Oregon Department of Transportation

Stage 1 Research Problem Statement

Number*: 25-25*

Proposed Title: Seismic Resilience Assessment of ODOT Reinforced Concrete Bridges

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.
In light of the considerable economic and safety implications associated with premature failure of bridges, a quantitative understanding of bridge performance subjected to the combination of chloride ingress and seismic events is important for bridge managers. Bridge deterioration can reduce the structural capacity to withstand a disastrous earthquake, while structural damages due to seismic events, in turn, may accelerate the corrosion process. Reinforcement corrosion induced by chloride contamination is a leading cause of structural damage and premature degradation in reinforced concrete (RC) structures. Concern is the greatest in coastal and northern states where these structures are exposed to marine environments and deicing salts, respectively, such as in the state of Oregon. ODOT has historic RC bridges along the Pacific coast that experience serious corrosion and degradation. In addition, RC bridges in seismic-prone areas may experience several earthquakes during their service periods, creating potential disruptions to bridge performance.

2. Document how this **transportation issue** is important to Oregon and will meet the [Oregon Research Advisory Committee Priorities]

The proposed project fits well with the ODOT's strategic goals of Safety and Stewardship of Public Resources, and addresses the research focus areas of **Safety** and **Cost reductions or savings to construction, operations, or asset maintenance**. In recent years, resilience is widely used to effectively measure RC bridge functionality in response to seismic events, which is defined as the ability of a bridge structure to withstand and recover rapidly from functionality disruptions. As the resilience of RC bridge can also be affected by chloride-induced rebar corrosion during its service life, it is essential to develop life-cycle resilience assessment to quantify the long-term bridge performance under the combined effects of corrosion and seismic activities.

The goal of this project is to provide realistic estimation of the long-term seismic performance of ODOT RC bridges in chloride-laden environments. To this end, we will investigate the interaction of the effects of rebar corrosion and seismic activities on structural behaviors, and then develop a comprehensive probabilistic framework to assess the life-cycle resilience of RC bridges. This framework incorporates models of fault raptures/movements, hazard analysis, climate prediction, structural analysis and performance assessment. Finally, an ODOT RC bridge will be utilized as the case study to illustrate the proposed framework.

3. What **final product or information** needs to be produced to enable this research to be implemented?
This project will develop a novel resilience assessment framework that provides a realistic estimation of life-cycle resilience for RC bridges, incorporating the interactive effects of corrosion and earthquake on structural behaviors as well as uncertainties. In addition to the large magnitude seismic events, this project considers the impacts of small magnitude earthquakes on the corrosion process of RC bridges, which is always ignored in existing studies. By doing so, this study can provide bridge managers with guidance on the change in the long-term performance of RC bridges due to corrosion and earthquake, which is important to determine the effective strategies to enhance structural resilience in risk management planning. Better resilience assessment will translate to making better bridge management decisions, and thus safeguarding the traveling public and saving money for taxpayers.

4. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

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5. Other comments:

To overcome the limitations identified in the existing approaches, this project proposes a quantitative framework for the life-cycle seismic resilience assessment of RC bridges in aggressive environments. Figure 1 compares the proposed approach with the conventional approach to assessing the resilience of RC structures under the combined effect of corrosion and seismic event, and summarizes the main contributions of this project. This proposed approach utilizes the probability seismic hazard analysis (PSHA) to generate a stochastic set of seismic events (all levels of magnitudes) and the ground motions at the bridge location (Baker, 2008), and then calculate life-cycle resilience by modeling the interaction of the effects of corrosion and seismic event on structural behaviors. By doing so, the proposed framework can provide bridge managers with a more realistic understanding of life-cycle seismic resilience for RC bridges in aggressive environments, which can help them to determine effective cost-effective resilience-enhancing solutions.

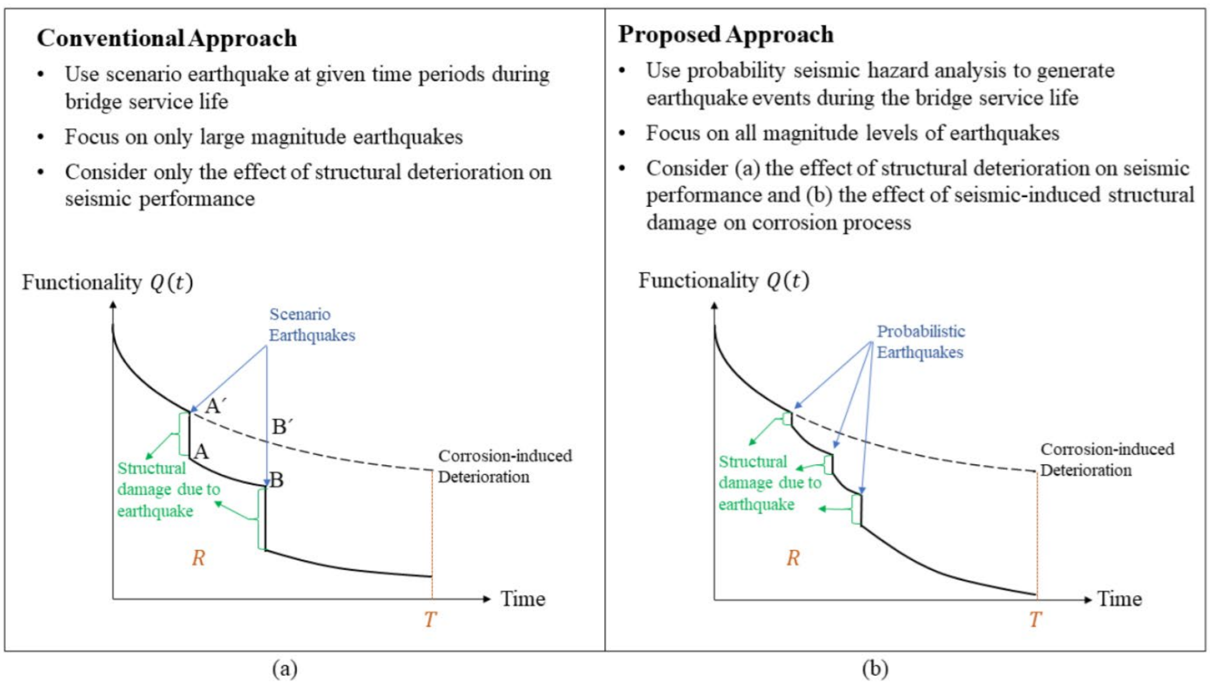

Figure 1. Comparison between the conventional approach and the proposed approach

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