

## EERI 2024 SDC Cornell and Krawinkler Award for Excellence in PBEE

This award is dedicated to C. Allin Cornell and Helmut Krawinkler, faculty colleagues at Stanford University. Cornell's expertise in structural reliability along with Krawinkler's expertise in seismic design and nonlinear analysis laid the groundwork for FEMA P-58, a project that shares the same dedication. In honor of their immeasurable contributions to Performance-Based Earthquake Engineering (PBEE), the team which demonstrates the best understanding of the PBEE process will be awarded the Cornell and Krawinkler Award for Excellence in PBEE. *The scoring of this award will not have an impact on the overall SDC scoring.*

### Problem statement

The client is interested in Performance-Based Earthquake Engineering (PBEE) to obtain a low repair cost and a quick return to function to minimize the social, environmental, and economic impact of a significant seismic event on the local community. A building that is designed to quickly regain function after an earthquake will inherently have less repair cost, less environmental impact from repairs, less lost revenue for the building owner, and contribute to the overall resilience of the community.

The client would like the building to achieve a mean repair cost less than 5% of the total building value and a median functional recovery time of less than 1 month at the Design Earthquake (DE) intensity. Since the budget only allows for limited time to be spent on this analysis (no more than 10 hours of your company's time), the results presented only need to represent a single iteration of performance-based design. Your company should present an analysis that identifies one structural and one non-structural component that has the greatest impact on the building's repair cost and recovery time in the event of an earthquake. Additionally, plans to mitigate these problematic components should be proposed and analyzed to show the quantitative effect of the mitigation.

### Analysis Requirements

The deliverable should address the following:

1. [15 points] A FEMA P-58 model in SP3 of the building's structural and non-structural components.
  - a. The structural system should be modeled as it would be constructed, not as balsa wood. The material should be selected based on engineering judgement (i.e. steel, concrete, dual system, etc.), but the elements should be representative of the elements in the balsa wood model (i.e. shear wall, moment connections, braced frame, etc.). The deliverable should include a rationale for the material and system selection to achieve maximum points.
  - b. Typical quantities of non-structural components may be assumed. Typical quantities of non-structural components are automated in SP3 and do not need to be refined for this award. Structural component quantities should be adjusted to match the actual quantity expected in the building.
2. [15 points] A structural response prediction for the DE shaking (GM#1).
  - a. Median peak drift, acceleration, and any system-specific engineering demand parameter (EDP) (e.g. chord rotation for shear walls) at each level of the building. Note that typically the median would be obtained from a set of ground motions, but since the SDC uses a single ground motion it's acceptable to treat the response you predict for the single GM#1 as the median response for this analysis.
  - b. Since the SDC only requires the prediction of roof drift and roof acceleration, the per-level EDP information may be approximated by scaling the results obtained from the SP3 Structural Response Prediction Engine (SRPE) automation in a manner that matches your predicted roof drift and roof acceleration. If you do have the per-level information as part of your EDP prediction process, that should be input into the model. No points will be deducted for scaling the SP3 SRPE if you clearly present your rationale on how you performed the scaling.
3. [25 points] Performance metrics at the DE intensity for minimum code compliance.
  - a. Mean Cost: the estimated repair cost of the building for the DE shaking.

- b. Median Functional recovery time: an estimate of the median time it will take to repair the building to a state of “functional” after an earthquake.
    - i. “Functional” is to be determined by ATC-138 methodology as implemented in SP3. Any non-default settings should be justified in the deliverable.
  - c. Problematic Components: Identify one structural and one non-structural system that have significant impacts on repair cost and functional recovery time.
4. [45 points] Performance metrics at the DE intensity for a refined “beyond code” design.
- a. Building improvements: explain the changes to the building and/or components that were made to improve the repair time and cost. Report the same cost and functional recovery time metrics from point 3 for this improved design.
  - b. Discuss what further steps could be taken to obtain the client’s goals if they are not satisfied by improving the components from point 3.

## **Deliverable**

The deliverable for this award is a pre-recorded video presentation (5 minutes maximum) that goes over the analysis points outlined above. The target audience of the presentation is a technical audience with a solid structural engineering background that is familiar with PBEE (i.e. you do not need to spend time explaining the FEMA P-58 and ATC-138 methodologies). The deliverable should address all the points in the *Analysis Requirements* section. A link to the video presentations should be emailed to [eeri-sdc@hbrisk.com](mailto:eeri-sdc@hbrisk.com) and copying [sdcc@eeri.org](mailto:sdcc@eeri.org) by 11:59 PM Pacific Time on March 15<sup>th</sup>, 2024. The email subject line should be in the format of “2024 SDC PBEE Award Submission – University Name”. The video may be hosted on Dropbox, YouTube, or any other platform that’s easily accessible to the judges.

## **SP3 License**

SP3 is a web-based seismic risk assessment software that enables fast and detailed building-specific analysis. SP3 will provide a free student license for use in this award. Email [eeri-sdc@hbrisk.com](mailto:eeri-sdc@hbrisk.com) to obtain an account. A pre-recorded webinar will be provided on [sp3risk.com](http://sp3risk.com) to cover the basics of the FEMA P-58 risk assessment framework, how to use SP3, and how to interpret analysis results.

## **Technical Resources**

There is no need (or time) to read the FEMA P-58 volumes or ATC-138 report cover-to-cover since the webinar will cover the relevant parts of the methodologies. They may, however, be useful for further understanding the concepts discussed in the webinar. The FEMA P-58 volumes can be downloaded from <https://femap58.atcouncil.org/reports>. Information on the ATC-138 methodology has been preliminarily published at <https://femap58.atcouncil.org/fr-methodology> (click the ATC-138-3 report link). SP3 has a knowledge base located at <https://support.sp3risk.com/space/KnowledgeBase/1777632906/SP3-RiskModel>. A link to the prerecorded webinar will be provided shortly after the release of these rules. Any competition-related questions or clarifications should be emailed to [eeri-sdc@hbrisk.com](mailto:eeri-sdc@hbrisk.com).