2020 Blind Prediction Contest for

Integrated Complex Structural/Non-Structural Assessment on Steel Hospital Building

Key Dates: *(All Dates are Tentative)*

Competition Phase I Start Date: **August 3, 2020**

Phase I Information Packets Distributed: **August 19, 2020**

E-defense Tests: **December 2020**

Phase I Prediction Submission Date: **November 20, 2020**

Select Recorded Data Uploaded to Website: **December 2020**

Competition Phase II Start Date: **December 29, 2020**

Phase II Prediction submission date: **April 23, 2021**

Top Three Teams Notified: **May 2021**

Lessons Learned/Results Workshop @International Conference: **TBD 2021/2022**

Motivation:

As of recent years, determining the resilience of structures has come to the forefront of earthquake research. In particular, hospitals have come under recent scrutiny for their ability to absorb disasters and continue to function with minimal impact. Research has shown that it is not only crucial for hospitals to be capable of treating patients affected by a disaster but also have the capacity to continue to see patients that need continuous care for chronic illnesses. Primarily, the research previously done examined only the structural vulnerabilities of hospitals with very few published papers taking a more holistic approach to measuring the resilience of the entire facility. Generating more robust resiliency models can improve hospital disaster prevention preparation and foster better decision making support for business continuity post-disaster.

The research proposed is an attempt to measure and classify functionality and the current resilience in a hospital setting by using: (1) a full-scale representation of a complex two-building multi-story hospital with both a fixed and isolated base, (2) various nonstructural components and (3) critical medical equipment. The testing will take place in December 2020, which presents an opportunity to host a multi-phase blind prediction competition. Each phase of the contest will highlight a different challenge: (a) Phase I – Prediction Techniques and (b) Phase II: Modeling and Verification. Students, researchers, and practicing engineers are encouraged to participate.

Rules:

1) Contestants may participate as a team or as an individual, though the same person may not be involved in multiple submissions.

2) Contestants will be separated by affiliation for scoring. Students, researchers and professionals are all encouraged to participate.

3) Contestants may use sophisticated software for modeling with two categories, commercial and non-commercial software.

4) There will be two phases for the competition. Phase I will consist of structural and non-structural prediction modeling and Phase II will consist of non-structural and functionality prediction modeling and analysis. Teams are encouraged to participate in both phases of the competition but may choose to participate in only one phase.

5) **For Phase I (Complex Structural / Non-Structural + Functional)**

    a) <u>Complex Structural Response Predictions (7 entry items)</u> - Contestants are to predict the peak values and moving averaged responses at each floor/story using the input ground motions.

        (7)   Floor Acceleration (Fixed)

        (8)   Story Drift (Fixed-base)

        (9)   Beam End Rotation (θp, $\Sigma \theta p$) (Fixed-base)

        (10) Column Base Rotation (θp) (Fixed-base)

        (11) Floor Acceleration (Base-isolated)

        (12) Displacement of Isolator (Base-isolated)

        (13) Relative Displacement Demand to Expansion Joint (Fixed-base)

    b) <u>Non-structural Response Predictions (10 entry items)</u> – Contestants are to predict the following values using the input ground motions.

        i)   Acceleration Amplification Factors

        (7) Piping

        (8) Elevated Tank

ii)   Displacement

   (3) Surgical Lights

   (4) Ceiling Pendant

   (5) HVAC/Air Conditioner (Constrained)

iii)   Damage States for the below non-structural elements

   (6) Partition Walls

   Damage States Classification

      (a) DS1: No Damage

      (b) DS2: Marginal Displacement, Loosening of Screws, Continuous Crack and/or displacement along joints and outer edges

      (c) DS3: Deformed out of the plane, Mounting Part or Base Damaged, Continuous Crack (<20% wall surface)

      (d) DS4: Total Separation, Continuous Crack (>20% wall surface) Mounting Part or Base Fallen Off

c)   <u>Functional Equipment Response Predictions</u>

   i)   Medical Equipment to be Analyzed

      (7) **NICU**: Incubator

      (8) **Dialysis**: Dialysis Machine

      (9) **Pharmacy**: Medicine Cabinet (unanchored)

      (10) **Surgery**: Surgical bed

   ii)   For the above equipment determine

      (a) Rocking, Overturning and/or Sliding

      (b) Damage State Classification

         (i)   DS1: Minimal Sliding (*0.0-4.0 cm Range*), No Rocking, No Damage, Remains Operational

(ii) DS2: Sliding Displacement (*4.1-16.0 cm Range*), Some Rocking, Collapse of a Support, Part needs replacement but still functional

(iii) DS3: Overturning, Sliding Displacement *(>16.1 cm Range)*, Collapse of Multiple Supports, Nonfunctional

2) **For Phase II (Non-Structural / Functional)** (10 entry items)– Contestants are to predict the following using the experimental test data provided:

a) Non-Structural Response Predictions

    i) Acceleration Amplification Factors

        (1) Piping

        (2) Elevated Tank

    ii) Displacement

        (3) Surgical Lights

        (4) Ceiling Pendant

        (5) HVAC/Air Conditioner (Constrained)

    iii) Damage States for the below non-structural elements

        (6) Partition Walls

        Damage States Classification

            (a) DS1: No Damage

            (b) DS2: Marginal Displacement, Loosening of Screws, Continuous Crack and/or displacement along joints and outer edges

            (c) DS3: Deformed out of the plane, Mounting Part or Base Damaged, Continuous Crack (<20% wall surface)

            (d) DS4: Total Separation, Continuous Crack (>20% wall surface) Mounting Part or Base Fallen Off

b) Functional Equipment Response Predictions

    iv) Medical Equipment to be Analyzed

        (7) **NICU**: Incubator

        (8) **Dialysis**: Dialysis Machine

        (9) **Pharmacy**: Medicine Cabinet (unanchored)

        (10) **Surgery**: Surgical Bed

    v) For the above equipment determine

        (a) Rocking, Overturning and/or Sliding

        (b) Damage State Classification

            (i) DS1: Minimal Sliding (*0.0-4.0 cm Range* Range), No Rocking, No Damage, Remains Operational

            (ii) DS2: Sliding Displacement (*4.1-16.0 cm* Range), Some Rocking, Collapse of a Support, Part needs replacement but still functional

            (iii) DS3: Overturning, Sliding Displacement (*>16.1 cm* Range), Collapse of Multiple Supports, Nonfunctional

7) Contestants should submit their results in a spreadsheet provided. In addition, contestants should provide a short one-page summary of their numerical approach in an international conference format of the contestant's choice.

8) Contestants will be provided select competition related test data for non-structural components and equipment for Phase II only, while pertinent structural competition data will be provided starting with Phase I.

9) Contestants will be provided with building drawings, room configurations, medical equipment manufacturers data and limited building details of non-structural components.

10) Unfiltered shake table recordings from the experimental tests will be provided to participants in December for Phase II.

11) Contestants competing in the complex structural discipline are required to submit the results of a minimum of five categories with at least one fixed and base isolated result.

12) For Phase I, non-structural/functional contestants are required to submit a minimum of five categories with at least one result from the non-structural and functional discipline.

 13) For Phase II, non-structural/functional contestants are required to submit a minimum of five categories with at least one result from the non-structural and functional discipline. Contestants that participated in the non-structural portion of Phase I may revise previous prediction results and resubmit for Phase II. The scores from Phase I and II will be separate.

 14) The scoring rubric will be released at a later date.

 15) Contestants are required to make an acknowledgement if any data or drawings provided are used for publication or conferences. Please use the following statement: "Part of the present research is supported by the Tokyo Metropolitan Resilience Project of the National Research Institute for Earth Science and Disaster Resilience (NIED)."