RAPID WEB-BASED SEISMIC RISK ANALYSIS OF BUILDINGS

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This paper puts forward a web-based system for evaluation and communication of risk to building structures under the earthquake hazard. The system under development is a practical effort to raise public awareness of the monetary and social aspects of the seismic risk. The need for such developments stems from recognition that in many earthquake-prone regions, such as Iran, there is a lack of deep concern amongst the public about the earthquake hazard. Upon occurrence of a strong ground motion, the public becomes conscious of the importance of better adherence to seismic guidelines in design and higher quality of construction, but this consciousness erodes over time, at least until the next severe earthquake event. The academic community has a social duty here, and that is to convey the results of scientific studies in layman's terms to the public. Probabilities, costs, and death toll are metrics comprehensible to the non-technical audience. Therefore, risk in the proposed system is defined as the probability of exceedance for monetary and social losses, i.e., costs and casualties, respectively.

The system is hosted at cira.civil.sharif.ir, where CIRA stands for Civil Infrastructures Risk Analysis. Three target groups are envisioned for this system: Building owners, engineers, and policy-makers. A building- owner inputs to the system a set of preliminary, observable information about the building, such as location, material, number of stories, footprint area, year of construction, and load bearing system. Figure 1: Screenshot of the input form for the risk analysis system shows the input form of this system. The location data that is acquired through Google Maps® will be employed to determine the probability distribution of the earthquake intensity, measured in terms of the peak ground acceleration and/or spectral acceleration.

Figure 1: Screenshot of the input form for the risk analysis system

The system will input this information into the built in probabilistic methods that predict the probability distribution of losses and/or its partial descriptors, such the mean loss. Two significant sources of uncertainty are considered: 1) Uncertainty in the parameters that define the ground motion, building response, and impacts; 2) Uncertainty associated with incomplete data. For instance, the owner may not be able to identify the type of the load bearing system of the building. In this case, the system will employ census data from similar regions to compute the probability of the building having different load bearing systems, and uses this probability to compensate for the missing data.

Figure 2 depicts example results that are shown to the end user in the output page of the system. The mean structural damage ratio is shown on left, which equals the total repair cost of the structural components divided by their total cost of replacement. For instance, this figure shows that the mean repair cost of the structure is 25% of its replacement cost. Furthermore, the probabilities of falling within five predefined damage states are shown on right in Figure 2. For instance, this figure indicates that there is 20% chance that a moderate damage is incurred in the structure.

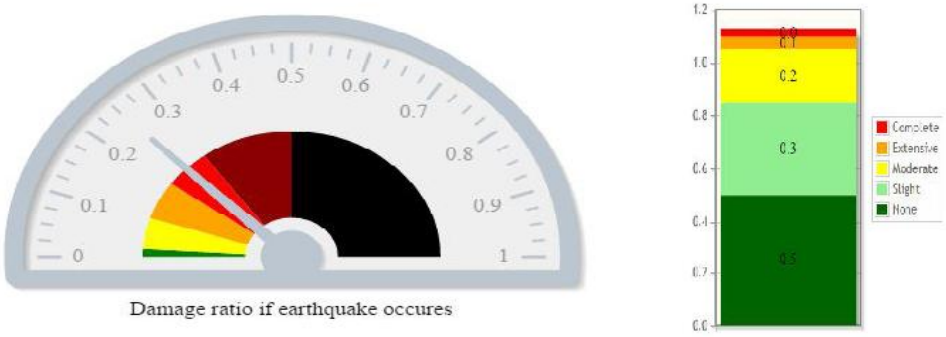

Figure 2: Output of the system: Damage ratio diagram on left, and damage state probabilities on right

The results will be expanded to present the probability distribution of losses in the future. The building information entered by the user, as well as the results of the risk analysis, is stored in a database and over time, a comprehensive building inventory accompanied by risk estimates is established and presented to policy-makers to help with making decisions on risk mitigation actions.

In the first stage of the project, a prevalent loss estimation methodology (FEMA–NIBS 2012) is implemented where modifications are applied to make it applicable to the conventional construction in Iran. The computer code is written in the PHP language and has an object-oriented design, which makes it readily maintainable and extensible. The vision for the future of this system includes the implementation of a more sophisticated risk analysis methodology that employs reliability methods and multiple interacting probabilistic models (Mahsuli and Haukaas, 2013). To facilitate such a costly computational approach, a connection of the system with a parallel processing cluster will be established.

REFERENCES

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