The List of Rule Revisions

Version No.	Date	Remarks
V1	2022-05-04	None

The content presented below serves as primary rules for this contest. However, if there are disputes that are not covered or clearly defined by these rules, the organizers retain the right to interpret.

1. Introduction

The objective of the contest for graduate student teams is to design and build an earthquake-resistant model building by applying advanced technologies. Teams can use their creativeness and innovations in the model building, with the concepts of energy dissipation and/or seismic isolation. Moreover, the model building must meet the practical issues such as space availability, feasibility, and cost-effectiveness.

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 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 follow 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 is limited to be a transparent acrylic plate (i.e., the thickness must be greater than or equal to 5 mm), to demonstrate the details of the isolation system.
- The number of stories must be greater than or equal to three. Floors are flexible in any size and shape; however, the total area of floor diaphragms (e.g., 1st floor + 2nd floor + 3rd floor +… +roof) is limited between 200,000 mm^2 ~ 240,000 mm^2. The area of floor diaphragms should take the load of mass blocks (i.e., the interior areas are surrounded by the columns of the lower floor). The total area must be determined by the judge. The model building in which of total floor area violates the limitation will be disqualified (Figures 3 and 4).
- The story height (e.g., the distance between the top surface of the lower-floor diaphragm and the bottom surface of the upper-floor diaphragm) is limited to be greater than or equal to 200 mm.
- The model building must carry 16 mass blocks of which each is about 2.5 kg with a dimension of 100 mm × 100 mm × 30 mm. The total weight that the building should

carry is about 40 kg. The weight should be evenly distributed over floors in accordance with floor areas (i.e., each floor must carry a certain weight and the weight distribution is judged by judges). All mass blocks must be adhesive to floor diaphragms by PVC hot glue. Mass blocks can be stacked onto each other by PVC hot glue.

- The mass blocks can only be glued on the floor diaphragms and are not permitted to contact other building members.
- The conceptual energy dissipation and/or seismic isolation system must be adopted 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 stick

Tools provided by IDEERS

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

Materials and Tools provided by Teams

- Only the floor diaphragms with a thickness ≧ 5 mm can be counted in the calculation of floor area. Team can use the 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.
- Teams can bring their own materials for seismic isolation and/or energy dissipation systems and have to present these materials at the conference. Only the reported and approved materials (by judges) can be used.
- Teams can prepare tools needed to construct the model building.

4. Accessibility Rules

- In a real-world building, each story needs windows and doors. Thus, the model building must have four windows and two doors per story. The sizes of windows and doors are 120 mm × 120 mm and 40 mm × 160 mm. If teams do not leave sufficient and correct space for the windows and doors, a 5% penalty to the score will be given for each missing /unqualified door and window.

5. Earthquake-Resistant Design

- A list of materials used in additional structural members and seismic isolation and/or energy dissipation systems should be prepared by teams, and these materials must be reported during registration. Only registered materials can be used in the model building.
- IDEERS encourages teams to enhance the seismic performance of the model building by utilizing various materials and additionally structural members. All sorts of registered parts, elements, and devices can be applied in the model building, while the assembly of seismic protection devices to the building must be completed on-site.

6. Contest Rules

- Teams should give a presentation regarding the model building design and the 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, teams should provide a new design. The new design must be reported to IDEERS by 9 am on the fabrication day and approved by judges.
- The design target of the earthquake-resistant model building is 1000gal. 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 columns are significantly damaged) during the test, the building is considered 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 considered as failure (Figure 5).
- If any components take apart from the model building or travel beyond the fabrication area (310 mm × 460 mm), the model building is considered as failure.

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 (Presentation): Teams provide the corresponding validation procedure of their seismic protection systems (40% of P2)
2. B2 (Contest day): Validation of the seismic protection system (60% of P2)

Teams should simply clarify and validate their seismic protection systems. A higher score will be given if simpler and more explicit methods are used in validation.

For example, a team designs a base-isolated building with a design displacement of 30 mm under a 400-gal seismic excitation. This team then needs to establish a simple and explicit method that can evaluate and validate the performance of the isolation system (***B1***=40%). When the excitation level is between 400 and 1000 gal in the test, the base displacement in this isolated building should exceed 30 mm which needs to be equivalent to their assessment in the validation.

- **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
S_H	100%	105%	115%	120%

- **Penalty (P)**

  P = (100%-N×5%)

  N：Total lack number of the window and door

- **Penalty for Collapse (P_c)**

  P_C =50% ：Building collapses during a test (over a half of columns or 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 best design is given to PGA = 1000 gal. In terms of scores, other achieved PGA levels are listed above.

Innovation award of seismic isolation and energy dissipation (sponsored by Sinotech Engineering Consultants, Inc.) (1 team, possibly without a winning team by the referee panel's decision)

- Panel of judges will select 3 ~ 6 teams, which have the innovations of seismic isolation and/or energy dissipation concepts, into the finalist; and equipped one accelerometer on the top floor of each model to measure the real floor accelerations during the tests.
- Team, which has the minimum sum of the acceleration reduction (E_{PFA}) under 400, 600, and 100 gal tests, will win the innovation award.

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

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

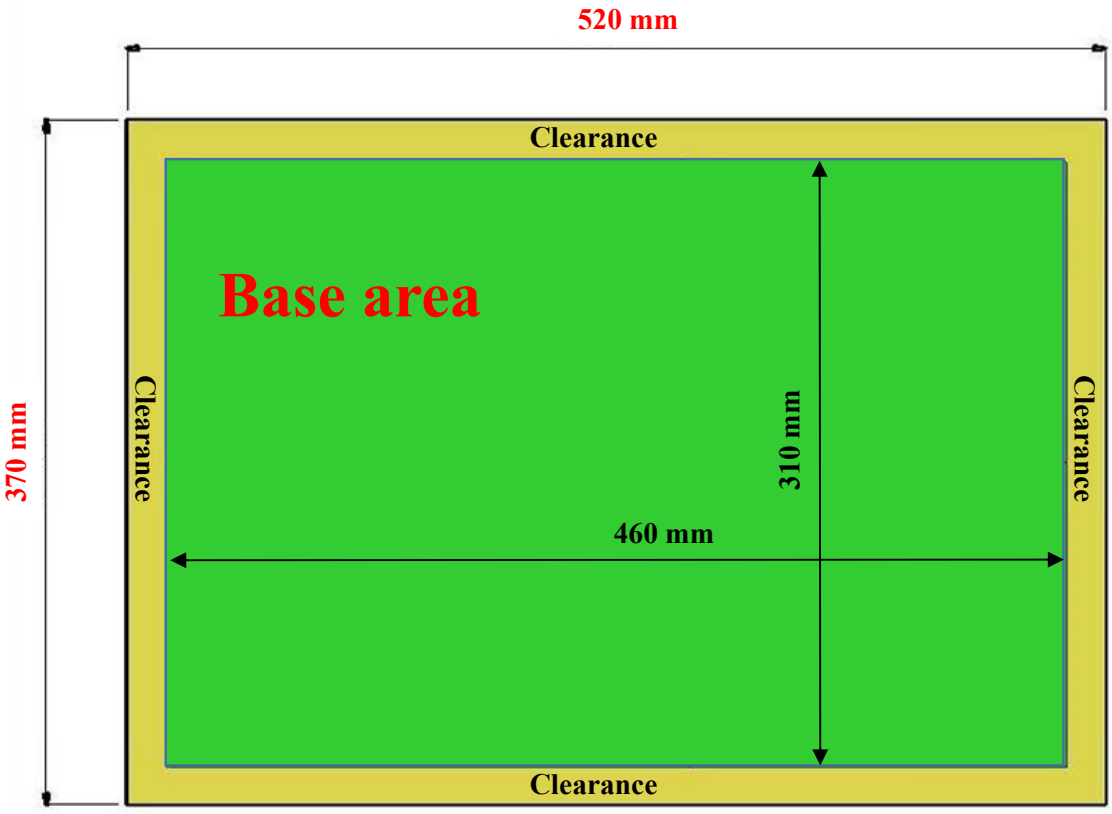

Figure 1: Top view of the MDF base board

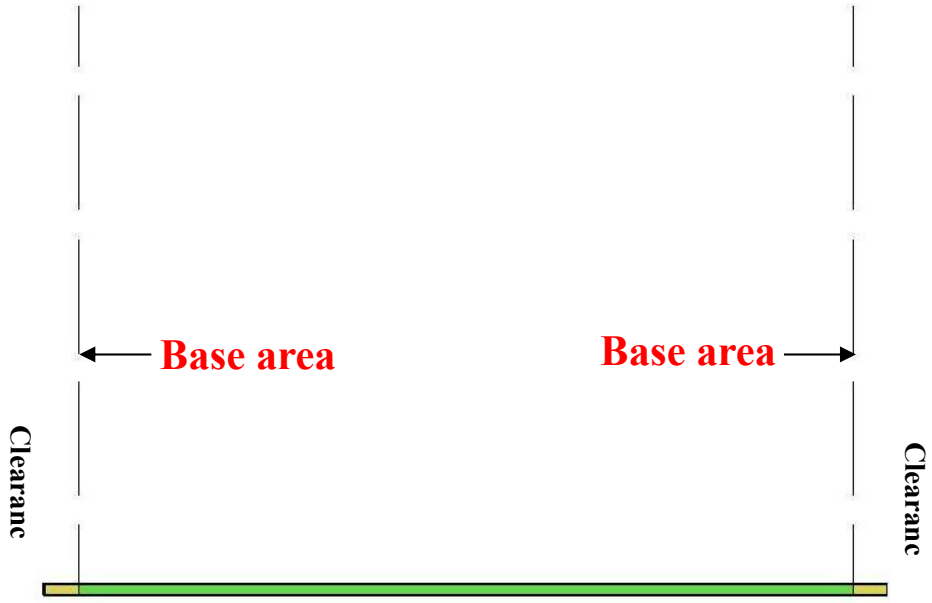

Figure 2: Side view of the MDF baseboard

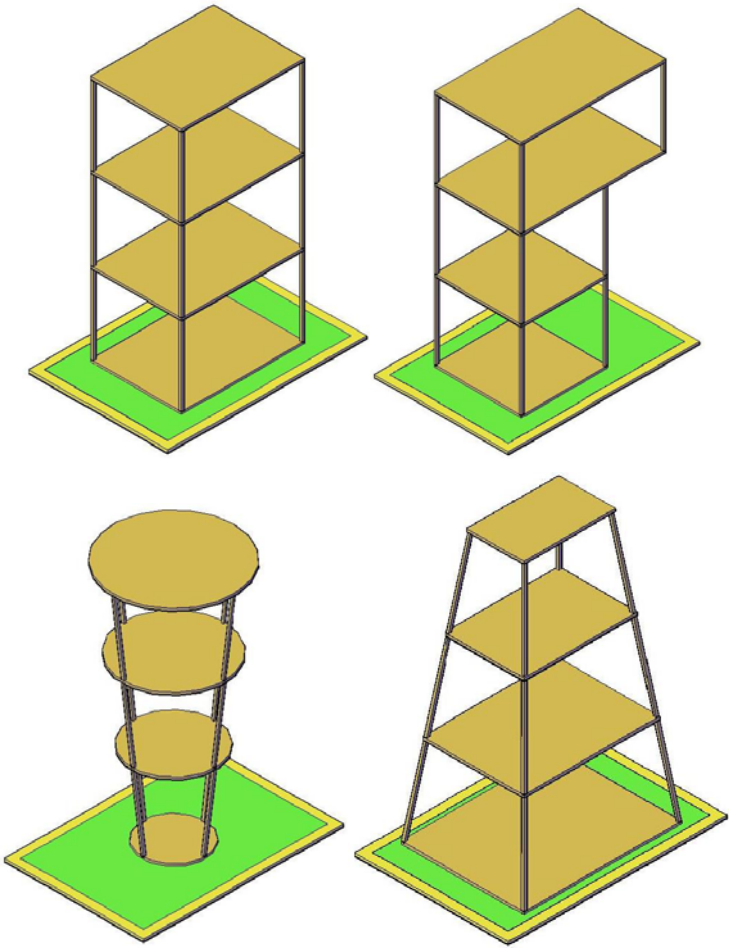

Figure 3：Samples of the model

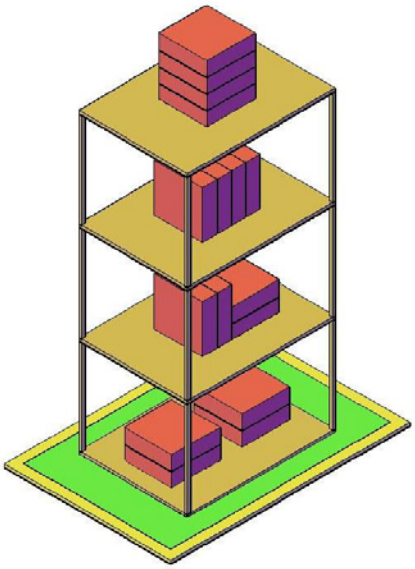

Figure 4: Arrangement of the mass blocks

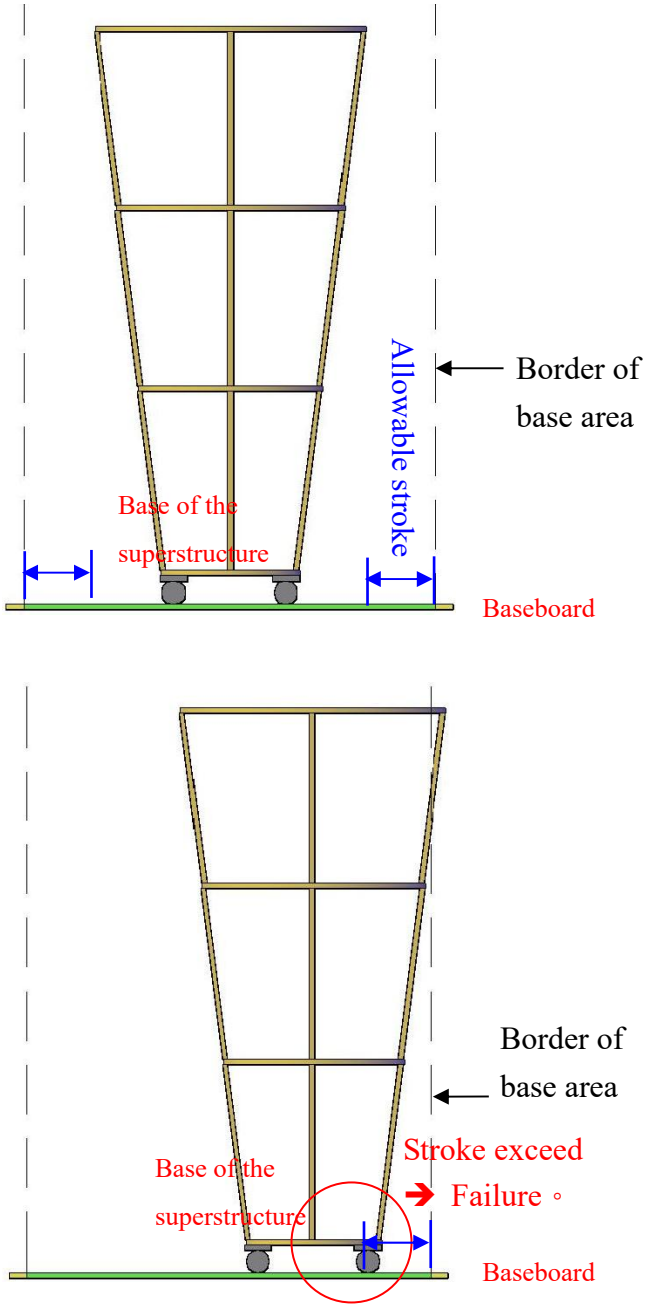

Figure 5: Illustration of the allowable stroke of the isolation system

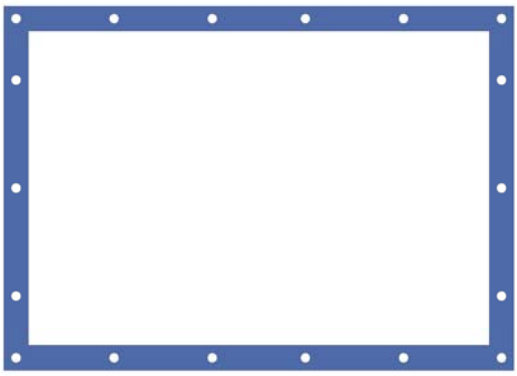

Figure 6. The clamping strip for fixing the baseboard.

8. The Exhibition Object

Each team must prepare an exhibition object displaying the design concept and creativity of the model. This exhibition object is done before this two-day competition. The object could be either two-dimensional or three-dimensional. The way of the exhibition could be in a static and/or dynamic style. The space for this exhibition is limited to 35 cm (height) × 25 cm (width) × 25 cm (depth) shown as Figure 7. The Design-Concept Exhibition Award is granted based on the clarity and creativity of displaying the design concept of the model. The affiliation of the team including the department and the university/college should be presented in the exhibition object. If the exhibition object uses electronic products, the team is responsible for the safekeeping of the electronic products. In addition, the team is responsible for the power supply to the electronic products.

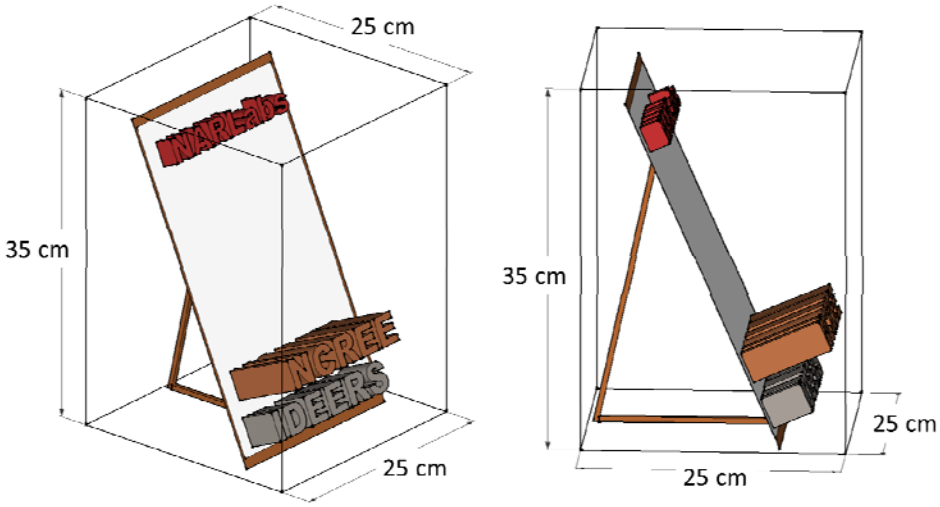

Figure 7. The allowable exhibition space

9. The team flag

Each team must design a team flag, which is installed on the model on the first day of this contest. This flag may be drawn 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 using the site area, 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%	● Aesthetic of architecture ● Architectural feature and creativity
the efficiency of using the site area 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 on the basis of the structural design of models, the concept, and creativity of seismic resistance. 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
Structural design	70%	● The arrangement of structural members ● The rationality of loading path
the 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
Introduction of the 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