA), 2006). These factors lead to the reconsideration of three important issues such as (i) the likely seismic performance of those non-seismically designed bridges, (ii) potential economic losses and (iii) selection of risk mitigation and performance improvement techniques, i.e. retrofitting or rehabilitation. Fragility curves describe the conditional probability, i.e. the likelihood of a structure being damaged beyond a specific damage level for a given ground motion intensity. Therefore, current seismic performance assessment methodologies are tending towards fragility curves as a means of describing the fragility of structures, such as highway bridges, under uncertain input. The general equation for fragility or conditional probability can be expressed as:

$$\text{Fragility} = P\,[LS|IM = y] \quad (1)$$

where,
LS is the limit state or damage state (DS),
IM is the intensity measure (ground motion), and
Y is the realized condition of ground motion IM.

APPLICATIONS OF FRAGILITY CURVES

The fragility curves are an important tool to assess seismic risk. Every building or structure has its own fragility

curve. This seismic fragility curves can be used as follows:
(i) for assessing potential effects and risks, including functional and loss in economic and lives
(ii) for emergency or disaster response planning
(iii) for risk mitigation efforts (retrofitting).

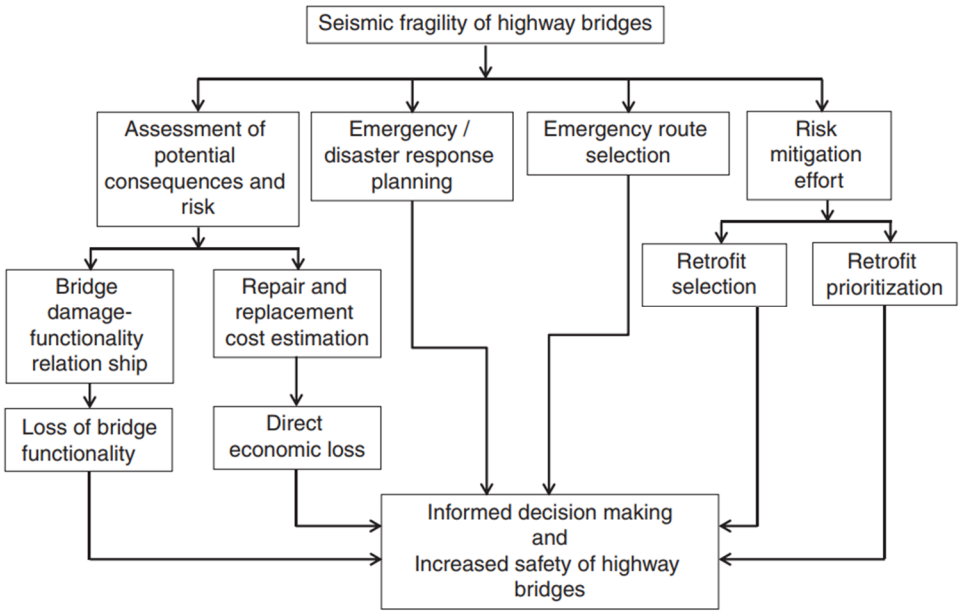

Figure 1. Various applications of seismic fragility curves (Muntasir Billah & Shahria Alam, 2015).

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