Twenty-Third Annual Undergraduate Seismic Design Competition (SDC)

OFFICIAL RULES

Organized and Run by:

EERI Student Leadership Council (SLC)

Competition Website:

https://slc.eeri.org/sdc-2026/

EERI and the SLC are deeply grateful to our 2026 SDC sponsors!

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1. INTRODUCTION

1.1 Competition Objectives

The objectives of the 23rd Annual Undergraduate Seismic Design Competition sponsored by EERI are:

- To promote the study of earthquake engineering among undergraduate students.
- To build professional relationships between EERI student members and EERI professional members.
- To provide civil engineering and architecture undergraduate students with an opportunity to work on a hands-on project designing and constructing a cost-effective frame building to resist seismic loading, and to promote collaborations between undergraduate students in different majors.
- To promote EERI activities among undergraduate students and the general public internationally.

1.2 Team Eligibility Requirements

The following eligibility requirements will be strictly enforced:

- Teams must be affiliated with a registered EERI student chapter in good standing. To start a student chapter, please reference the following website: https://www.eeri.org/get-involved/student-chapters/how-to-start-an-eeri-student-chapter
- Exceptions for first year teams creating a new EERI Chapter will be made on a case-by-case basis by the SLC Co-Presidents and EERI staff.
- Teams shall be composed of undergraduate students only. A team shall have at least two registered participants and may have as many undergraduate student participants as they wish.
- Each undergraduate student registered for a team must be a student member of the national EERI organization and a member of the EERI student chapter for the school being represented. Exceptions to this will be made on a case-by-case basis by the SLC Co-Presidents and EERI staff. Decisions by the Co- Presidents and Staff are final and may not be appealed.

- Each competing university shall enter only one undergraduate student team and one structure at the competition.

- Each team must complete all registration requirements.

- Any team member who has earned their undergraduate degree between the submission of the design proposal and the start of competition shall be permitted to participate in the competition, provided that their name appears on the design proposal. Team members meeting eligibility requirements can be added to the team roster after the design proposal has been submitted.

- Each team shall identify a team Point of Contact (PoC), formerly team captain, who will act as the team liaison for correspondence with the Seismic Design Competition Chairs (SDC Chairs, hereafter). Only one PoC may be identified per team. There are no co-PoCs. If a translator is needed the SLC will help in providing one for the team PoC.

1.3 Problem Statement

Portland, Oregon sits at the meeting point of the Willamette and Columbia Rivers, framed by the Cascade Range to the east and the Coast Range to the west. Known as “Bridge City,” its identity is shaped by bridges, greenways, and waterfront industry, and its architecture spans from 19th-century cast-iron commercial buildings to mid-century modernism and postmodern civic landmarks. As Oregon’s most populous city and a Pacific Northwest economic hub, Portland is equally recognized for its cultural vibrancy, environmental values, and forward-looking urban planning, exemplified by the Green Loop, a Central City 2035 [1] vision for a six-mile linear park that links neighborhoods, jobs, and the river through the heart of downtown.

Portland is in a seismically active region. The metropolitan area is considered the most seismically active in the state of Oregon, making earthquake resilience a critical consideration in urban planning and architectural design. The city is located within the influence of the Cascadia Subduction Zone (CSZ), a megathrust fault that could generate earthquakes with magnitudes greater than 9.0. Local crustal faults, including the Portland Hills Fault that runs directly beneath downtown, add to the risk. Deep alluvial soil deposits from the Willamette Valley can amplify shaking and increase the likelihood of liquefaction, compounding the city’s vulnerability.

Historical seismic studies, such as the modeling of a full-rupture Cascadia event, show the potential of widespread destruction, long-term disruptions to critical infrastructure, and severe economic impacts. In response, Portland has reinforced its seismic policies: requiring upgrades to unreinforced masonry buildings, updating building codes, and advancing regional preparedness through the Oregon Resilience Plan. These measures reflect both the city’s vulnerability and its commitment to building a seismically resilient urban environment.

Your team is tasked with designing a multi-use residential tower with public spaces that addresses complex structural and environmental challenges while adding a unique presence to Portland’s skyline and its surrounding

neighborhood. The client envisions a biophilic tower with a distinctive form inspired by Portland's nickname, "Bridge City". The building begins as two overlapping towers that merge into a single mass at the midsection, forming a link block with a publicly accessible garden terrace. Beyond this terrace, the form splits into two offset towers rising like the piers of a bridge. Near the top, the towers reconnect through an upper mass that includes rentable public floors, lookout spaces, and a rooftop terrace.

This articulated form and integrated garden terraces demand innovative lateral systems to ensure seismic safety, fire protection, and overall resilience in Portland's seismically active context. Mid and upper-level terraces serve as public or semi-public spaces that extend Portland's Green Loop vertically, embedding the tower within the urban fabric. These planted platforms enhance occupant well-being, support urban biodiversity, and encourage community engagement through shared green spaces.

The design draws inspiration from Portland's heritage and progressive vision, proposing a structure that honors the city's identity while contributing a forward looking, iconic tower not only in form but also in environmental performance. The project must align with Oregon's carbon reduction goals through sustainable design strategies and adherence to green building standards.

A scaled balsa wood model of the proposed building design will be constructed and tested to verify the performance of the seismic load-resisting system. The model will be subjected to two ground motions and must not collapse during either of them; these ground motions will be representative of United States risk models for Design Earthquake (DE) and Risk-Targeted Maximum Considered Earthquake (MCE_R) defined in ASCE/SEI 7-22 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* [2]. The roof drift and roof acceleration will be used to estimate monetary losses due to damage. The monetary losses will account for demolition, reconstruction, and downtime if a collapse occurs.

A cost-benefit analysis will be carried out to determine the most cost-effective building. This will be done by balancing the revenue with the initial building cost and seismic cost.

- The *Annual Revenue* (Section 4.3) will be a function of the rentable floor area. Bonuses in revenue will be given to those teams with the best design proposal, architecture, presentation, poster, and damping bonuses, if present.

These bonuses account for the positive effect that quality architecture and effective communication skills can have on increasing the value of the floor area to be sold or rented.

- The *Annual Building Cost* (Section 4.4) will be a function of the weight of the building model. Penalties that increase the initial cost will be applied to those models that do not meet all structural model requirements.

- The *Annual Seismic Cost* (Section 4.5) will be based on the building's seismic performance. A bonus will be given to the teams with the best performance predictions. This bonus will reduce the seismic cost of the building. This accounts for the fact that a detailed structural analysis can improve structural design and lead to desired seismic performance.

The winner of the competition will be the team with the highest *Final Annual Building Income* (Section 4.6), whose building is not deemed to have collapsed after both ground motions. Teams whose buildings are deemed collapsed will be ranked in a lower category than teams whose buildings are not deemed collapsed.

1.4 Important Deadlines and Deliverables

The following are the deadlines for the SDC deliverables. Cutoff will be at 11:59 PM Pacific Time.

Table 1 Important deadlines and deliverables.

Submittal	Deadline
Interest Survey	Friday, October 17, 2025*
Proposal Submission	Friday, January 16, 2026
Proposal Acceptance	Friday, January 30, 2026
Damping Proposal Submission	Friday, February 06, 2026
Damping Proposal Acceptance	Friday, February 20, 2026
Final Registration	TBD
Floor Area Calculations & Performance Predictions	TBD

*If a team has not submitted the interest survey but would like to participate in the competition, please contact sdc@eeri.org and slc@eeri.org.

Teams will be invited to participate by January 30, 2026.

The number of teams invited to participate in the competition will be determined by the Student Leadership Council (SLC). The Design Proposal (Section 7.1) will be used to evaluate which teams will be invited to the competition. Invitations will be announced by email to the team PoC and advisor by the date listed on the competition website. Historically, most teams have earned an invitation to participate in the SDC by submitting a competitive Design Proposal and meeting eligibility requirements. However, a growing interest in the SDC has led to an increasing number of applicants. The SLC continues to encourage all eligible teams to submit Design Proposals but retains the ability to restrict the number of invited teams based on time limitations and space availability at the conference venue. Therefore, the SLC recommends paying particular attention to the Design Proposal.

All deadlines, instructions, and forms will be posted on the competition website (listed on the cover page). Teams must be affiliated with a registered EERI student chapter in good standing. To start a student chapter, please refer to the following website: https://www.eeri.org/get-involved/student-chapters/how-to-start-an-eeri-student-chapter. Exceptions for first year teams creating a new EERI chapter will be made on a case-by-case basis by the SLC Co-Presidents and EERI staff. Any team failing to meet the aforementioned eligibility requirements or complete the registration requirements by the deadlines shall not be eligible to compete in the competition.

1.5 Units

The competition will employ United States customary units exclusively for measurements and specifications. Specifically, these include inches (in.) for length and pounds (lb.) for weight and loads. For reference, 1 in. = 25.4 mm and 1 lb. = 4.44822 N.

1.6 Summary of Notable Rule Changes for this Year

This year's competition brings several notable rule changes. Special attention should be given to the *Design Guide*, which serves as a vital supplement to the Official Rules. Key modifications in comparison to previous editions of the SDC include:

- **Annual Revenue per Floor (Section 4.3):** There has been a change in the annual revenue per floor, which is now based on building zones defined along the height of the structure and have a different cost.
- **Deadloads and Floor Plan Alterations (Sections 8.4, 8.5, and *Design Guide*)**: Significant changes have been made to deadloads, including their locations on the floor plan, as well as the rod configurations. Teams must closely adhere to the updated specifications outlined in these sections and the *Design Guide*.

- **Building Geometry Adjustments (Section 8.2) and Building Zones (Section 8.3):** Building geometry has undergone significant changes, with floor plan dimensions increasing in proportion to height. Additionally, floors are now categorized into distinct building zones along the height.

- **Rules for Artificial Intelligence Use (Section 2.4):** Rules for utilizing AI in the SDC have been updated and will be strictly policed and participants should familiarize themselves to ensure compliance.

- **Ethics Expectations for Non-team Members (Section 3.2):** The SLC have implemented new rules to further enforce these expectations during the competition.

- **Design Guide Changes:** The design guide has been modified to make most information regarding building the structure in one document. Some rules are still present in the official rules, but requirements have been mostly moved to the design guide.

1.7 Contact Information

Questions about the competition rules, team eligibility, and registration should be directed to: slc@eeri.org.

1.8 Competition Sponsors

EERI and the SLC are deeply grateful to our 2026 SDC sponsors! The listing below shows all sponsoring organizations who have confirmed as of the date of the Rules release. New sponsors will be added to the website.

We would like to extend a special thank you to Computers and Structures Inc. (CSI) for their generous support as the Anchor and Meal Sponsor of the 2026 Seismic Design Competition. The commitment of CSI, and our other sponsors, Degenkolb Engineers, California Earthquake Authority, Oregon State University College of Engineering, the Federal Emergency Management Agency (FEMA), Kinemetrics, UC Davis Center for Geotechnical Modeling, and Tipping Engineers, makes this event possible.

Anchor + Meal Sponsor:

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Computers & Structures Inc. (CSI) is EERI's inaugural Visionary-Level Subscribing Member and has been a longtime supporter of the Institute and our student activities, including the Student Leadership Council. Founded in 1975 by company president and CEO Ashraf Habibullah, CSI is recognized globally as the pioneering leader in software tools for structural and earthquake engineering. Software from CSI is used by thousands of engineering firms in over 160 countries for the design of major projects, including the Taipei 101 Tower in Taiwan, One World Trade Center in New York, the 2008 Olympics Birds Nest Stadium in Beijing and the cable-stayed Centenario Bridge over the Panama Canal.

T-Shirt Sponsor:

Degenkolb

Degenkolb Engineers is a longtime EERI Platinum-Level Subscribing Member, SDC Sponsor, and a Sustainer-level donor of the EERI Learning from Earthquakes Endowment Fund. Founded in 1940, Degenkolb's practice reflects more than seven decades of commitment to technical expertise, exceptional client service through close collaboration, and life-long learning. Its innovative award-winning structural designs have saved clients hundreds of millions of dollars.

Champion Sponsors:

CEA CALIFORNIA EARTHQUAKE AUTHORITY™

The California Earthquake Authority is a longtime EERI Platinum-Level Subscribing Member. CEA is a not-for-profit, privately funded, publicly managed organization that provides residential earthquake insurance to more than 1 million households in California. Since 1996, CEA has been making earthquake insurance as affordable as possible for all California residents, while helping reduce their risk of earthquake loss wherever they live.

Degenkolb Engineers is a longtime EERI Platinum-Level Subscribing Member and a Sustainer-level donor of the EERI Learning from Earthquakes Endowment Fund. Founded in 1940, Degenkolb's practice reflects more than seven decades of commitment to technical expertise, exceptional client service through close collaboration, and life-long learning. Its innovative award-winning structural designs have saved clients hundreds of millions of dollars.

The **Oregon State University College of Engineering** is a place of extraordinary talent and unstoppable drive. People with world-class expertise in nearly every major field of engineering have gathered at OSU to realize a shared mission: create a better future for our planet and all who inhabit it. Oregon State Beavers don't just build dams, they build bridges and bioreactors, rockets and robots, software and solar cells — and so much more.

Supporter Sponsors:

Since 1969, **Kinemetrics** and its subsidiaries continue to lead the global market in designing technologies, products, and solutions for monitoring earthquakes and their effects on people and structures. Today, Kinemetrics continues to lead the seismic industry's vision of earthquake resilience by delivering results that reinforce saving lives and operational continuity initiatives.

The **UC Davis Center for Geotechnical Modeling (CGM)** provides users access to world-class geotechnical modeling facilities, including 9-m and 1-m radius centrifuges with shaking tables, to enable major advances in the ability to predict and improve the performance of soil and soil-structure systems affected by earthquake, wave, wind and storm surge loadings. The UC Davis CGM provides ongoing maintenance and technical support for the shaking table that is used for testing during the SDC.

Student Leadership Council Travel Support:

The **Federal Emergency Management Agency (FEMA)** supports the SDC as a part of its role in the National Earthquake Hazards Reduction Program (NEHRP). Under NEHRP, FEMA is responsible for translating research results into design guidance products in addition to supporting: model building codes and national consensus standards; program implementation and outreach; multi-state Consortia and partnerships; State earthquake programs; disaster events (Subject Matter Expertise, technical assistance, earthquake information clearinghouses and post-event studies); and standards for critical lifelines infrastructure. FEMA provides travel support to SLC leaders through a Multi-State and National Earthquake Assistance (MSNEA) grant agreement with the purpose of enhancing seismic community professional development.

Shaking Table Transportation Sponsor:

Tipping is a service-forward structural engineering practice that unlocks greater possibilities for our clients and communities. Our unconventional approach blends creativity with technical mastery to push the boundaries of engineering, often in unexpected ways.

Tipping has provided sponsorship to the 2026 SDC to support the transportation of the shaking table to the conference venue.

2. EERI'S CODE OF CONDUCT

EERI's Code of Conduct applies to all members participating in EERI activities, including SDC team members, advisors, and observers involved in the SDC. Portions of the Code of Conduct are included below. **Code of Conduct violations are strictly prohibited and may result in disqualification, non-invitation of individuals or teams to future SDC events, or possible stripping of any titles won. Any disciplinary actions stemming from violations of the Code of Conduct are at the discretion of EERI.**

EERI is committed to fostering the exchange of ideas by providing a safe, productive, and welcoming environment at all EERI activities and on all EERI platforms, including use of the EERI mailing lists or member directory. We value the participation of every member of the community and want all participants to have an enjoyable and fulfilling experience.

All EERI members, event attendees, guests, staff, volunteers, vendors, and partners are expected to be considerate and collaborative, communicating openly with respect for others, and critiquing ideas rather than individuals. Behavior that is acceptable to one person may not be acceptable to another, so use discretion to be sure that respect is communicated.

By accepting an invitation to participate in an EERI event (by email or online registration), engaging in an EERI activity, or using and/or interacting with an EERI platform, participants agree to abide by the EERI Code of Conduct.

2.1 Expected Behavior

All participants are expected to maintain the following behaviors during all EERI activities and on all EERI digital platforms, including unofficial and/or social activities at EERI events:

- Treat all participants, attendees, and EERI staff with respect and consideration at all times.
- Be collaborative, recognizing the value of a diversity of experiences, views, and opinions.
- Communicate openly with respect for others, critiquing ideas rather than individuals.
- Be mindful of your surroundings and of your fellow participants. Alert EERI staff if you notice a dangerous situation or someone in distress.
- Abide by the rules and regulations of any digital or virtual platform, physical venue, or any other location associated with an EERI activity or event.

2.2 Unacceptable Behavior

Unacceptable behavior includes but is not limited to:

- Harassment, intimidation, or discrimination in any form.
- Offensive comments, either verbally or through any other communication channel, related to gender, gender identity, sexual orientation, disability, physical appearance, medical condition, body size, race, marital status, religion, national origin, or any other protected characteristic.
- Threats (implied or real) of physical, professional, or financial harm.
- Intentional, uninvited physical contact of any form.
- Behavior that is in violation of EERI expectations for professional conduct and the established ethics policies of one's home institution.
- Harassing, threatening, or offensive images, actions, gestures, or other behavior that are visible or audible to participants or presenters.

2.3 Consequences

Anyone requested to stop unacceptable behavior is expected to comply immediately. EERI may take actions deemed necessary and appropriate, including but not limited to:

- Immediate removal from the event, session, or platform without warning.
- Suspension or termination of membership in EERI, denial to participate in future EERI activities or events, or other action(s) may be taken at EERI's sole discretion, depending on the severity of the unacceptable behavior. EERI reserves the right to report the circumstances to the appropriate authorities, including but not limited to the police and/or the involved party's home institution(s).

Reports or evidence of past allegations or institutional proceedings resulting in a finding of professional misconduct, or any current formal complaints related to professional conduct, even if the matter is still pending, may be grounds for:

- Ineligibility or removal from EERI leadership positions.
- Ineligibility or rescindment of an EERI honor, award, or recognition.

The entire EERI Code of Conduct can be found at:
https://www.eeri.org/about-eeri/bylaws/code-of-conduct.

All participants (teams, advisors, and observers) are required to uphold and abide by this code (before, during and after the competition), including any future updates to the code that are active at the time of the competition.

All SDC team members, advisors, observers, and SLC leaders are encouraged to report any potential code of conduct violations or unacceptable behavior to EERI. Visit the EERI Code of Conduct website for reporting instructions prior to the competition or use the event-specific reporting form/mechanism shared in advance of the competition during the event.

2.4 Use of Artificial Intelligence within the SDC

The SLC and EERI acknowledge the powerful abilities of Artificial Intelligence. However, to ensure the intent of the SDC is kept, certain limitations on AI use in the competition are established:

- AI tools **may** be used to generate architectural renderings, as long as the results follow architectural and structural logic and align with the overall design concept and requirements. Renderings must not include implausible or unrelated elements. Any use of AI must be clearly declared. Misuse may result in violations.

- AI **may** be used to assist in the writing process to improve readability and language of a proposal or poster/presentation text. Acceptable uses include translation, spelling, references, and heavily revised text generation. Teams should carefully review and edit any results, as AI can generate incorrect, incomplete, or biased output.

- If AI is used for a proposal or poster/presentation text a statement of AI usage must be included within the document. The following example can be used:

  The preparation of this work used [tool or service used] in order to [reason for using tool]. After use of this tool the team reviewed and edited content as needed and takes full responsibility for content within this [document].

- Any team found in violation of these requirements may be subject to consequences in accordance with the EERI code of conduct. This may include disqualification from the SDC.

- The SLC reserves the right to request raw files utilized for generating visual content if unacceptable AI use is suspected. All files received by the SLC will be deleted at the conclusion of the investigation.

3. PARTICIPANT ROLE EXPECTATIONS

EERI aims to ensure a safe, fair, and educational competition experience for all participants by clearly defining roles for all participants.

Teams that don't abide by these role expectations or act in the spirit of these expectations may be subject to disciplinary action and found in violation of the competition rules or code of conduct. Disciplinary action may include disqualification of the team(s) or advisor(s) from participating in the 2026 SDC or future competitions, including stripping of any awards or titles.

3.1 Role Expectations for Undergraduate Team Members

The 2026 SDC is a strictly undergraduate competition, requiring all work contributing to it to be completed solely by registered EERI undergraduate students from the participating College or University. This includes the following:

- The entirety of the contents of the Design Proposal and Damping Device Proposal (if applicable), outlined in Section 4 and Section 7 of the 2026 Official Rules, must be completed by undergraduate students at the participating school.

- The design concept, including the building structural and architectural configuration, must be the work of the undergraduate team members.

- All construction must be completed by undergraduate students at the participating school; this includes the final building model that will be tested on the shake table and any preliminary models constructed prior to the competition (if applicable).

- All numerical and analytical modeling, and calculations related to the 2026 SDC must be completed by undergraduate students. This includes but is not limited to computer modeling of the balsa wood structure, modal analysis, time history analysis and the performance predictions and floor area calculations outlined in Section 4 and Section 8 of the 2026 Official Rules.

- All architectural productions, including but not limited to: renderings, representations, post-productions, conceptual design, floor plans, diagrams, must be done by undergraduate students at the participating school.

- Poster and Presentations which will be presented by undergraduate students and graded at the 2026 SDC, must contain contents only contributed by the undergraduate students at the participating school.

3.2 Ethics Expectation for Advisors

The competition is a student-led effort, and teams should only receive limited appropriate feedback and guidance from any advisors. Advisors include, but are not limited to, Faculty Advisors, Industry Professionals, Graduate Student Advisors, Professors/Lecturers, university staff, Alumni, and Team Sponsors.

Advisors may only play a limited role in the 2026 Undergraduate SDC by providing feedback and training for the participating undergraduate students on any problems or questions they may have throughout the process of applying, modeling, constructing, preparing deliverables, and ultimately participating in the SDC. All feedback and guidance should be provided in ways that promote team member learning by guiding them through a constructive line of inquiry, rather than directly proposing solutions or suggestions.

Advisors are not permitted to:

- contribute to any contents of the team proposals, posters, or presentations.
- work on construction or design of the structure in any capacity; however, the faculty advisor is permitted to oversee the construction for safety concerns but shall not contribute to the physical construction itself.
- contribute to any modeling and calculations required for the 2026 SDC. Advisors may provide feedback that helps the students troubleshoot modeling challenges or errors but may not edit the analytical model directly.
- contribute to any architectural productions.

Please note that these rules are also strictly enforced during the 2026 SDC. Advisors attending the competition will be given color coded name tags. If the SLC determines that an advisor is in violation of these rules, the team will be disqualified from the competition.

Fundraising and travel/shipping logistics may be led or supported by undergraduate team members, advisors, or other university representatives, as determined appropriate by the host university and EERI Student Chapter Faculty Advisor.

A form outlining advisor roles and ethics expectations will be provided to all teams. All advisors who assist the team must read and sign this form in acknowledgement that they understand their roles and expectations as an advisor. The form must be submitted to the SLC prior to the competition. Information on when the forms are due and how to submit these forms will be announced by the SLC as the competition approaches. Teams that do not submit their signed form will not be eligible for any awards. To be eligible to compete, at least one signature from an advisor or EERI student chapter president is required, but all non-participants who assist must sign the acknowledgement form. If the SLC determines a team did not include all non-participant assistance, they will be disqualified from the competition.

4. SCORING

To test the seismic performance of the proposed design solution, a scaled balsa wood model that is representative of a real building design must be constructed and tested. The model will be subjected to two specific ground motions: **GM#1**, representative of the Design Earthquake (DE), and **GM#2**, representative of the Risk-Targeted Maximum Considered Earthquake (MCE_R) as defined in the ASCE/SEI 7-22 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. **In this edition of the SDC, only the GM#1 record will be available before Shake Day.**

To ensure life safety, the client requires a design that does not collapse for either **GM#1** or **GM#2**. In addition, the response of the model in terms of roof drift and roof acceleration will be measured for both ground motions. Peak relative roof drift will be used to estimate the monetary loss from structural damage, while peak roof accelerations will be used to estimate the monetary loss due to damaged equipment contained inside the building. If a building is deemed collapsed (as defined in Section 8.10), the monetary losses will account for demolition, reconstruction, and downtime. Finally, the *Annual Seismic Cost* will be the sum of the economic loss estimated for each of the earthquakes divided by their respective return periods.

This section describes the method used to score the performance of the buildings in the seismic competition. Scoring is based on three primary components:

1. Annual Revenue,
2. Annual Building Cost, and
3. Annual Seismic Cost.

The overall measure of structural performance is the *Final Annual Building Income*, which is calculated as the *Annual Revenue* minus the *Annual Building Cost* minus the *Annual Seismic Cost*. In the event of a tie for an award in any category, the *Analysis Prediction Score* (Section 4.2.a) will be used as the tiebreaker.

4.1 Design Proposal, Presentation, Poster, Damping Device and Architecture

The design proposal portion is detailed in Section 7.1. Bonuses in revenue will be given to teams that rank highest in the design proposal, presentation, poster, or architecture scores. These bonuses account for the positive effect of having effective communication skills or the quality of architectural productions that could increase the value of the floor to be sold or rented. An additional bonus can be earned for incorporating a damping device (Section 7.2).

Failure to complete any of the requirements in Sections 4.1.a and 4.1.b will result in an increase in the factor V (Section 4.4). Specific penalties are quantified in each section.

4.1.a Presentation

Each team is required to give an oral presentation of no longer than ten minutes to a panel of judges at the scheduled time for the team. Judges will have up to five minutes to ask questions following the presentation, which can only be answered by the presenters. The presentations will be open to the public.

Teams must follow the instructions and guidelines for the presentation that will be provided in the Presentation Requirements document on the competition website. Failure to follow the Presentation Requirements will lead to ineligibility to receive the presentation annual revenue bonus.

Any team that does not present at the scheduled time will have 100 added to V (Section 4.4).

Teams must submit their presentation files via Google Form before the week of the competition (check the official website for the exact deadline). Any team that does not email their final presentation by the deadline will have 10 added to V (Section 4.4).

4.1.b Poster

Teams are required to display a poster providing an overview of the project. This year, teams will not be required to submit their poster by email. Having a physical poster in the designated display area by the time listed in the schedule will act as the deadline. Therefore, teams must ensure enough time to print their poster and have it ready before the time listed in the schedule. Individual teams are responsible for providing the physical poster for display.

Teams must follow the instructions and guidelines for the poster that will be provided in the Poster Requirements document on the competition website. Failure to follow the Poster Requirements will lead to ineligibility to receive the poster annual revenue bonus.

Any team that does not have a poster in the display area meeting all requirements in this section by the time listed in the schedule will receive up to 50 added to V (Section 4.4).

4.1.c Architecture

Architecture will be evaluated as an integral part of the design that reflects spatial quality, function, and structural system. The competition encourages collaboration between architectural and structural designers from early stages to ensure coherence. The architectural concept must align with the structural concept rather than contradict it. Clarity and integration are prioritized over decoration.

Judging will consider the quality of architectural productions (including renderings, plans, diagrams, and the design concept), alignment with the structural model, ADA compliance, sustainability, post-earthquake resilience, emergency and safety measures, adherence to the concept and program, and fulfillment of architectural requirements as outlined in the document on the website. Architectural work presented on the poster, in the presentation, and the tower design will determine the final architecture score.

This year, for realism, one floor in the balsa and structural model will correspond to two floors in architectural representations (e.g., a 19-floor balsa model [18 regular floors with double-height lobby] will be shown as a 38-story building with a double-height lobby). This applies exclusively to architectural productions. Teams must ensure their work reflects this scale both vertically and horizontally.

Refer to the competition website for the full instructions and guidelines that will be provided in the architectural requirements document and scoring rubric. Failure to comply may disqualify teams from the architecture bonus.

4.1.d Damping Device Bonus

An *Annual Revenue* bonus will be given to teams that incorporate creative and unique damping devices (Section 7) into their structure. The damping bonus will be contingent on an accepted damping proposal (Section 7.1) and the proper implementation of the damping device (Section 7.2). The annual revenue bonus quantity will be based on the quality of the proposal, research, and design of the damping device. Damping proposals that are not accepted will not be eligible for the damping bonus. In addition, to receive the damping device bonus, the damping device must deviate from any similar device a previous team from the same school has used in the past four years.

4.1.e Bonus Scoring

The increase in *Annual Revenue* will be determined by the team's rank in the design proposal, oral presentation, poster, and architecture. Only the top 9 teams in each category will receive this benefit. See Table 2 for the percentage increase per rank.

Table 2 *Annual Revenue* bonus.

Rank	Proposal	Presentation	Poster	Architecture
1st	10%	10%	10%	10%
2nd	9%	9%	9%	9%
3rd	8%	8%	8%	8%
4th	7%	7%	7%	7%
5th	6%	6%	6%	6%
6th	5%	5%	5%	5%
7th	4%	4%	4%	4%
8th	3%	3%	3%	3%
9th	2%	2%	2%	2%
10th	1%	1%	1%	1%
≥11th	0%	0%	0%	0%

4.2 Performance Predictions and Floor Area Calculations

A bonus will be given to the teams with the best performance predictions. This bonus will reduce the seismic cost of the building. This accounts for the fact that a detailed structural analysis can improve structural design, leading to better seismic performance.

Teams are required to predict the peak roof drift and the peak roof absolute acceleration of the structure under **GM#1** shaking in both the North-South and East-West directions. This means making a total of four predictions: N-S drift, N-S acceleration, E-W drift, and E-W acceleration. Note that only one pair of drift and acceleration values will be utilized based on the specific ground motion direction chosen by the SLC on Shake Day (as outlined in Section 8.6).

These performance predictions must be submitted before the deadline specified on the competition website. Instructions for submission will be provided on the competition website as well. If predictions are not submitted on time, the SDC chairs will assume zero values for all predictions.

4.2.a Performance Predictions Requirements

The *Annual Seismic Cost* will be reduced based on the team's rank in the performance predictions for **GM#1**. Each team must report two values: the peak relative roof displacement in inches (referred to as $Disp_{1,Predicted}$) and the peak absolute roof acceleration (denoted as $Accl_{1,Predicted}$) expressed as a fraction of the standard gravity acceleration g:

$$Disp_{1,Predicted} = |\Delta_{1,Roof\ Predicted}[\text{in}] - \Delta_{1,Base\ Predicted}[\text{in}]| \quad (1)$$

$$Accl_{1,Predicted} = |Accl_{1,Roof\ Predicted}[g]| \quad (2)$$

The *Analysis Prediction Score* (APS) is used to evaluate the accuracy of the predicted performance (taken to two significant figures). The APS is defined as the sum of the displacement prediction score, APS_{disp}, and the acceleration prediction score, APS_{accl}, is for the peak roof absolute acceleration.

$$APS_{disp} = \frac{\left|\frac{Disp_{1,Predicted}}{Structural\ Model\ Height} - XPeak\right|_1}{XPeak_1} \quad (3)$$

$$APS_{accl} = \frac{|Accl_{1,Predicted} - APeak_1|}{APeak_1} \quad (4)$$

$$APS = APS_{disp} + APS_{accl} \quad (5)$$

See Section 4.5 for how $XPeak_1$, and $APeak_1$ are determined.

Each team will be ranked based on the accuracy of the predictions. Any team that does not submit a prediction by the deadline will receive an APS equal to 100%. Any team with an APS value greater than 100% will receive an APS value of 100%.An *Analysis Prediction Score Bonus (APS Bonus)* will be awarded to teams based on the APS determined.

$$APS\ Bonus = 0.1 - 0.1 \times APS \quad (6)$$

4.2.b Floor Area Calculations

Along with performance predictions, teams are required to submit their rentable floor areas (Design Guide Section 6). Submitted floor areas will be verified by the SDC Chairs. Any team that does not submit their rentable floor areas by the deadline will receive the minimum value (Table 1 of Design Guide) for those floors.

4.3 Annual Revenue

The *Annual Revenue* will be based on the total rentable floor area

- $250 per year per square inch for zone 1
- $650 per year per square inch for zone 2
- $500 per year per square inch for zone 3
- $800 per year per square inch for zone 4

The *Annual Revenue* is equal to the sum of each rentable floor area multiplied by its respective revenue per square inch factor.

4.4 Annual Building Cost

The *Annual Building Cost* will be obtained as a function of the *Construction Cost* (C_c), *Additional Construction Cost* (C_a), *Land Cost*, and *Design Life*. No discount rate is considered in these annual cost calculations.

$$C_c = (2{,}000{,}000\ [\ \frac{\$}{\text{lbf}^2}]) \times (W_s\ [\text{lbf}])^2 + 6{,}000{,}000\ [\$] \tag{7}$$

$$C_a = (150{,}000\ [\$]) \times V \tag{8}$$

$$Land\ Cost = (35{,}000\ [\ \frac{\$}{\text{in}^2}\ ]) \times (A_f[\text{in}^2]) \tag{9}$$

$$Design\ Life = 100\ [\text{years}] \tag{10}$$

$$Annual\ Building\ Cost = \frac{C_c[\$] + C_a[\$] + Land\ Cost\ [\$]}{Design\ Life\ [\text{years}]} \tag{11}$$

Any violations will result in an increase in V and will contribute to the *Additional Construction Cost*, C_a. The structural model weight, W_s, is defined in Section 12 of the design guide. The building footprint, A_f, is defined as the maximum floor plan area projected onto the base plate in square inches.

4.5 Annual Seismic Cost

The $Annual\ Seismic\ Cost$ will be based on the building's seismic performance, the $Equipment\ Cost$, the $Return\ Period_n$ of a given ground motion **GM#*n***, the structural damage XD_n (Section 8.9.a), the equipment damage AD_n (Section 8.9.b), and $Construction\ Cost$ (Section 4.4).

$$Equiment\ Cost = 15{,}000{,}000\ [\$] \tag{12}$$

$$Return\ Period_1 = 50\ [\text{years}] \tag{13}$$

$$Return\ Period_2 = 300\ [\text{years}] \tag{14}$$

The structural damage as a percentage of the construction cost, XD_n [%], and equipment damage as a percentage of the equipment cost, AD_n [%], for a given ground motion **GM#*n***, are calculated using a cumulative distribution function (Section 8.9) and are defined as follows:

$$XD_n = \text{CDF}(\mu_X\ [\%], \sigma_X[\%], XPeak_n\ [\%]) \tag{15}$$

$$AD_n = \text{CDF}(\mu_A\ [g], \sigma_A[g], APeak_n\ [g]) \tag{16}$$

The mean and standard deviation peak roof drift and mean and standard deviation peak roof acceleration are defined as follows:

$$\mu_X = 1.5\ [\%] \tag{17}$$

$$\sigma_X = 0.5\ [\%] \tag{18}$$

$$\mu_A = 1.75\ [g] \tag{19}$$

$$\sigma_A = 0.7\ [g] \tag{20}$$

The measured peak roof drift, $XPeak_n$ [%], and measured peak roof acceleration, $APeak_n$ $[g]$ for a given ground motion **GM#$\boldsymbol{n}$**, are calculated using the absolute roof displacement, absolute base displacement, absolute roof acceleration (Section 8.8), and *Structural Model Height (Design Guide Section 3.1a)* and are defined as follows:

$$XPeak_n = \frac{|\Delta_{Roof\ n}\ [\text{in}] - \Delta_{Base\ n}\ [\text{in}]|}{Structural\ Model\ Height\ [\text{in}]} \tag{21}$$

$$APeak_n = |Accl_n\ [g]| \tag{22}$$

If the structural model is not deemed collapsed (Section 8.10.c) after ground motion **GM#$\boldsymbol{n}$** and all previous ground motions, the *Economic Loss* for the given ground motion, **GM#$\boldsymbol{n}$**, will be equal to:

$$\begin{aligned} Economic\ Loss_n \\ &= XD_n\ [\%] \times Construction\ Cost\ [\$] \\ &+ AD_n\ [\%] \times Equiment\ Cost\ [\$] \end{aligned} \tag{23}$$

The accelerometer must be left in place for **GM#2**. However, the data from the accelerometer will not be used for computing XD_n and AD_n for **GM#2**. If the structural model does not collapse after **GM#2**, both XD_n and AD_nwill be equal to 50%.

If the structural model is deemed collapsed (Section 8.10.c) after ground motion **GM#*n***, the *Economic Loss* for the given ground motion, **GM#*n***, and subsequent ground motions will be equal to:

$$\begin{aligned} Economic\ Loss_n \\ &= Equipment\ Cost\ [\$] \\ &+ 2 \times Construction\ Cost\ [\$] \\ &+ 3 \times Annual\ Revenue\ [\$] \end{aligned} \tag{24}$$

The Annual Economic Loss, AEL, for a given ground motion, **GM#*n***, is equal to:

$$AEL_n = \frac{Economic\ Loss_n}{Return\ Period_n} \tag{25}$$

A penalty, D_n, for unsecured floor dead loads will be applied after each ground motion, **GM#*n*** (Section 8.10.a).

The Annual Seismic Cost is equal to:

$$Annual\ Seismic\ Cost = AEL_1(1 + D_1) + AEL_2(1 + D_2) \tag{26}$$

4.6 Final Annual Building Income

The team with the largest Final Annual Building Income ($FABI$) will be the winning team. $FABI$ is equal to the Final Annual Revenue (FAR) minus the Final Annual Building Cost ($FABC$) and Final Annual Seismic Cost ($FASC$).

Final Annual Revenue (FAR) is equal to:

$$\begin{aligned} FAR = (1 &+ Proposal\ Bonus + Presentation\ Bonus \\ &+ Poster\ Bonus + Architecture\ Bonus \\ &+ Damping\ Device\ Bonus) \\ &\times (Annual\ Revenue) \end{aligned} \tag{27}$$

Final Annual Building Cost ($FABC$) is equal to:

$$FABC = Annual\ Building\ Cost \tag{28}$$

Final Annual Seismic Cost ($FASC$) is equal to:

$$FASC = (1 - APS\ Bonus) \times Annual\ Seismic\ Cost \tag{29}$$

The Final Annual Building Income ($FABI$) is equal to:

$$FABI = FAR - FABC - FASC \tag{30}$$

4.7 Additional Criteria for Factor V

The SLC reserves the right to assess the addition of a penalty of 30 added to V with the aim of improving rule compliance within the context of the competition. In line with the code of conduct, in the event of disrespectful behavior towards SLC members or other competition participants, including but not limited to participation in disrespectful arguments and disputes or failure to abide by the SLC instructions throughout the competition, penalty might be added. This penalty seeks to uphold respect, discipline, and smooth coordination within the competition's environment.

If, during presentations, a judge notifies an SLC member of potentially disrespectful behavior of a team viewing presentations, then that team/members will be given a warning. Any subsequent disrespectful behavior while watching other team presentations will result in a penalty of 30 V.

Additionally, considering the importance of maintaining a clean and organized workspace for all participants, teams might be penalized if they neglect to promptly clean up their designated areas for tower construction or setup, especially if they have already received a warning to clean their space. Vacuums or cleaning equipment may not be readily accessible at the venue, and thus teams must be responsible for keeping their space organized and clean. Any violation of these rules will result in a penalty of 30 V.

Furthermore, teams are urged to avoid materials such as Styrofoam beads for packaging due to their challenging cleanup and potential environmental impact. Failure to comply with these guidelines may result in penalties of up to 30 added to V.

These penalties collectively serve to uphold the principles of order, responsibility, and environmental consciousness within the competition, ultimately fostering a more harmonious and sustainable event.

5. SUMMARY OF DISQUALIFICATION RULES

5.1 Code of Conduct and Plagiarism (Section 2)

Code of Conduct violations are strictly prohibited and may result in disqualification, non-invitation of individuals or teams to future SDC events, or possible stripping of any titles won. Any disciplinary actions stemming from violations of the Code of Conduct are at the discretion of EERI.

Plagiarism is strictly prohibited throughout the competition. Taken from OSSJA [3], examples of plagiarism include:

- Taking credit for any work created by another person.
- Copying any work belonging to another person without indicating that the information is copied and properly citing the source of the work.
- If not directly copied, using another person's presentation of ideas without putting it in your own words or form and not giving proper citation.
- Creating false citations that do not correspond to the information you have used.

The use of artificial intelligence in a manner that violates the acceptable use guidelines of Section 2.4 is against the spirit of the SDC and may result in the disciplinary actions described above.

So-called common knowledge does not need to be cited; for more information, see What is Common Knowledge? | Academic Integrity at MIT [4].

Reports of plagiarism will be investigated as a potential violation of the Code of Conduct and may lead to disqualification.

5.2 Violation of Role Expectations (Section 3)

Teams that do not abide by, or act in the spirit of, the role expectations defined in Section 3 may be subject to disciplinary action and found in violation of the competition rules or code of conduct. Disciplinary action may include disqualification of the team(s) or advisor(s) from participating in the 2026 SDC or future competitions, including stripping of any awards or titles.

5.3 Structural Model Materials (Design Guide, Section 2)

All frame members and wall members shall be made of balsa wood. Members may be joined with an adhesive glue.

5.4 Building Geometry (Design Guide, Section 3)

The structural model of the building is required to satisfy the global geometric constraints defined in Section 3 of the Design Guide. Violating these requirements will result in the structural model not being tested on the shake table and the structure deemed as collapsed for all ground motions.

5.5 Floor Isolation (Design Guide, Section 3.1.e.)

Floor isolation of any kind is strictly prohibited. This includes isolating floor dead loads and the roof plate.

5.6 Damping Devices (Section 7.2)

Any use of a damping device that is not pre-approved or in a pre-approved location will result in disqualification.

5.7 Building Finish (Design Guide, Section 11)

The finish on all frame and wall members must be bare wood. Paint or other coatings will not be allowed on any portion of the model.

5.8 Appealing after Signing Scoring Sheet(s) (Section 0)

If a team PoC tries to make an appeal for penalties assessed on the scoring sheet(s) already signed, the team PoC will be warned. If after the team PoC is warned and they attempt to continue appealing for penalties assessed on the scoring sheet(s) already signed, the team will be disqualified.

5.9 Judging and Appealing (Section 0)

Under no circumstances may anyone, other than the **team PoC,** approach an SDC Chair regarding penalties or scoring. This includes but is not limited to other teammates, alumni, professors, and especially other SLC members. If this becomes an issue, the team PoC will be warned, and in extreme cases, the SDC Chairs reserve the right to disqualify the team.

6. COMPETITION AWARDS

6.1 Competition Winner and Ranking

The team that designs the building with the highest Final Annual Building Income ($FABI$) that is not deemed collapsed in any of the two ground motions will be the winner of the competition.

Teams whose buildings collapse will be ranked in a lower category than teams whose buildings do not collapse. Within each category, teams will be ranked based on the Final Annual Building Income, $FABI$.

The teams ranked 2nd and 3rd overall will also be awarded.

6.2 Best Architecture Award, presented by CEA

The team that showcases architectural excellence within the competition deserves recognition. An award for Best Architecture will be awarded to the team ranked 1st in architecture.

This Award is presented by: **California Earthquake Authority (CEA)**

6.3 Best Seismic Performance, presented by CEA

The team that produces a building design that performs well during the competition deserves recognition. An award for Best Seismic Performance will be awarded to the team with the lowest Final Annual Seismic Cost, $FASC$.

This Award is presented by: **California Earthquake Authority (CEA)**

6.4 Best Communication Skills Award, presented by CSI

An award will be given to the team that best exemplifies professional communication throughout all facets of the competition. The communications score will be primarily considered for this award, but the SLC reserves the right to consider other variables as needed to determine the winner.

$$\begin{aligned} &Communications\ score \\ &\quad = 1.5(Presentation\ Score) + (Poster\ Score) \\ &\quad + (Proposal\ Score) \end{aligned} \tag{31}$$

The SLC reserves the right to assess a penalty of a 5% reduction in the communications score to any team that demonstrates unprofessional written or oral communications to anyone involved with EERI or the observing public at any time leading up to or during the competition.

This Award is presented by: **Computers & Structures Inc. (CSI)**

6.5 Charles Richter Award for the Spirit of the Competition, sponsored by Kinemetrics

The most well-known earthquake magnitude scale is the Richter scale, which was developed in 1935 by Charles Richter of the California Institute of Technology. In honor of his contribution to earthquake engineering, the team that best exemplifies the spirit of the competition will be awarded the Charles Richter Award for the Spirit of Competition. The participating teams will determine the winner of this award.

This Award is sponsored by: **Kinemetrics**

6.6 Egor Popov Award for Structural Innovation, presented by Degenkolb Engineers

Egor Popov was a Professor at the University of California, Berkeley, for almost 55 years before he passed away in 2001. Popov was born in Russia and escaped to Manchuria in 1917 during the Russian Revolution. After spending his youth in China, he immigrated to the U.S. and studied at UC Berkeley, Cal Tech, MIT, and Stanford. Popov conducted research that led to many advances in seismic design of steel frame connections and systems, including eccentric bracing. In honor of his contribution to structural and earthquake engineering, the team that makes the best use of technology and/or structural design to resist seismic loading will be awarded the Egor Popov Award for Structural Innovation. The winner of this award will be determined by the SLC members.

This Award is presented by: **Degenkolb Engineers**

6.7 Most Improved Team, presented by FEMA

Learning from the design process is an important aspect of the SDC. This award will be given to the team that has improved most from last year's SDC. The scores will be normalized from the 2025 SDC results, and the team with the largest improvement will receive this award. Participation in the 22nd annual SDC is required to be eligible for this award.

This Award is presented by: **Federal Emergency Management Agency (FEMA)**

6.8 Rookie of the SDC

Competing in the SDC for the first time can be an entire challenge of its own. This award will be given to a new team with the highest $FABI$. A new team will be defined as a team that has not participated in any stage of the SDC within the past four years.

6.9 T-Shirt Competition Award, presented by Degenkolb Engineers

An award for T-Shirt Design will be presented to the team whose shirt design is selected for wear in the SDC T-Shirt Competition. The winning team will receive a

$200 prize, a complimentary shirt, and the distinction of having their design worn by all participating teams and SLC members during the competition.

Details and rules for the T-Shirt Design Competition will be announced separately leading up to the SDC.

This Award is presented by: **Degenkolb Engineers**

7. DESIGN PROPOSALS AND DAMPING DEVICE APPROVAL PROCESS

7.1 Design Proposals

Your team is required to submit a proposal for evaluation by the SDC Chairs. Invitation to participate in the competition will be determined by the proposal score. If a team fails to submit their proposal by the deadline, they will not be invited to participate in the competition. The number of accepted teams will be based on time limitations and space availability at the conference venue. A bonus score multiplier will be awarded to the nine best proposals (Section 4.1.e). Teams must follow the instructions and guidelines for the proposal that are provided in the *Proposal Requirements* document on the competition website.

7.2 Damping Device Approval Process

All proposed damping devices shall be subject to the approval process. A separate Google Form will be created for submission of damping device proposals. The requirements of the damper proposal can be found on the competition website. This year, the accepted damping proposals will be eligible to be awarded a bonus up to 10% (Section 4.1.d). The date of the submission of the damping device proposal is shown in Table 1. The proposed damping device must be described in detail, explaining the materials used and the device's placement(s) within the structural model. Figures are highly recommended to aid in describing the damping device.

The SDC Chairs will evaluate the proposal based on the rubric that can be found in the *Damper Proposal Requirements* document. Approved damping devices are required to be used in the submitted structural model at the competition and will be checked by the SDC Chairs prior to the competition.

The criteria used by the judges to approve a damping system are as follows:

- If the damping system is removed, the balsa wood structure, with all dead load weights attached, should be stable and firmly fixed to the base plate.
- The primary purpose of the pre-approved damping devices is to dissipate energy.
- Base or floor isolation of any kind is prohibited.
- The proposal meets all the guidelines that are provided in the Damping Device Proposal Requirements on the competition website.

General notes:

- Damping devices may be attached to the base plate.
- All damping devices should dissipate energy at each location used in the structural model.
- Any material is allowed to be used in a damping device.
- The damping device must be designed by the team and cannot come pre-made or in a kit.
- 3D printing objects for the damping device is acceptable as long as the object is designed by the team and not pre-made. The SDC chairs may request the model file it deemed necessary.
- Furthermore, the damping device must not interfere with dead load installation locations.

If a damping device is approved, the damping device shall not deviate from the proposed design approved through this process in the final structural model. If a team wishes to change their damping device in any way (e.g., installation location, connection to structure, material, etc.) after the results of the damper proposal, they must submit a revised damper proposal; however, they will lose any bonus given to them in this category. Moreover, the device may only be located at the approved locations.

Teams must submit only one damping device proposal by the final deadline. If the device is not approved, and it is after the final deadline, teams are not allowed to use the disapproved device on their model.

All damping devices will be checked during pre-judging of structures. Damping devices that have not been approved by the SDC Chairs or deviate from the approved damping device proposal (e.g., installation location, connection to structure, material, etc.) will have to be removed, and the team will lose the corresponding bonus. If a team is unable to remove an unapproved damping device, the structure will be considered collapsed for all ground motions.

8. STRONG GROUND MOTION TESTING

The building will be subjected to two ground motions of increasing intensity. The structural response to both ground motions will contribute to the annual seismic cost.

8.1 Scaled Ground Motions

Structures will be subjected to two scaled and modified ground motions named Ground Motion 1 (**GM#1**) and Ground Motion 2 (**GM#2**). Both the ground motions will be based on the hazard level and soil condition at the building site in Portland, Oregon. These two ground motions will be selected and released to the participants as follows:

8.1.a Ground Motion 1 (GM#1)

GM#1 will be selected to approximately represent the Design Earthquake (DE) hazard level at the building site. This is verified by plotting the response spectrum for the chosen ground motion and comparing (approximately) with the DE spectrum given by ASCE 7-22 [2]. **GM#1** will be released on the competition website listed on the cover page.

8.1.b Ground Motion 2 (GM#2)

GM#2 will be selected to approximately represent the Risk-Targeted Maximum Considered Earthquake (MCE_R) hazard level as defined in ASCE 7-22 [2]. Recall that the MCE_R response spectral coordinates can be directly obtained by scaling up the DE response spectrum by a factor of 3/2. Note that **GM#2** will not be released until the day of the competition.

8.2 Target Response Spectra

A few **important** notes about the selection of ground motions are:

- The DE and MCE_R response spectra will be uploaded to the competition website. These spectra are developed by translating the design response spectra from ASCE 7-22 response spectra. For site class information, a map of Portland shear wave velocity will be uploaded. This is acceptable for determining the site class (using United States codes) of the project location.

- Teams can refer to the PEER NGA-Subduction strong ground motion database , (NGA-Subduction Database — The B. John Garrick Institute for the Risk Sciences)to pick suitable ground motions that can represent **GM#2** (Section 8.1.b) to consider qualitative similarity of the response spectrum with the MCE_R spectrum. Such motions can be used to

assess/design the building teams are proposing, should they want to. Teams may or may not scale the motions (in time or acceleration) to match the intensity of the MCER. *A ground-motion selection guide* will be available on the competition website describing the use of the PEER NGA-West2 database. Additionally, a $.csv$ file will be uploaded of the DE and MCER spectrums, which can be used in the "User Defined Spectrum" of the database.

- **GM#1** will be released in its scaled form, exactly as it will be used on the shake table. **GM#2** will be chosen by the SDC to align with the criteria in Section 8.1 and adhere to shake table limitations: Peak Ground Acceleration, $PGA \leq 2.5g$; Peak Ground Velocity, $PGV \leq 33$ [in/s]; and Peak Ground Displacement, $PGD = 3$ [in].

- Note that the response spectra for DE and MCER prescribed in ASCE 7-22 are derived using probabilistic analyses and hence its similarity with the response spectrum of a specific ground motion is only going to be reasonable and qualitative rather than exact (both on the spectral amplitude and the time scale).

8.3 Shake Table

Structures will be tested on the University Consortium for Instructional Shake Tables (UCIST) unidirectional earthquake shake table, with plan dimensions of 18.0 in. by 18.0 in. The specific direction in which the building will be shaken will be determined on Shake Day, as outlined in Section 8.6.

8.4 Dead Load Specifications

8.4.a Floor Dead Loads

A floor dead load shall be installed at the locations specified in Design Guide Section 7 and illustrated in Design Guide Figure 2 and Figure 3 following the instructions in Section 8.5.a. The representation of the floor dead loads can be found in the *Design Guide*. Dead load configurations have been changed, and are categorized by zones. The dead load located in Zone 4 adds up to 2.76 lbs, whereas the dead loads in Zone 3 will add up to 2.37 lb /floor, and the dead loads in Zones 1 & 2 will add up to 1.96 lb/floor.

8.4.b Roof Dead Loads

The roof dead load will be represented by the accelerometer and two C-clamps. The two C-clamps will be used to secure the accelerometer to the structural model roof plate. Each C-clamp has a jaw opening of 1 in. and a

throat opening of 1 in. The total weight of the roof dead load is equal to 0.85 lb.

8.5 Dead Load Installation

8.5.a Floor Dead Loads

Each floor dead load shall be securely attached to the structural model at the floors indicated in Design Guide Section 7 in the direction perpendicular to shaking. A floor dead load is defined as secured if it is restricted from movement in any translational direction after installation (including the vertical direction). Movement of the floor dead loads can be restricted with frame or wall members and/or using friction from tightening the nut at each end of the threaded rod (keep in mind nuts can become loose during shaking). Each team is responsible for installing and securing the floor dead loads. See Section 7 of the Design Guide for penalties associated with unsecured floor dead loads.

If a floor dead load connection is not available at a floor required to have a floor dead load connection, the judge may have the team install a floor dead load on the required floor and try to secure the floor dead load using the nuts and washers. If the floor dead load is physically unable to be installed while centered in plane with the center of the base plate, or if the judges deem the floor dead load connections are intentionally not available at a required floor or direction, the model will not be allowed to be tested and will be assumed collapsed for both ground motions.

Each floor dead load shall be installed by inserting the ½ in. threaded rod through structural model at the dead load connection locations (Section 7 of Design Guide). From the building to the end of the threaded rod, the order of the washers, nuts, and plates for each end of the threaded rod are as follows: 1 washer, 1 nut, required number of plates (per *Design Guide*), 1 washer, and 1 nut. The nut immediately following the washer touching the building on each side of the rod are recommended to be tightened by hand to ensure the floor dead loads are restricted from movement in any translational direction.

Each team will have 10 minutes to install and tighten the dead loads. If the allocated time has passed and the team has not finished installing the floor dead loads, a penalty of 20 will be added to V. Teams may recruit other non- team members (excluding SDC Chairs) to assist in installing floor dead loads.

A SDC Chair shall be present while the team is installing the floor dead loads to ensure proper installation of the floor dead loads. Another SDC Chair shall check the floor dead loads before the structural model is attached to the shake table (Section 8.6). If the SDC Chair finds any weights free to move in any translational direction, the SDC Chair shall notify the team PoC prior to shaking. After the 10 minutes, the team will not be able to make any changes to the structural model or dead loads, shaking shall commence, and unsecured floor dead loads will be penalized after each ground motion as described in Section 8.10.a.

8.5.b Roof Dead Loads

The roof dead load shall be attached to the structural model roof plate with two C-clamps at opposing corners (scaled drawings of the C-clamps will be provided in the *Design Guide*). It is the responsibility of the SDC Chair(s) to secure the roof dead load to the structural model roof plate before installing the structural model to the shake table (Section 8.6). The time required to attach the roof accelerometer will not be included in the time each team has for installing the dead loads. If the roof dead load is not level before **GM#1**, then the roof dead load will be removed from the structural model for **GM#1**. The roof dead load is considered not level if the bubble of the level is completely outside of the lines. See Section 8.10.a for penalties associated with an unsecured or not level roof dead load.

8.6 Attachment of Structural Model to the Shake Table

SDC Chairs will determine the direction of shaking by flipping a coin prior to the beginning of shaking. The coin flip will determine if shaking is in the North-South direction or East-West direction and apply to all structures for the duration of the competition.

Each team will attach the structural models to the shake table with at least 6 C-clamps at the corners and center along the two sides of the structural model base plate parallel with the direction of shaking. Two 18 in. long aluminum angles (1 in. legs and 1/8 in. wall thickness) will span on top of the structural model base plate perpendicular to the direction of shaking on each side of the building. The two aluminum angles will be secured with the 4 corner clamps. Two 12 in. long aluminum angles (1 in. legs and 1/8 in. wall thickness) will span on top of the structural model base plate parallel to the direction of shaking on each side of the building. The two aluminum angles will be secured with a center clamp. If the base plate is warped, the corners of the base plate will be clamped so there are no gaps at the corners between the shake table base, the aluminum angle, and the base plate. A SDC Chair will check each clamp after installation. All necessary clamps and aluminum angles will be provided on Shake Day.

8.7 Instrumentation

Two accelerometers will be used in the competition: one accelerometer will be attached to the shake table, and the other accelerometer will be part of the roof dead load (Section 8.4).

8.8 Data Processing

The raw acceleration data obtained from the two accelerometers, at the base and at the roof, will be processed using a suitable Butterworth filter to remove low-frequency noise. The processed acceleration data will be used to determine the roof and base displacement time history.

8.9 Damage Calculations

8.9.a Structural Damage Calculations

Structural damage to the building will be calculated using a function of the measured peak roof drift, $XPeak_n$ This function is a cumulative normal probability density function with peak roof drift mean and standard deviation listed in Section 4.5. The structural damage as a percentage of the construction cost (XD_n) is a function of $XPeak_n$ and is plotted in Figure 1.

Tip: The cumulative distribution function can be computed using many commercially available software packages (e.g., the NORMDIST function in Microsoft Excel, with the 'cumulative' field set to TRUE).

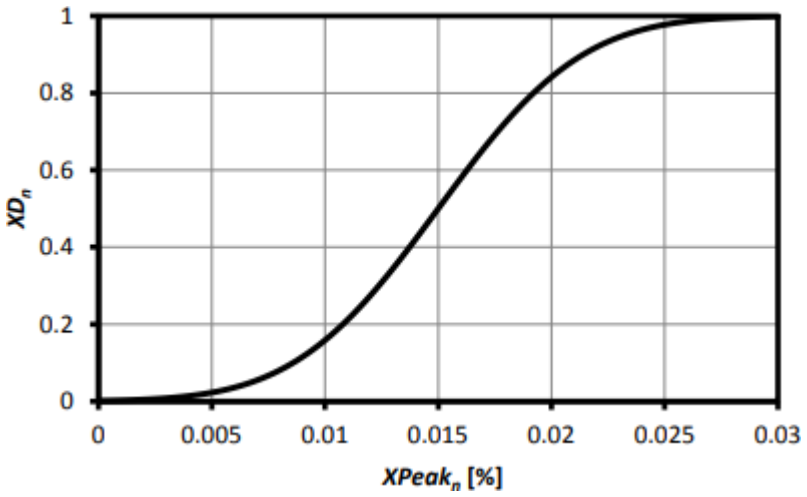

Figure 1 Function relating peak roof drift, $\boldsymbol{XPeak_n}$ and structural damage as a percentage of construction cost ($\boldsymbol{XD_n}$).

8.9.b Equipment Damage Calculations

The building is assumed to house equipment that is sensitive to acceleration. Damage to this equipment will be a function of the measured roof acceleration, $APeak_n$. This function is a cumulative normal probability density function with peak roof acceleration mean and standard deviation listed in Section 4.5. The equipment damage as a percentage of the equipment cost (AD_n) is a function of $APeak_n$ and is plotted in Figure 2.

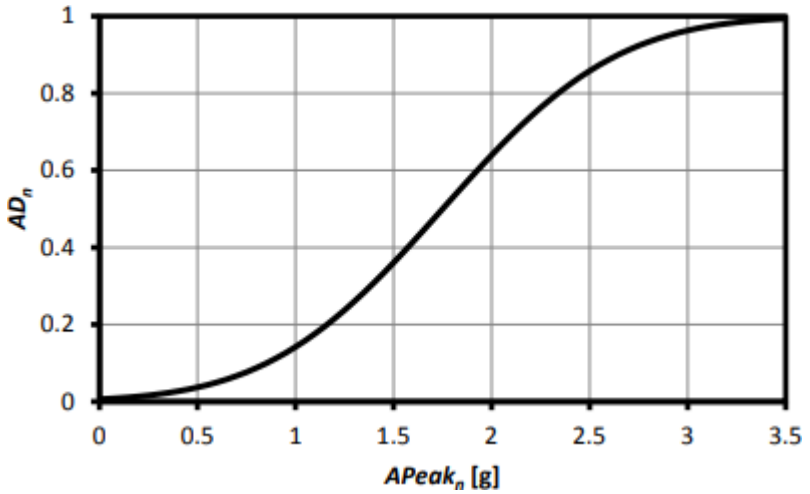

Figure 2 Function relating peak roof drift, $\boldsymbol{APeak_n}$ and structural damage as a percentage of construction cost ($\boldsymbol{AD_n}$).

8.10 Penalties and Determining Collapse

8.10.a Unsecured Floor Dead Load Penalties

After each ground motion, an SDC Chair will inspect the building for any unsecured floor dead loads (Section 8.5.a). 5% will be added to D_n for each unsecured floor dead load. If a penalty D_n is applied, it will only affect the monetary structural and equipment damage for the ground motion immediately following the inspection. If a structural model is deemed collapsed by a SDC Chair (Section 8.10.c), a penalty D_n will not be applied for the ground motion(s) in which the structural model is deemed collapsed.

For example, if all of the floor dead loads remain secured after Ground Motion 1, the penalty D_1 for Ground Motion 1 will be equal to 0%. If two of the floor dead loads are found to be unsecured after Ground Motion 2, the penalty D_2 for Ground Motion 2 will be equal to 10%.

A floor dead load is considered unsecured:

- If any end of the floor dead load has moved more than ½ in. in any translational direction from its original pre-shaking location measured at the exterior face of the building
- If any end of the floor dead load can be moved more than ½ in. in any translational direction measured at the exterior face of the building. This includes the vertical direction. The amount of force

applied by the SDC Chair to the floor dead loads will be enough to check for movement and is at the discretion of that SDC Chair.

- If one floor dead load is in contact with another floor dead load, both are considered unsecured.

8.10.b Unsecured or Not Level Roof Dead Load

Before each ground motion, an SDC Chair will inspect the roof dead load. If an SDC Chair deems the roof dead load is not secured to the structural model or not level, the roof dead load will be removed from the structural model and the score will assume maximum structural and equipment damage for any of the ground motions where the roof dead load is not attached to the structural model. An unstable roof plate is not grounds to declare a structural model collapsed.

8.10.c Defining Collapse of a Structural Model

An SDC Chair deems a structural model has collapsed if any of the following happens:

- 50% or more of the floors are not level.
- 50% or more of the frame members or walls attached to the base plate are separated from the base plate or the structural model.
- 50% or more of the floor dead loads are considered unsecured (Section 6.9.a).
- 50% or more of the vertical and diagonal members (combined) connecting any two floors are disconnected.
- The structural model base plate has delaminated to the point where the structural model is rocking on the shake table.

The floor levels will be checked with a level. If the whole bubble is outside of the lines on the level, the floor is considered not level.

The frame members and/or walls attached to the base plate will be visually inspected to see if separation has occurred between the member and the base plate and/or the rest of the structural model.

If any of the conditions for collapse are met prior to **GM#1**, the structural model will still be shaken but deemed collapsed for both ground motions regardless of the outcome after shaking has completed.

If collapse occurs during **GM#1**, collapse will be assumed to happen for **GM#2** for scoring purposes

9. SCORE SHEETS

All score sheets can be reviewed and signed by the team Point of Contact immediately after judging has been completed. Only team PoC shall discuss penalties and score sheets with the SDC Chairs (Section 0).

At the team meeting, the SDC Chairs will indicate a time when team PoC can begin to come by the judging table to review the judging sheets. The indicated time may change depending on the time required to review all the models.

The SDC Chairs will specify a cut-off time for appeals when the final competition schedule is released (check the website for updates). After this time, the judges can refuse to review any score sheets and hear any appeals. The score sheets will be signed by two SDC Chairs and the penalties assessed can no longer be appealed.

9.1 Judging Sheet Review

The judging sheet review process will occur as follows:

- The judging sheet will be explained by an SDC Chair to the team PoC.
- The SDC Chair will show the violation(s), if any, on the model.
- If applicable, penalties will be marked with a red permanent marker or stickers on each structural model for quick visual identification.
- An SDC Chair will show the team PoC the rule/violation and penalty assessed in the official rules (or clarifications) if needed.
- If no penalties were found, the team PoC may sign the judging sheet or let two SDC Chairs sign the scoring sheet.
- If a penalty is assessed, a team PoC may do one of the following:
    - Sign the scoring sheets and forfeit the opportunity to appeal the penalty(s).
    - Review the penalties with his or her team members to prepare for an appeal. The SDC Chair will continue reviewing other team's scoring sheets and the team PoC will need to wait for the next available SDC Chair for the appeal.
    - Appeal the penalties.

The appeal process is explained in Section 11.1.

Once the scoring sheets have been signed either by the team PoC or two SDC Chairs, a team PoC may not make any appeals for the penalties assessed on the scoring sheets already signed. If a team PoC tries to make an appeal for penalties assessed on the scoring sheet(s) already signed, the team PoC will be warned. If after the team PoC is warned and they attempt to continue appealing for penalties assessed on the scoring sheet(s) already signed**, the team will be disqualified.**

9.2 Verification of Electronic Score Sheet Entry

Either during or at the end of shaking day, teams will receive a "shaking day score sheet" via email or hard copy. This score sheet will be a version of the final score sheet: it will contain information including but not limited to building weight, total violations (V), and shake table performance; it will not contain any information about other scores or bonuses received.

It is the duty of the team PoC to review the information on this sheet for typographical errors. Any such errors, especially those affecting the calculation of scores, must be reported to the SDC Chairs, either in person or by email, before 9:00 PM competition local time on the evening before the awards ceremony. The SDC Chairs will review the hard-copy score sheets and will rectify any errors that are reported in this way. If a team PoC has not reported any errors by the deadline, it is assumed that they have reviewed their score sheet and accept all information as typographically accurate.

Please note that this is **not** an opportunity to initiate any appeals or to dispute the scores in any other way. This is only an opportunity to verify that the information entered electronically is typographically consistent with the information recorded on hard copy (which has already been signed by the team PoC or two SDC Chairs, as explained above)

10. RULE CLARIFICATION

All rule clarification requests and answers will be posted on the competition website. The posted question and answer will also include the name of the school submitting the question. To submit a rule clarification, the team PoC must fill out and submit an online submission form, which can be found on the competition website. Questions or clarifications about the rules sent via email will not be answered. Be sure to read the rules, guide, and any other current year clarifications thoroughly before submitting a question.

11. JUDGING AND APPEALS

The SDC Chairs have complete authority over the interpretation of the rules and oversight of the competition and are responsible for scoring and decisions. All decisions made by the SDC Chairs are final. If any questions arise during the competition, the team PoC should ask one of the SDC Chairs, not other SLC members.

Only a team PoC may discuss decisions or appeals with SDC Chairs. SDC Chairs will refuse to discuss a decision or appeal to anyone other than the team PoC. A team PoC may only make an appeal regarding his or her team. Under no circumstances may anyone, other than the team PoC, approach a SDC Chair regarding penalties or scoring. This includes but is not limited to other teammates, alumni, professors, and especially other SLC members. If this becomes an issue, the team PoC will be warned. If the behavior continues after the team PoC is warned, the team will be disqualified.

The SDC Chairs strive to be fair and consistent with all teams regarding the official rules. During the judging process, the judges are trained and supervised to evaluate all of the structural models for the same requirement(s) so there is consistency in judging. Please be considerate and respectful to the SDC Chairs when making an appeal.

11.1 Appeals Process

A team PoC can make an appeal about a penalty or decision before signing a score sheet. An appeal begins the very instant the team PoC questions the penalty(s) to a Seismic Design Competition Chair(s). Only one appeal per team can be made for all penalties assessed. The team PoC must explain using the official rules and clarifications why the penalty or decision should be changed. An SDC Chair will hear the team PoC's appeal and may consult other SDC Chairs before making a final decision. After a final decision has been made by the SDC Chair(s), the team PoC cannot appeal the penalty any further. If the team PoC refuses to sign the score sheet, two SDC Chairs will sign the score sheet instead and the score sheet will be considered signed by the team PoC.

In the interest of time, no appeals are allowed once shaking of the structures has begun. The team PoC may ask for an explanation on why their structure was determined as collapsed, but the buildings must be tested and moved along.

11.2 Rule Modifications

In very rare cases, unexpected circumstances may arise that threaten the spirit of the competition. In these cases, the SDC Chair(s) reserve the right to modify the rules, if such a modification would preserve the quality of the competition.

12. REFERENCES

[1] City of Portland Bureau of Planning and Sustainability, *Central City 2035 Plan documents*, adopted July 2018. [Online] Available: https://www.portland.gov/bps/planning/central-city/central-city-2035-documents

[2] ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI 7-22, Reston, Virginia: American Society of Civil Engineers, 2022.

[3] OSSJA, "Code of Academic Conduct," 28 April 2023. [Online]. Available: https://sja.ucdavis.edu/cac.html.

[4] MIT, "What is Common Knowledge?," n.d.. [Online]. Available: https://integrity.mit.edu/handbook/citing-your-sources/what-common-knowledge.