June 7, 2011

Seismic Response of Five-Story Steel Frame With and Without Seismic Isolation

Blind Analysis Contest Description

1. Purpose

A Blind Analysis Contest is held in order to contribute to development of computational prediction of seismic response and efficient modeling techniques for steel frame buildings, including those incorporating seismic isolation devices. The final goal is to improve seismic performance of steel frames through numerical simulation. In 2009, a similar contest was organized for prediction of this same full-scale five-story steel frame with both steel buckling-restrained braces and viscous dampers.

Because the actual dynamic load patterns will be determined during the course of the testing based on observed response of the shaking table, the contest has two steps:

1. Pre-test blind predictions based on the anticipated earthquake loading.
2. Post-test predictions using the actual loading. The same analytical models must be used both for pre-test and post-test predictions.

All contest information can be accessed from the website: *http://www.cuee.titech.ac.jp/contest*. All questions can be directed to the contest organizers at: *contest@cuee.titech.ac.jp*.

2. Contest Organization

The contest is hosted by the Center for Urban Earthquake Engineering at Tokyo Institute of Technology, in collaboration with NEES-TIPS and NIED/E-Defense. A special committee has been formed to organize the contest, and is responsible for the announcement, distribution of data, answering questions, judgment, and producing the necessary experimental data for the contest. The chair of the Blind Analysis Contest is Kazuhiko Kasai (Tokyo Institute of Technology), and the working groups are as follows:

Planning Working Group
Makoto Ohsaki (Leader, Hiroshima University), Tsuyoshi Hikino (Nippon Steel Engineering Inc.) Keri Ryan (University of Nevada, Reno), Eiji Sato (E-Defense), Tsuyoshi Furuhasi (Nippon University), Shojiro Motoyui (Tokyo Institute of Technology)

Operation Working Group
Troy Morgan (Leader, Tokyo Institute of Technology), Taichiro Okazaki (Hokkaido University), Gilberto Mosqueda (State University of New York, Buffalo), Kazuhiro Matsuda (Tokyo Institute of Technology), Pu Wuchuan (Tokyo Institute of Technology), Shoichi Kishiki (Tokyo Institute of Technology)

3. Qualification of the participants

The participants can be either an individual or a team, but one individual can be involved in only one team or as an individual. A member of the above-mentioned organizing committee or a person who has an access to test specifications prior to the official announcement can still submit his/her prediction results, but is not eligible to compete for awards.

4. Categories

The contest is categorized by the building configuration, as shown below. Winners will be selected for each of the following two categories:

Category 1:	Conventional Fixed-Base Building Configuration
Category 2:	Base Isolated Building Configuration

Each category will have one winner and both winners will receive awards according to Section 11. To be considered for an award, participants must submit analysis results for **both** categories. The teams with three best results in each category will be reported in the website of CUEE, and will receive a certificate for recognition.

5. Schedule

The current schedule for the contest is as follows:

May 31	Distribution of schedule and rules of the contest, specification of structural components and basic material properties
July 15	Deadline for contest registration
Aug 15	Submission of pre-test analysis results by participants
Aug 16-20	Shaking-table tests at E-Defense
Sept 19	Distribution of actual input data for post-test analysis
Oct 31	Submission of post-test analysis results by participants
Dec 31	Announcement of the winners

*Note: Deadlines are at 6:00pm (JST). JST is GMT +9:00. All dates are for year 2011.

6. Plan of test and analysis

The five-story steel specimen used in the upcoming NEES-TIPS/E-Defense tests has already been tested extensively as part of an experimental program on passively-controlled steel frames by the E-Defense steel working group. Publications describing the previous testing of the bare steel frame will be made available to contest participants for their use in preparing a submission.

The seismic motion to be used in the test is the 1995 Hyogo-ken Nanbu Earthquake Takatori record[1]. The scale factor of the record will be 0.7 for both conventional and isolated configurations. The orientation of the Takatori record is diagonally defined such that South-East component in X direction

[1] The actual record, orientation and scale factors to be used are subject to modification.

and North-East component in Y direction of the frame.

The analysis model and method for analysis are to be fixed by the pre-test analysis. The same model and method as the pre-test analysis should be used in the post-test analysis except the seismic motion, which is replaced by the measured motion of the shaking-table.

7. Specimen data to be provided

The following data will be distributed via contest website:

1. Structural geometry: plan, elevation, cross-sectional properties of structural members, and detailed description of the specimen including connections to non-structural components.
2. Details of mass configuration (including non-structural components)
3. Results of previous testing of specimen at E-Defense
4. Material test results: properties of steel and concrete, which are obtained by the test based on Japanese specification.
5. Time-history and response spectrum of seismic motion: target acceleration for pre-test analysis, and measured acceleration for post-test analysis.
6. Photographs of the specimen during the construction process.

8. Analysis results to be submitted

Pre-test analysis

The following response quantities must be predicted and submitted as part of the pre-test analysis:

1. Maximum absolute displacement at each floor relative to the shake table platform
2. Maximum absolute acceleration at each floor
3. Average roof spectral acceleration over the frequency range $0.25\text{ Hz} \leq f \leq 0.75\text{ Hz}$ (assuming 5% damping)
4. Maximum absolute story drift angle at each floor of the superstructure
5. Maximum absolute base shear
6. Maximum bidirectional isolator displacement at Northwest corner
7. Maximum compressive axial force in isolator at Northwest corner

Additionally, the following information shall be submitted:

8. Description of computational environment, model and method of analysis
9. Name of analysis program, type of availability of program (free, commercial, research purpose), name of computer, CPU time, number of degrees of freedom, constitutive models, definition of damping, and method of time integration should be described.
10. Input files to the analysis program. Data should be in ASCII format, and all the non-default values such as damping factor, hardening parameters, etc., should be explained. The input echo of the analysis program is preferred, while the geometry data such as nodal coordinates and node-element relations are not needed.

Post-test analysis

Responses to be predicted are same as (1)-(6) above for the pre-test analysis. This only difference between this pre- and post-test analysis is the input ground acceleration, which will be the actual recorded acceleration from the shake table test program. Also, items (7)-(9) shall be submitted to establish consistency with the previously submitted model. Judges will evaluate the post-test submission to ensure that the same data except or the input motion is the same between the pre-test and post-test analysis.

General remarks

Unless otherwise indicated, all prediction shall be made in both the X and Y directions. The maximum absolute values of relative displacement and absolute acceleration are evaluated on the upper surface at the center of each floor. All predictions shall be reported in SI units (mm, kN, sec, rad); do not use derived units such as 'g' or '%'. Each number shall have four significant figures. For example, a story drift angle can be reported as 0.01234 rad. Conversions: 1 inch = 25.4 mm, 1 kip = 4.448 kN.

9. Evaluation methodology

To judge the accuracy of predicted quantities, the error is computed for each response quantity prediction. For the k^{th} response quantity, the error is defined as

$$E_k = \sqrt{\sum_j (F_{k,j} - F^*_{k,j})^2} \qquad (1)$$

where

$F_{k,j}$: analysis result of k^{th} response quantity at jth floor/story
$F^*_{k,j}$: experimental result of k^{th} response quantity at jth floor/story

For quantities which are evaluated at a single floor, j is set to that particular floor level, and no summation is applied. The total score P is computed from the n computed errors as

$$P = \sum_{k=1}^{n} w_k b_k \qquad (2)$$

where the value b_k for the k^{th} response quantity is as follows: 8 for the lowest error, 5 for the second lowest, 3 for the third lowest, and 1 for the fourth lowest. The weights w_k for each response parameter will be announced before submission of the pre-test analysis.

The team/individual with maximum total score P will be the winner for each of the two categories. The judgment will be carried out completely anonymously. Judges will only know the participant submission name only via an ID number. In each category, up to and including the third place winners will be announced and the names of all the participants will be asked to disclose their names and affiliations.

10. Awards

The first-place award winners from each of the two categories will be invited to the 9th International Conference on Urban Earthquake Engineering, 2012, held by the Center for Urban Earthquake Engineering (CUEE), Tokyo Institute of Technology, Japan. CUEE will cover the travel, accommodation, and registration expenses for the winners' participation in the CUEE conference. The teams with three best results in each category will be reported in the website of CUEE, and will receive a certificate of recognition.