The List of Rule Revisions

Version No.	Date	Remarks
V1.1	2023-05-11	None

This document lists the primary rules for this contest. Should there exist any nonincluded issues or any ambiguity arise, IDEERS reserves the right of final interpretation for these rules.

1. Introduction

The objective of the contest for graduate student teams is to design and build an earthquake-resistant model building by applying advanced seismic reduction technologies. Teams are expected to creatively and innovatively apply the concepts of energy dissipation and/or seismic isolation to construct their model buildings. Moreover, the model buildings are expected to meet the practical requirements such as space availability, feasibility,…, etc.

2. Requirements for Model Building

- The model building must be constructed on a wooden board with a dimension of 370 mm (W) × 520 mm (L)× 6 mm (H), while the base area of the model building is limited to 310 mm (W) × 460 mm (L). IDEERS will provide a medium-density fiberboard (MDF) as the base wooden board. The baseboard should have a 30-mm clearance left at the four edges so that the model building can be fixed on the shaking table (Figures 1 and 2). The model building can be in any shape, but the fabrication area of the building is restricted to meet the IDEERS requirement.
- The floor diaphragms must be made from MDF, and the thickness of diaphragms is limited to be greater than or equal to 5 mm. If seismic isolation is adopted, the floor diaphragm above the isolation layer must be a transparent acrylic plate (with its thickness greater than or equal to 5 mm), such that the details of the isolation system can be seen.
- The number of stories must be greater than or equal to three. Floors can be in any size and shape. However, the total area of floor diaphragms (i.e., 1^{st} floor + 2^{nd} floor + 3^{rd} floor + … + roof) must be between 200,000 mm^2 ~ 240,000 mm^2. Only the area of floor diaphragms that can bear the loading of mass blocks counts (i.e., the interior areas surrounded by the columns, the braces, or other vertical elements of the lower floor). The eligibility of the floor area will be determined by the judges should ambiguious or constroversial situations occur. The model building that violates the rule of total floor area stated herein will be disqualified (Figures 3 and 4).
- The story height (the distance between the top surface of the lower-floor diaphragm and the bottom surface of the upper-floor diaphragm) must be greater than or equal to 200 mm. Adequate space needs to be preserved to install the mass blocks even if certain control devices such as isolation bearings, dampers, or other innovative devices are used.

- The model building must carry 16 mass blocks. Each mass block weighs about 2.5 kgw and has size 100 mm × 100 mm × 30 mm. The total weight that the building should carry is about 40 kgw. These mass blocks are also used to represent the space occupied by the residents or facilities. Thus, the mass blocks should be reasonably distributed over the floors. That is, a reasonable amount of weight should be carried by each floor and in addition, the weight should be reasonably distributed on the floor diaphragms. The adequacy of the weight installation will be determined by the judges. All mass blocks must be fixed to floor diaphragms by using PVC hot glue. Mass blocks can be stacked on each other by using PVC hot glue.
- The mass blocks can only be glued on the floor diaphragms and are not permitted to contact any other building members.
- At least one energy dissipation and/or seismic isolation system must be implemented in the model building.
- Teams are required to provide the design drawings of the model building and the calculation sheet of the total floor area.

3. Materials and Tools

Materials Provided by IDEERS

- Wooden board (MDF): 370 mm × 520 mm × 6 mm × 1 (baseboard)
- Wooden board (MDF): 310 mm × 460 mm × 6 mm × 4 (floor plate)
- Acrylic plate: 310 mm × 460 mm × 6 mm × 1 (optional transparent acrylic floor diaphragm for demonstration of an isolation system)
- Wooden bar (MDF): 6 mm × 6 mm × 400 mm
- PVC hot glue sticks

Tools provided by IDEERS

- Cutter
- Hacksaw
- Tape measure
- PVC hot glue gun

Materials and Tools provided by Teams

- Only the floor diaphragms with thickness ≧ 5 mm can be counted in the calculation of the total floor area. Teams can use wooden or acrylic boards (thickness ≧ 5 mm) prepared by themselves.

- Except for the restrictions on the thickness and total area of floor diaphragms, other model members can be of any size and shape.
- Self-prepared materials and devices for seismic isolation and/or energy dissipation systems are required to be brought to and presented in the conference. Only the reported and approved materials and devices (by judges) can be used.
- Teams can prepare any required tools to construct the model building on the fabrication day.

4. Accessibility Rules

- In a real-world building, each story needs windows and doors. Thus, the model building must reserve space for four windows and two doors for each story. The sizes of windows and doors are 120 mm × 120 mm and 40 mm × 160 mm, respectively. If the model building fails to provide the required space for the windows and doors, a 5% penalty to the score will be given for each missing /unqualified window and door.

5. Earthquake-Resistant Design

- A list of materials and devices to be used in structural members and seismic isolation and/or energy dissipation systems should be prepared by teams. These materials and devices must be reported during registration. Only registered materials and devices can be used in the model building.
- IDEERS encourages enhancement of the seismic performance of the model building by innovatively utilizing various materials and additional structural members. All registered parts, elements, and devices can be applied in the model building, as long as they are and only are assembled into the model building on-site, on the fabrication day.

6. Contest Rules

- Teams are requird to give a presentation regarding the model building design and the adopted concept of seismic isolation and/or energy dissipation systems. If the concept is not qualified to be a seismic isolation and/or energy dissipation system, a new design should be submitted to IDEERS no later than 9 AM on the fabrication day. The new design must be approved by the judges before it can participate in the contest.
- The design target of the earthquake-resistant model building is 1000gal. The excitation levels of the shake table tests include 400, 800, 900, 950, 1000, 1050, 1100, and 1200 gal. If the model building fails in the 400 gal test, the building is disqualified and the team will not have any ranking.

- If the model building collapses (or more than half of the columns are significantly damaged) during the test, the building is regarded as failure and a 50% penalty to the score will be given.
- If a seismic isolation system is used and the system exceeds the allowable displacement during a test, the model building is regarded as failure (Figure 5).
- If any components take apart from the model building or travel beyond the fabrication area (310 mm × 460 mm) during a test, the model building is regarded as failure.
- Models regarded as failure but without imminent danger of collapse or the possibility to cause damage to their neighboring models can be considered by the judges to continue to be shaked on the table for fun. The 50% collapse penalty will not apply if they collapse.

7. Score Rules:

S= *P1* × *P2* × S_A × S_H × *P* × P_C × *A*

- **Evaluation from presentation（P1）:（70%~100%）**

P1 = 70% + (A1 + A2 + A3 + A4) × 30%

A1: Concept of the seismic isolation and/or energy dissipation system （0~40%）

A2: Numerical simulation （0~25%）

A3: Experimental validation （0~25%）

A4: Presentation quality （0~10%）

- **Validation of design concept（P2）:（0%~100%）**

P2 = B1 + B2

1. B1 (0%~40%): The score B1 will be given based on the presentation of a proposed validation method delivered on the conference day. The validation method is one to be used to validate the efficacy of the used seismic mitigation system. The efficacy includes two performance targets: (a) the seismic mitigation system should start working at the 400-gal excitation level, and (b) it should fail when the excitation is greater than the expected fail level 1000 gal. The simpler, more creative, and more explicit the validation procedure, the higher the score.
2. B2 (0%~60%): The score B2 will be given on the contest day. It depends on whether or not the proposed validation method indeed works as planned on the contest day.

For example, a team designs a base-isolated building with a design displacement of 30 mm under a 400-gal excitation. That means, the used base-isolation system ideally should have already started working when the excitation level is equal to or greater than 400 gal. The base displacement should exceed 30 mm when the excitation level is between 400 and 1000 gal. In addition, since the design earthquake level is 1000 gal, the used base-isolation system ideally should fail at an excitation level at 1050 gal. The team needs to propose a practical and explicit validation method on the conference day (***B1***) such that the efficacy of the used base-isolation system can be proved. For example, spaghetti noodles can be glued at appropriate positions (30 mm away from the isolation layer, and on the boundary of the region in which the isolation layer is allowed to move) such that on the contest day, the spaghetti noodles glued at the corresponding positions can be seen hit (***B2***) when the excitation level reaches 400 and 1050 gal.

For model that utilizes semi-active or active control strategies, in addition to the method showing the efficacy in controlling the seismic responses of the buildings to the two aforementioned performance targets, each teams should also provide a practical validation method to show that the utilized semi-active or active control devices indeed work as designed during the tests.

- **Score for Floor Area（S_A）**

A = total area of floor diaphragms

Total area (mm^2)	A>200,000~	A<215,000	A <230,000	A <240,000
S_A	100%	105%	110%	120%

- **Score for Total Height（S_H）**

H = building height

Building height (mm)	H<650	650<H<700	700<H<800	800<H<900	H>900
S_H	100%	105%	115%	120%	50%

To avoid damage to the neighboring models when the model collapses during the contest, the building height is limited to 900 mm maximum (from the base plate to the slab of rooftop). Additional 60 mm height above the rooftop is allowable for decoration, fixing, and so on.

- **Penalty（P）**

P = (100% - N × 5%)

N：Total number of the lacked or unqualified windows and doors

- **Penalty for Collapse （P_c）**

  P_C = 50% ：Building collapses during a test (or more than half of the columns or the vertical members damaged)

  P_C = 100%：Building does not collapse during a test

- **Accuracy of the seismic strength（A）**

PGA (gal)	400	800	900	950	1000	1050	1100	1200
A	30%	45%	75%	85%	100%	90%	80%	50%

The design earthquake level is targeted to be 1000 gal. Thus, the target is to design and construct a model building that sustains at the 1000-gal excitation but fails at the 1050-gal excitation. In terms of the scores, the corresponding values of ***A*** associated with other achieved PGA levels are listed above.

Innovation award of seismic isolation and energy dissipation (sponsored by Sinotech Engineering Consultants, Inc.) (One or zero winner, decided by the panel of judges)

- The panel of judges will select 3 ~ 6 models, that most innovatively implement the concepts of seismic isolation and/or energy dissipation, as the candidates of this award. An accelerometer will be installed on the top floor of each candidate model to measure the real floor acceleration during the tests.
- The model that has the minimum $E_{PFA,}$ the sum of the reduction ratios of the peak floor acceleration (PFA) under 400, 800, and 1000 gal tests, wins the innovation award.

PGA (gal)	400	800	1000
PFA	PFA_{400}	PFA_{800}	PFA_{1000}

E_{PFA} = $PFA_{400}/400 + PFA_{800}/800 + PFA_{1000}/1000$

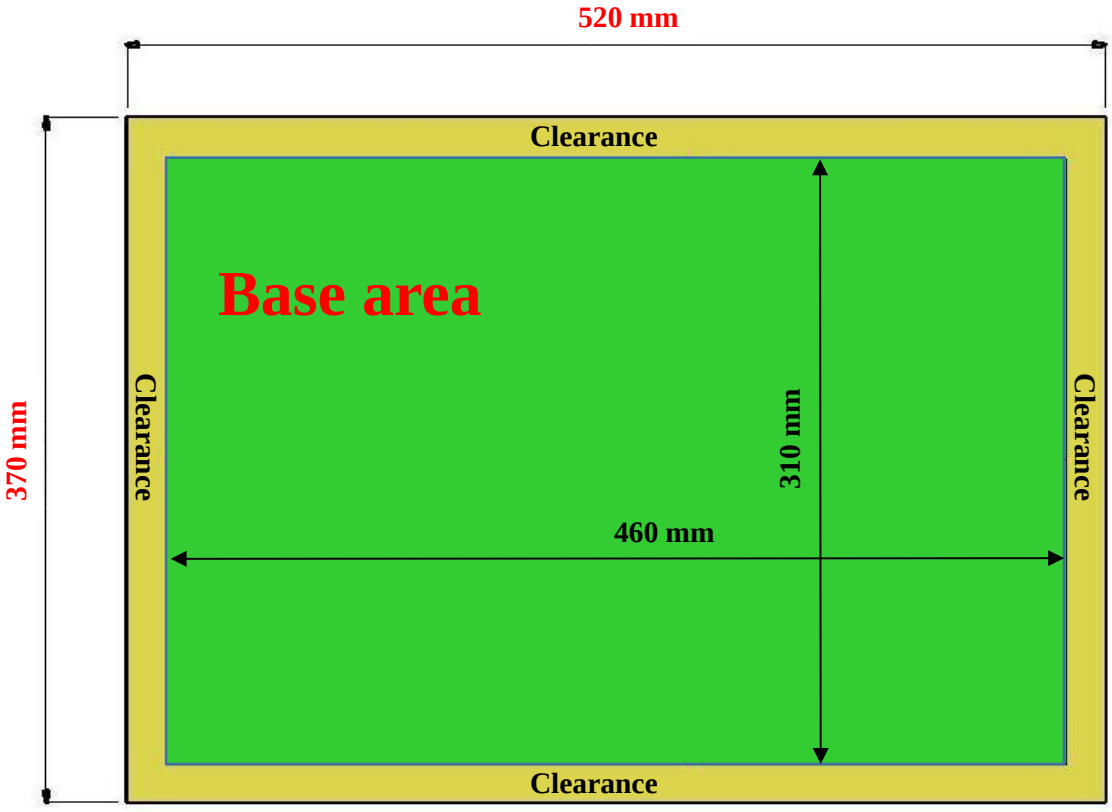

Figure 1: Top view of the MDF base board

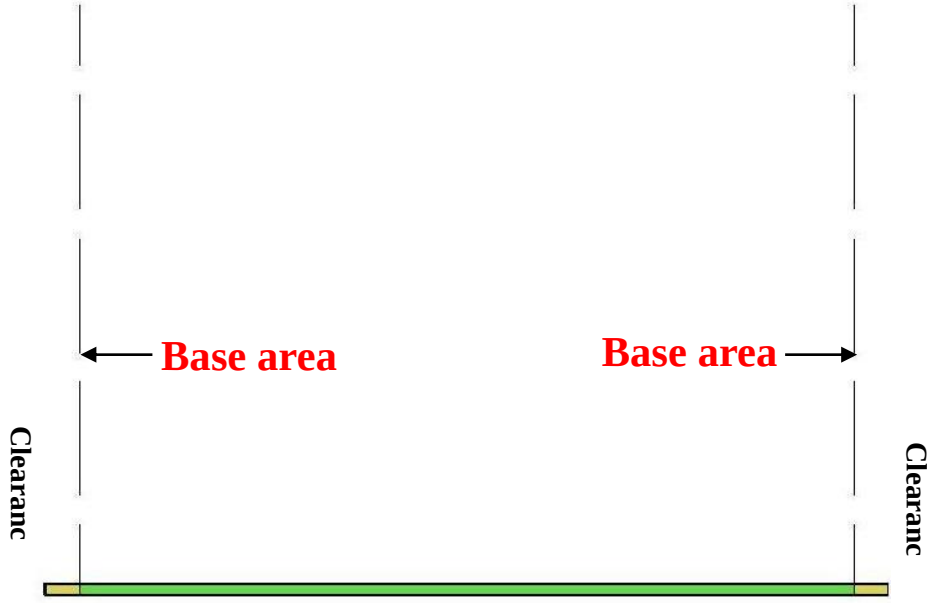

Figure 2: Side view of the MDF baseboard

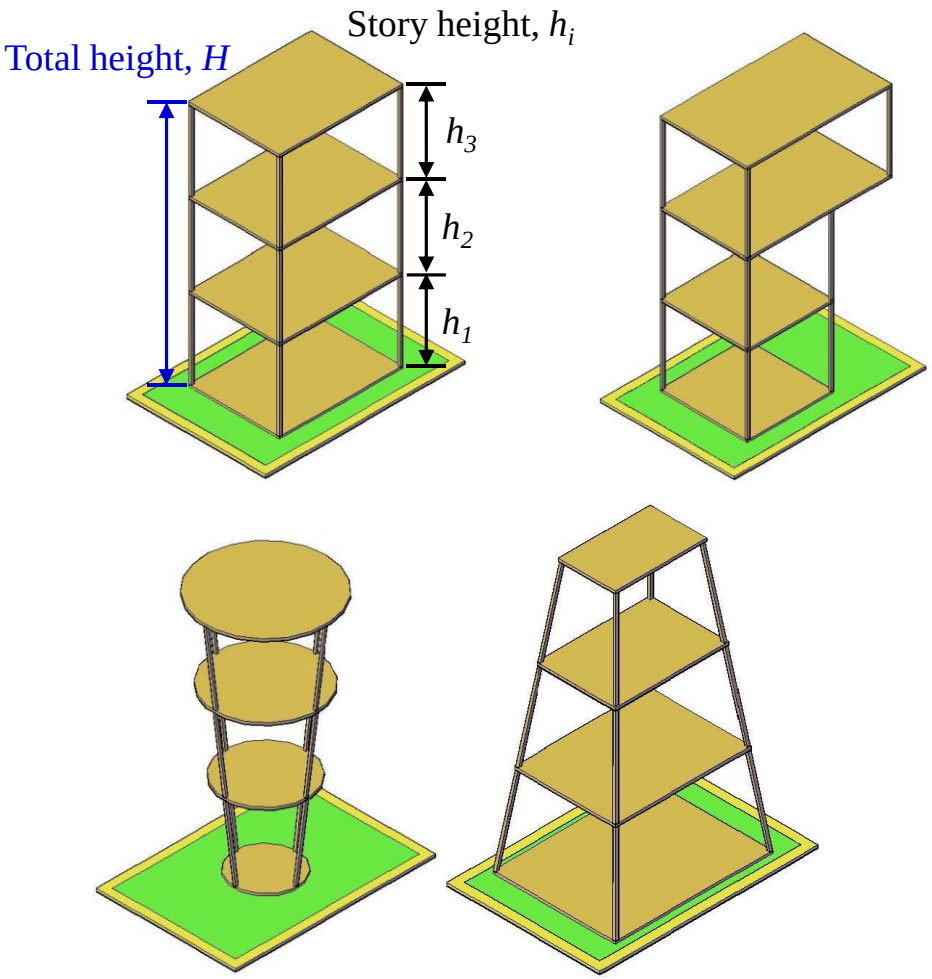

Figure 3：Samples of the model

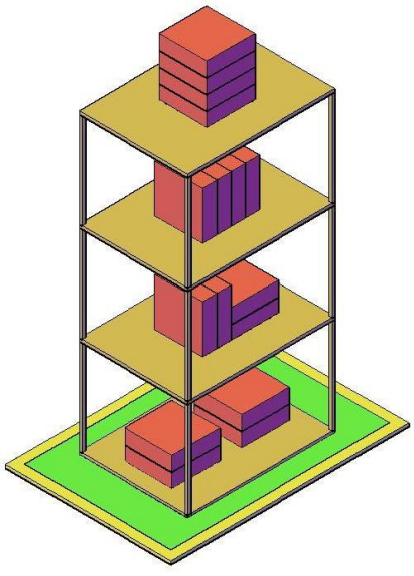

Figure 4: Arrangement of the mass blocks

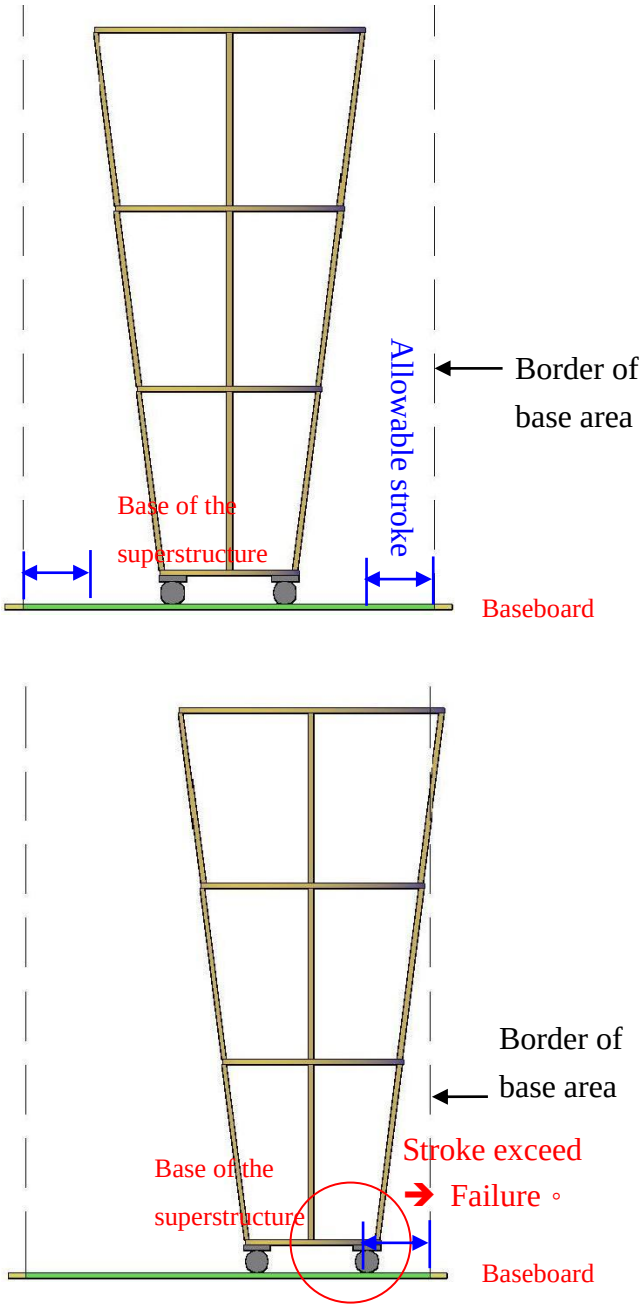

Figure 5: Illustration of the allowable stroke of the isolation system

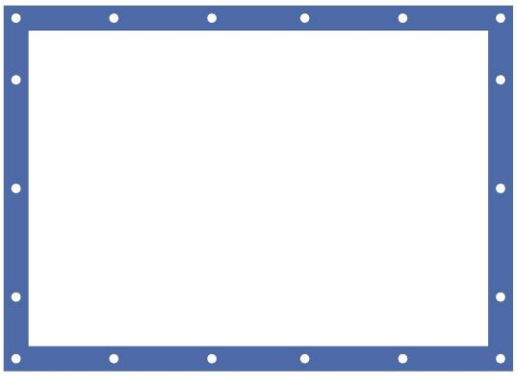

Figure 6. The clamping strip for fixing the baseboard.

8. The Exhibition Object

Each team must prepare an exhibition object that manifests the design concept and the creativity used in constructing the model. This exhibition object should be created before this two-day competition. It can be a two-dimensional or three-dimensional object. The way of the exhibition can be static and/or dynamic. The space for this exhibition is limited to 35 cm (height) × 25 cm (width) × 25 cm (depth), as shown in Figure 7. The Design-Concept Exhibition Award is granted based on the clarity and creativity in the demonstration of the design concept. The affiliation of the team including the department and the university/college should be included. If electronic products are used, the team is responsible for the required power supply as well as their safekeeping.

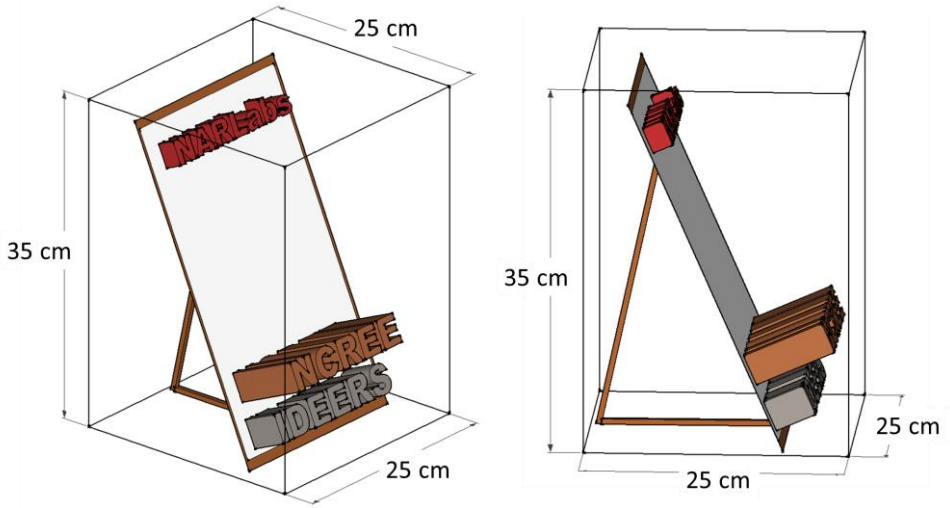

Figure 7. The allowable exhibition space

9. The team flag

Each team must design a team flag, which is to be installed on the model on the first day of this contest. This flag may be created before or during this contest. All possible shapes of this flag are allowed. Nevertheless, the size of this flag should be no larger than that of a sheet of A6-size paper (14.4 cm L × 10.5 cm W, i.e., a quarter of an A4-size paper). This flag can be installed on the model by using any provided materials, such as bamboo sticks.

10. Architectural Aesthetic Awards, Structural Design Awards, and Design-Concept Exhibition Awards

10.1 Aesthetic Architecture Awards are granted on the basis of the architectural features, the efficiency of site area usage, and the plan of inner space. The jury chooses at most three models for these awards. The team winning this award will be granted NT$5000 and a certificate for each team member. The evaluated items and the corresponding weights for these awards are:

item	weight	contents
Architectural features	70%	● Aesthetics of architecture ● Architectural feature and creativity
Efficiency of site area usage and the plan of inner space	30%	● The rationality and comfort of inner space ● The rationality of using the site area

10.2 Structural Design Awards are granted considering the overall structural design, the rationality and the creavitity in the employed seismic resistance system. The jury chooses at most three models for these awards. The team winning this award will be granted NT$5000 and a certificate for each team member. The evaluated items and the corresponding weights for these awards are:

item	weight	contents
Overall structural design	70%	● The arrangement of structural members ● The rationality of loading path
Concept and creativity of seismic resistance	30%	● The rationality of the concept of seismic resistance ● The creativity of the concept of seismic resistance

10.3 Design-Concept Exhibition Awards are granted on the basis of the clarity and **creativity of displaying the design concept of the model**. The jury chooses at most three models for these awards. The team winning this award will be granted NT$3000 and a certificate for each team member. The evaluated items and the corresponding weights for these awards are:

item	weight	contents
Design concept	60%	The clarity of introducing the design concept
The way of showing the design concept	40%	● The vividness of the way showing the design concept ● The creativity of the way showing the design concept