Spring 2017 Undergraduate Seismic Competition

OFFICIAL RULES

University of California, Irvine
Henry Samueli School of Engineering
Thursday, April 6th, 2017

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1.0 INTRODUCTION

1.1 Spirit of the Competition

The Seismic Competition provides an opportunity for collegiate Civil Engineers to gain knowledge and practice in the discipline of Earthquake Engineering. The threats earthquakes pose along the Southwest region of the United States, and specifically Southern California, are great; it is in the best interest of civil engineering students to accumulate knowledge in the building of structures, which possess the ability to counteract such threats.

The objectives of the Seismic Competition are as follows:
To provide an opportunity for undergraduate Civil Engineers to engage in the design of lateral load resisting systems for multi-story buildings.
To foster an educational and professional environment for undergraduates to pursue meaningful relationships between their peers and professionals.
To supplement undergraduate studies in Civil Engineering with an alternative to seismic design through the creation of a balsa wood-made, multi-story, model of a building.

All parameters will be measured in Imperial Units.

1.2 Competition Problem Statement

The Pacific Southwest Region of the United States continuously faces seismic threats to its engineered structures. With many faults running along the west coast, such as the San Andreas, the Cascadian, and the Hayward faults, the comprehension of seismic design is of the utmost importance.

Your company has just won a bid on a contract for the design of a seismically-resistant multi-story building. The client has yet to decide which area specifically they would like the building to be situated in and has instead opted to choose the location of the building based upon the creative aesthetic of your choosing. The only restriction the client requests to abide by is that the location of the building be somewhere in the Pacific West of the United States. The architecture of the building must reflect the unique culture of the location you choose.

The client would like the height of the first floor of the building to be two times the height of the typical floor. Furthermore, the client strongly believes in the pursuit of environmentally-friendly designs and requests a living roof,

also known as a green roof, on the top of the building and an open layout for the first, second and third floors. An open layout on these floors means that these levels are unhindered by structural elements for at least 42 in^2. The architecture of the building should incorporate these structural requests.

Before construction begins, the client has requested a balsa wood model of the building design, which will be subjected to multiple scaled-down ground motions, representative of recorded historical earthquakes.

The model of the building must not collapse during any seismic ground motion simulations. Collapse is defined as a breakdown of the lateral load resisting system, whether that may be total collapse or non-serviceability. If the building can no longer be safely occupied by human beings at any level of the structure, the model will be deemed collapsed. Safe serviceability is defined by the fracture of more than 4 balsa wood members of the lateral load resisting system at any floor. Balsa wood members are defined in Section 2.1.

Characteristics of the building under loading, such as roof displacement and roof acceleration will be recorded and considered for the final score of the competition. Should the building collapse, the team is automatically placed in a second tier for judging and the roof drift and roof acceleration will be the highest recorded prior to collapse.

Teams will receive a score for the architectural design, roof drift and roof acceleration, annual revenue (based upon the rentable floor area), the corresponding presentation, and the corresponding poster. Annual revenue calculations will be included in presentation slides and on the poster. **There will be no proposal nor design paper to be submitted.** However, the expectation is that the presentation shall be comprehensive and professional enough to act as an oral design paper.

1.3 Registration

Teams must notify the organizers of the competition of their intent to compete prior to Friday, February 17, 2017.

Participating teams must comply with the following requirements for registration:

1. Teams must be affiliated with one of the schools participating in the PSWC hosted by UC Irvine chapter of ASCE.
2. Team members must be undergraduates at one of the affiliated universities participating.
3. Teams must register by the date stated above, February 17.
4. Teams may only submit one structure, one presentation, and

one poster on behalf of each university participating.

2.0 STRUCTURAL MODEL COMPLIANCE

2.1 Balsa Wood Model

The competition model must be made from balsa wood and be representative of a multi-story building. The building must be no more than 30 floors tall. There is no limitation to how short the building model is to be; however, since a significant portion of the total score depends on the annual revenue (which is proportional to the amount of floor space), it is advisable to have at least 18 floors. Damping devices may be used in any capacity, provided they are approved by the judges beforehand. If damping devices are to be used, you must notify the Seismic Competition Committee within a month of the competition (Friday, March 3rd, 2017). Contact Information and important dates and deadlines are provided in Appendix A.1 and Appendix A.2, respectively.

All aspects of the model must be constructed out of Balsa Wood. The only exceptions to this are the approved dampers, the base plate, and the roof plate. All architectural members (defined as members which do not provide structural support and only serve an aesthetic purpose) must be made from balsa wood and must be able to be characterized as a wall member, frame member, or connection.

2.1.1 Wall Members

Dimensions of wall members must not be larger than 0.15 in. x 3.15 in. x 11.15 in. and must be at least 1 inch in length (in one dimension).

2.1.2 Frame Members

Dimensions of all frame members must not be larger than 0.315 in. x 0.315 in. x 15.00 in. and must be at least 1 inch in length (in one dimension).

2.1.3 Floor and Roof Parameters

The maximum floor plan dimension must not exceed 16 in. by 16 in. The total number of floors must not be greater than 30. The floors are defined at the height at which the floor plan subsides. For example, the first floor is at a height of 0 inches.

The first story must be 4 inches tall and all subsequent stories will be 2 inches tall. A floor must have at least 30 square inches of rentable floor area and is characterized by beams that run along the perimeter of the specified floor.

The roof is not defined as a floor but rather as the

covering of the highest floor of the building. The roof plate, which is what the accelerometer is attached to, will be attached to the roof of the model. More information about the roof plate and the precautions it necessitates is in Section 2.4.

2.1.4 Connections

The only way connections may be made is through glue; teams may use any type of glue they deem useful for their model. All members touching the base plate must be glued to the base plate. Likewise, all members touching the roof plate must be glued to the base plate.

2.1.5 Gusset Plates

Gusset plates must not be touching any wall members and be connecting at the least two frame members. Gusset plates must not have larger dimensions than 0.165 in. by 1.15 in. by 1 in. and the connection to the frame members must be in compliance with Section 2.1.4.

2.2 Floor Dead Load Connections

Dead loads will be added to select floors before being subjected to ground motions; take care in designing a structure that will be able to hold the dead loads in place at each floor they must be placed on.

The direction in which the team's structure will be oriented will be determined the day of the competition; thus, dead load connections must be made available in both orientations of the team's structure. That is, dead loads must be able to be fitted within the center of the floor plan and may be secured in both the N-S and E-W orientation of the team's structure.

Starting at the sixth floor, all buildings will have dead loads at every third floor. For example, a 13-floor building will have dead loads at the 6th, 9th, and 12th floors.

Dead loads will have their metal rods go through the building model at the specified floors. They will be secured through nuts; it is necessary to ensure that the balsa wood members at these floors are sufficiently strong enough to hold the dead loads in place. Should the dead loads fall out of place at any point during the shake testing and damage the structural integrity of any of the floors, the structure will be deemed collapsed.

2.3 Damping Devices

Dampers all allowed to be used as part of the lateral-load

resisting system. As previously stated, if dampers are to be used, the team must notify the Seismic Competition Committee of the intent by Friday, March 3rd, 2017.

A one-page PDF document must be submitted and include a picture of the damper to be used and proof that the damper will be able to dissipate energy through the building once the building is subjected to seismic forces. Provided that these two requirements are satisfied, the dampers can be made up of any material.

Teams using damping devices will be checked by the judges prior to ground motion testing on the day of the competition to ensure compliance with the above provisions.

2.4 Base Plate and Roof Plate

2.4.1 Base-Isolated Systems

Base-isolated systems are not permitted since the model must be connected to the base plate. As stated previously, all balsa-wood members of the first floor must be glued to the base plate; the type of glue is up to the team's discretion.

2.4.2 Base Plate Compliance

To comply with the dimensions of the shake table, the base plate must be a plywood square with the dimensions 18 in. by 18 in. and not be more than 0.75 inches thick. Since the building needs to be glued to the base plate, teams will supply their own base plates.

Base plates will be clamped down onto the shake table so teams must make sure that there is an adequate amount of space supplied by the base plate to allow it to be clamped down without damaging balsa wood model members.

2.4.3 Roof Plate Compliance

The accelerometer will be attached to the roof plate so the roof plate must be a 0.375 in. thick plywood square with the dimensions 6 x 6 in^2.

The roof plate will be clamped down to the roof the balsa-wood model; thus, it is up to the teams to design a roof that will allow the roof plate to be securely fastened with clamps. Teams must provide two roof plates at the competition for determining the structure's weight (more details are in Section 2.5).

2.5 Model Weight Requirements

The balsa-wood model must not exceed 7 lbs. This restriction of 7 lbs. includes all balsa wood members, glue, dampers (if

used), the base plate, and the roof plate.

2.6 First, Second, and Third Floor Requirements

The client has made it clear that the first three floors must provide an open space to encourage more environmentally friendly aspects of the building. The open space must be at least 42 in^2. Thus, these three floors must not be encumbered by neither structural nor non-structural elements in the floor plan for 42 squared inches. The goal is to make it as open as possible. The architect of the building is free to design this open space to be whatever they deem appropriate with the client's requests. More information on the architecture of the building in Section 4.0.

2.7 Allowable Computer Modeling Programs

Teams may use any Finite Element Modeling Software that is available to them to design, model, and predict the behavior of the balsa-wood model. This includes, but is not limited to SAP2000 and ETABS.

2.8 Additional Provisions

The name of the school and the name of the building must be put on the top of the building model, whether that be in paper or engraved into the balsa wood model is up to the discretion of the individual teams.

3.0 SEISMIC GROUND MOTION TESTING PROVISIONS

3.1 Dead Loads

3.1.1 Floor Dead Loads

The dead loads of the floors that they occupy will be steel rods, weighing an approximate two pounds each.

3.1.2 Installation of Dead Loads

Dead loads will be securely installed in the direction that is perpendicular to the random direction chosen in which the ground motions will be exerted. Each floor that is required to have a dead load (Section 2.2) must be secured in the manner that Section 2.2 dictates.

3.2 Seismic Ground Motions

The direction that the building will be oriented with respect to the direction of the ground motions will be determined at random the day of the competition by the judges.

The scaled down ground motions to be used for the shaking competition will be available on the competition website, seismiccomp17.weebly.com.

4.0 ARCHITECTURE

The architecture of the building should be representative of the area, region, or city in which the team chooses to situate the building. The architecture score of the building will depend on the following:

1. The integrative design of the building with its location
2. Aesthetic of the balsa-wood model
3. Aesthetic of the architecture rendering

The full rubric of the architecture score will be available on the competition website, seismiccomp17.weebly.com.

5.0 PRESENTATION

Presentations will take place on Thursday, April 6th, 2017 at the Henry Samueli School of Engineering from 9:00 am—12:00 pm. The exact location and the order in which the schools will present will be provided to participating teams in the coming weeks.
Presentations must be no more than five minutes long; judges will be given two minutes after the presentation to ask presenters questions regarding the material of their presentation and the corresponding balsa-wood model. There may be no more than three people presenting on behalf of each team; however, beyond that limitation, the number of presenters representing each university team is up to the individual team's discretion.

Presentations must include, but are certainly not limited to, the computer modeling of the balsa-wood structure, the lateral load resisting system, the predicted roof drift and roof accelerations, the calculated annual revenue, the design and construction process, the architectural rendering, and the overall theme of the structure and how that theme is incorporated into the city of the team's choosing.

Presentations must include the name of the representing school and the name of the building on the presentation title slide.

Presentations must be sent to the Seismic Competition Committee by Friday, March, 31st, 2017. Contact information is

listed in Appendix A.1. Teams who do not provide a presentation by the above date will automatically have their presentation scored halved. Teams who do not present will receive no points in this category for the overall competition score, which is detailed in Section 6.0.

The full presentation rubric will be posted on the competition website, seismiccomp17.weebly.com.

6.0 POSTER PROVISIONS

All teams must provide a poster at the competition, which will be displayed alongside the teams' balsa-wood models. The poster must include the name of school, the name of the building, the computer model of the structure, the floor plan of the first floor and the typical floors (all floors after the third floor), the design and construction process, and the estimated annual revenue (based on floor space and detailed in Section 7.2)

The poster must not exceed dimensions 32 x 42 in^2. Teams who do not have poster will receive no points for this category in the overall scoring.

The full poster rubric will posted on the website for the competition, seismiccomp17.weebly.com.

7.0 COMPETITION SCORING

7.1 Units

The competition will be in Imperial units; parameters will be measured in inches and pounds.

7.2 Rentable Floor Area

Rentable floor area is defined as the area of any floor, not including the first three floors, that is enclosed by the perimeter beams of each floor. The structural balsa-wood members that are defined as wall members or frame members are not to be subtracted from the total rentable floor area.

The total rentable floor area, from the 4^{th} floor to the last floor, shall not exceed 6000 in^2. Should the total rentable floor area exceed this number, nothing past 6000 in^2 will be counted in the annual revenue equation.

Again, the first three floors are not to be considered rentable floor area.

7.2.1 Annual Revenue

The annual revenue for the respective floors will be calculated according the following specification:

1. Floors 4—10: $100 per square per inch
2. Floors 11—19: $150 per square per inch
3. Floors 20—24: $200 per square per inch
4. Floors 25—27: $350 per square per inch
5. Floors 28—30: $600 per square per inch

7.3 Overall Scoring Rubric

All rubrics concerning the judging of the architecture, the presentation, the poster, the building's performance in terms of roof drift and roof acceleration, and the annual revenue score will be available on the competition website at seismiccomp17.weebly.com. These rubrics will also be emailed to all teams upon registration for the competition

7.4 Awards Presented

Teams will be awarded in the following categories:

1. Highest Overall Score
   This includes the architecture score, presentation score, poster, building performance, and annual revenue score
2. Most Innovative Lateral Load Resisting System
3. Most Integrative Architectural Design

A. APPENDIX

A.1 Contact Information

Should teams have any questions, clarifications, or appeals to be made, please send all official inquiries to seismic.comp17@gmail.com.

A.1.a Competition Website: seismiccomp17.weebly.com

A.1.b Competition Email: seismic.comp17@gmail.com

A.2 Important Dates, and Competition Schedule

Please submit all materials to the competition email, seismic.comp17@gmail.com

Submission Description	Date
Competition Registration	Friday, February 17, 2017
RFI (Request for Information)	Friday, March 3, 2017
Dampers Notification	Friday, March 3, 2017
Poster Submission	Friday, March 31, 2017
Presentation Submission	Friday, March 31, 2017

Event Schedule	
9—10:30 am	Presentations
10:30—11 am	Coffee Break
11 am—12 pm	Presentations
12—1 pm	Lunch
1—3 pm	Shaking
3—3:30 pm	Break
3:30—5 pm	Shaking